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DOE/OR/01-2505&D1

2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee

Data and Evaluations

BECHTEL JACOBS
Bechtel Jacobs Company LLC

DOE Contract No. DE-AC05-98OR22700
Job No. 23900
WRRP-2011-0008
March 22, 2011

Mr. John R. Eschenberg
Assistant Manager for
Environmental Management
U.S. Department of Energy
Post Office Box 2001
Oak Ridge, Tennessee 37831

Dear Mr. Eschenberg:

DE-AC05-98OR22700: Transmittal of the *2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2505&D1)

Bechtel Jacobs Company LLC (BJC) is pleased to deliver 20 copies (and 2 compact diskettes) of the D1 version of the *2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2505&D1) for your distribution to the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation. The scheduled Federal Facility Agreement (FFA) milestone for submittal to these regulatory agencies is March 30, 2011.

Representatives from the regulatory community were provided an opportunity to review draft versions of their respective chapters in January 2011. No comments were received from the regulators. Other comments received from the Department of Energy (DOE) and BJC internally were incorporated into this D1 version of the 2011 Remediation Effectiveness Report (RER).

Included in this annual RER (Appendix A) is the DOE certification that all requirements of the approved Land Use Control Implementation Plans (LUCIPs) have been implemented. The LUCIP for the Melton Valley Watershed was approved in May 2006, and is the only LUCIP currently approved.

Note that per FFA protocol, the formal deadline for providing regulator comments back to DOE is June 30, 2011.

Questions or comments should be addressed to Lynn Sims at (865) 241-1158.

Sincerely,

Joseph F. Nemec
President and General Manager

JFN:LS:rsw

Enclosures: *2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2505&D1)

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DOE/OR/01-2505&D1

2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee

Data and Evaluations

Date Issued—March 2011

Prepared by the
Water Resources Restoration Program
Bechtel Jacobs Company LLC

Prepared for the
U. S. Department of Energy
Office of Environmental Management

BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Y-12 National Security Complex Oak Ridge National Laboratory
under contract DE-AC05-98OR22700
for the
U. S. DEPARTMENT OF ENERGY

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CONTENTS

FIGURES

TABLES

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ACRONYMS

ACB	auxiliary charcoal bed
ALARA	as low as reasonably achievable
AM	Action Memorandum
AOC	area of contamination
ARAR	applicable or relevant and appropriate requirements
ARRA	American Recovery and Reinvestment Act
AWQC	ambient water quality criteria
BCBG	Bear Creek Burial Ground
BCK	Bear Creek kilometer
BCV	Bear Creek Valley
BFK	Brushy Fork kilometer
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
BMAP	Biological Monitoring and Abatement Program
BMP	best management practice
BORCE	Black Oak Ridge Conservation Easement
BOS-LABS	Balance of Sites Laboratories
BSWTS	Big Spring Water Treatment System
BV	Bethel Valley
B&W	Babcock & Wilcox Y-12
BYBY	Boneyard/Burnyard
CA	Characterization Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CMTS	Central Mercury Treatment System
COC	contaminant of concern
COE	Corp of Engineers (U.S. Army)
ChR	Chestnut Ridge
CR	Clinch River
CRK	Clinch River kilometer
CRM	Clinch River mile
CR/PC	Clinch River/Poplar Creek
CROET	Community Reuse Organization of East Tennessee
CVOC	chlorinated volatile organic compound
CY	calendar year
D&D	decontamination and decommissioning
DARA	Disposal Area Remedial Action
DCA	dichloroethane
DCG	derived concentration guidelines
DMC	Document Management Center
DNAPL	dense non-aqueous-phase liquid
DOE	U. S. Department of Energy
DSWM	Division of Solid Waste Management
DVS	Dynamic Verification Strategy
EDE	effective dose equivalent
EE/CA	Engineering Evaluation/Cost Analysis
EEMTS	East End Mercury Treatment System
EEVOC	East End Volatile Organic Compound

EFK	East Fork kilometer
EFPC	East Fork Poplar Creek
ELCR	excess lifetime cancer risk
EM	Environmental Management
EMWMF	Environmental Management Waste Management Facility
EPA	U. S. Environmental Protection Agency
EPP	excavation/penetration permit
ESD	Explanation of Significant Difference
ETTP	East Tennessee Technology Park
EU	exposure unit
FCA	fixed contamination area
FCAP	Filled Coal Ash Pond
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
FIR	federal controlled industrial/research
FIT	Facility Inspection and Training Manual
FLUTe	Flexible Liner Underground Technologies, LLC
FS	feasibility study
FSD	Fuel Salt Disposition
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	fiscal year
FYR	Five-Year Review
GHK	Gum Hollow kilometer
HCK	Hinds Creek kilometer
HF	hydrofluoric acid
HFIR	High Flux Isotope Reactor
HI	hazard index
HTF	Hillcut Test Facility
ICMA	Interim Corrective Measure Areas
IP	integration point
IROD	Interim Record of Decision
ISG	*in situ* grouting
KHQ	Kerr Hollow Quarry
LEFPC	Lower East Fork Poplar Creek
LLLW	liquid low-level waste
LTS	long-term stewardship
LUC	land use control
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
LWB	Lower Watts Bar
LWBR	Lower Watts Bar Reservoir
MBK	Mill Branch kilometer
MCK	McCoy Branch kilometer
MCL	maximum contaminant level
MEK	Melton Branch kilometer
MIK	Mitchell Branch kilometer
MRF	Metal Recovery Facility
MSRE	Molten Salt Reactor Experiment
MV	Melton Valley
NFA	No Further Action
NNSA	National Nuclear Security Administration

NPDES	National Pollutant Discharge Elimination System
NSC	Non-Significant Change
NT-3	North Tributary 3
NTF	North Tank Farm
OLFSCP	Oil Landfarm Soil Containment Pad
ORAU	Oak Ridge Associated Universities
OREIS	Oak Ridge Environmental Information System
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations
ORR	Oak Ridge Reservation
OU	operable unit
PC	Poplar Creek
PCB	polychlorinated biphenyl
PCCR	Phased Construction Completion Report
PCE	tetrachloroethene
PCM	Poplar Creek mile
PCR	Post-Construction Report
PDCC	Project Document Control Center
PHK	Pinhook Branch Kilometer
PIDAS	Perimeter Intrusion Detection and Assessment System
PP	Proposed Plan
PPA	property protection area
PRG	Preliminary Remediation Goal
psig	pounds per square inch gauge
PUF	Predominantly Uncontaminated Facilities
PWTC	Process Waste Treatment Complex
QAPP	Quality Assurance Program Plan
RA	remedial action
RAO	remedial action objective
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act of 1976
RDR	Remedial Design Report
RER	Remediation Effectiveness Report
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	remediation level
RMA	Radioactive Materials Areas
RmAR	Removal Action Report
ROD	Record of Decision
RPP	Radiation Protection Plan
SAP	Sampling and Analysis Plan
S&M	surveillance and maintenance
SCF	South Campus Facility
SDWA	Safe Drinking Water Act of 1974
SIOU	Surface Impoundments Operable Unit
SNS	Spallation Neutron Source
SRS	Sediment Retention Structure
SWPPP	Storm Water Pollution Prevention Program
SWSA	Solid Waste Storage Area

TC RmA	time-critical removal action
TDEC	Tennessee Department of Environment and Conservation
Tl	Thallium
TEF	Toxicity Equivalency Factor
TMDL	Total Maximum Daily Load
TRM	Tennessee River mile
TRU	transuranic
TTEQ	Total Toxicity Equivalency Quotient
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
UEFPC	Upper East Fork Poplar Creek
UNC	United Nuclear Corporation
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	Waste Area Grouping
WBIWG	Watts Bar Interagency Working Group
WCK	White Oak Creek kilometer
WEMA	West End Mercury Area
WOC	White Oak Creek
WOCC	Waste Operations Control Center
WOCE	White Oak Creek Embayment
WOD	White Oak Dam
WOL	White Oak Lake
WQC	Water Quality Criteria
WRRP	Water Resources Restoration Program
WWSY	White Wing Scrap Yard
Y-12	Y-12 National Security Complex
ZVI	zero valent iron

ACKNOWLEDGEMENTS

Primary tasks of the U.S. Department of Energy Oak Ridge Operations (DOE-ORO) are contracted to various entities (public and non-profit companies, as well as educational institutions). Bechtel Jacobs Company LLC (BJC) conducts environmental cleanup and long-term stewardship (LTS) at sites with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as the primary regulatory authority on the Oak Ridge Reservation (ORR) and impacted sites off the reservation (e.g., Lower East Fork Poplar Creek). BJC's Water Resources Restoration Program (WRRP) implements a comprehensive, integrated environmental monitoring program for the ORR and prepares the annual Remediation Effectiveness Report (RER). B&W Y-12 operates the Y-12 National Security Complex, which manages the production and refurbishment of nuclear weapon components for the DOE and the National Nuclear Security Administration. A partnership between the University of Tennessee and Battelle, UT-Battelle, manages and operates the Oak Ridge National Laboratory (ORNL) for the DOE.

The BJC WRRP gratefully acknowledges the contributions and efforts of many organizations and individuals on the ORR for providing support in preparation of the 2011 RER. Particular thanks are due to the Ecological Assessment Group of the Environmental Sciences Division (UT-Battelle) at the ORNL for providing field support, biological data, and technical interpretations included in the biological monitoring sections of this report. Where applicable, ORR monitoring data collected by other programs were used to augment the WRRP sampling results. Considerable thanks are due to UT-Battelle's Environmental Protection and Waste Services Division; B&W Y-12 Environment, Safety and Health Organization and Groundwater Protection programs; BJC's Environmental Compliance and Protection Organization (East Tennessee Technology Park) for providing National Pollution Discharge Elimination System Clean Water Act data; and BJC's Radiation Protection Organization for providing radiological surveillance data for sites with residual contamination. LTS information used in the RER is collected and compiled in conjunction with the BJC Surveillance and Maintenance programs, B&W Y-12's Liquid Waste Operations, and UT-Battelle Facilities Management Division. The Tennessee Valley Authority generously provided historical sampling results that were used to construct some graphs depicting off-site data. A sincere note of thanks is due to Commodore Advanced Sciences Inc. sampling and support personnel for their diligent efforts in completing much of the field work for the WRRP monitoring program.

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EXECUTIVE SUMMARY

Under the requirements of the Oak Ridge Reservation (ORR) Federal Facility Agreement (FFA) established between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency, (EPA) and the Tennessee Department of Environment and Conservation (TDEC) in 1992, all environmental restoration activities on the ORR are performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Since the 1990s, the environmental restoration activities have experienced a gradual shift from characterization to remediation. As this has occurred, it has been determined that the assessment of the individual and cumulative performance of all ORR CERCLA remedial actions (RAs) is most effectively tracked in a single document. The Remediation Effectiveness Report (RER) is an FFA document intended to collate all ORR CERCLA decision requirements, compare pre- and post-remediation conditions at CERCLA sites, and present the results of any required post-decision remediation effectiveness monitoring. First issued in 1997, the RER has been reissued annually to update the performance histories of completed actions and to add descriptions of new CERCLA actions.

Monitoring information used in the 2011 RER to assess remedy performance was collected and/or compiled by DOE's Water Resources Restoration Program (WRRP). Only data used to assess performance of completed actions are provided. In addition to collecting CERCLA performance assessment data, the WRRP also collects baseline data to be used to gauge the effectiveness of future actions once implemented. These baseline data are maintained in the Oak Ridge Environmental Information System and will be reported in future RERs, as necessary, once the respective actions are completed. However, when insufficient data exist to assess the impact of the RAs, e.g., when the RA was only recently completed, a preliminary evaluation is made of early indicators of effectiveness at the watershed scale, such as contaminant trends at surface water integration points (IPs).

Long-term stewardship (LTS) information used in this report is collected, compiled, and tracked by the WRRP in conjunction with the Bechtel Jacobs Company LLC (BJC) Surveillance and Maintenance (S&M) program, the BJC Radiation Protection Organization at East Tennessee Technology Park (ETTP), ETTP Environmental Compliance Program, B&W Y-12 Liquid Waste Treatment Operations, and UT-Battelle Facilities Management Division. Additionally, documentation verifying the implementation of administrative land use controls (LUCs) [i.e., property record restrictions, property record notices, zoning notices, and excavation/penetration permit (EPP) program] is also obtained from many sources throughout the fiscal year (FY), including County Register of Deeds offices for property record restrictions and property record notices, City Planning Commission for zoning notices, and BJC project engineers for EPP program verification. Copies of this documentation are obtained by the WRRP and maintained with the project RER files.

REPORT ORGANIZATION

The implementation of the large watershed-scale Records of Decision (RODs), in some instances, can take multiple years to complete. While the RODs are not complete until all actions are implemented, incomplete RODs with selected completed actions usually affect the ROD's watershed goals. Therefore, in this RER, select watershed maps contain completed actions, actions not implemented, and actions which are in progress (e.g., Figure 4.1 "CERCLA Actions in BCV Watershed").

The 2011 RER is issued and is identified as the *2011 RER: Data and Evaluations*. The 2007 RER, a compendium of the details and background on all CERCLA decisions made as of September 30, 2006, will be updated every five years in the ORR CERCLA Five-Year Review (FYR). You may request a copy at the DOE Information Center, 475 Oak Ridge Turnpike, Oak Ridge, Tennessee. The 2006 RER FYR can also be accessed online under the document request link at:

<http://www.oakridge.doe.Gov/external/Home/PublicActivities/DOEInformationCenter/tabid/126/Default.aspx>.

The annual RER contains the required monitoring data evaluation and effectiveness assessment for the completed CERCLA remediation activities, as well as the compliance assessment with LTS requirements (i.e., engineering and LUCs). This greatly streamlines the RER document process and focuses the annual review on the sampling data gathered and results at those sites where the work has been completed.

Within the 2011 RER, a chapter is devoted to each of the ORR administrative watersheds, as well as a chapter each to Chestnut Ridge, ETTP, and a single chapter to all off-site actions. Each chapter of the 2011 RER identifies single actions and, if applicable, watershed-scale ROD actions with on-going monitoring and/or LTS activities. The remedial action objectives and performance monitoring criteria are provided, followed by an evaluation of the monitoring results with a comparison to stated performance metrics. When insufficient data exist to assess the impact of the RAs, e.g., when the RA was only recently completed or not all RAs prescribed by the watershed ROD have yet to be implemented, a preliminary evaluation is made of early indicators of effectiveness at the watershed scale, such as contaminant trends at surface water IPs. Each chapter concludes with any technical issues and/or recommendations for monitoring changes.

REMEDIATION EFFECTIVENESS SUMMARY

Highlights of the effectiveness of completed RAs are provided below. Issues and recommendations identified since the 2006 RER/FYR including current year evaluations of performance monitoring data are summarized in Chap. 1 of this 2011 RER. A more detailed discussion of the issue(s) resulting from the 2011 RER evaluations is provided in the appropriate chapter.

Bethel Valley (BV)

In FY 2010, BV monitoring results showed a continued significant decrease in mercury concentrations in White Oak Creek (WOC) following implementation of a RA at Bldg. 4501, and an increase in the average ^{90}Sr concentration at 7500 Bridge attributable to Corehole 8 plume discharges. The Building 4501 action of routing ion exchange treated mercury-contaminated groundwater collected in building basement sumps to treatment at the Process Waste Treatment Complex (PWTC) continued to reduce mercury concentrations in WOC. During FY 2010, the mercury concentrations at the 7500 Bridge were below the TDEC ambient water quality criteria (AWQC) value. A statistical comparison of mercury concentration in surface water at 7500 Bridge confirms that the post-diversion stream concentrations are significantly lower than the pre-diversion concentrations.

Tritium concentrations in surface water in WOC in BV have increased as a result of collection and transfer of former groundwater discharges from Melton Valley (MV) to the wastewater treatment system in BV. This condition is a result of the MV RA. Concentrations in surface water throughout WOC are below the DOE derived concentration guide and below remedy human health risk goals.

Aquatic biological monitoring results continue to indicate improvement in ecological conditions.

During FY 2010, the ^{90}Sr reduction goal was not attained for the Corehole 8 Plume collection system due to an increase in ^{90}Sr discharges to First Creek from the Corehole 8 Plume. The cause of increased plume discharge is related to leaks in the Oak Ridge National Laboratory (ORNL) potable and fire water system as well as operational problems with the plume collection system (identified as an issue in the 2010 RER

Table 1.1). Strontium-90 and $^{233/234}U$ concentrations measured in groundwater at well 4411 were relatively stable for ^{90}Sr and decreased for $^{233/234}U$ from previous years results. Strontium-90 concentrations measured in groundwater at Corehole 8 Zone 2 continued to rise during FY 2010 while $^{233/234}U$ decreased to near pre-FY 2009 levels. Water line leaks were repaired in FY 2010 with repairs continuing as new leaks are identified in FY 2010. Additionally in response to the deficiencies in the plume collection system, DOE is installing additional extraction wells with a system upgrade.

The technical issue/recommendation associated with ungauged ^{90}Sr flux was carried forward from the 2006 FYR. Additional sampling will occur during FY 2011 to determine if excess ungauged ^{90}Sr impacts BV ROD goals as summarized in Table 1.1. The Bethel Valley Burial Grounds project was initiated in FY 2010 with the capping of solid waste storage area (SWSA) 1 and the start of hydrologic isolation and capping of SWSA 3. Three new monitoring wells were installed west of SWSA 3 to monitor the groundwater exit pathway to the headwaters of Raccoon Creek.

Melton Valley (MV)

Radiological goals for ^{137}Cs, ^{90}Sr, and tritium, which are the principal surface water contaminants in MV, were met at WOD. Concentration trends for these contaminants were stable or decreasing during FY 2010. Principal contaminant concentrations at tributary and mainstem monitoring locations remained compliant with ROD goals. Although a slight increase in the ^{90}Sr was observed during FY 2010, the contaminant fluxes from MV remained low relative to the responses observed during wet years prior to remediation.

An assessment of relocated stream reaches in Melton Branch and the HRE tributary was conducted in FY 2010 and determined that the reaches in both streams were categorized as non-impaired. Additionally, the Former Emergency Waste Basin and Former Intermediate Holding Pond, both wetlands mitigation activities were evaluated and both were identified as successfully supporting a wetland habitat.

Groundwater level monitoring of the hydrologic isolation areas in MV showed that performance criteria were met at 37 of 44 locations. Four of the wells not meeting the performance criteria are located in SWSA 4. Two of those are located near the downgradient trench which, based on these wells performance, show evidence of deteriorated performance during FY 2010. This is identified as an issue in Table 1.1. Additional seepage sampling will be instituted in FY 2011 to determine if well maintenance will enhance performance.

With a few exceptions, groundwater contaminant concentrations around the shallow land burial sites are generally decreasing or stable compared to concentrations measured before completion of the MV remedy.

During FY 2010, 33 of 36 available deep groundwater exit pathway zones were sampled and 36 samples were collected. Groundwater monitoring continues to show a broad area that exhibits high pH, fluoride, and dissolved solids. Some of the dissolved constituents, such as chloride and sulfate, are predominantly naturally occurring, as is barium in samples from brine zones. None of the detected alpha activity values exceeded the drinking water standard however because of high total dissolved solids the minimum detectable alpha activity in some instances was greater than the drinking water standard. Strontium-90 was detected in one of 36 sampled zones at an activity less than the 8 pCi/L drinking water standard equivalent level. Several volatile organic compounds (VOCs) were detected for the first time in some sample zones.

In FY 2010, a project to install offsite groundwater monitoring wells west of the Clinch River was completed with the installation of 16 sampling points. Low concentrations of some metals and VOCs were detected in initial sampling events. Hydraulic head data suggest groundwater flow toward the river. Sampling will continue in FY 2011. This is identified as a new issue in this RER. An issue that continues to be carried forward from the 2008 RER is the detected and elevated contaminant results for some zones in the MV exit pathway wells. New issues and issues/recommendations carried forward from the 2009 RER are summarized in Table 1.1.

Bear Creek Valley

During FY 2010, surface water monitoring at the IP (BCK 9.2) showed that the ROD goal of ≤34 kg/yr of uranium was not attained. The measured uranium flux at the IP was about 119 kg. About 29% of the FY 2010 uranium flux is attributed to surface water discharged from the S-3 Ponds plume as measured at BCK 12.34 and about 51% of the FY 2010 uranium flux originated in the Bear Creek Burial Grounds (BCBGs) and discharged to Bear Creek via North Tributary (NT)-8.

Other contributors to the total uranium flux include deeper groundwater flows in the S-3 plume that discharge to Bear Creek via springs SS-4 and SS-5 and diffuse bed seepage, as well as smaller contributions from NT-3, NT-5, and NT-7. During FY 2010, the risk level associated with uranium at the IP remained about twice the ROD goal. Nitrate concentrations measured at the IP during FY 2010 were less than the 58 mg/L risk-based screening criteria (RBC). Both nitrate and cadmium concentrations meet AWQC requirements at the IP.

DOE has recommended a re-instatement of flow-paced monitoring at NT-3 and NT-5 and the creation of an additional flux monitoring station (BCK 10.15) downstream of SS-4 but upstream of NT-7 to attempt to determine inputs directly to the stream channel from karst discharges. DOE will send an Appendix I-12 letter to the regulators recommending these changes.

During FY 2010, the average nitrate concentration measured at BCK 12.34 near the S-3 Pond source area was less than the industrial RBC. The RBC for nitrate in an industrial land use scenario is 160 mg/L. During FY 2010, the average nitrate concentration was 35 mg/L based on 52 weekly grab sample results. None of the samples exceeded the 160 mg/L RBC.

Groundwater monitoring during FY 2010 showed that groundwater contaminant trends in monitored areas are relatively stable and changes from FY 2009 levels are minor. Increases in some VOC constituents were observed in groundwater at the BCBGs.

A new technical issue identified in Bear Creek Valley from an evaluation of FY 2010 data is the high uranium flux discharging from NT-8. DOE will be collecting surface water samples along a transect from the NT-8 flume upstream to the BCBGs fence to identify contaminant inputs. Additionally, records for the non-CERCLA groundwater seepage collection system in the NT-8 headwaters will be retrieved and system performance evaluated (identified as a new technical issue).

Because of improved stream riparian vegetation at the NT-3 site, DOE recommends that no further stream habitat or riparian vegetation monitoring will be conducted at that site. Similarly, improved habitat at the Bear Creek Weir restoration site suggest that stream habitat, riparian vegetation, and wetland monitoring are no longer needed and a recommendation to that affect is made.

Current issues and issues/recommendations carried forward from the 2010 RER are summarized in Table 1.1.

Chestnut Ridge

Filled Coal Ash Pond (FCAP) — The monitoring results since the RA indicate that the remedy is successfully lowering the concentration of contaminants of concern (COCs) in surface water as it exits the constructed wetland. Arsenic concentrations, however, exceed the AWQC in both the upgradient and downgradient locations at the FCAP wetland. Biological communities in McCoy Branch/Rogers Quarry have improved over time, but still remain impacted relative to uncontaminated reference streams. For pollution-tolerant benthic macroinvertebrates at the downstream McCoy Branch site there is little difference between the FY 2010 observations and those at reference sites.

Kerr Hollow Quarry (KHQ) — Results of statistical evaluations of FY 2010 groundwater analytical data for KHQ do not indicate a contaminant release for the uppermost aquifer and do not warrant any response action, as specified in the post-closure permit that governs the site.

United Nuclear Corporation (UNC) — Elevated gross beta activity continues to be observed in downgradient well GW-205 at the UNC site, suggesting a potential contaminant release from the site. The gross beta activity does not appear to be caused by ^{90}Sr, but does track closely to ^{40}K. A downgradient spring, added to the monitoring network in FY 2008 to assess the potential impacts of the UNC groundwater seepage on surface water quality, exhibits data consistent with results from other downgradient monitoring locations at the site that do not detect any COCs above an action limit. It does yield a low level gross alpha detection in one sample which is well below the action level.

This issue regarding the elevated gross beta activity downgradient of the UNC site was identified in the 2008 RER and is carried forward. The gross beta in sample results from the UNC area will continue to be trended in future RERs. Completed or resolved issues at Chestnut Ridge are summarized in Table 1.2.

Upper East Fork Poplar Creek (UEFPC)

Surface water contaminant discharge conditions in UEFPC during FY 2010 reflected the increased rainfall during FY 2010 relative to FY 2006 through FY 2008. During FY 2010, mercury discharges measured at the West End Mercury Area IP (Outfall 200A6) and at the watershed IP (Station 17) using flow-paced sampling were about 5 and 7 kg, respectively, discounting the effect of an August flux spike at Outfall 200A6. The 7 kg watershed discharge of mercury reflects the affect of above average rainfall during FY 2010. The Big Spring Water Treatment System (BSWTS) was fully operational during FY 2010 with no significant downtime or operational problems. However, BSWTS was bypassed for significant periods of time during FY 2010 when influent exceeded the treatment capacity of the facility. The average effluent concentration for BSWTS was 0.025 μg/L, the same as it was in FY 2009, which is less than the performance standard of 0.2 μg/L.

The mercury ROD goal at Station 17 is 200 ng/L. The average flow-paced composite mercury concentration during FY 2010 was 476 ng/L and the average concentration obtained from grab samples was 392 ng/L.

The performance standard for uranium at Station 17 is to monitor the trend. The uranium flux at Station 17 in FY 2010 remains elevated, near FY 2009 levels, relative to that observed in drought years. Uranium concentration and fluxes in UEFPC originate from groundwater seepage and storm water transport of surface contamination at the Y-12 plant. Groundwater contamination in the WEMA is a source of uranium flux at Outfall 200A6. Another source of the increased uranium flux observed at Station 17 may be the former Oil Skimmer Basin.

Aquatic biological monitoring shows that mercury concentrations in fish tissue at EFK 23.4 remain stable with levels measured in previous years near the watershed IP. Polychlorinated biphenyls (PCBs) concentrations in fish tissue increased in 2010 over FY 2009 but remained much lower than the peak levels observed in the mid-1990s. The number of fish and benthic communities in the upper reaches of UEFPC (EFK 23.4) remain below the reference communities in nearby streams; however, the number of fish species in reaches further downstream (EFK 13.8) has improved to the point of meeting or exceeding the reference communities.

The performance of the groundwater pump-and-treat system of the East End Volatile Organic Compound Plume is measured by evaluating reductions in VOC concentrations downgradient of the extraction well, GW-845. FY 2010 data indicate that the groundwater pump and treatment system has effectively withdrawn contaminant mass from the permeable limestone downgradient in Union Valley, thereby meeting the performance criteria of the action memorandum (AM). An apparent trend of increasing ^{234}U and ^{238}U identified in the 2010 RER showed a decline in FY 2010.

A new technical issue is identified relating to the bypass of the BSWTS when inflow exceeds treatment capacity during high rainfall events. This introduces an undetermined flux of mercury into UEFPC. It is recommended that the potential undetermined flux be estimated and, if determined to be significant, mitigation be considered.

Issues carried forward from previous RERs include elevated mercury fish tissue concentrations within East Fork Poplar Creek (EFPC) even though mercury surface water concentrations have decreased. The recommendation includes a working team (to develop a conceptual model. Recently, two reports have been drafted [(Southworth et al 2010) and (Peterson *et al.* pending publication)] focused on mercury sources, transport and fate. Technical issues/recommendations carried forward from previous years' performance data evaluations for the UEFPC watershed are summarized in Table 1.1.

CERCLA Off-Site Actions

Performance monitoring of the Clinch River and Poplar Creek continues to indicate a downward trend in fish PCB concentrations since the late 1980s. PCB levels are at or below fish advisory levels in channel catfish in most recent years in the Clinch River but at or near advisory levels in Poplar Creek. However, very large fish, e.g., striped bass, are substantially higher. Mercury concentrations in fish at monitored sites continue to indicate the influence of mercury sources from EFPC, with the highest levels in fish in Poplar Creek and lower levels with distance downstream. Overall, the performance monitoring has been successful in addressing the ROD goal of evaluating changes in fish contaminant levels and how those levels compare to fish advisory limits.

Performance monitoring results from Lower Watts Bar Reservoir obtained during FY 2010 continue to indicate that mercury and PCB levels in fish are below commonly-used fish advisory levels.

Evaluations of current performance monitoring data did not identify any issues that warrant specific recommendations for any of the Off-site actions during the FY.

ETTP

Removal of soil and debris from the K-1070-C/D Burial Grounds in 1999 has reduced the concentration of VOCs in groundwater downgradient of the removal area. An evaluation of VOC concentrations in wells UNW-064, UNW-114, and TMW-011 over the past several years indicates that generally VOC concentrations in groundwater have declined and remain relatively stable with fluctuations related to climatic cycles.

During FY 2010, monitoring results for the principal surface water and groundwater locations at ETTP indicate that contaminant levels are generally stable to decreasing in most instances. The hexavalent chromium collection system and treatment functioned as planned and protected surface water quality in Mitchell Branch. Contaminants detected during previous years in exit pathway groundwater near the K-1007-P1 weir were not detected in FY 2010. Low concentrations of PCE and TCE greater than the maximum contaminant level (MCL) were detected in a bedrock well in the exit pathway at the mouth of Mitchell Branch. These contaminants have been detected previously but were not present during recent drought years. Most of the groundwater plumes monitoring results indicate stable contaminant levels compared to recent years.

Storm damage to the fish barrier at the K-1007 P1 Holding Pond in FY 2010 created potential for undesirable fish species to re-enter the pond. This is recognized as a current issue. The barrier was repaired and strengthened and undesirable fish were removed to the extent practicable. A fish community survey in 2010 suggested weir breach did not jeopardize the RA. Performance monitoring began in FY 2010 and will continue to determine whether the entry of undesirable fish species is problematic.

The northern section of ETTP Zone 1 was identified as the Black Oak Ridge Conservation Easement in March 2005 and is to be utilized for recreational use including hiking, bicycling, and select controlled deer hunts. This is different than the end use identified in the Zone 1 ROD which states the area is unrestricted industrial with no recreational use designated. A consistent end use will be changed from industrial to recreational in an Explanation of Significant Difference (ESD) and amendment to the Zone 1 Interim ROD (DOE 2002a). Technical issues/recommendations carried forward from previous years' performance data evaluations are summarized in Table 1.1.

Oak Ridge Associated Universities (ORAU) South Campus Facility (SCF)

VOCs in groundwater at the SCF have exhibited a long-term decreasing concentration history, consistent with a monitored natural attenuation remedy.

Evaluations of current performance monitoring data for the ORAU SCF did not identify any technical issues/recommendations.

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1. INTRODUCTION

1.1 OBJECTIVE OF THE ANNUAL REMEDIATION EFFECTIVENESS REPORT

The objective of the annual Remediation Effectiveness Report (RER) is to assess and document effectiveness, or progress toward a stated goal, of each completed remedy performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) on and around the U. S. Department of Energy (DOE) Oak Ridge Reservation (ORR). As part of this assessment, compliance with long-term stewardship (LTS) requirements (e.g., engineering and land use controls [LUCs]) of CERCLA decisions is also evaluated.

Various CERCLA instruments are used to document remedial decisions on the ORR. Typically, either a Record of Decision (ROD) for a remedial action (RA) or Action Memorandum (AM) for a removal action defines the selected remedy for a site. These instruments serve as the statutory decision guiding the performance of site remediation activities and may also specify monitoring and LTS requirements. However, because most decision documents generally lack monitoring specifics, additional details are typically found in post-ROD documents, such as remedial action work plans (RAWPs), post-construction reports (PCRs), remedial action reports (RARs), removal action reports (RmARs), phased-construction completion reports (PCCRs) or ROD monitoring plans.

Monitoring information used in the 2011 RER to assess performance of completed CERCLA actions was compiled under DOE's Water Resources Restoration Program (WRRP). The WRRP was established to implement a comprehensive, integrated environmental monitoring and assessment program for the DOE ORR and to minimize duplication of field, analytical, and reporting efforts. Groundwater, surface water, sediment, and biota are monitored and evaluated as part of this assessment program. In addition to collecting CERCLA performance assessment data, the WRRP also collects baseline data to be used to gauge the effectiveness of future actions once implemented. All data used in the RER are collected in accordance with the watershed-specific monitoring and/or sampling plans, Quality Assurance Project Plan for the WRRP (BJC 2010), and are maintained in the Oak Ridge Environmental Information System (OREIS). Baseline data will be reported in future RERs, as required, once the respective actions are completed.

Select biological monitoring data collected by the WRRP provide a usable measure of overall improvements in aquatic conditions. However, these data are not intended to imply any conclusions regarding the current status of ecological risk. The risk to ecological receptors will be evaluated in future studies, such as Remedial Investigations (RIs), and addressed by final decisions for each of the watersheds or Operable Units (OUs).

When remediation is complete, selected sites will require some level of LTS to ensure protection of human health and the environment from the remaining hazards, or residual contamination. LTS ensures that remediation remains effective for an extended, or possibly indefinite, period of time until residual hazards are reduced sufficiently to permit unrestricted use and unlimited access (DOE 2003a). LTS is designed to:

- Prevent the residual hazard from migrating to the receptor (generally through engineering controls), and
- Prevent the receptor from encountering the residual hazard (generally through LUCs).

Engineering controls include actions to stabilize and/or physically contain or isolate waste, contamination, or other residual hazards. Engineered controls include *in situ* stabilization; capping of residual contamination; groundwater extraction and treatment systems; and vaults, repositories, or engineered landfills designed to isolate waste or materials.

LUCs are legal and other non-engineering measures intended to prevent the public from coming into contact with contamination left in place. LUCs include administrative controls such as property record restrictions, property record notices, zoning notices, and excavation/penetration permit (EPP) programs, as well as physical controls, such as state advisories/postings, fences, signs, and surveillance patrols.

LTS encompasses both engineering controls and LUCs. The RER evaluates the performance of engineering controls and LUCs that are required by CERCLA documents (e.g., RODs, AMs, RAWPs, Removal Action Work Plans, PCCRs, RARs, RmARs) to protect human health and the environment. The definitions encompassing LTS have evolved over time and earlier decision documents used the term "institutional controls" loosely instead of LUCs and engineering controls. This term "institutional controls" is used throughout the RER when using citations directly from these earlier decision documents.

LTS information used in this report was collected and/or compiled by the WRRP in conjunction with the Bechtel Jacobs Company LLC (BJC) Surveillance and Maintenance (S&M) programs and the BJC Radiation Protection Organization at East Tennessee Technology Park (ETTP). Site-specific inspections to assess the condition of engineering controls, as well as physical LUCs (i.e., access controls, signs, and security patrols), are performed by BJC S&M programs at Y-12 National Security Complex (Y-12), Oak Ridge National Laboratory (ORNL), and ETTP, in accordance with site-specific S&M plans. Inspection checksheets are completed for each location and tied to any needed maintenance request forms. This documentation is maintained by the Project Document Control Center (PDCC) for each site and ultimately filed in the BJC Document Management Center (DMC). The WRRP routinely obtains copies of these checksheets to monitor the effectiveness of the remedy throughout the fiscal year (FY) and uses this information to summarize the status of compliance with the LTS requirements annually in the RER. LTS requirements at ETTP also include radiological surveys, Contamination Area postings, storm drain sampling, and surface water monitoring for areas with remaining contamination. Radiological monitoring information is maintained by the BJC Radiation Protection Organization in the ETTP Compliance Survey Database, and a summary of the survey results are provided annually to the WRRP for incorporation into the RER. Storm drain sampling and surface water monitoring is performed by the ETTP Environmental Compliance Program.

Documentation verifying the implementation of administrative LUCs (i.e., property record restrictions, property record notices, zoning notices, and EPP programs) is also obtained from many sources throughout the FY, including County Register of Deeds offices for property record restrictions and property record notices, City Planning Commission for zoning notices, and BJC project engineers for EPP program verification. Copies of this documentation are obtained by the WRRP and maintained with the project RER files.

Select LUCs, for Melton Valley (MV) only, require an annual certification. The RER contains, in Appendix A, the Certification of Land Use Controls FY 2010 (for MV). The Land Use Control Assurance Plan (LUCAP) (DOE 1999a) requires that the Manager, DOE Oak Ridge Operations (ORO), annually verify in the RER that Land Use Controls Implementation Plans (LUCIPs) are being implemented on the ORR.

1.2 ORGANIZATION OF THE REPORT

The 2011 RER provides the current status and updates to completed CERCLA actions on the ORR, as well as the technical evaluation of effectiveness for each remedy that includes monitoring and/or LTS requirements. For each of these actions, the 2011 RER provides: (1) a summary of performance goals and objectives; (2) specific monitoring locations and parameters that fulfill the requirements contained in the respective decision document(s); and (3) a comparison of monitoring results to stated goals or metrics to evaluate the performance of the remedy. Based on this evaluation, changes and recommendations to the monitoring program are proposed, as appropriate. Monitoring program changes are requested, as applicable, in accordance with Federal Facility Agreement (FFA) Appendix I-12. Actions that do not have LTS or monitoring requirements or have been terminated or superseded by watershed-scale actions are not discussed in the 2011 RER. Lastly, Appendix A provides the applicable compliance certification for the approved MV LUCs.

The format of the RER is streamlined to facilitate annual reviews and to focus on data evaluations to assess performance of completed actions and compliance with LTS requirements. The 2007 RER (DOE 2007a) is a compendium of all CERCLA decisions finalized through September 30, 2006. It contains a concise description of each RA in the context of a conceptual contaminant fate and transport model for each watershed, and summarizes the goals of the remedy. Section 1.4 of the 2007 RER provides the physical context with which to better understand the CERCLA decision and activities to date, including a summary of the contaminant source areas and surface water, groundwater, and biological resources. The 2007 RER also includes CERCLA decisions that include future actions and any ongoing actions. The next Five Year Review (FYR) in 2011, will include an up-to-date compendium of all CERCLA decisions. As appropriate, this will be referenced in future RERs for site histories.

Figure 1.1 shows the boundaries of the administrative watersheds on the ORR, and Figure 1.2 depicts the boundaries of the impacted watersheds downstream of the ORR. The implementation of the large watershed-scale RODs, in some instances, can take multiple years to complete. Therefore, in this RER, select watershed maps use different symbols to identify completed actions, actions not implemented, and actions which are in progress (e.g., Figure 4.1. CERCLA Actions in BCV Watershed). Within the 2011 RER, a chapter is devoted to each of the watersheds, as well as a chapter each to Chestnut Ridge (ChR), ETTP, and a single chapter to all off-site actions. Rather than forming a single defined hydrologic watershed, ChR and the ETTP comprise several individual sub-watersheds, but are treated as a single unit for planning and administrative purposes (Figure 1.1). Each chapter identifies completed single actions and, as applicable, completed watershed-scale ROD actions with ongoing monitoring and/or LTS activities. The remedial action objective (RAO) and performance monitoring criteria are provided, followed by an evaluation of the monitoring results with a comparison to stated performance metrics. When insufficient data exist to assess the impact of the RA(s), e.g., when the RA was only recently completed or not all RAs prescribed by the watershed ROD have yet to be implemented, a preliminary evaluation is made of early indicators of effectiveness at the watershed scale, such as contaminant trends at surface water integration points (IPs).

Figure 1.1 also shows areas of known groundwater contamination in each of the ORR administrative watersheds. No final groundwater decisions have been made on the ORR to date, although several groundwater RAs have been undertaken. Progress toward groundwater remediation has been challenging on the ORR because of the hydrogeologic complexity of fractured rock and karst systems, as well as the recalcitrant nature of some groundwater contaminants. During the 1990s, DOE attempted several passive groundwater RAs using *in situ* media to capture or degrade contaminants. None of these

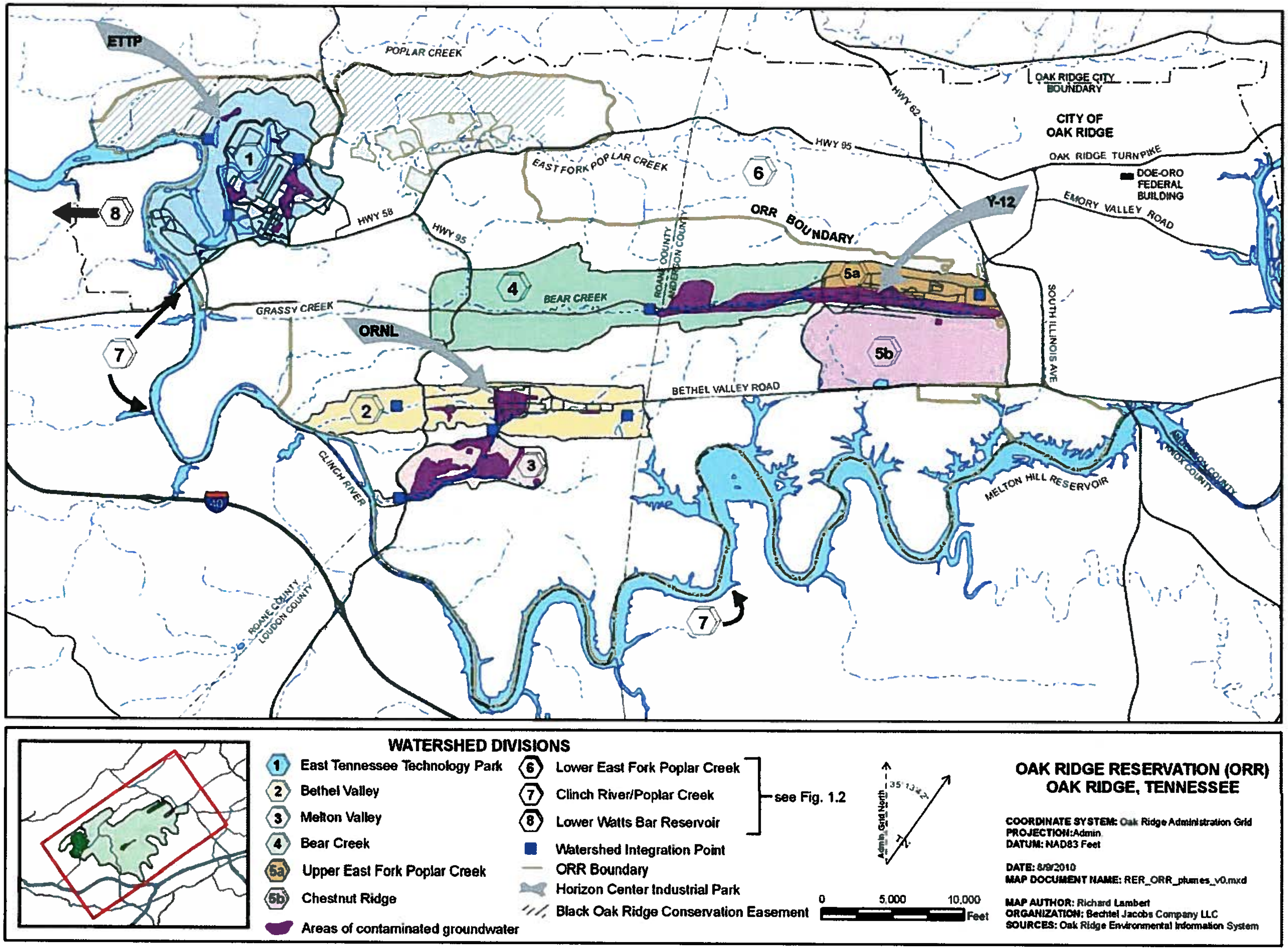

Figure 1.1. Watersheds on the ORR.

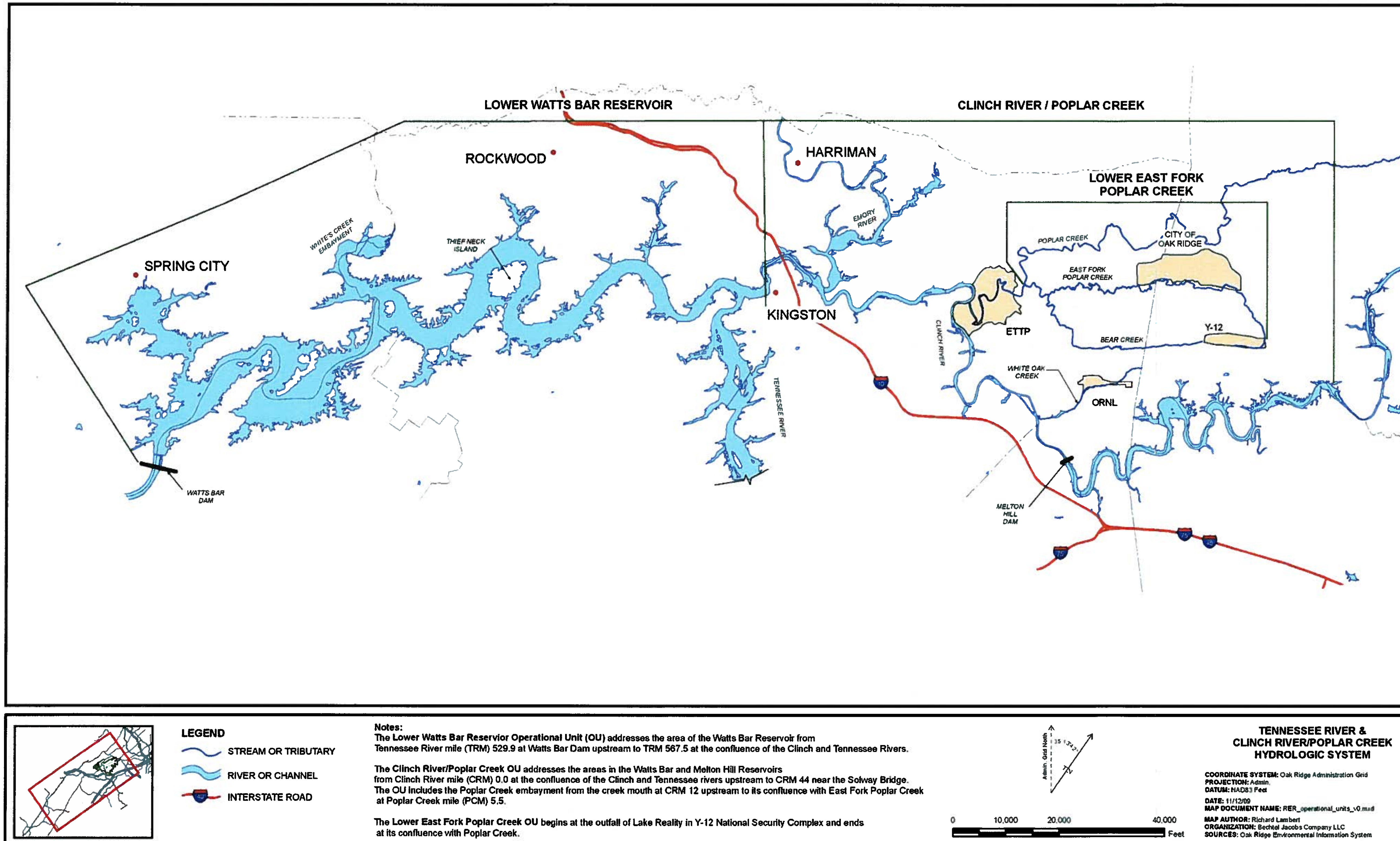

Figure 1.2. Lower Watts Bar, Clinch River/Poplar Creek, and Lower East Fork Operational Units.

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projects met with long-term success and all were terminated under agreements with the FFA parties. Actions on the ORR that have been successful at prevention of the spread of groundwater contamination have included containment pump-and-treat systems and aggressive hydrologic isolation of wastes left in place by capping and *in situ* stabilization. Containment pump and treat systems are successful at mitigation of offsite plume migration at the Y-12 east-end volatile organic compound (VOC) plume in Upper East Fork Poplar Creek (UEFPC) and at the hexavalent chromium plume at ETTP. Such systems do require periodic maintenance and potential modification, as is the case at the Core Hole 8 plume in Bethel Valley (BV). In MV at ORNL, aggressive hydrologic isolation and *in situ* solidification by grouting of wastes left in place is successful in halting formation of contaminated leachate which feeds groundwater contaminant plumes. Dense non-aqueous phase liquids (DNAPLs) containing chlorinated VOCs in fractured bedrock are known to exist at the ETTP site and in Bear Creek Valley (BCV) and may be present in other areas of the ORR. Such contaminant problems are extremely difficult and in some instances have been determined to be technically impracticable to remediate. DOE is currently conducting groundwater treatability studies at two chlorinated VOC sites on the ORR – one at ETTP and one at ORNL – to evaluate the feasibility of remediating these contaminants in the ORR groundwater setting. The current ORR FFA remediation strategy and sequencing of actions places final groundwater decisions and RAs several years into the future.

The order of presentation within the 2011 RER is as follows:

- Chapter 2–Bethel Valley Watershed (BV)
- Chapter 3–Melton Valley Watershed (MV)
- Chapter 4–Bear Creek Valley Watershed (BCV)
- Chapter 5–Chestnut Ridge (ChR)
- Chapter 6–Upper East Fork Poplar Creek (UEFPC), including Union Valley
- Chapter 7–Off-Site Actions, including Lower East Fork Poplar Creek (LEFPC), Clinch River/Poplar Creek (CR/PC), and Lower Watts Bar Reservoir (LWBR)
- Chapter 8–East Tennessee Technology Park (ETTP)
- Chapter 9–Other Sites

Chapter 10 provides a list of references used in the preparation of this report. Chapter 11 includes a bibliography of the relevant documentation for actions initiated, in progress, or completed under CERCLA for each watershed that were used to prepare the initial tables of each chapter (e.g., Table 2.1, Table 3.1, Table 4.1, etc.). Appendix A provides the required DOE certification that relevant LUCIP requirements were implemented in accordance with the LUCAP (DOE 1999a). Appendix B of this report includes graphical presentations of data that support discussions of MV performance assessments in Chap. 3.

1.3 ORR-WIDE RAINFALL

The quantity, duration, and intensity of rainfall affect contaminant concentrations in groundwater and surface water across the ORR. Because of this, general rainfall trends for FY 2010 are summarized in this section to provide a general context for the remainder of this report.

Details of rainfall distribution within FY 2010 are illustrated in Figure 1.3. Mean monthly rainfall values for FY 2010 for the ORR vary from ~2.5 inches/month to more than 8 inches/month. During FY 2010, the greatest monthly rainfall occurred in December 2009 and the lowest monthly rainfall occurred during November 2009. Rainfall occurred frequently during FY 2010, with relatively dry conditions during November 2009 and April 2010.

Total rainfall on the ORR during FY 2010 measured over 55 inches based on a composite of six rain-gauge stations located throughout the reservation (Figure 1.4). The total rainfall during FY 2010 was not significantly different from the long-term mean for the ORR of 54 inches/year, suggesting a return to more normal precipitation than reported in recent RERs.

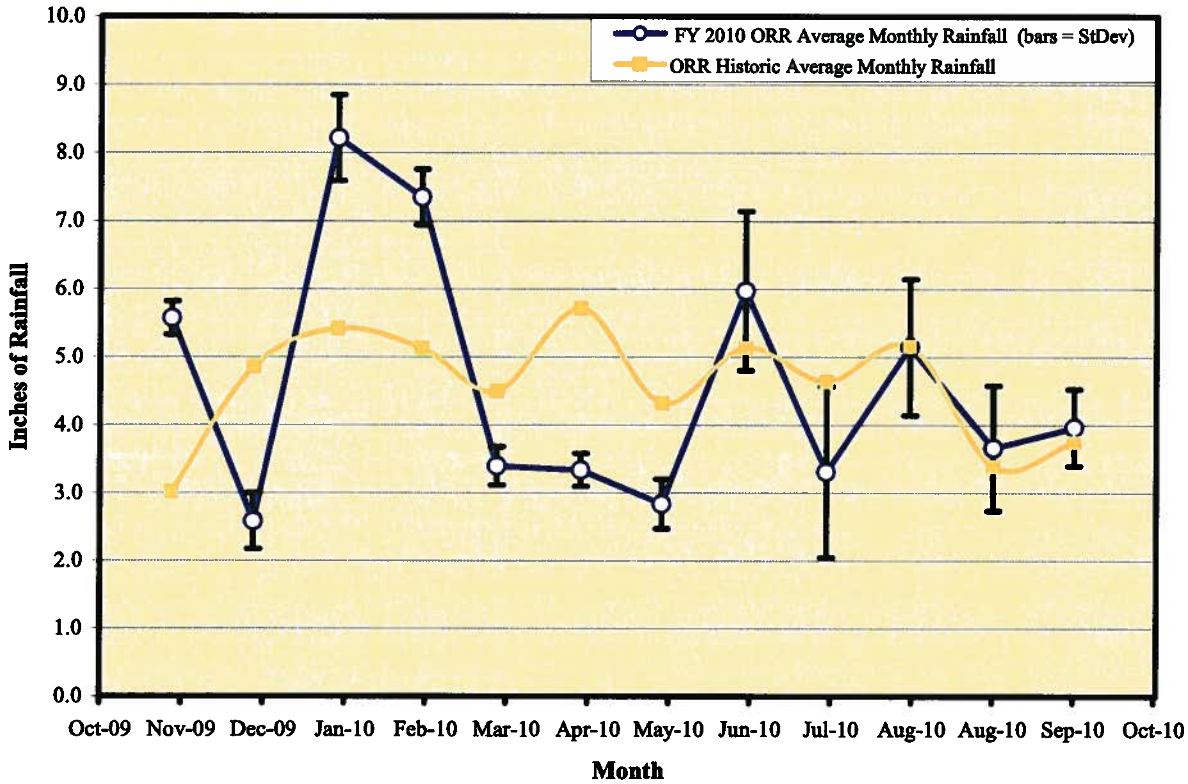

Figure 1.3. FY 2010 monthly average rainfall from six rain gauges on the ORR.

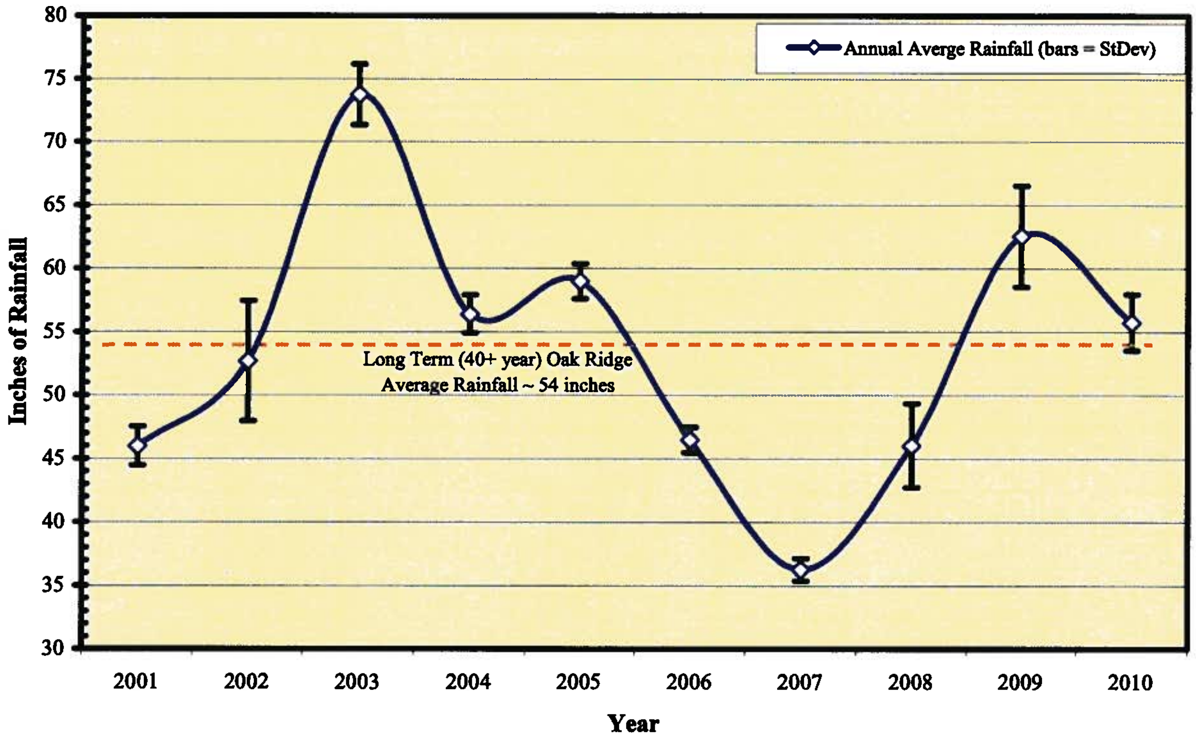

Figure 1.4. Mean annual rainfall from six rain gauges on the ORR, 2001-2010.

1.4 ISSUES AND RECOMMENDATIONS

Table 1.1 summarizes issues identified through evaluation of performance monitoring data and provides recommendations, as appropriate. To track issues through their resolution, the table includes a compilation of: (1) the issues identified in subsequent chapters of this 2011 RER, and (2) unresolved issues carried forward from a previous RER. Table 1.2 identifies those issues that are closed out in the 2011 RER and will no longer be tracked in future RERs or FYRs. Table 1.3 includes open issues relevant only to the 2006 FYR that are provided a status as of December 2009. Some of these issues are duplicated in Table 1.1. Table 1.4 identifies FYR issues that are completed.

An issue that is carried forward from a previous years' RER is only discussed in the respective chapter of the text if FY 2010 monitoring data clarifies, modifies, or otherwise impacts the issue in any way. For example, because many of the issues currently included in Table 1.1 require completion of future actions within the watershed, those particular issues will remain in the table for tracking purposes, but generally will not be discussed in any detail in the respective chapter.

Table 1.1. 2011 summary of technical issues, recommendations, and follow-up actions
(New issues identified in this RER are in bold and blue text.)

Issue[a]	Action/ Recommendation	Responsible parties Primary/Support	Target response date
Melton (MV)			
1. Initial sampling of new offsite wells (2 events) yielded indication of the presence of VOCs and some metal contaminants. (2011 RER)[a]	1. Continue sampling in FY 2011 to confirm presence of contaminants, establish existence of any trend, and establish on-site vs off-site hydrologic head relationship. Consolidate offsite well sampling with that specified in MV Monitoring Plan after four quarters of sampling and with agreement of sampling specifics (parameters and locations) with the core team.	DOE/ EPA & TDEC	FY 2011
2. During FY 2010, groundwater level control at the SWSA 4 downgradient trench deteriorated as indicated by water level measurements in the trench, within the nearby portion of SWSA 4, and the former IHP area. (2011 RER)[a]	2. (a) During winter of 2011 DOE will collect seepage samples from the IHP adjacent to the SWSA 4 downgradient trench during or soon after large rainfall events to determine if SWSA 4 contaminants are being discharged to surface water in the IHP. (b) DOE will evaluate the performance of SWSA 4 downgradient trench extraction wells to determine if well maintenance may improve the system performance.	DOE/ EPA & TDEC	FY 2011
3. Monitoring results for some zones in the MV exit pathway wells yield elevated alpha and beta activity results that are apparently the result of elevated suspended and/or dissolved solids. These results raise concern over possible migration of contamination across the DOE property boundary in western MV. (2008 RER)[a]	3. Monitoring will continue to establish baseline conditions. In 2010, DOE established an offsite monitoring system including two clusters of newly drilled wells and two reconfigured wells. Monitoring of the new system was agreed upon for four quarters. After which the Core Team will discuss the monitoring results (see Action/Recommendation from Melton Valley Issue #1 above).	DOE/ EPA & TDEC	FY 2011
Bethel Valley (BV)			
1. Corehole 8 Plume collection system performance does not meet RmAR performance goals. (2010 RER)[a]	1. (1) UT-Battelle is identifying and repairing potable water lines in vicinity of contaminant source areas to lessen contaminant release and migration from soils. (2) RDR/RAWP for the BV Corehole 8 Extraction System was submitted and approved. Work was started on the drilling of additional extraction wells and an upgrade of the extraction system.	DOE/ EPA & TDEC	UT-Battelle identified and repaired line leaks in FY 2010. New extraction wells will be online in FY 2011.
2. The ^{90}Sr contamination from non-point sources has become the dominant contributor to ^{90}Sr flux at	2. During FY 2010, non-point ^{90}Sr sources comprised less than 10% of the 0.33 Ci measured at 7500 Bridge compared to the 40% comprised by Corehole 8 Plume discharges to First Creek. Sampling will occur during	DOE/ EPA & TDEC	Sampling to continue and reported on in 2012

Table 1.1. 2011 Summary of technical issues, recommendations, and follow-up actions (cont.)
(New issues identified in this RER are in bold and blue text.)

Issue[a]	Action/ Recommendation	Responsible parties Primary/Support	Target response date
the 7500 Bridge location. SWSA 3 may also be contributing to increased flux seen at Raccoon Creek. (2006 FYR)[a]	FY 2011 to determine if excess ungauged ^{90}Sr impacts BV ROD goals. SWSA 3 capping was initiated in FY 2010 along with additional extraction wells to capture the Corehole 8 plume.		RER. SWSA 3 capping initiated and additional extraction wells are being installed to capture Corehole 8 plume in FY 2011.
Upper East Fork Poplar Creek (UEFPC)			
1. During FY 2010 inflow to BSWTS exceeded system design treatment capacity necessitating bypass flow to occur during significant periods of time. (2011 RER)[a]	1. Recommend the evaluation of Hg flux bypassing the system relative to rainfall intensity. It is not believed that a significant mass bypassed the system but this should be confirmed.	DOE/ EPA & TDEC	2012 RER
2. Mercury concentrations in fish within the EFPC system remain elevated, despite decreasing concentrations in aqueous mercury levels. (2007 RER)[a]	2. A team consisting of DOE EM, NNSA, and Office of Science continue working together to develop a conceptual model(s) for mercury fate and transport relevant to methyl mercury concentrations in the EFPC ecosystem. Two recent reports focused on mercury sources, transport, and fate have been drafted or published (Southworth *et al.* 2010, Peterson *et al.* pending publication).	DOE/ EPA & TDEC	Report to be issued final in FY 2011.
3. FY 2005 pre-action Hg concentrations at Station 17 are above the 200-ppt performance goal. Hg concentrations in fish in UEFPC have yet to respond to commensurate reductions of Hg from historical RMPE actions. Biota monitoring in UEFPC shows impaired diversity and density of pollution-intolerant species. (2006 FYR)[a]	3. Remedial measures required by the UEFPC Phase I ROD are expected to reduce Hg concentrations at Station 17 Action/Recommendation from UEFPC Issue #2 above will support Hg reductions in fish. FY 2010 Hg levels in LEFPC fish remain above federal AWQC, but are less than peak levels observed in 2001-2002.	DOE/ EPA & TDEC	UEFPC Phase I ROD, refer to the FFA Appendix E and Appendix J for planned implementation schedules.
Bear Creek Valley (BCV)			
1. Documented discharge of contaminants from upstream sources in NT-8. (2011 RER)[a]	1a. Surface water samples will be collected along a transect from the NT-8 flume upstream to the BCBG fence to identify inputs of uranium, VOCs, and PCBs to NT-8. 1b. Engineering design and operational records for the non-CERCLA groundwater seepage collection system in the NT-8 headwaters associated with BCBG D-West will be reviewed and the system performance will be evaluated.	DOE/ EPA & TDEC	FY 2012

Table 1.1. 2011 Summary of technical issues, recommendations, and follow-up actions (cont.)
(New issues identified in this RER are in bold and blue text.)

Issue[a]	Action/ Recommendation	Responsible parties Primary/Support	Target response date
2. Monitoring results for Zone 1 of BCV exhibit trace-to-low contaminant concentrations in groundwater, thereby compromising the Phase I ROD goal to maintain clean groundwater acceptable for unrestricted use. (2010 RER)	2. The contaminant concentrations have remained low and are observed intermittently at various monitoring locations. In FY 2010, concentrations continued to trend downward or were not observed at all. The intermittent plume in the Maynardville Limestone will continue to be monitored during FY 2011.	DOE/ EPA & TDEC	2012 RER
3. Results for BCK 9.2 show an increase in the proportion of ungauged uranium flux beginning in FY 2002. Increasing uranium trends are not observed at gauged monitoring stations, or in principal groundwater exit points contributing to Bear Creek surface flow. (2006 FYR)[a]	3. Uranium flux mass balance in the Bear Creek watershed is complicated by the karst groundwater system. However, during FY 2010 the mass balance between source area contribution and the BCK 9.2 total matched within an 1% (<1 kg). DOE is sending an Appendix I-12 letter to the regulators recommending re-instatement of flow paced monitoring at NT-3 and NT-5 and the creation of an additional flux monitoring station at BCK 10.15 (downstream of SS-4 but upstream of NT-7) to attempt to determine inputs to the stream channel from karst discharge. Flow calibration at BCK 10.15 is on-going in FY 2011.	DOE/ EPA & TDEC	BCV Phase I & II RODs, BCV Groundwater ROD; refer to FFA Appendix E and J for planned implementation schedule.
4. In addition to surface water monitoring at the BYBY, the PCCR (DOE 2003d) specifies stream-stability monitoring, riparian vegetation monitoring, and in-stream biological monitoring of the restored NT-3 channel. (2008 RER)[b]	4. DOE completed the fifth and final year of stream-stability monitoring at BYBY during FY 2008. DOE recommends that in-stream and riparian vegetation monitoring be discontinued because of improved habitat and lack of a need for further actions.	DOE/ EPA & TDEC	Upon 2011 RER approval, DOE will send an Appendix I-12 letter to EPA and TDEC.
5. Five years of riparian monitoring has been completed at Bear Creek restoration site (BCK 4.55). (2011 RER)[a]	5. Monitoring has shown that the site is well on its way to recovery. Since a five year commitment to monitor recovery has been completed and the restoration site is in excellent condition it is recommended that no further monitoring be conducted.	DOE/ EPA & TDEC	Upon 2011 RER approval, DOE will send an Appendix I-12 approval letter to EPA and TDEC.
East Tennessee Technology Park (ETTP)			
1. Fish barrier in K-1007-P1 Holding Pond was damaged during storm events allowing reintroduction of undesirable fish species into the pond. (2011 RER)[a]	1. Fish barrier was repaired and undesirable fish were removed to the extent practicable in FY 2010. Performance monitoring was started in FY 2010.	DOE/ EPA & TDEC	2011 FYR

Table 1.1. 2011 Summary of technical issues, recommendations, and follow-up actions (cont.)
(New issues identified in this RER are in bold and blue text.)

Issue[a]	Action/ Recommendation	Responsible parties Primary/Support	Target response date
2. The northern section of ETTP Zone 1 has been identified as a conservation easement (BORCE). The BORCE is utilized for recreational use: hiking, bicycling, and select controlled deer hunts. The end use identified in the ETTP Zone 1 ROD is unrestricted industrial, i.e., recreational use was not designated. (2010 RER)[a]	2. DOE acknowledges the land use differences that exist between the BORCE use and that which is in the Zone 1. The end use of the portion of Zone 1 that is also identified as part of the BORCE will be changed from industrial to recreational in an ESD and amendment to the Zone 1 Interim ROD (DOE 2002a) with the appropriate level of public participation. The *Addendum to the Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2010s) includes the risk assessment to support this change.	DOE/ EPA & TDEC	FY 2011 with ESD and amendment to Zone 1 ROD

[a] The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2008 RER).

AWQC = ambient water quality criteria
BCK = Bear Creek kilometer
BCBG = Bear Creek Burial Grounds
BORCE = Black Oak Ridge Conversation Easement
BYBY = Boneyard/Burnyard
BSWTS = Big Spring Water Treatment System
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EFPC = East Fork Poplar Creek
EM = Environmental Management
EPA = Environmental Protection Agency
ESD = Explanation of Significant Difference
IHP = Intermediate Holding Pond
NNSA = National Nuclear Security Administration
NT = North Tributary
PCB = polychlorinated biphenyl
RDR/RAWP = Remedial Design Report/Remedial Work Plan
RMPE = Reduction of Mercury in Plant Effluents
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
TM = Technical Memorandum
UNC = United Nuclear Corporation
VOA = volatile organic analysis
VOCs = volatile organic compound

Table 1.2. Summary of closed-out technical issues and recommendations in 2011

Issue[a]	Action/ Recommendation	Responsible parties Primary/Support	Target response date
East Tennessee Technology Park			
1. Per the K-1420 PCCR, if the concentration of total uranium continues to show results below 2,600 pCi/L, this will confirm that storm water runoff from Building K-1420 slab is stabilized, and sampling of the pad during rain events will be discontinued. Based on results from the past year, additional monitoring of the K-1420 pad can be discontinued. (2009 RER)[b]	1. FY 2010 sampling discussed in 2011 RER with no further discussion in subsequent RERs. Regulators approved April 2010.	DOE/ EPA & TDEC	FY 2009 Completed

[a] The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2008 RER). Only issues that are closed out in this RER (2011) are included. Similarly prior RERs have identified issues which were closed out in that year.

EPA = Environmental Protection Agency
NT = North Tributary
TDEC = Tennessee Department of Environment and Conservation

Table 1.3. Summary of unresolved technical issues, recommendations, and follow-up actions from the FYR

Issue	Affects protectiveness Y/N		Recommendation/ follow-up action	Responsible parties		Target response date	December 2010 status
	Current	Future		Primary	Support		
Lower Watts Bar Reservoir (LWBR)							
1. The RI/FS/ROD process evaluated mercury fish ingestion risk using the toxicity factor for mercuric chloride. The current risk assessment practice is to use the toxicity factor for methyl mercury. The cesium slope factor has changed since the time of the RI/FS/ROD.	N	N	1. There is no required immediate action since the State of Tennessee fish advisories address fish ingestion. The fish advisory takes into consideration the methyl mercury toxicity factor. Exposure to cesium is controlled by the WBIWG process. The new cesium slope factor was addressed in the 2006 FYR. The factor does not impact protectiveness of the action.	DOE	TDEC	Ongoing	To be evaluated in 2011 FYR.
Clinch River/Poplar Creek (CR/PC)							
1. The RI/FS/ROD process evaluated mercury fish ingestion risk using the toxicity factor for mercuric chloride. The current risk assessment practice is to use the toxicity factor for methyl mercury. The cesium slope factor has changed since the time of the RI/FS/ROD.	N	N	1. There is no required immediate action since the State of Tennessee fish advisories address fish ingestion. The fish advisory takes into consideration the methyl mercury toxicity factor. Exposure to cesium is controlled by the WBIWG process. The new cesium slope factor was addressed in the 2006 FYR. The factor does not impact protectiveness of the action.	DOE	TDEC	Ongoing	To be evaluated in 2011 FYR.
Melton Valley (MV)							
1. There has been a change in some toxicity factors for radionuclides since the Interim ROD was approved.	N	Y	1. Toxicity factors and final cleanup goals will be evaluated as part of the 2011 FYR and the Final ROD for MV.	DOE	EPA/ TDEC	MV Final ROD, refer to FFA Appendix J for current +estimated date.	To be evaluated in the 2011 FYR. The Final ROD schedule is in the FFA Appendix C.
Bethel Valley (BV)							
1. The ^{90}Sr contamination from non-point sources has become the dominant contributor to ^{90}Sr flux at the 7500 Bridge location. SWSA 3 may also be contributing to	N	Y	1. During FY 2010, non-point ^{90}Sr sources comprised less than 10% of the 0.33 Ci measured at 7500 Bridge compared to the 40% comprised by Corehole 8 Plume discharges to First Creek. Sampling will	DOE	EPA/ TDEC	BV ROD, refer to FFA Appendices E and J for	SWSA 3 capping initiated and additional extraction wells to capture Corehole 8 plume in

Table 1.3. Summary of unresolved technical issues, recommendations, and follow-up actions from the FYR (cont.)

Issue	Affects protectiveness Y/N		Recommendation/ follow-up action	Responsible parties		Target response date	December 2010 status
	Current	Future		Primary	Support		
increased flux seen at Raccoon Creek.			occur during FY 2011 to determine if excess ungauged ^{90}Sr impacts BV ROD goals. SWSA 3 capping was initiated in FY 2010 along with additional extraction wells to capture the Corehole 8 plume.			planned implemen-tation schedules.	FY 2011.
Upper East Fork Poplar Creek (UEFPC)							
1. FY 2005 pre-action Hg concentrations at Station 17 are above the 200-ppt performance goal. Hg concentrations in fish in UEFPC have yet to respond to commensurate reductions of mercury from historical RMPE actions. Biota monitoring in UEFPC shows continued diversity and density of pollution-intolerant species.	Y	Y	1. Remedial measures required by the UEFPC Phase I ROD are expected to reduce Hg concentrations at Station 17, as well as in fish in UEFPC (see Issue Carried Forward #1 above). These measures include Hg source removal and surface water treatment. The BSWTS was fully operational during FY 2010 although BSWTS was bypassed by flow exceeding treatment capacity for significant periods of time. Also, FY 2010 Hg levels in LEFPC fish remain above federal AWQC, but are less than peak levels observed in 2001-2002. It is anticipated that implementation of the Hg-source removal actions will result in a similar decrease in flux at the IP.	DOE	EPA/ TDEC	UEFPC Phase I ROD, refer to FFA Appendices E and J for planned implemen-tation schedules.	UEFPC Phase I ROD, refer to the FFA Appendix E and Appendix J for planned implementation schedules.
Bear Creek Valley (BCV)							
1. Flux results for BCK 9.2 show an increase in the proportion of ungauged uranium flux beginning in FY 2002. Increasing uranium trends are not observed at gauged monitoring stations, or in principal groundwater exit points contributing to Bear Creek surface flow.	N	N	1. Uranium flux mass balance in the Bear Creek watershed is complicated by the karst groundwater system. However, during FY 2010 the mass balance between source area contribution and the BCK 9.2 total matched within an 1% (< 1 kg). DOE is sending an Appendix I-12 letter to the regulators recommending re-instatement of flow paced monitoring at NT-3 and NT-5 and the creation of an additional flux monitoring station at BCK 10.15 (downstream of SS-4 but upstream of NT-7) to attempt to determine inputs to the stream channel from karst discharge. Flow	DOE	EPA/ TDEC	BCV Phase I & II RODs, BCV Ground-water ROD; refer to FFA Appendix E and J for planned implemen-tation	Identified as a BCV issue in Table 1.1. Target response date BCV Phase I and II RODs, BCV Groundwater ROD; refer to FFA Appendix E and J for planned implementation schedule.

Table 1.3. Summary of unresolved technical issues, recommendations, and follow-up actions from the FYR (cont.)

Issue	Affects protectiveness Y/N		Recommendation/ follow-up action	Responsible parties		Target response date	December 2010 status
	Current	Future		Primary	Support		
			calibration at BCK 10.15 continues in FY 2011.			schedules.	

AWQC = ambient water quality criteria
BCK = Bear Creek kilometer
BSWTS = Big Stream Treatment System
EPA = U.S. Environmental Protection Agency
FS = Feasibility Study
NT = North Tributary
RMPE = Reduction of Mercury in Plant Effluents
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
WBIWG = Watts Bar Interagency Working Group

Table 1.4. Summary of completed technical issues and recommendations from the FYR

Issue	Affects protectiveness Y/N		Recommendation/ follow-up action	Responsible parties		Target response date	December 2010 status
	Current	Future		Primary	Support		
Lower Watts Bar Reservoir (LWBR)							
1. Some fish advisory signs are damaged.	N	N	1. In the August 20, 2008 FFA meeting it was agreed that DOE will notify the State of these conditions and that the State has an active program to address these conditions.	TDEC	DOE	Ongoing	Action completed. FFA Meeting Minutes, August 20, 2008.
Clinch River/Poplar Creek (CR/PC)							
1. Some fish advisory signs are damaged.	N	N	1. In the August 20, 2008 FFA meeting, it was agreed that DOE will notify the State of these conditions and that the State has an active program to address these conditions.	DOE	TDEC	Ongoing	Action completed. FFA Meeting Minutes, August 20, 2008.
Upper East Fork Poplar Creek (UEFPC)							
1. Pre-action data do not definitively indicate whether there is a net gain or loss of Hg mass between source areas in the western portion of Y-12 and OF-200A6. Substantial fluctuations in Hg mass balance (flux) have been observed the past three years.	N	N	1. The monitoring methods for mercury for the Phase I ROD have been reviewed with the UEFPC Core Team. A letter (per FFA Appendix I-12) was sent to EPA/TDEC asking for approval of the modified monitoring program in August 2006, and approval was granted in October 2006 and is being implemented.	DOE	EPA/ TDEC	Letter per FFA Appendix I-12, October 2006.	Completed.
2. Access to OF-169 is no longer available due to changes in the Y-12 security boundary. Alternative sampling locations were evaluated, but a single suitable alternate was not identified.	N	N	2. The monitoring methods for mercury for the Phase I ROD were reviewed with the UEFPC Core Team and a letter (per FFA Appendix I-12) was sent to EPA/TDEC in August 2006 asking for approval to change the four WEMA outfalls listed in the ROD to OF-200A6. Regulator approval was granted in October 2006 and is being implemented. Upon completion of Phase I actions, the feasibility of resuming monitoring at OF-169, or locating a	DOE	EPA/ TDEC	Letter per FFA Appendix I-12, October 2006.	Completed.

Table 1.4. Summary of completed technical issues and recommendations from the FYR (cont.)

Issue	Affects protectiveness Y/N		Recommendation/ follow-up action	Responsible parties		Target response date	December 2010 status
	Current	Future		Primary	Support		
			suitable alternative station, should be evaluated.				
Bear Creek Valley (BCV)							
1. Performance monitoring for the BYBY action has shown that annual uranium flux has remained below the goal of 4.3 kg/year for two consecutive years.	N	N	1. This issue was discussed with EPA/TDEC representatives in the fall of 2006. A letter (per FFA Appendix I-12) was sent to EPA/TDEC asking for approval of monitoring changes in December 2006. Approval granted in April 2007.	DOE	EPA/ TDEC	Letter per FFA Appendix I-12, December 2006.	Action completed.
2. Multiple large-scale construction activities have occurred in the eastern portion of the watershed (e.g., EMWMF, capping actions at BYBY, and SNS construction). This has resulted in large-scale clearing of mature woodland-forested areas, extensive cut-and-fill construction, complete diversion of NT-4, and regrading most of the NT-3 drainage basin. This may have altered runoff and infiltration patterns and evapotranspiration rates. Additionally, uranium flux attributable to NT-7 and NT-8 has not been quantified since the RI.	N	Y	2. See response to Issue 2. Similar response and actions needed.	DOE	EPA/ TDEC	Final BCV Ground-water ROD; refer to FFA Appendices E and J for planned implemen-tation schedule.	Closed out.

BYBY = Boneyard/Burnyard
EMWMF = Environmental Management Waste Management Facility
EPA = U.S. Environmental Protection Agency
NT = North Tributary
SNS = Spallation Neutron Source
TDEC = Tennessee Department of Environment and Conservation
WEMA = West End Mercury Area

2. CERCLA ACTIONS IN BETHEL VALLEY WATERSHED

2.1 INTRODUCTION AND OVERVIEW

The BV Watershed contains most of the ORNL active facilities and a considerable fraction of the CERCLA facilities and contaminated sites at ORNL. Table 2.1 lists the CERCLA actions within the watershed and Figure 2.1 shows the locations of key CERCLA sites and actions. In 2002, the *Record of Decision for Interim Actions at Bethel Valley, Oak Ridge, Tennessee* (DOE 2002a) was signed. This ROD specifies RAs for CERCLA facilities and establishes protectiveness and cleanup levels for the watershed. All RAs specified by the BV ROD have yet to be completed; however, in FY 2010, both remedial and decontamination and decommissioning (D&D) activities were ongoing (See Sect. 2.1.1). Only sites that have performance monitoring and LTS requirements, as noted in Table 2.1, are included in the performance evaluations provided herein. In subsequent sections performance goals and objectives, monitoring results, and an assessment of effectiveness of each completed action are presented. RAOs that form the basis for the interim RAs conducted as part of the BV ROD are based on future land uses outlined in Figure 2.2. These future land uses require certain restrictions regarding site access and allowable activities within the areas summarized in the LTS requirements presented in Table 2.2.

For a complete discussion of background information and performance metrics for each remedy, a compendium is provided in Chap. 2 of Vol. 1 of the FY 2007 RER (DOE 2007a). This information is updated in the annual RER and republished every fifth year at the time of the CERCLA FYR.

2.1.1 Status and Updates

Bethel Valley Watershed-wide Actions

The BV ROD defined RAs for soil and sediment and included three different tasks: (1) capping at two large waste sites, Solid Waste Storage Area (SWSA) 1 and the SWSA 3 area; (2) soil removal actions that vary in size from limited extent to large areas; and (3) removal of stream sediments from seven stream-reach exposure units.

The Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) for Soils, Sediments and Dynamic Characterization Strategy (DOE 2009a) which addresses soil and sediment RAs and characterization activities in BV, as set forth in the BV ROD, received regulatory approval on December 7, 2009. In addition to defining the scope of remediation work to be performed and describing the methods of accomplishment to be used to execute the work, the RAWP also addresses the ROD requirement to develop a statistically-based soil characterization strategy to acquire additional data to verify, following RAs, that the BV ROD RAO requirements are met. The cleanup strategy includes a series of workshops to identify sampling needs in specific portions of BV. More than 15 workshops were conducted in FY 2010 and field activities, focused on the Raccoon Creek drainage and the western end of BV including the northwest corner of the ORNL main campus, have been completed. With the exception of areas adjacent to Raccoon Creek, 487 acres west of the Contractors Landfill were identified No Further Action (NFA) by the end of FY 2010. Activities were ongoing as of September 30, 2010.

Table 2.1. CERCLA actions in BV

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ LTS required	RER section
		Watershed-scale actions		
BV Interim Actions	ROD (DOE/OR/01-1862&D4): 05/2/02	Actions complete.	Yes/Yes	2.2
	NSC (05/2/04) NSC (submitted 09/10/09)	• PCCR for the Tanks T-1, T-2, and HFIR (DOE/OR/01-2238&D1) 11/16/05.	No/No[b]	
	NSC (12/3/04) ESD (DOE/OR/01-2446&D2) submitted 08/02/10.	• PCCR for the Bethel Valley Mercury Sumps Groundwater Action (DOE/OR/01-2472&D1) approved 08/27/10.	Yes/Yes	2.2.2.1.2
		Actions in progress • RDR/RAWP for ORNL soils and sediments (DOE/OR/01-2378&D4), approved 12/07/09. • RDR/RAWP for the BV Burial Grounds (DOE/OR/01-2427&D2/A1), approved 07/01/10. • Treatability Study Work Plan (7000 Area) (DOE/OR/01-2475&D2), submitted 09/22/10.		
		Single-project actions		
WAG 1 Corehole 8 Removal Action (Plume Collection)	AM (DOE/OR/02-1317&D2): 11/10/94 Addendum AM (Letter): 04/22/98 Addendum AM (DOE/OR/01-1831&D2): 09/30/99	• RmAR (DOE/OR/01-1380&D1) approved 09/11/95. • Phase I Operations Report (DOE/OR/01-1832&D1) • Phase II Operations Report (DOE/OR/01-1882&D1) approved 06/21/00.	Yes/No	2.3.1
Bldg. 3001 Canal Removal Action	AM (DOE/OR/02-1533&D2): 11/18/96	RmAR (DOE/OR/01-1599&D2) approved 08/22/97.	No/No[c]	–
SIOU RA	ROD (DOE/OR/02-1630&D2): 09/25/97	• RAR for Impoundments A (DOE/OR/01-2086&D2) approved 05/17/04. • RAR for Impoundments C and D (DOE/OR/01-1784&D2) approved 04/19/99.	No/Yes	2.3.3
MRF RA	AM (DOE/OR/01-1843&D2): 03/3/00	RmAR [(DOE/OR/01-2000&D2/R1) approved with the acceptance of the Completion Letter (waste disposition) 06/18/08].	No/Yes	2.3.4
WAG 1 Tank WC-14 TC RmA (1) Liquid removal	AM (DOE/OR/02-1322&D2): 02/16/95	RmAR (DOE/OR/01-1397&D1) approved 08/21/95.	Discontinued/ No	–

Table 2.1. CERCLA actions in BV (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ LTS required	RER section
WAG 1 Tank WC-14 TC RmA (2) Sludge removal	AM (DOE/OR/02-1598&D2): 09/3/97	RmAR (DOE/OR/01-1738&D2) approved 12/15/98.	No/No	–
Waste Evaporator Facility Removal Action	AM (DOE/OR/02-1381&D2): 07/28/95	RmAR (DOE/OR/01-1460&D1) approved 12/12/96.	No/No	–
GAAT OU Interim Removal Action	ROD (DOE/OR/02-1591&D3): 09/2/97	RAR (DOE/OR-01-1955&D1) approved 10/2/01.	No/No	–
Inactive LLLW Tanks Removal Action	AM (DOE/OR/01-1813&D1): 05/26/99 AM Addendum (DOE/OR/01-1833&D2): 09/30/99	RmAR (DOE/OR/01-1953&D2) approved 10/2/01.	No/No	–
GAAT Stabilization Removal Action (Shells/Risers)	AM (DOE/OR/01-1957&D2): 07/13/01	RmAR (DOE/OR/01-2010&D1) approved 08/21/02.	No/No	–
Single-project action; pending additional action				
Corehole 8 Plume Source (Tank W-1A) Removal Action	AM (DOE/OR/01-1749&D1): 09/18/98 Amended in 1999	RmAR (DOE/OR/01-1969&D1) issued August 2001.[d] • RDR/RAWP for BV Corehole 8 Extraction System (DOE/OR/01-2469&D2) submitted 09/22/10	No/Yes Yes/Yes	2.3.2
ORNL decontamination and demolition projects				
Non-Reactor Facilities D&D	TC AM (DOE/OR/01-2412&D1): 09/30/09 TC AM (DOE/OR/01-2407&D1): 04/09/09	RDR/RAWP for the D&D of Non-Reactor Facilities (DOE/OR/01-2428&D2),issued December 2009. • Addendum to the RDR/RAWP for the D&D for the Non-Reactor Facilities (DOE/OR/01-2428&D2/A2), approved 02/03/10.		
BV Isotopes Facilities D&D	TC AM (DOE/OR/01-2402&D1): 03/24/09 TC AM (DOE/OR/01-2402&D2) submitted 03/30/09			

[a]Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <http://www.bechteljacobs.com/ettp-ffa-appendices.html>.

[b]The PCCR for the T-1, T-2, and HFIR Tank (DOE 2005c) states that the above-ground areas of these sites are subject to routine maintenance and radiological surveys. However, this requirement was superseded by the MV RAR which omits any LTS requirements for these sites. The long-term stewardship of these sites is no longer reported in the RER. The T-1 and T-2 Tanks are located on the BV Watershed map (Figure 2.1) and HFIR Tank is located on the MV Watershed map (Figure 3.1).

[c]The RmAR for the Bldg. 3001 Canal required monthly inspections of the grout and paint for one year only. The monthly checks were conducted through 2006 and are no longer reported in the RER.

[d]In FY 2010, sampling and characterization to delineate the extent of remaining contamination for the removal of Tank W-1A and the excavation of remaining transuranic soils was completed. Removal action scheduled for completion in FY 2011.

ESD = Explanation of Significant Difference

NSC = Non-Significant Change

Table 2.1. CERCLA actions in BV (cont.)

HFIR = High Flux Isotope Reactor
GAAT = Gunite and Associated Tanks
MRF = Metal Recovery Facility
TC RmA = time-critical removal action
WAG = Waste Area Grouping

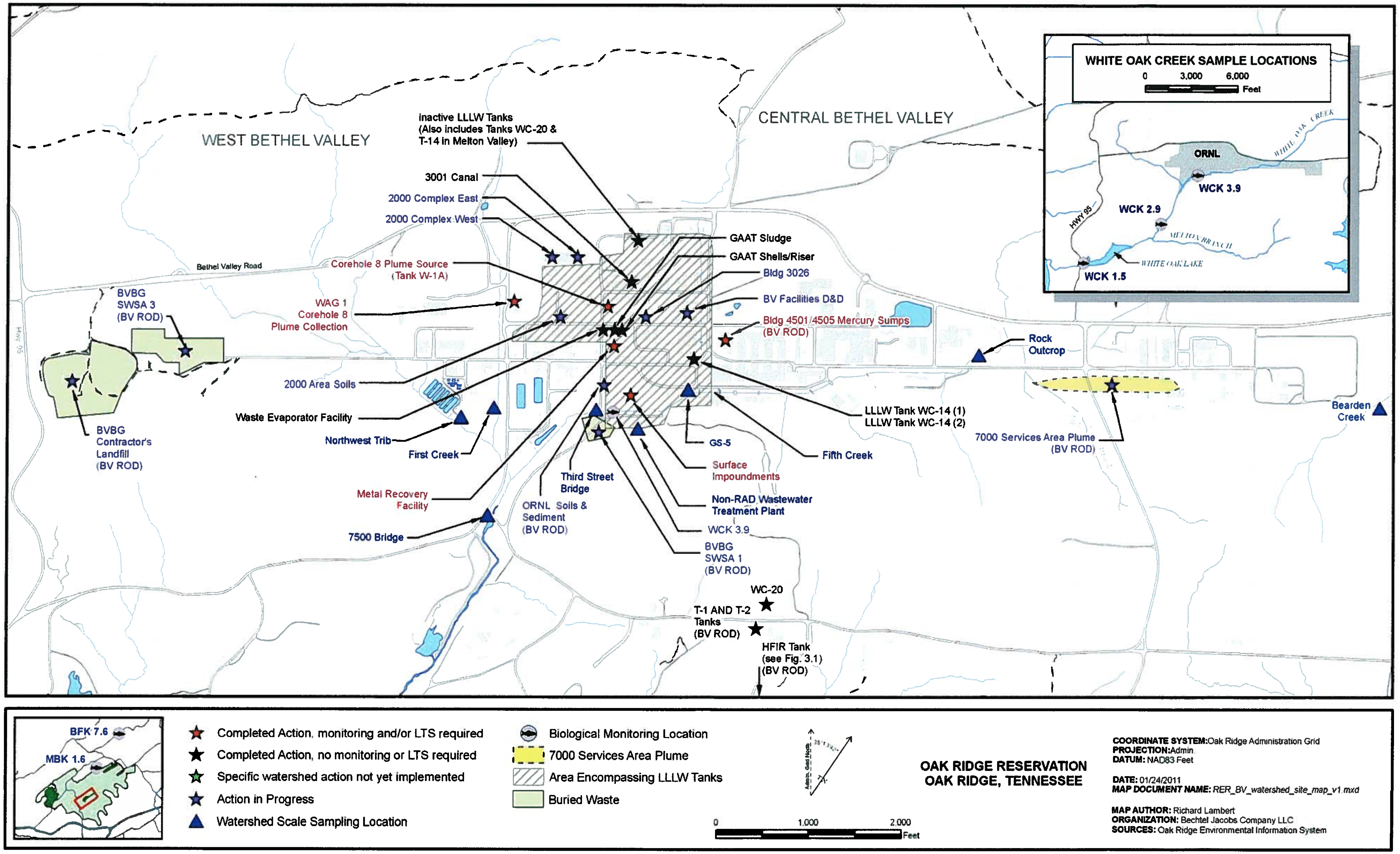

Figure 2.1. Bethel Valley Watershed site map.

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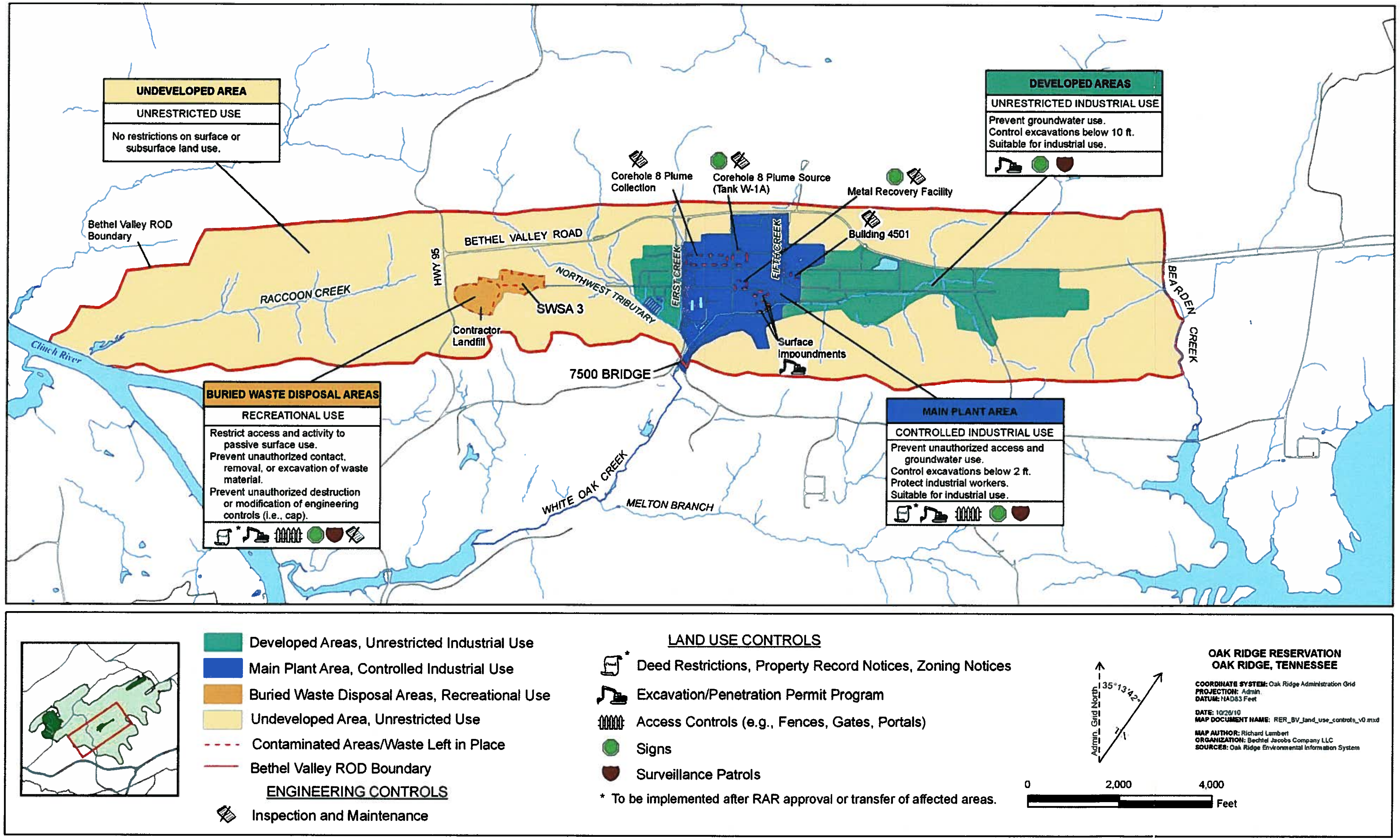

Figure 2.2. BV ROD-designated land use and interim controls.

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Table 2.2. LTS requirements for CERCLA actions in BV Watershed

Site/Project	LTS requirements: LUCs	LTS requirements: Engineering controls	Status	RER section
Watershed-scale actions				
ROD for Interim Actions in BV[a] BV Mercury Sumps GW Action PCCR (Bldg 4501)	<u>Watershed LUCs</u> Administrative: ▪ land use and groundwater deed restrictions ▪ property record notices ▪ zoning notices ▪ excavation/penetration permits program Physical: ▪ access controls ▪ signs ▪ security patrols	▪ Maintain caps ▪ Maintenance of pretreatment system	<u>LUCs in place</u> ▪ Physical LUCs in place. ▪ Administrative LUCs required at completion of actions. ▪ Engineering controls remain protective.	2.2.4
Completed single project actions				
WAG 1 Corehole 8 Removal Action (Plume Collection)[b]	None specified		NA	2.3.1
SIOU RA	▪ Maintain existing EPP program		▪ LUCs in place.	2.3.3.1
MRF Removal Action	▪ Signs	▪ Maintain gravel cover	▪ LUCs in place. ▪ Engineering controls remain protective.	2.3.4.1
Completed single project actions—pending additional action				
Corehole 8 Plume Source (Tank W-1A) Removal Action	▪ Signs	▪ Maintain backfill	▪ LUCs in place. ▪ Engineering controls remain protective.	2.3.2.1

[a] Remaining actions requiring LTS have not been implemented.
[b] Extraction system is maintained.

MRF = Metal Recovery Facility
NA = not applicable
WAG = Waste Area Grouping

In December 2007, an action specified in the BV ROD to reduce mercury-contaminated groundwater discharging to White Oak Creek (WOC) was partially completed by the UT-Battelle as a maintenance action. This action consisted of re-routing mercury-contaminated basement sump water at Bldg. 4501 to the treatment system at the Process Waste Treatment Complex (PWTC). An ion exchange treatment system to remove mercury from the contaminated wastewater prior to treatment at the PWTC, installed in FY 2009, started operation in October 2009. The PCCR for the Mercury Sumps (DOE 2010a) received regulatory approval on August 27, 2010. Monitoring to measure the effectiveness of the Bldg. 4501 sump water re-route action is discussed in Sect. 2.2.2.1.2.

In April 2010, DOE received regulatory approval for the RDR/RAWP for the BV Burial Grounds (DOE 2010b). This RDR/RAWP presents the design for hydrologic isolation of buried waste at two former waste sites that are sources of contaminant release: SWSA 1 in Central BV and SWSA 3 in West BV, as well as contaminated areas in the vicinity of SWSA 1 and SWSA 3. The BV Burial Grounds remediation will hydologically isolate SWSAs 1 and 3 and remove and dispose of associated "hot spot" soil contamination. Former Waste Pile Area (FWPA) and Nonradioactive Wastewater Treatment Plant (NRWTP) Debris Pile soil covers were completed in FY 2010, the Resource Conservation and Recovery Act of 1976 (RCRA) cap for SWSA 1 was 90% complete as of September 30, 2010 and other activities were in progress in FY 2010. Three new monitoring wells were installed west of Highway 95 along Raccoon Creek to monitor the SWSA 3 Exit Pathway. These wells will be discussed in the SWSA 3 RAR. Project completion is planned for 2011.

A Treatability Study Work Plan for the 7000 Services Area Groundwater Plume (DOE 2010c) was submitted on September 22, 2010. The objective of this activity is to determine the feasibility of bioremediation technologies to remove VOCs from groundwater in the area. FY 2010 activities included: sampling groundwater to determine the presence of naturally dechlorinating microbes; analyzing groundwater to determine the degradation capacity of the indigenous microbes; and injecting dye into several wells to determine the groundwater transport characteristics. A pilot study is planned for FY 2011.

Bethel Valley Single-action Projects

Tank W-1A and Associated Soils Excavation. Remediation of Tank W-1A includes excavating, packaging, and transporting waste for disposal; removing, size-reducing, containerizing, and transporting the concrete pad and tank supports and tank shell to the Nevada Test Site; and performing soil sampling and characterization along a Tank W-1A feed pipeline to delineate the extent, type, and concentration of contamination for excavation. In FY 2010 the project installed a weather enclosure over the Tank W-1A area. In addition, sampling and characterization were completed along a Tank W-1A feed pipeline to delineate the extent of remaining contamination. Data is being evaluated to determine the extent of the area to be removed. The removal action is scheduled to be completed in FY 2011.

Core Hole 8 Plume Extraction Wells Installation. As reported in the 2010 RER, large increases in ^{90}Sr and uranium discharge were observed in First Creek. Because of these increased discharges, DOE initiated a project to install additional plume groundwater extraction wells to improve plume collection and treatment. During FY 2010 DOE submitted the ***Remedial Design Report/Remedial Action Work Plan for the Bethel Valley (Corehole 8) Extraction System at Oak Ridge National Laboratory, Oak Ridge, Tennessee*** (DOE 2010d). Well installation was initiated in August 2010, with completion expected during 2011. The purpose for the additional extraction wells is to increase plume water removal from the bedrock zone to prevent it from seeping upward into the shallow soils where the contamination can seep into storm drains that discharge into the stream. Included in the project are installation of up to four bedrock wells with associated pumps, piping, electrical, and control systems, and upgrade of controls and pumps in the existing shallow groundwater collection system. Since the Corehole 8 plume project was initiated in 1995 as a single-action project, the ongoing system performance monitoring has been reported in the single-action section of the RER. Upon signature of the BV ROD the groundwater/surface water protection aspects of this action became elements of the ROD effectiveness. Beginning in the 2012 RER the Corehole 8 plume collection system will be reported in the BV ROD performance evaluation and will no longer be reported as a single-action.

Bethel Valley D&D

In FY 2009, DOE prepared a RDR/RAWP for D&D of non-reactor facilities and legacy material removal in the BV watershed (DOE 2009b). The RDR/RAWP addresses D&D of approximately 180 facilities including near-term projects funded by the American Recovery and Reinvestment Act (ARRA) that are planned for completion in 2011, and other (non-ARRA funded) facility D&D and legacy material removal scope planned for implementation over a 20+ year period. Key work components described in the RDR/RAWP are site preparation, removal of legacy material, building D&D to slab or grade level, waste management, site restoration, and demolition. The RDR/RAWP received regulatory approval on February 3, 2010. Waste handling plans have been approved with field activities initiated in July 2010. Asbestos abatement work is currently in progress. Remediation of building slabs and soils, D&D of reactor facilities, and other RAs identified in the BV ROD will be addressed in separate CERCLA documents.

Demolition was initiated in FY 2009 on one of the highest hazard excess facilities at ORNL, the Facility 3026 C&D Radioisotope Development Laboratory. A roof failure in 2007 damaged the fire suppression sprinkler system, requiring it to be deactivated. DOE determined that the resulting risks from this deactivation warranted implementing a Time-Critical AM (DOE 2009c) to remove the Facility 3026 C&D wooden structure. Preliminary work for the demolition was initiated in FY 2009 with the removal of asbestos-containing materials, the removal of hazardous materials, and the removal of hot-cell piping and ductwork and was completed in November 2009. The demolition and stabilization were completed on February 26, 2010. Over 1.7 million pounds of building debris were sent to the Environmental Management Waste Management Facility (EMWMF). An additional 25 cubic yards of waste were processed and dispositioned via alterative pathways. The remaining hot cell structures and the slab were coated with a polyurea-type coating to stabilize the surfaces and the 3026 C&D area was transitioned to the DOE hot-cell D&D contractor on September 23, 2010. Any required follow-on monitoring will be addressed in the RmAR.

The Time-Critical AM for the 2000 Complex Facilities Demolition (DOE 2009d) received regulatory approval on October 2, 2009. The demolition of the 2000 Complex Facilities was a two phase process. The first phase (2000 Complex East) was completed in FY 2010 with the demolition of six buildings (2001, 2019, 2024, 2087, 2088, and 2092). Work on the second phase demolition (2000 Complex West, Buildings 2000 and 2034) was also initiated in FY 2010. During FY 2010 Phase 1 work, over 5,700 cubic yards of waste were transported for disposal at the Y-12 landfill.

The Time-Critical AM for buildings 3074 & 3136, and the 3020 Stack (DOE 2009e) was approved by Tennessee Department of Environment and Conservation (TDEC) on May 4, 2009. This removal action includes the dismantlement of buildings 3074 and 3136 which was completed in FY 2010 to allow for the dismantlement of the 3020 Stack.

2.2 RECORD OF DECISION FOR INTERIM ACTIONS FOR THE BETHEL VALLEY WATERSHED

The ROD for Interim Actions in BV (DOE 2002a) was approved by the three FFA parties on May 2, 2002. Under this decision, a combination of RAs, including containment, stabilization, removal, treatment, monitoring, and LUCs, will be implemented to address inactive units, accessible sources of contamination, and contaminated media to the extent practicable. The scope includes contaminated buildings and other facilities designated for D&D, buried waste, underground liquid low-level waste (LLLW) tanks, accessible underground process and LLLW transfer pipelines, accessible contaminated surface and subsurface soil, contaminated sediment and surface water, contaminated groundwater, and groundwater monitoring wells and piezometers no longer needed for monitoring. The scope does not include active facilities (e.g., Bldg. 4500N) and infrastructure at ORNL that have ongoing missions, nor does it include contaminated media or sources that are considered inaccessible due to the presence of the active facilities and infrastructure. Also, a final groundwater decision is not within the scope of this ROD. The participating federal and state agencies desire to complete source control actions, monitor their effectiveness, and collect limited additional characterization data. Figure 2.1 shows the BV area, locations of completed and ongoing CERCLA actions, and elements of the BV remedy. Areas of groundwater contamination in the Central BV area are shown on Figure 2.3 and areas of contaminated groundwater in West BV and the Raccoon Creek headwaters are shown on Figure 2.4.

2.2.1 Performance Goals and Monitoring Objectives

The BV ROD specified surface water quality, surface water risk goals, and groundwater controls to be achieved within specified periods after completion of the RAs. The ROD also included specific performance objectives that would be used as the metrics to evaluate the effectiveness of the remediation. These goals and metrics are presented below. The evaluation of performance during FY 2010 is presented in Sect. 2.2.2.

RAOs were developed separately for the Central and East BV and the West BV and Raccoon Creek areas. This was done because contamination in West BV/Raccoon Creek is limited to discrete areas (i.e., SWSA 3, the Contractor's Landfill, the Closed Scrap Metal Area, and a few small areas of potential surface soil contamination), while the Central/East BV area contains widespread contamination resulting from its use as a nuclear research laboratory. Thus, land use options that were considered in the feasibility study (FS) for the West BV/Raccoon Creek area were different from those considered for the Central/East BV area. Additional information concerning the RAOs for the ROD for Interim Actions in BV are included in Chap. 2 of Vol. 1 of the FY 2007 RER (DOE 2007a).

The BV ROD stipulated a RAOs for BV based on future land use including controlled industrial use (the main ORNL Plant area), unrestricted industrial use (the other currently developed areas), a recreational use area (buried waste disposal areas), and unrestricted use areas (including West BV/Raccoon Creek and portions of the Bearden Creek drainage to the east), protection of surface water, protection of groundwater and protection of ecological receptors (Table 2.3). Highlighted portions of the RAO are supported by ongoing monitoring and are discussed in detail in subsequent sections for this RER.

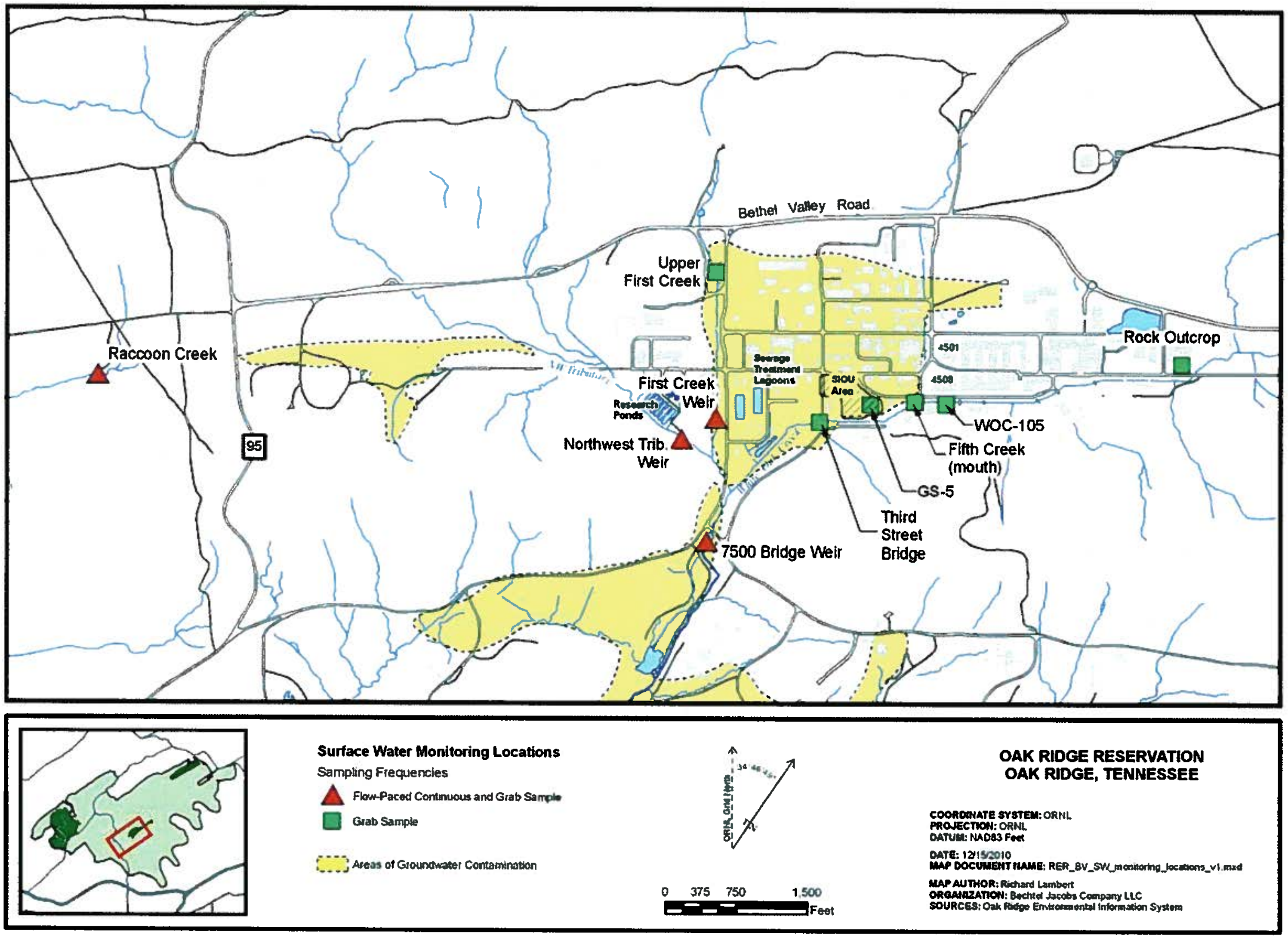

Figure 2.3. CERCLA surface water monitoring locations in ORNL main plant area.

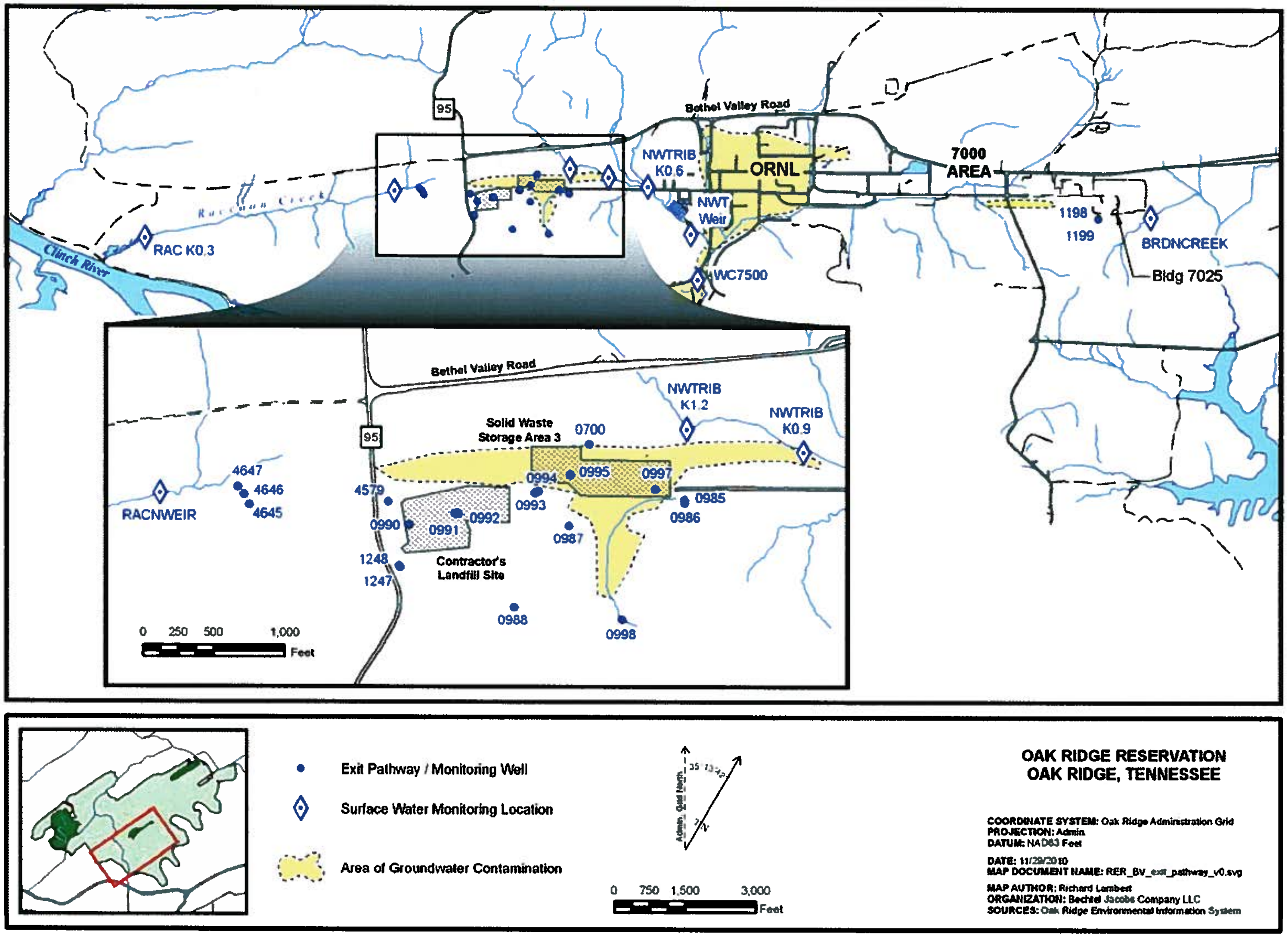

Figure 2.4. BV exit pathway monitoring locations.

Table 2.3. RAOs for the selected remedy for BV

Issue	*Protection goals*
Future land use	*Protect human health for: (1) controlled industrial use in ORNL's main plant area, (2) unrestricted industrial use in the remainder of the ORNL developed areas, (3) recreational use of SWSA 3 and the Contractor's Landfill, and (4) unrestricted use in the undeveloped areas, all to a risk level of* 1×10^{-4}
Protection of surface water bodies	*Achieve AWQC for designated stream uses in all waters of the state*
	Achieve at least 45% risk reduction at the 7500 Bridge
	Maintain surface water and achieve sediment recreational risk-based limits to a goal of 1×10^{-4}
Groundwater protection	*Minimize further impacts to groundwater*
	Prevent groundwater from causing surface water exceedances in all waters of the state
Protection of ecological receptors	*Maintain protection for area populations of terrestrial organisms; protect reach-level populations of aquatic organisms*

AWQC = ambient water quality criteria

RAOs for surface water include attainment of a 45% risk reduction from baseline levels of 1994 at the 7500 Bridge and attainment of ambient water quality criteria (AWQC) for designated stream uses. Principal contaminants of concern (COCs) identified for risk reduction at the 7500 Bridge include ^{90}Sr and ^{137}Cs. In addition, the ROD specifies the attainment and maintenance of water quality and sediment contaminant levels of 1×10^{-4} for a hypothetical recreational use scenario. The RAO for groundwater is to prevent further degradation of water quality by remediation of soils that contribute to groundwater contamination above a 1×10^{-4} risk level for a hypothetical industrial use scenario, to protect surface water by continued collection and treatment of groundwater that causes surface water exceedances, and to reduce surface water risk from contaminated groundwater discharge. The ROD also includes the requirements to monitor groundwater exit pathway wells and to monitor groundwater in the vicinity of contaminant source control areas to measure effectiveness of contaminant source control actions. Post-remediation monitoring and LTS requirements will be developed in the PCCR for each element of the remedy.

The BV ROD included specific performance objectives and performance measures that form the basis of remediation effectiveness monitoring. These performance objectives provide a quantitative basis to evaluate the effectiveness of remedial activities including the attainment of AWQC numeric and narrative goals related to contaminant discharges to surface water, and the evaluation of hydrologic isolation at limiting contaminant releases from buried waste by monitoring groundwater fluctuation within hydrologic isolation areas. Table 2.4 includes the ROD performance objectives and performance measures for the defined elements of the remedy.

Table 2.4. *Performance measures for major actions in Bethel Valley, ORNL, Oak Ridge, Tennessee*[a]

Waste type	*Unit*	*Remedial actions*	*Performance objective (protection goals)*	*Performance measure (demonstration of effectiveness)*
Facilities D&D *(buildings and appurtenances)*	*Multiple* (53) *structures*	*Remove facilities to grade. Remaining structures at or below grade will undergo decontamination and stabilization or removal depending on cost effectiveness and underlying soil contamination*	*Protect human health for industrial use; minimize further impacts to groundwater*	*Contamination removed to protect industrial worker to 0.6 m (2 ft) or 3 m (10 ft). Loose contamination in subsurface removed to the extent practicable*
	Graphite Reactor building	*Stabilize Graphite Reactor core*	*Protect human health for industrial use and visitors*	*Negative pressure in building interior no longer needed*
Buried waste	*SWSA 1*	*Install a cap*	*Protect human health for controlled industrial use; minimize further impacts to groundwater*	*Entire area of buried waste covered by cap; infiltration limited by cap*
	Former Waste Pile Area	*Install and/or maintain soil cover*	*Protect human health for controlled industrial use*	*All debris and contamination above remediation levels covered*
	NRWTP Debris Pile	*Install and/or maintain soil cover*	*Protect human health for controlled industrial use*	*All debris and contamination above remediation levels covered*
	SWSA 3	*Install multilayer cap and upgradient surface water and groundwater diversion trench*	*Protect human health through access controls; minimize further impacts to groundwater*	*Entire area of buried waste covered by cap designed to meet relevant RCRA landfill cover requirements; stable or decreasing surface water concentrations; stable groundwater concentrations*
	Contractor's Landfill	*Install and maintain soil cover*	*Protect human health through access controls*	*All contamination above remediation levels covered*
Tank sludge and linings	*Tank contents*	*Remove sludge and liquid from S-424, T-1, T-2, and HFIR*	*Minimize further impact to groundwater*	*Sludge removed to the extent practicable*
	Tank shells	*Fill the four tanks with grout*	*Minimize further impacts to groundwater*	*Tanks filled to the extent practicable*
Inactive LLLW pipelines	*Inside main plant area*	*Stabilize pipelines and add trench barriers*	*Maintain surface water recreational risk-based limits; achieve at least 45% risk reduction at 7500 Bridge; minimize further impacts to groundwater*	*Surface water goals met. Pipelines filled to the extent practicable*
	Outside main plant area	*Remove pipelines and contaminated bedding material [estimated at 1000 lin m (4000 lin ft)]*	*Protect human health for unrestricted industrial use*	*Meet remediation levels to 3 m (10 ft)*
Contaminated soil impacting worker protection	*Main plant area*	*Remove contaminated surface soil [estimated at 9000 m^3 (12,000 yd^3)]. Up to 10% of area may be covered.*	*Protect human health for controlled industrial use*	*Meets remediation levels to 0.6 cm (2 ft). Substitutions of covers for removal determined on a case-by-case analysis during design*
	Outside main plant area	*Remove contaminated soil to 3 m (10 ft) [estimated at 500 m^3 (700 yd^3)]*	*Protect human health for unrestricted industrial use*	*Meets remediation levels to 3 m (10 ft)*

Table 2.4. *Performance measures for major actions in Bethel Valley, ORNL, Oak Ridge, Tennessee*[a] (cont.)

Waste type	*Unit*	*Remedial actions*	*Performance objective (protection goals)*	*Performance measure (demonstration of effectiveness)*
	Vicinity of SWSA 3 (multiple contaminated locations)	*Remove soil [estimated at 17,500 m^3 (22,900 yd^3)]*	*Protect human health for unrestricted use*	*Meets remediation levels*
Contaminated soil impacting groundwater	*Bethel Valley*	*Remove contaminated soil [estimated at 1500 m^3 (2000 yd^3)]*	*Minimize further impacts to groundwater*	*No soil above trigger levels and not contributing above 10^{-4} industrial risk from groundwater*
Sediment and floodplain soils	*White Oak Creek, First Creek and Fifth Creek*	*Remove contaminated sediment to depth of deposition and floodplain soils to a maximum depth of 0.6 m (2 ft) [estimated at 13,500 m^3 (17,600 yd^3)]*	*Achieve recreational risk-basked limits in sediment, achieve at least 45% risk reduction at 7500 Bridge (primarily ^{137}Cs); protect human health for controlled industrial use; protect reach-level benthic invertebrate populations*	*Meets remediation levels and results in healthy benthic invertebrate populations. Meets surface water goals of at least 45% risk reduction at 7500 Bridge*
Groundwater	*Core Hole 8 Plume*	*Extract groundwater from four wells and from sumps at seven stormwater junction boxes [estimated at combined rate of 380 L/min (100 gal/min)]*	*Prevent groundwater from causing surface water exceedances (at least 45% risk reduction at 7500 Bridge); minimize further impacts to groundwater*	*Controls plume growth; collect highly contaminated groundwater to extent practicable; effluent meets surface water goals and plant NPDES permit*
	^{90}Sr-contaminated sumps	*Pump from 27 existing sumps [estimated at combined rate of 360 L/min (81 gal/min)]; continue to treat to remove ^{90}Sr*	*Prevent groundwater from causing surface water exceedances (recreational risk-based levels and at least 45% risk reduction at 7500 Bridge)*	*Streams meet surface water goals (recreational risk and at least 45% risk reduction at 7500 Bridge); effluent meets surface water goals and plant NPDES permit*
	Mercury-contaminated sumps	*Pump from four existing sumps at a combined rate of 34 L/min (9 gal/min); add treatment to remove mercury*	*Prevent groundwater from causing surface water exceedances (meet AWQC)*	*Streams meet AWQC in surface water; effluent meets surface water goals and plant NPDES permit*
	VOC Plume	*Implement enhanced in situ anaerobic bioremediation*	*Minimize further impacts to groundwater*	*Biodegradation occurs and reduces VOC mass and concentration*
	Well P&A	*Grout obsolete or poor quality monitoring wells and piezometers and abandon in place (estimated at 229 wells); in areas designated for unrestricted industrial or unrestricted use, remove to depth of 3 m (10 ft)*	*Protect human health for the specified industrial use; minimize further impacts to groundwater*	*No unacceptable risk to workers. Consistent with TDEC plugging and abandonment standards [1200-4-6-.09(6)]*

[a]Source: Table 2.37 of BCV ROD.

AWQC = ambient water quality criteria
LLLW = liquid low-level (radioactive) waste
NPDES = National Pollutant Discharge Elimination System
NRWTP = Nonradiological Wastewater Treatment Plant
ORNL = Oak Ridge National Laboratory
P & A = plugging and abandonment
RCRA = Resource Conservation and Recovery Act of 1976
Sr = strontium
SWSA = solid waste storage area
VOC = volatile organic compound

2.2.2 Evaluation of Performance Monitoring Data

2.2.2.1 Surface Water Monitoring Data

This section presents the results of remedy effectiveness evaluation surface water monitoring in BV. Section 2.2.2.1.1 summarizes the remediation goals for surface water. Section 2.2.2.1.2 presents information concerning major radionuclide concentrations and fluxes at the surface water IP monitoring stations. Section 2.2.2.1.3 presents data obtained at the tributary sampling locations.

2.2.2.1.1 Surface Water Quality Goals and Monitoring Requirements

Surface water goals include protection of the Clinch River to meet its stream use classification (e.g., as a domestic water supply), and to achieve AWQC in waters of the state. The ROD includes specific surface water remediation levels (RLs), as outlined in Table 2.5. Locations where surface water monitoring occurs to evaluate the remedy performance are shown on Figure 2.3. The following excerpts from the BV ROD (Sect. 2.12.7.3 Remediation Levels for Surface Water) include the specific concentration goals for the principal surface water COCs in BV.

Remediation levels for surface water

Remediation levels for surface water are established for each of the three surface water protection or remediation goals stated in the RAO (Sect. 2.8.2). These three goals and a brief explanation of their origin are given below.

1. *Achieve AWQC for designated stream uses in all waters of the state. White Oak Creek is classified for Fish and Aquatic Life, Recreation, and Livestock Watering and Wildlife uses, but not for Domestic or Industrial Water Supply or Irrigation. All other named and unnamed surface waters in the valley are also classified for Irrigation by default under the Rules of the TDEC Chap. 1200-4-4. Both numeric AWQC and narrative criteria for the protection of human health and aquatic organisms will be met. Numeric AWQC exist for selected compounds under the Recreation and Fish and Aquatic Life use classifications. Consistent with EPA guidance, compliance with numeric AWQC for Recreation and Fish and Aquatic Life classifications is sufficiently stringent to ensure protection of other uses for which there are narrative, but not numeric, criteria (i.e., Irrigation or Livestock Watering and Wildlife).*

2. *Maintain surface water risk below the recreational risk-based limit of 1×10^{-4}. This goal is a more explicit statement on how the narrative criteria portion of the AWQC goal described above will be achieved for Bethel Valley. The CERCLA risk assessment process is used for quantifying remediation levels to address the narrative AWQC for recreational use.*

3. *Achieve at least 45% risk reduction in surface water exiting Bethel Valley. This goal is a direct corollary of a goal in the Melton Valley watershed ROD to protect an off-site resident user of surface water within 10 years from completion of actions in Melton Valley and Bethel Valley. To protect the off-site resident, the Melton Valley watershed ROD established remediation levels at the confluence of White Oak Creek with the Clinch River to achieve an annual average ELCR of 1×10^{-4} and an HI of 1 for a residential exposure scenario (i.e., general household use). The Melton Valley watershed FS (DOE 1998c) estimated that the risk at White Oak Dam was 6.4×10^{-4} ELCR under a hypothetical residential scenario and 1994 baseline conditions. Of this total risk, Bethel Valley contributed approximately 20% (1.3×10^{-4} ELCR), primarily in the form of ^{90}Sr and ^{137}Cs. Assuming the Melton Valley remedy achieves at least an 82% reduction of the*

Melton Valley contribution to the risk at White Oak Dam, then Bethel Valley must achieve at least a 45% risk reduction in surface water exiting Bethel Valley to meet the Melton Valley watershed ROD goal of protection the off-site resident.

Remediation levels for the three goals are summarized in Table 2.5 (*Table 2.38 in ROD) and explained in more detail in the following three subsections: Numeric AWQC, Narrative Criteria, and Risk Reduction for Off-Site Releases. The surface water remediation levels will be met within 10 years from completion of source actions in Bethel Valley.*

Numeric AWQC. *The Bethel Valley RI/FS noted numeric AWQC exceedances for cadmium, chromium, copper, iron, and mercury in White Oak Creek, First Creek, and Fifth Creek (Remedial Investigation/Feasibility Study for Bethel Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee, DOE/OR/01-1748&D2, Oak Ridge, Tennessee). However, AWQC will be met for all site-related contaminants in all waters of the state. The numeric AWQC for (1) Fish and Aquatic Life and (2) Recreation (organisms only) use classifications are tabulated in Rules of the TDEC Chap. 1200-4-3.03. Compliance will be based on statistically valid data assessments. The initial sampling locations proposed for determining compliance were shown previously in* Figure 2.3*(Figure 2.36 in ROD) ; these sampling locations will be finalized in a post-ROD sampling Plan. The locations are generally at the downstream end of individual reaches but before any confluence with other major streams. Samples taken from such locations would essentially integrate contamination entering the reach from any sources upstream of the sampling location.*

Table 2.5. Surface water remediation levels for Bethel Valley, ORNL, Oak Ridge, Tennessee

Bethel Valley	***Numeric AWQC***	***Narrative criteria***[a]	***Risk Reduction for off-site releases***
Receptor	*Hypothetical recreational user: fish and aquatic life*	*Hypothetical recreational user*	*Hypothetical off-site resident*
Areas affected	*All waters of the state*	*All waters of the state*	*Confluence of WOC with the Clinch River*
Anticipated compliance locations	*See Fig. 2.36* (Figure 2.3*)*	*See Fig. 2.36 (remediation levels are applied to selected reaches*[b]*)*	*7500 Bridge or equivalent integration point*
Remediation level	*Levels established in Rules of the TDEC Chap. 1200-4-3-.03*	*Annual average ELCR* $<1 \times 10^{-4}$ *and HI <1*	*Surface water risk (based on* ^{90}Sr *and* ^{137}Cs *only) will be at least 45% less than the 1994 baseline*
Exposure scenarios	*NA (numeric criteria tabulated in regulation; no separate calculation using exposure scenarios needed)*	*Hypothetical recreational wading for waters of the state (the exposure scenario does not include fish ingestion)*	*Hypothetical residential (i.e., general household use) scenario at confluence of WOC with the Clinch River translated to a risk reduction of at least 45 percent in surface water exiting Bethel Valley (i.e., 7500 Bridge) from a 1994 baseline*

[a]*Unacceptable risks in surface water do not exist in Bethel Valley based on the RI/FS analysis. If unacceptable risks are encountered in the future, then the narrative criteria will be achieved by developing remediation levels based on a hypothetical recreational receptor.*

[b]*Surface water reaches: First Creek, Fifth Creek, Northwest Tributary, Raccoon Creek. WOC between 7500 Bridge and First Creek. WOC between First Creek and Fifth Creek, and WOC above Fifth Creek.*

AWQC = ambient water quality criteria
ELCR = excess lifetime cancer risk
FS = feasibility study
HI = hazard index
NA = not applicable
RI = remedial investigation
TDEC = Tennessee Department of Environment and Conservation
WOC = White Oak Creek
Source: Bethel Valley ROD Table 2.38.

Narrative Criteria. *The CERCLA risk assessment process is used to address the narrative criteria for waters of the state. A recreational risk scenario considered representative of the surface water use classifications is used to calculate cumulative risk from measured concentrations of surface water contaminants or, conversely, to derive allowable concentrations from risk-based limits.*

Based on the human health risk assessment in the Bethel Valley RI/FS, no waters of the state exceeded recreational risk-based limits. Therefore, no surface water risk-based COCs were identified for which allowable concentrations need to be derived at this time. However, if in the course of periodic surface water monitoring, consistently unacceptable recreational risks are found and new significant COCs are identified, then the risk assessment process will be used to derive allowable concentrations for the new surface water COCs.

Waters of the state must achieve an annual average ELCR less than 1 x 10-4 and an HI less than 1 for a recreational exposure scenario. This goal applies only to surface water and only to those COCs, such as radionuclides, that do not have numeric AWQC. The numeric AWQC for individual contaminants is generally equivalent to risk levels ranging up to 10^{-5}*. The annual average risk goal of* 1×10^{-4} *meets the intent of the AWQC because, when multiple contaminants are present in the surface water, their individual risk levels would be roughly equivalent to the AWQC-equivalent risk of* 10^{-5}*. A lower risk goal could require individual contaminant risks to be below the AWQC-equivalent risk of* 10^{-5}*.*

Under this ROD, the recreational scenario is defined as a wading scenario in the streams. It does not include fishing because the streams are too small to support fishable fish. The initial sampling locations proposed for determining conformity with these levels are shown in Figure 2.3 *(Fig. 2.36 in ROD); these sampling locations will be finalized in a post-ROD sampling plan. The locations are at the downstream end of individual reaches (i.e., First Creek, Fifth Creek, NWT, Raccoon Creek, White Oak Creek between 7500 Bridge and First Creek, White Oak Creek between First Creek and Fifth Creek, and White Oak Creek above Fifth Creek) but before any confluence with other major streams. Samples taken from such locations would essentially integrate contamination entering the reach from any sources upstream of the sampling location.*

Risk Reduction for Off-Site Releases. *Surface water exiting Bethel Valley must achieve at least 45% risk reduction from a 1994 baseline. This 45% risk reduction will be based on the combined risk from* ^{90}Sr *and* ^{137}Cs*, the two principal risk contributors, and is in addition to that reduction attributable to radioactive decay from 1994. The 45% reduction in total residential ELCR must be achieved within 10 years from completion of source actions selected in this ROD in Bethel Valley.*

Samples to demonstrate compliance with the 45% risk reduction will be taken at the 7500 Bridge or equivalent integration point. If the continuous samplers are used at the 7500 Bridge, as expected, averages of the measured concentrations rather than the UCL_{95} *will be used for the average concentration parameter in the risk calculation.*

Sampling locations, schedules and analytical parameters to provide data to meet surface water performance metrics are shown in Table 2.6.

2.2.2.1.2 Surface Water Monitoring Results

This section presents the surface water monitoring results of watershed-scale contaminant discharge monitoring and project-specific monitoring results related to completed or ongoing CERCLA projects under this ROD such as the Building 4501 mercury sumps action and the SWSAs 1 & 3 RA. Watershed-scale surface and groundwater monitoring provides baseline data against which to determine the effectiveness of RAs as well as verifying reduction of offsite releases of contaminants.

Table 2.6. Watershed-scale CERCLA monitoring requirements and performance standards for BV Watershed[a]

Media	Monitoring location	Schedule	Parameters	Performance standard
Surface water	7500 Bridge weir	Continuous flow-proportional monthly composite sample	^{90}Sr, ^{3}H, gamma[b] (flux)	Achieve 45% risk reduction from 1994 levels at 7500 Bridge (based on combined risk from ^{90}Sr and ^{137}Cs); achieve AWQC for all designated stream uses in all waters of the state.
		Semiannual grab sample	Metals (including Hg), gross alpha, gross beta, gamma, ^{90}Sr, ^{3}H	Baseline
		Annual grab sample (year prior to FYR)	AWQC	AWQC
		Monthly grab sample	Hg	Integration Point Hg assessment
	First Creek weir	Continuous flow-proportional monthly composite sample	gross alpha, gamma, ^{90}Sr (flux)	^{90}Sr and ^{137}Cs (flux)
		Semiannual grab sample	gross alpha, gross beta, gamma, ^{90}Sr, ^{3}H	Baseline
		Annual grab sample (year prior to FYR)	AWQC	AWQC
	NWT weir	Continuous flow-proportional monthly composite sample	gamma, ^{90}Sr, ^{3}H (flux)	gamma, ^{90}Sr, ^{3}H (flux)
		Semiannual grab sample	Metals, gross alpha, gross beta, gamma	Baseline
		Annual grab sample (year prior to FYR)	AWQC	AWQC
	Raccoon Creek weir	Continuous flow-proportional monthly composite sample	^{90}Sr, ^{3}H (flux)	^{90}Sr, ^{3}H (flux)
		Semiannual grab sample	Metals, gross alpha, gross beta, gamma	Baseline
		Annual grab sample (year prior to FYR)	AWQC	AWQC
	Bearden Creek	Semiannual grab sample	^{3}H	Baseline
Groundwater	West BV/Raccoon Creek area exit pathway wells	Semiannual[c] grab samples	gross alpha, gross beta, ^{90}Sr	Exit pathway monitoring to determine if contaminants are leaving known contaminated areas.
	East BV exit pathway wells	Semiannual grab samples	^{3}H, VOCs	

[a]This table represents current requirements for monitoring included in the ROD for Interim Actions for the BV Watershed, post-decision primary documents, or any subsequent addenda that have received concurrence/approval from the U.S. Environmental Protection Agency and Tennessee Department of Environment and Conservation.

[b]Gamma scan provides ^{137}Cs, ^{60}Co, and ^{40}K activity.

[c]Per the BV Groundwater Engineering Study Report, semiannual grab samples in each monitoring zone were recommended for two years (starting in FY 2006), which provided a total of six baseline values. If analytical results are consistent, monitoring will be reduced to high- and low-base sampling every three years. If those results are consistent for a period of nine years (through

Table 2.6. Watershed-scale CERCLA monitoring requirements and performance standards for BV Watershed[a,b] (cont.)

FY 2016), monitoring will be reduced to high- and low-base sampling every five years. Monitoring at this frequency will continue until a statistically valid decreasing concentration trend is clearly demonstrated. Note: monitoring has not been reduced due to presence of contamination.

Surface water monitoring in BV includes both continuous, flow-paced monitoring at key locations and routine collection of grab samples. Figure 2.3 shows the locations of CERCLA surface water monitoring sites in Central BV. The Raccoon Creek surface water and exit pathway groundwater monitoring locations and Bearden Creek surface water and exit pathway groundwater monitoring locations are shown in Figure 2.4.

Watershed-scale Surface Water Monitoring Results

Radiological Discharges to White Oak Creek

Historic and ongoing discharges of ^{90}Sr and ^{137}Cs in surface water in the central part of BV are principal COCs that directly impact the condition of the watershed and are performance metrics for the BV ROD. Tritium discharges in WOC surface water in BV originate primarily from sources outside the BV CERCLA area of contamination (AOC) – from groundwater collected in MV and transferred to the PWTC via the groundwater collection and treatment system, and wastewaters generated by Office of Science facilities [High Flux Isotope Reactor (HFIR) and Spallation Neutron Source (SNS)] that are discharged via the PWTC and sanitary sewage systems.

Figure 2.3 shows locations in the ORNL main plant area in BV where contaminant concentrations and flows are measured to estimate the discharge fluxes from various contributing areas or outfalls. Strontium-90 is the principal radiological COC in surface water in BV because it is a fairly widely distributed contaminant in buried waste, in contaminated soils related to LLLW pipeline leaks, and in groundwater. Cesium-137 is a significant surface water contaminant in WOC and its sources include discharges from the PWTC effluent and contaminated soils on the WOC floodplain from the former Surface Impoundments Operable Unit (SIOU) area downstream to 7500 Bridge Weir.

While ROD actions that will directly address several known source areas of ^{137}Cs have not yet been completed, ongoing measurement of these contaminants is conducted to track baseline discharge conditions. However, three CERCLA actions included in the BV ROD are currently in progress that are expected to reduce ^{90}Sr discharges to surface water – the Bethel Valley Burial Grounds RAs at SWSA 1 and SWSA 3, installation of additional groundwater plume extraction wells in the Corehole 8 plume, and completion of the excavation of Tank W-1A and associated contaminated soils. As summarized in Sect. 2.2, surface water goals include 45% reduction of risk levels associated with COCs at the 7500 Bridge monitoring station compared to FY 1994 levels.

Table 2.7 includes the average annual ^{90}Sr and ^{137}Cs activities calculated from the flow-paced composite samples collected at the 7500 Bridge for FY 1994 and FY 2001 through FY 2010. Also included are the concentration goals for ^{90}Sr and ^{137}Cs based on the 45% risk-reduction requirement. As shown in Table 2.7, ^{90}Sr activities exceeded the risk-based goal in 1994, 2004, 2005, 2009, and 2010 while ^{137}Cs activities exceeded the goal in each year except 2006 through 2010. The elevated ^{90}Sr activities of 2004 and 2005 have been noted in previous RERs and were the consequence of prolonged above normal rainfall patterns. Higher than average rainfall during 2009 and 2010 compounded with problems associated with the Corehole 8 system (Sect. 2.3.1) are responsible for the increase in ^{90}Sr during the past two years. Figure 2.5 shows the annual average activities and the average plus one standard deviation activities of ^{137}Cs, ^{90}Sr, and tritium at the 7500 Bridge. The risk-based goals calculated based on the 45% reduction of ^{137}Cs and ^{90}Sr stipulated in the ROD are also shown.

Although the average ^{90}Sr activity at 7500 Bridge increased slightly during FY 2010 compared to FY 2009, the amount of ^{90}Sr discharged remained stable at 0.33Ci. During FY 2010, ungauged ^{90}Sr sources contributed about 5% of the total in comparison to the approximate 40% that originated from Corehole 8 plume discharges to First Creek.

Table 2.7. 7500 Bridge risk-reduction goal evaluation

Year	Average ^{90}Sr (Goal = 37 pCi/L)[b]	Average ^{137}Cs (Goal = 33 pCi/L)[b]
1994[a]	**67**	**59**
2001	37	**219**
2002	37	**116**
2003	37	**41**
2004	**78**	**47**
2005	**70**	**78**
2006	35	33
2007	27	17
2008	27	<6
2009	**40**	12
2010	**42**	10

Bold values indicate years during which annual average concentration exceeded the ROD risk-based goal.

[a]BV ROD baseline year.
[b]Goal = 45% reduction in average concentrations measured during baseline year.

Tritium concentrations in surface water in the BV portion of WOC have increased as a result of collection and transfer of former groundwater discharges from MV to the wastewater treatment system in BV. This activity is conducted as a condition of the MV RA. However, tritium concentrations in surface water throughout WOC are still below the DOE-derived concentration guide and below remedy human health risk goals.

Radiological Discharges to Raccoon Creek and Bearden Creek

Raccoon Creek and Northwest Tributary (SWSA 3 Area). Surface water in the western end of BV is monitored to determine if contaminants discharge to Raccoon Creek and the Clinch River via a western exit pathway. Figure 2.4 shows locations where BV exit pathway sampling is conducted. Contaminated groundwater originating in SWSA 3 seeps to the headwaters of Raccoon Creek, a short distance to the west of Tennessee Highway 95. The seepage pathway from SWSA 3 to Raccoon Creek was discovered in the early 1980s and monitoring has been conducted at the Raccoon Creek Weir since the 1990s. The principal contaminant detected in the Raccoon Creek headwaters is ^{90}Sr. The annual flux of ^{90}Sr discharging via Raccoon Creek has been measured since 1999 with the exception of FY 2005, 2006, and part of 2007 when problems with flow measurements at the site prevented the ability to estimate flux. Surface water and groundwater monitoring to obtain pre-remediation baseline data for the remediation of SWSA 3 was started in FY 2010.

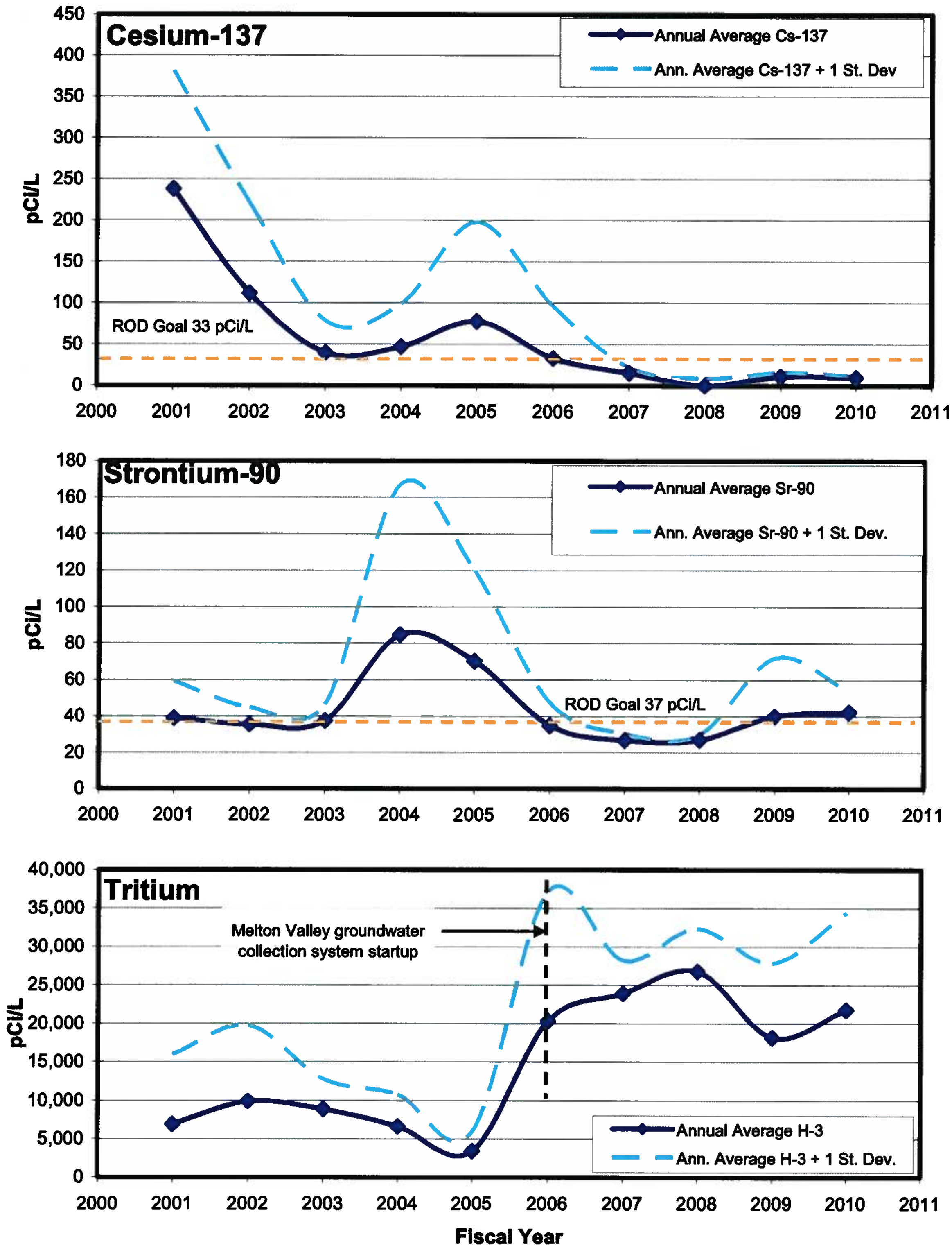

Figure 2.5. Annual average activities of ^{137}Cs, ^{90}Sr, and tritium at 7500 Bridge.

Table 2.8 summarizes average ^{90}Sr activity data from continuous flow samples collected at the Raccoon Creek Weir and estimated flux for periods when reliable station flow data were available. The ^{90}Sr activities at the weir have historically fluctuated inversely to the amount of flow at the station because the seepage pathway from the source is in bedrock and groundwater seepage constitutes a higher proportion of baseflow during dry seasons than it does during wet seasons. During above-normal rainfall periods, such as those experienced in 2003 and 2004, the flux of ^{90}Sr discharged via Raccoon Creek increases. Historically, during 1998, the highest ^{90}Sr activities measured at Raccoon Creek were nearly 100 pCi/L.

Table 2.8. ^{90}Sr data from Raccoon Creek Weir

Year	Flow volume (L)	^{90}Sr Result (pCi/L)	^{90}Sr Flux (Ci)
FY 1999 Total	244,698,985		4.40E-04[a]
FY 2001 (11 months)	315,555,053	6.7[b]	6.10E-04
FY 2002 Total	318,825,472	8.7[b]	9.35E-04
FY 2003 Total	380,747,035	5.9[b]	1.07E-03
FY 2004 Total	254,073,296	9.6[b]	1.68E-03
FY 2005	NA[c]	16.8[b]	--
FY 2006	NA[c]	29.3[b]	--
FY 2007 (Feb. – Jul.)	86,992,200[d]	14.5[d]	3.9E-04[d]
FY 2008	117,209,419	15.5	6.4E-04
FY 2009	235,559,024	7.6	6.2E-04
FY 2010	279,337,003	5.6[e]	1.9E-04

[a]Flux for FY 1999 was reported at 0.37 mCi in the 2000 Remediation Effectiveness Report (DOE 2000a). The flux was subsequently recalculated to include "nondetected" concentrations omitted from the original calculation.
[b]Activity value represents average activity for all monthly flow composite samples at the station.
[c]The FY 2005 and 2006 flow and flux data are not reported as the data have been deemed unusable due to problems associated with the weir.
[d]Station was returned to full operation at end of January 2007. Reported flows and fluxes are calculated for the months when flow was present after station maintenance.
[e]Strontium-90 was below minimum detectable activities in 7 of the 12 monthly composite samples during FY 2010.
NA = not applicable

Surface water monitoring is also conducted in the Northwest Tributary as part of general watershed monitoring as well as for pre- and post-remediation performance evaluation of the Bethel Valley Burial Grounds SWSA 3 RA. The surface water sampling in Raccoon Creek and Northwest Tributary are conducted to establish both the activity level and flux of ^{90}Sr which is the principal contaminant of concern in surface water in the area. Continuous flow sampling has been conducted at the Northwest Tributary Weir (NWT Weir) and the Raccoon Creek Weir (RACNWEIR) for many years. Semi-annual grab samples are collected at the NWTRIB K0.3, K0.6, 0.9, and K1.2 stations, as well as at RAC K0.3. Instantaneous flow measurements are made in the stream channels at the time samples are collected to provide an estimate of flux (Table 2.9).

Table 2.9. Daily ^{90}Sr flux grab sample activity

Station	Instantaneous ^{90}Sr flux (Ci/day)	
	10/26/2009	3/16/2010
NWTRIB K1.2	dry	6.22E-08
NWTRIB K0.9	dry	dry
NWTRIB K0.6	0.75	1.05
NWTWeir	0.37	0.68
RACNWEIR	6.47E-03	4.02E-03
RAC K0.3	< 7.49E-01[1]	<2.16E-03[1]

[1] ^{90}Sr activity below MDA - MDA value used to calculate a maximum value for flux
MDA = minimum detectable activity

The long-term flux monitoring of both the Northwest Tributary and the Raccoon Creek weir show that the amount of ^{90}Sr leaving the SWSA 3 area via Raccoon Creek is on average less than 5% of the surface water flux for both streams combined. Strontium-90 activity levels in Raccoon Creek are low and during FY 2010, seven of the 12 monthly composite samples had results below the minimum detectable activity (MDA) which ranged from 1.5 to 2.5 pCi/L. Figure 2.6 shows the monthly percentage that Raccoon Creek comprises of the combined Raccoon Creek and Northwest Tributary ^{90}Sr discharge as well as the measured ^{90}Sr activity in each monthly composite sample for FY 2006 through FY 2010.

Bearden Creek (7000 area). Surface water is sampled in a tributary of Bearden Creek at the eastern end of BV to evaluate contaminant discharges to surface water eastward from the 7000 Services Area. The principal contaminant source that affects this area is the former tritium handling facility at Bldg. 7025 (Figure 2.4). Tritium has been detected in groundwater and surface water in the area, as described below. The 7000 Services Area is also the site of a VOC plume in groundwater (Figure 2.4) that migrates westward from its source.

Surface water monitoring has been conducted in the Bearden Creek tributary near the ORNL 7000 Services Area since the mid-1990s. Parameters included in analytical suites have varied over the monitoring history and have included metals, VOCs, and radionuclides. Metals, VOCs, and gross alpha and beta activity have not exceeded drinking water criteria with the exception of aluminum, which may be related to suspended solids as indicated by elevated turbidity levels in field measurements. Of 23 results obtained since the mid-1990s, 12 contained detectable activities of tritium. During 1998 and 1999, two samples were reported to contain tritium at activities greater than the drinking water limit; however, these results are considered suspect because of possible laboratory problems. During the period 2000 through 2005, 7 of 10 samples analyzed contained detectable tritium at activities ranging from 417 pCi/L to 949 pCi/L, all of which were less than 5% of the drinking water EDE limit of 20,000 pCi/L. During FY 2010, the Bearden Creek headwater location was sampled once in January and tritum was not detected. During July a sample was collected from the tributary of Bearden Creek near its confluence with the mainstem. The tritium activity in that sample was 511 pCi/L which is similar to levels detected previously near the source area.

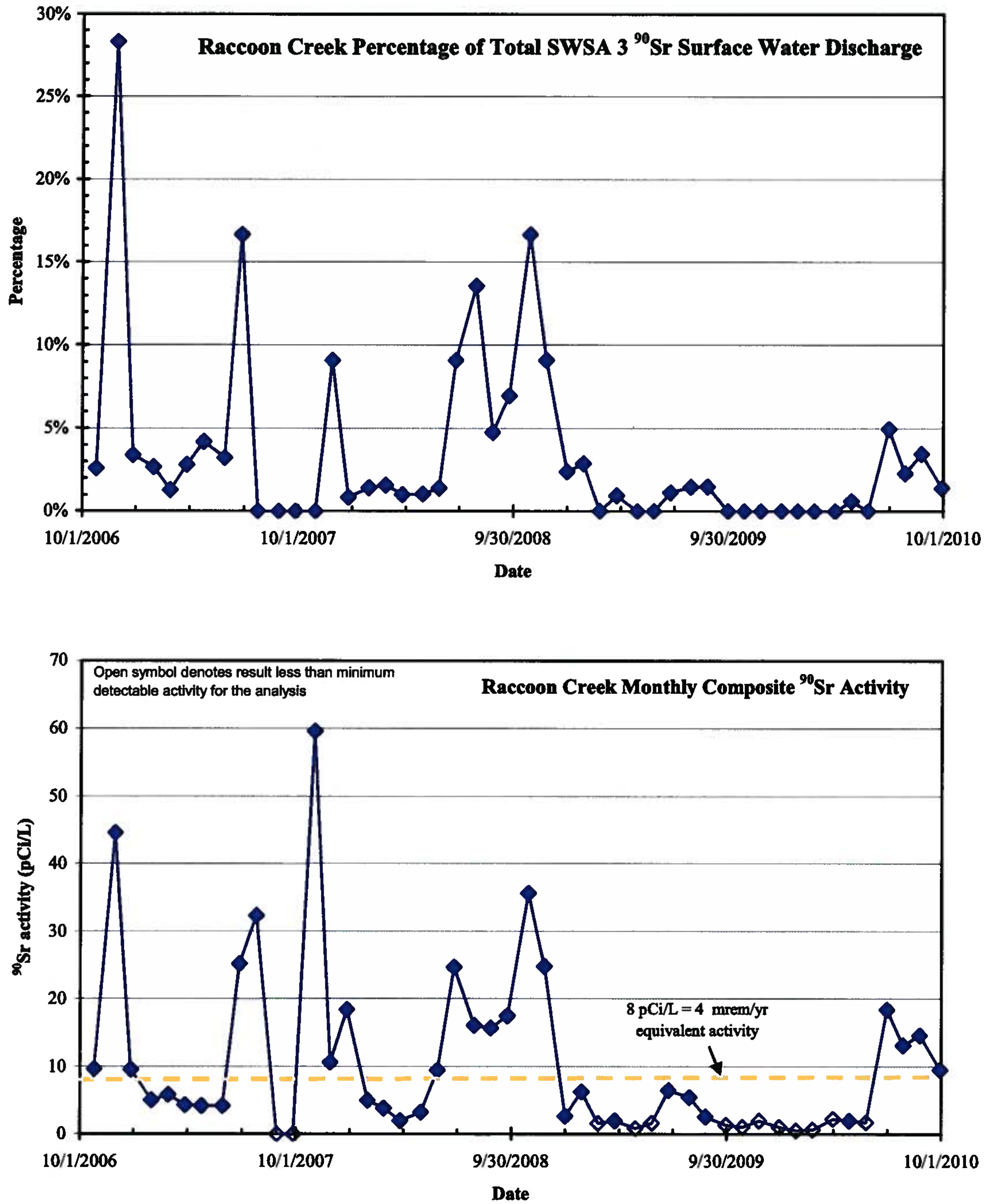

Figure 2.6. Raccoon Creek Percentage of combined SWSA 3 surface water ^{90}Sr discharge.

FY 2010 Ambient Water Quality Criteria Monitoring

During FY 2010 surface water was sampled at ten locations in BV in March and August. Sampling locations are shown on Figure 2.3. The AWQC analytes include an extensive list of metals, volatile and semi-volatile organic compounds, pesticides, polychlorinated biphenyls (PCBs), and dioxin/furan compounds.

- Metals: The only metal that exceeded the AWQC was mercury which is discussed in detail in the following sections.

- VOCs: No volatile or SVOCs approached or exceeded the AWQC.

- PCBs: PCBs were not detected in surface water, although they are known to exist in the Fifth Creek and First Creek drainage areas based on their presence in fish tissue collected from these creeks.

- Dioxin/furans: Dioxin/furan compounds are detected or estimated to be present at very low concentrations at most sampling locations. These compounds are fairly ubiquitous in the environment because they are combustion byproducts and are widely dispersed through atmospheric transport. None of the surface water results from Bethel Valley indicated an exceedance of the AWQC. The sampling location that appears to show a higher level of these compounds than other areas is Fifth Creek where elevated levels of octachlorodibenzo[b,e][1,4]dioxin was detected at 245 and 327 pg/L. Elevated levels of the same compound were detected downstream in WOC. This observation suggests a possible association with the PCB source in Fifth Creek.

- Pesticides: Pesticide residues are also present in surface water in BV. Chlordane exceeds the AWQC at both locations sampled in First Creek and at the upstream location in WOC (Rock Outcrop). The suspected source of chlordane in First Creek is historic treatment of the original facility buildings and grounds in the western part of the main plant area, while a possible source in upper WOC is residue from spray tank cleaning that was conducted near the ORNL 7000 area. Heptachlor was also present at a level greater than the AWQC at the upper WOC location.

Surface Water Mercury Monitoring

Mercury is also a contaminant of concern in surface water in BV because of its strong bioaccumulation tendency in fish. Mercury sampling has been conducted for many years at the 7500 Bridge. Since winter of 2008, following diversion of the Building 4501 basement sump discharges, semiannual sampling of mercury has been conducted at First Creek, Northwest Tributary, Raccoon Creek, and Fifth Creek. Those monitoring results indicate that Raccoon Creek, First Creek, and Northwest Tributary are not significant contributors of mercury as each of these sites has routinely contained less than 5 ng/L of total mercury. The current AWQC concentration for mercury is 51 ng/L. Fifth Creek contains mercury at concentrations that are most often in the <5 – 30 ng/L range with occasional spikes to levels greater than 75 ng/L based on a total of 18 grab samples collected during FY 2010. Three of the 18 samples collected from Fifth Creek during FY 2010 exceeded the 51 ng/L criterion. The mercury in Fifth Creek originates from the Building 4501 area and enters the stream via storm drains. Additional mercury monitoring results related to the RA for mercury discharges from Building 4501 are discussed below.

Project-specific Surface Water Monitoring Results

Building 4501 Mercury Contaminated Sump Discharges. In December 2007, the first RA specified in the BV ROD was partially completed by re-routing mercury-contaminated basement sump water at Building 4501 to treatment at the PWTC. Prior to the action, mercury-contaminated groundwater collected in building basement sumps at Building 4501 was discharged to WOC via storm drain Outfall 211. In October 2009, the Building 4501 sump system was completed with the installation of an ion exchange system for the collected groundwater to remove particle-associated mercury and dissolved mercury from the wastewater stream prior to its treatment at the PWTC. This system installation includes a pre-filter and ion exchange and is located in the basement of Building 4501. It serves to pre-treat the sump water which is then routed to the PWTC for final treatment and discharge.

Mercury monitoring is conducted at several surface water sampling locations in BV and two locations are key to measuring the effectiveness of the Building 4501 sump water re-route. These locations include the watershed IP surface water sampling location at the 7500 Bridge and an instream sampling location (WOC-105) that is located downstream of the Outfall 211 storm drain (Figure 2.3). Figure 2.7 shows the mercury concentration history for these two locations. As shown on Figure 2.7, there has been only one measured exceedance of the TDEC AWQC for total Hg at 7500 Bridge and none at WOC-105 since the contaminated sump water was routed to the PWTC.

During FY 2010, the mercury concentrations at WOC-105 and 7500 Bridge were below the TDEC AWQC value of 51 ng/L.

Statistical comparison of the 44 post-diversion mercury concentration in surface water at 7500 Bridge to the 44 values sequentially preceding diversion confirms that the post-diversion stream concentrations are significantly lower than the pre-diversion concentrations including the summer of 2009 concentration spike. Both the Student's t test and the Wilcoxon-Mann-Whitney methods confirmed that the reduction is statistically significant at the 95% confidence coefficient.

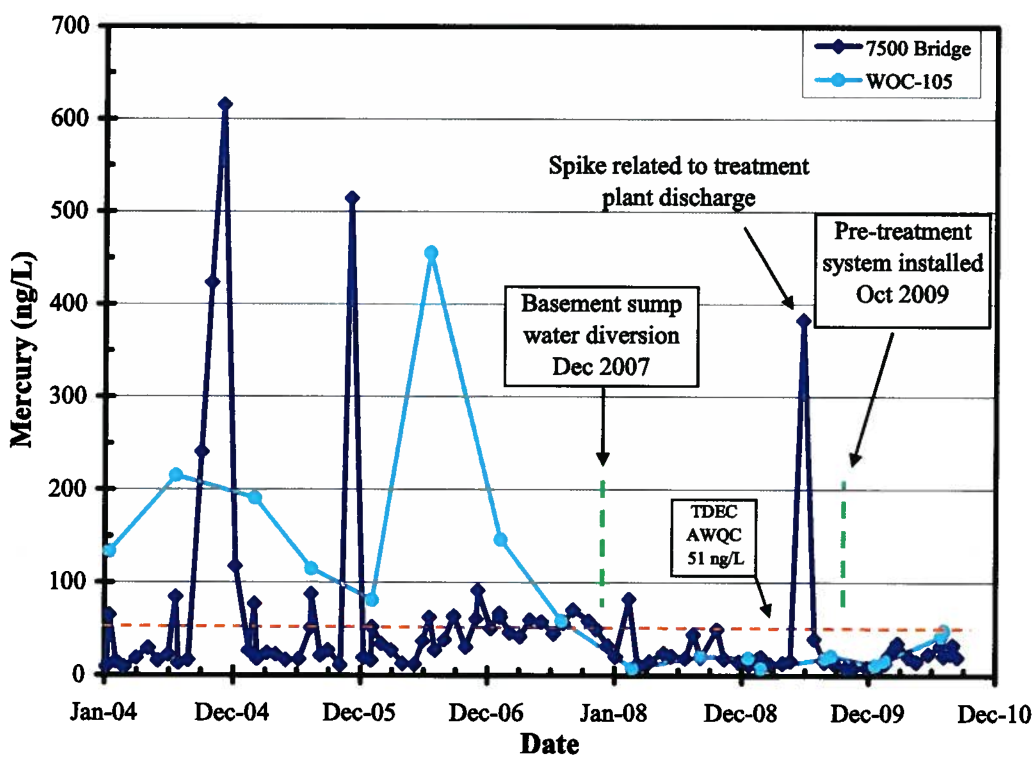

Figure 2.7. Mercury concentration history at 7500 Bridge and WOC-105 monitoring locations.

2.2.2.2 Groundwater Monitoring Data

Groundwater monitoring is conducted in the eastern and western ends of BV to determine if contaminants discharge to Raccoon Creek and Bearden Creek. Figure 2.4 shows locations where BV exit pathway sampling is conducted. Additionally, groundwater monitoring is conducted at SWSAs 1 and 3 to measure the effectiveness of the BV Burial Ground RAs. The SWSA 3 / Raccoon Creek exit pathway monitoring results for FY 2010 are discussed in Sect. 2.2.2.2.2. The Bearden Creek exit pathway data discussion also follows. During FY 2010 three new exit pathway wells (wells 4645, 4646, and 4647 shown on Figure 2.4) were installed in the Raccoon Creek headwaters as part of the BV Burial Ground RA.

2.2.2.2.1 Groundwater Quality Metrics and Monitoring Requirements

Based upon the RAO of unrestricted land use in the area surrounding SWSA 3 and the closed Contractors Landfill and in the Raccoon Creek area and in the immediate vicinity of Bearden Creek (Figure 2.2), drinking water maximum contaminant levels (MCLs) are considered appropriate criteria for screening of groundwater monitoring results.

2.2.2.2.2 Groundwater Monitoring Results

SWSA 3 / Raccoon Creek Exit Pathway

The SWSA 3 area groundwater sampling was conducted in the dry season of October 2009 and in the wet season of March 2010. Groundwater sampling was conducted at all the wells shown on Figure 2.4 (inset) at least once. Well 1247 was sampled only once because the well was dry during the first sampling round. Well 4579, the Westbay® well, was sampled three times during FY 2010 in the combined BV Burial Ground and WRRP sampling activities. Wells 4645, 4646, and 4647 were constructed in FY 2010 and were sampled once in August 2010.

Analytical parameters included metals, anions and alkalinity, VOCs, and a suite of radionuclides that included ^{90}Sr, tritium, gross alpha and beta activities, and gamma-emitting radionuclides. Table 2.10 includes a screening summary of results of analyses compared to MCLs or to the 8 pCi/L (4 mrem/yr activity equivalent) level for ^{90}Sr.

- Radionuclides: Beta activity exceeded the 50 pCi/L screening level in groundwater at well 0994 and at three monitoring locations in the Northwest Tributary. Strontium is the source of the elevated beta activity and ^{90}Sr exceeded the 8 pCi/L activity level in 17 samples including those from four wells around the SWSA 3 perimeter and in surface water samples from three locations in the Northwest Tributary.

- VOCs: Trichloroethene exceeded its MCL in one 1 out of 2 samples (but was detected in both) from well 0985 on the eastern edge of SWSA 3 and in the deep sampling zone at well 4579-01 on the one occasion it was detected of the three different sampling events. Cis-1,2-DCE was also detected along with the TCE but did not exceed its MCL. Vinyl chloride was detected below the MCL in two wells on the eastern edge of SWSA 3 near well 0985 but was not detected in combination with TCE suggesting migration of groundwater experiencing natural decomposition of the TCE and cis-1,2-DCE. Carbon tetrachloride was detected in one out of two samples from Northwest Tributary station

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Table 2.10. Groundwater sampling summary for SWSA 3 area – FY 2010

Analyte	Number of locations	Number of samples	Number of detects	MCL	Number of MCL exceedances	Locations exceeding MCL (maximum detection presented)	Comments
Alpha Activity	24	47	8	15 pCi/L	0	-	
Antimony	24	47	0	6 µg/L	0		
Arsenic	24	47	3	10 µg/L	2	Well 1248 (18 µg/L)	
Barium	24	47	47	2 mg/L	0		
Beryllium	24	47	0	4 µg/L	0		
Cadmium	24	47	8	5µg/L	0		
Chromium	24	47	5	100 µg/L	0		
Copper	24	47	2	1.3 mg/L[c]	0		
Fluoride	24	47	12	2[a], 4[b] mg/L	4	Well 1248, Well 4579-01 (9.6 mg/L), Well 4579-02	
Lead	24	47	2	15µg/L[c]	0		
Mercury	24	47	44	2 µg/L	0		no AWQC exceedances
Selenium	24	47	1	50 µg/L	0		
Thallium	24	47	2	2µg/L	2	Wells 0992, 4579-03 (2.26 µg/L each)	
Cis-1,2-DCE	24	57	4	70µg/L	0		
Trichloroethene	24	57	5	5µg/L	2	Well 0985, Well 4579-01 (45 µg/L)	
Vinyl chloride	24	57	2	2 µg/L	0		
Benzene	24	57	10	5 µg/L	7	Well 4579-01 (13.2 µg/L), Well 4579-02	
Ethylbenzene	24	57	6	700 µg/L	0		
Toluene	24	57	10	1 mg/L	0		
Total xylenes	24	95	10	10 mg/L	0		Includes results for all individual reported analytes in the xylene group
Carbon tetrachloride	24	47	1	5 µg/L	0		

Table 2.10. Groundwater sampling summary for SWSA 3 area -- FY 2010 (cont.)

Analyte	Number of locations	Number of samples	Number of detects	MCL	Number of MCL exceedances	Locations exceeding MCL (maximum detection presented)	Comments
Strontium-90	24	51	26	8 pCi/L[c]	17	Wells 0992, 0993, 0994 (461 pCi/L), 0997, 4579-01, 4579-03, 3 locations in NWTrib	
Tritium	24	47	7	20,000 pCi/L[d]	0		
Aluminum	24	47	28	200 µg/L[a]	22	Wells 0700 (3.1 mg/L), 0985, 0987, 0988, 0992, 0993, 0998, 1248, 4579-01, 4579-02, 4 locations in NWTrib, 2 locations in Raccoon Creek	May be associated with turbidity
Sulfate	24	47	47	250 mg/L[a]	1	Well 4579-01 (1240 mg/L)	
Chloride	24	47	47	250 mg/L[a]	0		
Iron	24	47	40	300 µg/L[a]	27	Wells 0700, 0986, 0987, 0992 (3.8 mg/L), 0993, 0994, 0998, 4579-03, 4 locations in NWTrib, 2 locations in Raccoon Creek	May be associated with turbidity
Manganese	24	47	40	50 µg/L[a]	15	Wells 0985, 0991, 0992 (2.4 mg/L), 0993, 0997, 0998, 4579-03, 2 locations in NWTrib, 1 location in Raccoon Creek	May be associated with turbidity

Table 2.10. Groundwater sampling summary for SWSA 3 area – FY 2010 (cont.)

Analyte	Number of locations	Number of samples	Number of detects	MCL	Number of MCL exceedances	Locations exceeding MCL (maximum detection presented)	Comments
pH	24	49	49	6.5 – 8.5[a]	10	Low **0985 (5.5), 0992, 0993, 0987** High [**4579-01, 4579-02, 1248 (12.0)**]	
Zinc	24	47	5	5 mg/L[a]	0		

MCLs are primary drinking water criteria unless otherwise noted.

Number of samples exceeding criterion shown per total number of samples per station. Maximum detected values exceeding criteria denoted in bold text

[a] concentration is a secondary drinking water criterion.

[b] concentration is a primary drinking water criterion.

[c] 8 pCi/L for ^{90}Sr is the 4 mrem/yr effective dose equivalent activity.

[d] 20,000 pCi/L for tritium is the 4 mrem/yr effective dose equivalent activity.

[e] Action level for concentration reduction of copper and lead in public water supplies

- but at a concentration below its MCL. Benzene/toluene/ethylbenzene and xylene (BTEX) compounds were detected in the two deeper Westbay sampling zones in well 4579. Its appearance in only these two bedrock zones and its absence elsewhere in the area suggests the possibility that it is derived from a natural petroleum source in bedrock. Natural petroleum has been encountered in relatively shallow bedrock elsewhere in BV.

- Metals: Fluoride exceeded its MCL at wells 1248 and in the two deeper zones of well 4579. These wells both had pH levels greater than 9.5. Four wells around the perimeter of SWSA 3 had pH values less than 6.5. Arsenic exceeded its MCL in the two samples from well 1248 and thallium slightly exceeded its MCL in well 0993 and in the shallowest zone of well 4579. Aluminum, iron, and manganese exceeded their secondary MCLs in numerous wells. Elevated concentrations of these metals are commonly associated with suspended particulates in water samples that have been acid-preserved for laboratory analysis.

Samples were collected from the new exit pathway wells constructed west of Hwy 95 in August 2010. The placement for these monitoring wells was included in the Bethel Valley Burial Grounds RDR/RAWP (DOE 2010b). The monitoring objective was to determine if groundwater underflow of the Raccoon Creek tributary carries ^{90}Sr contamination via deeper flow paths along geologic strike from the source area.

The wells were constructed in a roughly north-south line. The ground surface at the deep well is at about the 824 ft elevation and at the shallow well the elevation is about 809 ft. The deepest well (4645) intersected the Bowen/Witten Formation contact at a depth of about 110 ft below ground surface (bgs) and was constructed with a 15-ft long screen between about 100 – 115 ft bgs. Cavitose zones were encountered at depths of about 49, 77, 87, and 96 ft. The intermediate-depth well (4646) was located about 80 ft north of the deep well and drilled to a depth of 40 ft and a sand/gravel-filled cavity was encountered at a about 34 – 36 ft bgs. The well was constructed with a 10-ft screen from 29 – 39 ft. The shallow well (4647) was located approximately 70 ft northwest of the intermediate well near the confluence of the Raccoon Creek channel and the tributary where topography suggested the possibility of groundwater occurring above the bedrock surface. The well penetrated about 10 ft of silt and clay that did not yield sufficient water at the bedrock surface to construct a viable well so drilling proceeded about 10 ft into bedrock. Weathered zones were noted at depths of about 13 – 14 ft and 19 – 21.5 ft. The well was constructed with a 10 ft screen between 9.8 and 19.8 ft bgs and the sandpack extended 2 ft up into the soil zone to allow sampling of any water at the soil/bedrock interface as well as water in the noted weathered zones in the screened interval.

Results of the first round of samples collected from wells 4645, 4646, and 4647 showed groundwater pH ranged from about 7 to 7.5, conductivity ranged from 536 µmho/cm in the deep well to about 700 µmho/cm in the shallow well, dissolved oxygen was less than 1 ppm, and redox potential was moderately reductive (-105 to -195 mV). Reductive conditions are favorable to the presence of dissolved metals such as aluminum, manganese, and iron, as well as other transition series metals. Both unfiltered and field filtered samples were analyzed for metals to allow evaluation of possible suspended solids contribution to total metals. To evaluate the potential for transport of metals by particulate, both total metals (unfiltered) and dissolved metals (field filtered) were analyzed. Antimony, arsenic, beryllium, cadmium, lead, and selenium were not detected in any of the samples. Chromium was detected at 2 and 4 µg/L in unfiltered samples from 4565 and 4567, respectively. Chromium was not detected in any of the field-filtered samples. Copper was detected in the unfiltered samples from 4645 and 4646 and from both the filtered and unfiltered samples from 4647 at concentrations less than 3 µg/L which is nearly 1000-fold less than the 1.3 mg/L action level for public drinking water supplies. Aluminum was detected in the unfiltered aliquot from all three wells but did not exceed its secondary MCL. Iron and manganese were detected at concentrations greater than their secondary MCL levels in all the samples. Fluoride was detected in all three wells at less than 0.5 mg/L, well below the MCL.

The only VOCs detected were very low concentrations of benzene, toluene, and chloroform in well 4645. Based on occurrence of natural crude oil in several bedrock core borings in the ORNL Main Plant Area during site characterization investigations conducted during the 1980s and 1990s, the occurrence of low concentrations of BTEX constituents in bedrock may be a natural condition.

The only detection of a man-made radionuclide was 2.4 pCi/L of ^{90}Sr that was detected in the shallow well (4647). This result is not unexpected since the well was constructed near the confluence of Raccoon Creek and the tributary known to receive ^{90}Sr-contaminated seepage from SWSA 3. The only detection of beta activity at the 3.6 to 4 pCi/L minimum detectable activity level was at well 4647 and is associated with the observed ^{90}Sr. Alpha activity was not detected in any of the samples at minimum detectable activity in the 3.8 – 4.5 pCi/L range. Radium (an alpha-emitting radionuclide in the uranium and thorium decay series) was detected at activity levels less than 1 pCi/L in samples from wells 4645 and 4647. The MCL for radium in drinking water is 5 pCi/L. Bismuth-214 and ^{214}Pb (daughters in the ^{238}U series) were detected in samples from wells 4646 and 4647. Total uranium was detected at very low (< 1 μg/L) levels in all three wells. The uranium MCL is 30 μg/L.

The metals detected in groundwater samples are at levels suggestive of natural occurrences as are the BTEX constituents. The ^{90}Sr detection in the sample from 4647 was not unexpected as the well was located to evaluate a known seepage pathway. Monitoring of these wells will continue.

Bearden Creek Exit Pathway

Groundwater monitoring data from wells 1198 and 1199 that are located southwest of Building 7025 (the former Tritium Target Facility) have exhibited detectable tritium concentrations since 1991 (Figure 2.4). Well 1198 is a shallow well, screened from about 28 – 43 ft bgs and well 1199 is a deeper well screened from about 53 to 73 ft bgs. Tritium concentrations in these wells have decreased steadily since the inception of monitoring when peak tritium activities of about 8,000 pCi/L were measured in well 1199 and about 15,000 pCi/L in well 1198. During FY 2010, tritium activities were measured at approximately 500 pCi/L in well 1199 and approximately 1,700 pCi/L in well 1198. Site investigations conducted by the Office of Science for a new facility to be constructed near the Bearden Creek exit pathway (and to the northeast of the Building 7025 facility) encountered tritium in groundwater in the area. All lab results on groundwater samples in the area were less than the drinking water 20,000 pCi/L MCL EDE. Analyses for VOCs has been conducted throughout the monitoring history at both wells. The only detections of organic compounds occurred in the January 2010 sampling event during which TCE and cis-1,2-DCE were detected at 56 μg/L and 3.4 μg/L, respectively. Neither constituent was detected in the dry season sample collected in September 2010.

2.2.2.3 Other Watershed Monitoring

2.2.2.3.1 Aquatic Biological Monitoring in WOC

Biomonitoring data are available for several locations in BV, including a location in WOC near the watershed's exit point (Figure 2.8). This information is useful in evaluating watershed trends and the effectiveness of watershed-scale decisions defined in the ROD for Interim Actions in BV. Biological monitoring data for the WOC watershed includes: (1) contaminant accumulation in fish; (2) fish community surveys; and (3) benthic macroinvertebrate surveys. Fish bioaccumulation results for mercury and PCBs from all of WOC, including stream sections downstream of the Melton Branch confluence, are presented in this chapter (Figure 2.9 and Figure 2.10, respectively).

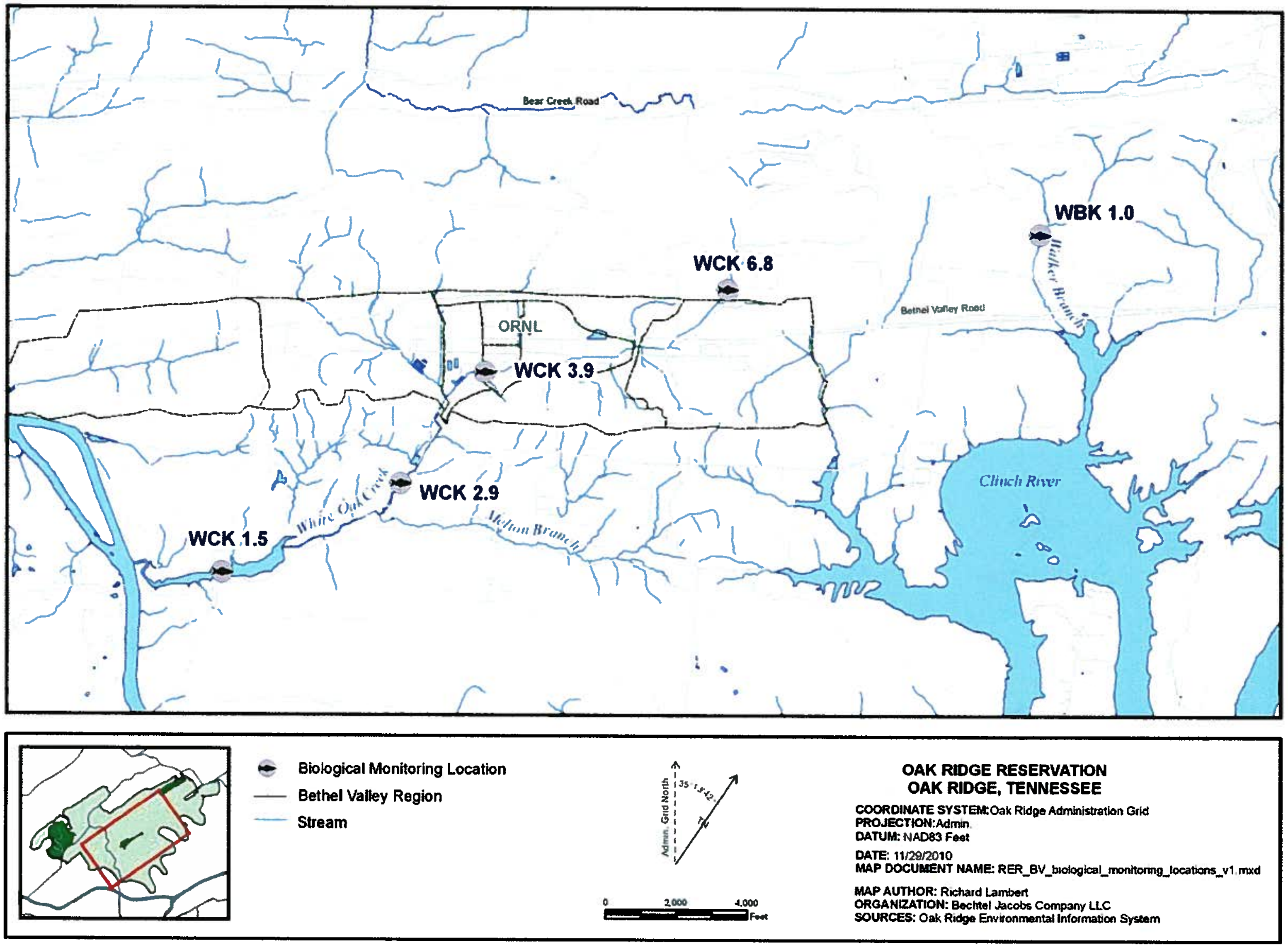

Figure 2.8. Biological monitoring locations at the ORNL site.

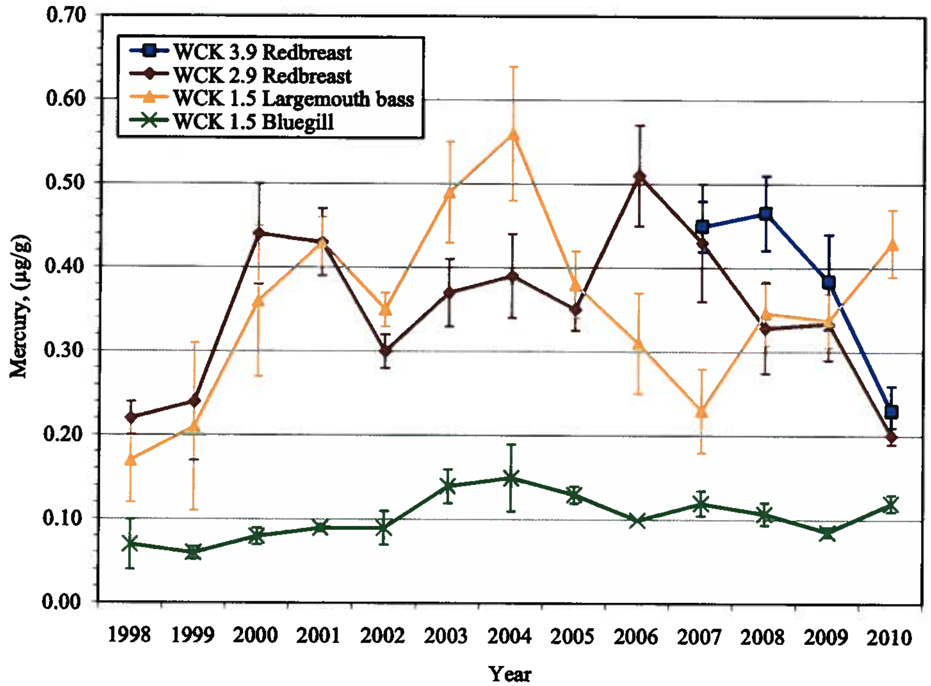

Figure 2.9. Mean concentrations of mercury (µg/g, ± SE, N = 6) in muscle tissue of sunfish and bass from WOC (WCK 2.9 and WCK 3.9) and WOL (WCK 1.5), 1998–2010.

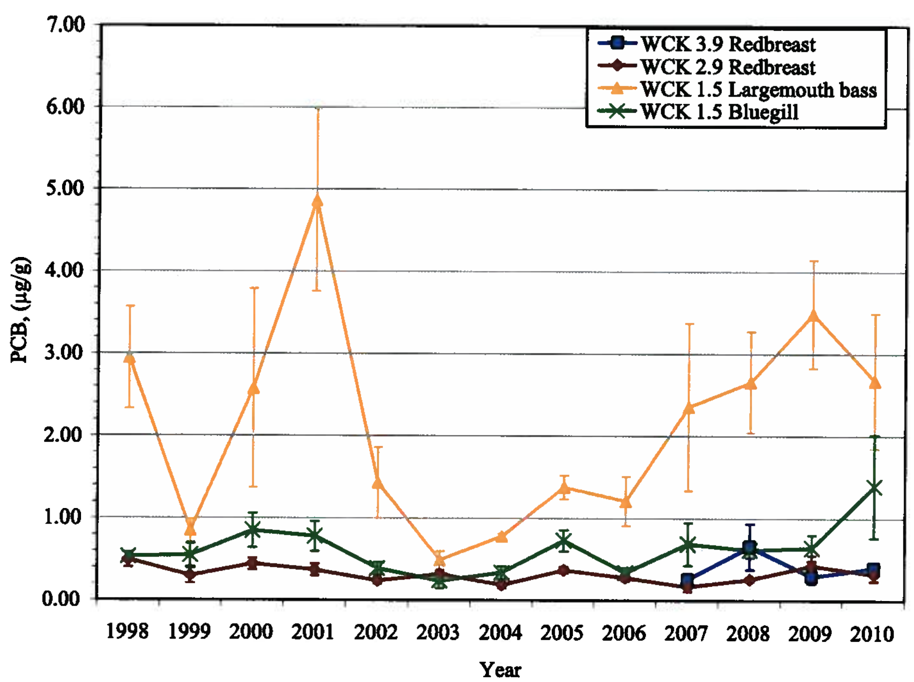

Figure 2.10. Mean PCB concentrations (µg/g, ± SE, N = 6) in fish fillet collected from the WOC Watershed, 1998–2010.

Mercury concentrations in fish collected in 2010 at White Oak Creek kilometer (WCK) 2.9 and WCK 3.9 averaged 0.20 and 0.23 µg/g, respectively (Figure 2.9). This represents a significant decrease in Hg values in fish collected at these sites, bringing Hg levels below the U.S. Environmental Protection Agency (EPA) fish-based mercury AWQC of 0.3 µg/g. These reductions in fish tissue Hg levels are likely due to the decreases in aqueous mercury concentrations as a result of the Bethel Valley Mercury Sumps Groundwater Action (DOE 2010a). Future monitoring efforts will show whether this is a long-term trend. Fish collected in White Oak Lake (WOL) (WCK 1.5) have not yet responded to the results of this action. Concentrations in sunfish and in bass collected at this site increased in 2010, averaging 0.12 and 0.43 µg/g, respectively.

Mean PCB concentrations in redbreast sunfish from the WOC watershed remained within historical ranges (Figure 2.10). PCB levels in redbreast collected from WCK 3.9 slightly increased (average 0.40 ± 0.05 µg/g), while levels in redbreast at WCK 2.9 decreased slightly (average 0.32 ± 0.09 µg/g) in 2010. Mean PCB values for bluegill sunfish collected at WCK 1.5 increased significantly from 0.64 µg/g in 2009 to 1.39 µg/g in 2010. This increase puts these fish above the PCB advisory limit of 0.8 – 1.0 µg/g in the State of Tennessee. Largemouth bass PCB concentrations were lower than in 2009 but were within the range of values found in recent years (average 2.68 ± 0.82 µg/g) (Figure 2.10). The increasing trend in WOL fish PCB concentrations (i.e., at WCK 1.5) since 2003 may indicate changing prey patterns in the lake (e.g., a change to shad prey that are relatively high in PCBs). There is no known source of increasing PCBs farther upstream in the watershed.

Fish and benthic communities are degraded relative to reference sites, although improvements have occurred since the mid-1980s. The fish communities in WOC in 2010 have been fairly stable in terms of overall numbers of species in recent samples, with numbers of fish species being well below the Brushy Fork reference site (BFK 7.6), but similar or above the number of fish found at the Mill Branch reference site (MBK 1.6) (Figure 2.11). Recent introductions of fish species into WOC watershed have been successful, at least initially, with reproduction observed in all five species and expanded distributions for two species. The introduced species fill in missing groups of fish, including sensitive species such as darters and suckers, and should help the overall richness of the fish fauna in WOC be more comparable to area reference streams. The fish introductions are a management tool to compensate for the isolation of WOC watershed by dams and weirs that prevent natural upstream fish passage. Results for the benthic macroinvertebrate community in 2009 continue to indicate that no major changes in trends have occurred at WCK 3.9 since 2002 (Figure 2.12). Thus, although ecological conditions remain degraded at this site, the moderate recovery observed after 1996 has persisted.

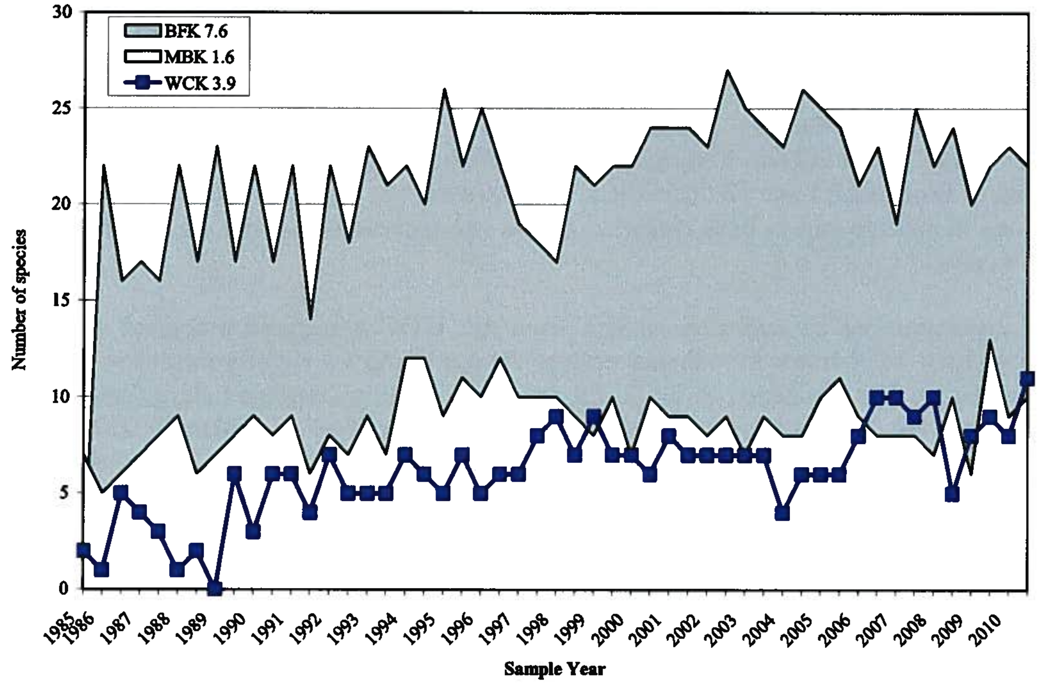

Figure 2.11. Species richness (number of species) in samples of the fish community in WOC (WCK 3.9) and reference streams, Brushy Fork kilometer (BFK) and Mill Branch kilometer (MBK), 1985–2010.

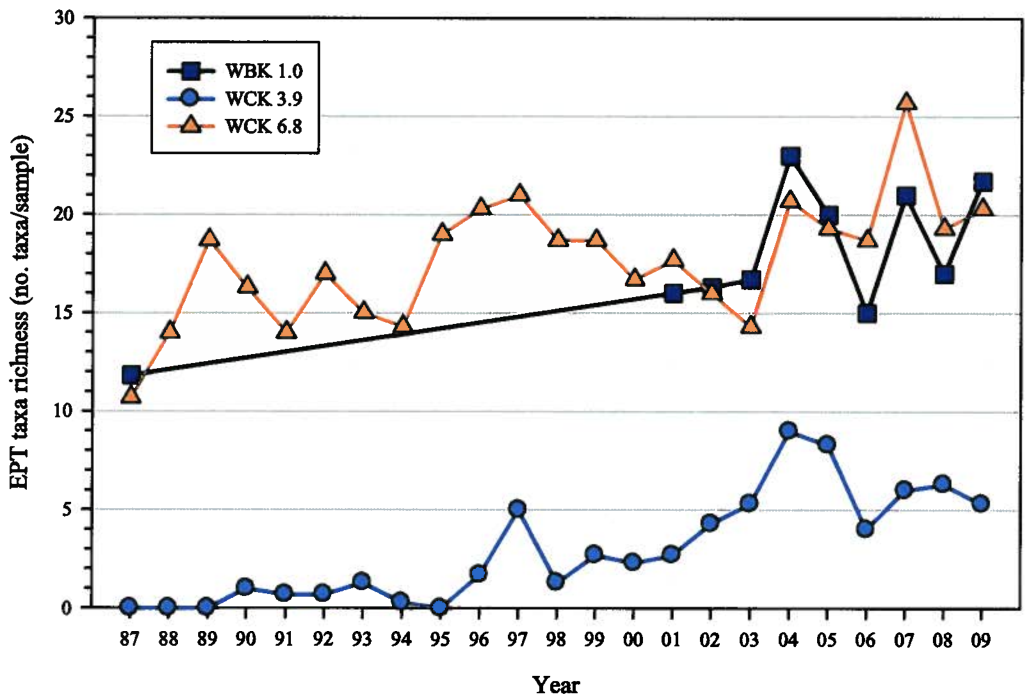

Figure 2.12. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in upper WOC and Walker Branch, April sampling periods, 1987–2009. [a,b]

[a]WBK = Walker Branch kilometer. EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, caddisflies, and stoneflies.
[b]Samples collected in 2010 have not yet been processed. Data were not available for Walker Branch from 1988-2000.

2.2.3 Performance Summary

In FY 2010, BV monitoring results showed a continued significant decrease in mercury concentrations in WOC following the mercury treatment system hookup at Building 4501, and an increase in the average ^{90}Sr concentration at 7500 Bridge. The action that caused the mercury reduction was a re-route of basement foundation sump water from discharge to a storm drain to pretreatment and to the PWTC. In October 2009 installation of a pre-filter and ion exchange water treatment system was completed. This system is located in the basement of Building 4501 and it serves to pre-treat the sump water which is then routed to the PWTC for final treatment and discharge. The mercury concentrations measured at the 7500 Bridge were below the TDEC AWQC of 51 ng/L (the most stringent of the applicable AWQC for WOC) in all of the 12 monthly grab samples. Two samples were collected from WOC near the former mercury discharge outfall and neither result exceeded the AWQC criterion. Most other monitoring results were consistent with ongoing trends.

During FY 2010, the risk reduction goals for ^{137}Cs was attained at the BV watershed IP (7500 Bridge). However, during FY 2010, the ^{90}Sr reduction goal was not attained because of an increase in ^{90}Sr discharges to First Creek from the Corehole 8 Plume. Increased plume discharges are results of leaks in the ORNL potable and fire water system, as well as operational problems with the plume collection system. This issue is discussed in Sect. 2.3 and is identified as an issue in Sect. 2.4.

Reduction of ^{90}Sr discharges from BV is an ongoing problem and is an issue carried forward (identified in Sect. 2.4) from previous remedy evaluations. DOE has implemented increased surface water monitoring to identify sources of ^{90}Sr discharge into WOC and its tributaries. To date, the releases identified during periods of increased ^{90}Sr discharge have been related to infrastructure operations that cause groundwater collection systems to underperform.

The installation of three monitoring wells in the headwaters of Raccoon Creek was completed and pre-construction groundwater and surface water monitoring continues. Seepage pathways to Raccoon Creek and the Northwest Tributary are monitored to assess discharge of ^{90}Sr to surface water.

Biological monitoring of the BV watershed continues to indicate moderate recovery.

2.2.4 Compliance with LTS Requirements

2.2.4.1 Requirements

Watershed-wide Requirements

The ROD requires implementation of LUCs to protect against unacceptable exposures to contamination during the RAs, as well as after completion of all RAs in BV. During RAs, interim LUCs are being imposed and will remain until permanent LUCs are established in future remedial decisions for this area. Because the final groundwater decision is being deferred, groundwater use restrictions in contaminated areas will be required regardless of land use. Other objectives of the LUCs are as follows:

- Controlled industrial area: Restrict excavations or penetrations deeper than 0.6 m (2 ft) and prevent uses of the land more intrusive than industrial use above 0.6 m (2 ft).

- Unrestricted industrial area: No restrictions on excavations or penetrations shallower than 3 m (10 ft) and prevent uses of the land more intrusive than industrial use deeper than 3 m (10 ft).

- Recreational area (as applied to the SWSA 3 Burial Ground and the Contractor's Landfill): Restrict recreational activity to passive surface use of disposal areas; prevent unauthorized contact, removal, or excavation of waste material; prevent unauthorized destruction or modification of engineered controls; and preclude use of the areas for additional future waste disposals or alternate uses inconsistent with the management of currently disposed waste.

An Explanation of Significant Difference (ESD) (DOE 2010e) from the BV ROD is planned for approval in FY 2011 and will extend the SWSA 3 cap to cover contaminated soil in the Contaminated Soil Area No. 2 (CSA2) and Contaminated Soil Area No. 3 (CSA3), as well as buried waste in the Closed Scrap Metal Area (CSMA). These areas were designated as unrestricted land use in the ROD (after excavation). Now that they will be under the SWSA 3 cap, future land use designation for these areas is being changed under this ESD to recreational.

PCCR Specific Requirements

LTS requirements specified in the PCCR for the BV Mercury Sumps Groundwater Action (DOE 2010a) include maintenance of the mercury pretreatment system in Building 4501, specifically maintenance of the pump and replacement of the cartridge prefilter, as needed. Additionally, the ion exchange resin should require annual replacement. It is also a requirement of the PCCR that the WRRP collect system performance and operational data.

The BV Burial Grounds action is planned for completion in 2011. Once complete, the LTS for this action will include cap and soil cover inspections and maintenance, radiological surveys, and access controls.

No additional RAs requiring LTS specified by the ROD have yet been completed in BV.

2.2.4.2 Status of Requirements for FY 2010

Interim LUCs were maintained for the specified land use areas identified in the BV ROD. Signs were maintained to control access, and surveillance patrols conducted as part of routine S&M inspections were effective in preventing access by unauthorized personnel. The EPP program functioned according to established procedures and plans for the site.

Inspections of the Building 4501 pretreatment system were conducted weekly in FY 2010 by the UT-Battelle Facility Manager in accordance with the operating manual. Monthly system status updates were submitted to the WRRP documenting system operations, monthly pumped/treated volume, and influent/effluent concentrations. Routine maintenance included monthly inlet filter changes and replacement of the resin column in May. Major operational problem and extended downtimes occurred in May when software issues kept the system from operating. Performance data associated with the system is discussed in Sect. 2.2.2.1.2.

2.3 COMPLETED SINGLE ACTIONS IN BETHEL VALLEY WITH MONITORING AND/OR LTS REQUIREMENTS

2.3.1 Waste Area Grouping (WAG) 1 Corehole 8 Removal Action (Plume Collection)

In 1991, CERCLA characterization efforts identified a plume of ^{90}Sr-contaminated groundwater, referred to since that time as the Corehole 8 Plume (Figure 2.13). Note that the Corehole 8 Plume Source (Tank W-1A) is addressed as a separate action and included in Sect. 2.3.2. A removal site evaluation performed in 1994 concluded that contaminated groundwater seeping into the ORNL storm drain system was being discharged into First Creek at storm drain Outfall 342. First Creek is a tributary to WOC and ultimately to the Clinch River. Further investigation showed that contaminated groundwater entered the storm water collection system by in-leakage to three catch basins in the western part of ORNL.

Figure 2.14 is a conceptual block diagram of the Corehole 8 Plume that shows the plume confined within a dipping limestone bed that is approximately 10 ft thick. Contaminants seep into the weathered limestone bed beneath the North Tank Farm (NTF) in the vicinity of Tank W-1A. Groundwater seepage within the dipping bed carries contamination downward and westward, as shown by the seepage arrows in Figure 2.14. The flow rises to discharge into the base of the soil profile near the western edge of the ORNL Central Campus near First Street, where the plume collection system was installed during implementation of the removal action. Contaminant concentrations are attenuated along the seepage pathway with approximately 100-fold reduction in concentration measured between well 4411 (near the source area) and at well 0812 and in the collection system at the western end of the plume.

The AM for the project was approved in November 1994 (DOE 1994a). Installation of a groundwater collection and transmission system began in December. Water collected in the two porous sumps is pumped into the Corehole 8 sump and then on to a process waste system manhole in the NTF. Startup of the system occurred on March 31, 1995. Collected groundwater is piped to the ORNL PWTC for treatment and is discharged through an existing National Pollutant Discharge Elimination System (NPDES) outfall (X12).

In October 1997, monitoring of surface water in First Creek identified elevated levels of ^{90}Sr and ^{234}U known to be caused by the Corehole 8 Plume. Additional sampling conducted in December 1997 identified two unlined storm drain manholes as the point of entry for the contamination. In March 1998, an additional groundwater interceptor trench was installed that connects to one of the Corehole 8 Plume collection sumps.

In September 1999, an addendum to the AM (DOE 1999b) authorized additional groundwater extraction and treatment actions expected to enhance the effectiveness of the original removal action. The additional actions involved pumping contaminated groundwater out of well 4411 and discharging it into the PWTC for further treatment. Well 4411 is located downgradient and down-dip from Tank W-1A and intersects a thin limestone bedrock layer determined to be the preferential flow pathway for the Corehole 8 Plume.

2.3.1.1 Performance Goals and Monitoring Objectives

The AM (DOE 1994a) estimated that the plume collection system would intercept between 20% and 50% of the Corehole 8 Plume water prior to its entering First Creek. Evaluation of the ^{90}Sr flux measured at First Creek monitoring station is used as the performance metric for remedy effectiveness evaluation.

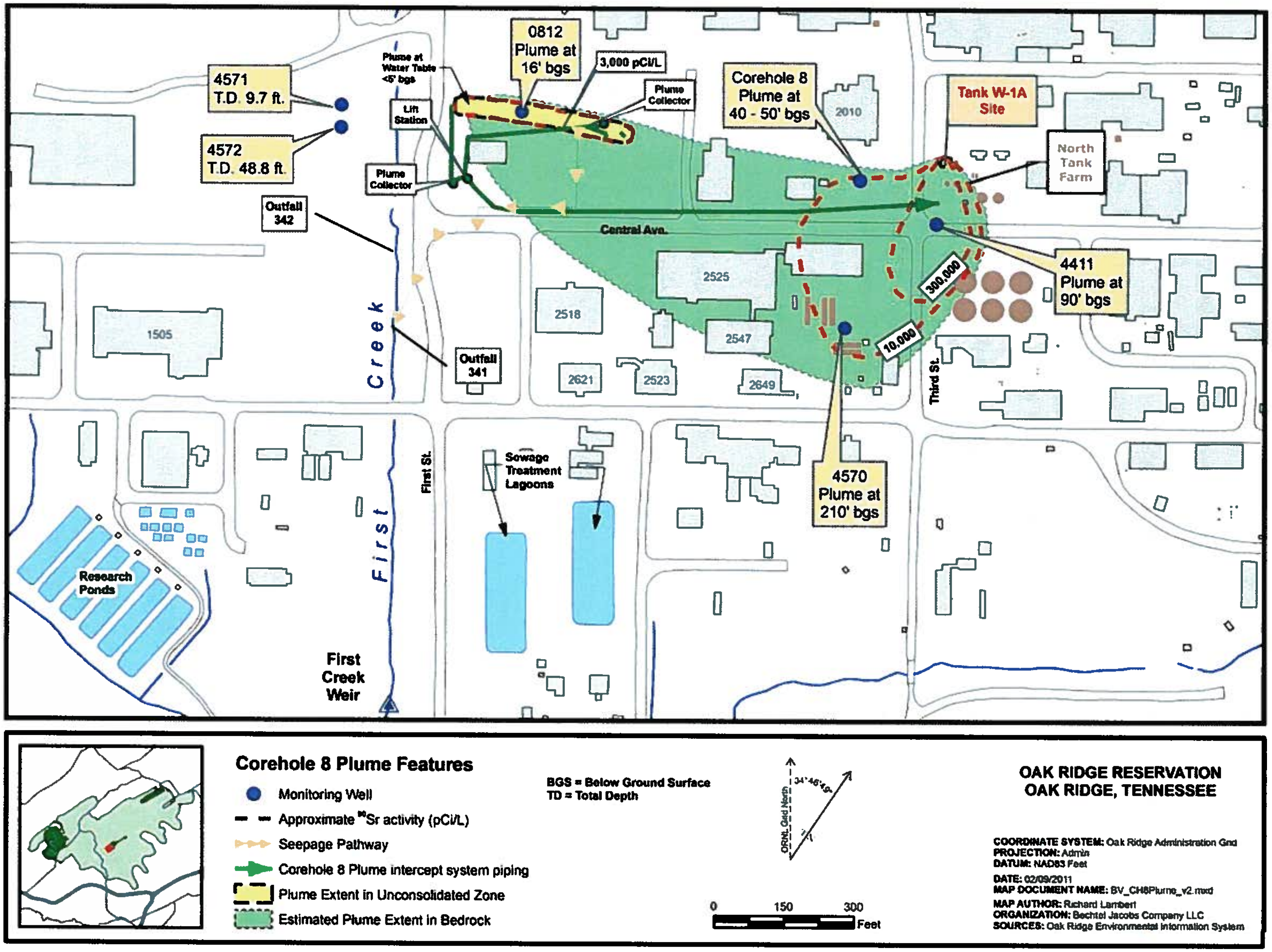

Figure 2.13. Location and features of the Corehole 8 Plume.

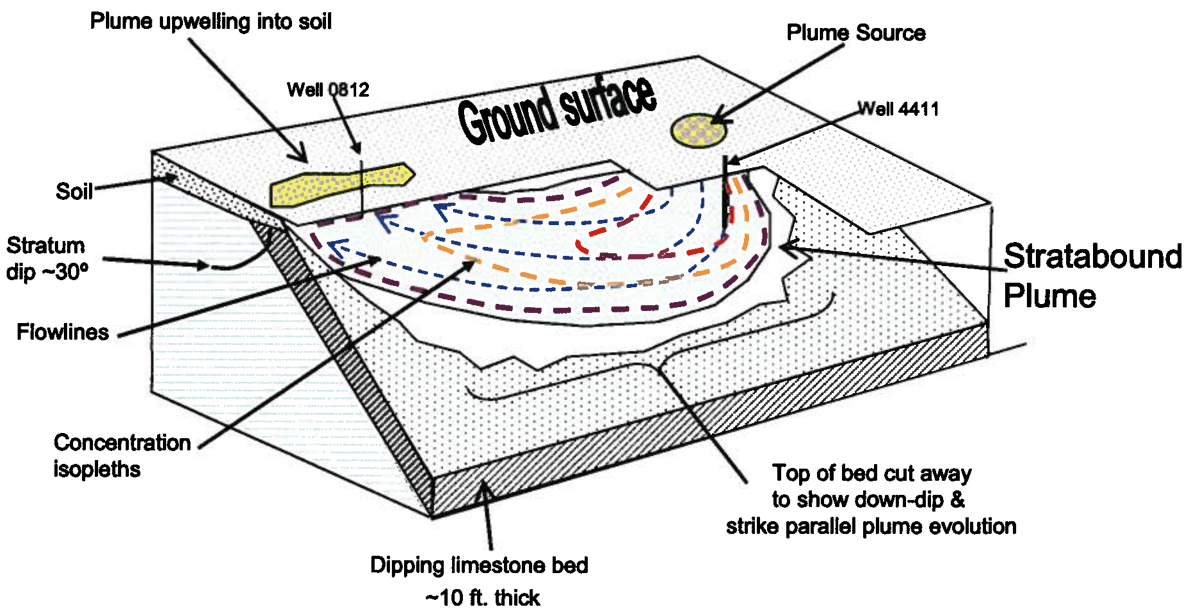

Figure 2.14. Conceptual block diagram of the Corehole 8 Plume.

2.3.1.2 Evaluation of Performance Monitoring Data

During FY 2010, the Corehole 8 Plume interceptor system did not achieve the performance goal for reduction of ^{90}Sr discharge to First Creek. The reasons for not attaining the performance goal are mechanical problems with the plume capture pumping system compounded by leaks in the potable and firewater utility systems in several locations.

First Creek is the receiving surface water body for discharge of contaminated groundwater in the Corehole 8 Plume. Continuous flow-paced monitoring of First Creek has been ongoing since before the Corehole 8 Plume removal action was conducted. Table 2.11 includes the FY 2010 monthly flow volumes, ^{90}Sr activities, and ^{90}Sr fluxes, as well as similar data from 1994 prior to the removal action. The flux of ^{90}Sr measured in First Creek in FY 2010 was approximately 95% of the flux measured during calendar year (CY) 1994 prior to startup of the Corehole 8 groundwater collection system. Table 2.12 shows the history of ^{90}Sr fluxes and flux reduction factors in First Creek from CY 1993 through FY 2010.

Performance evaluation data summarized above (Table 2.12) show that the Waste Area Grouping (WAG) 1 Corehole 8 Removal Action effectively reduced contaminant discharge to First Creek through FY 2008, but that performance deteriorated in FY 2009 and remained poor during FY 2010.

Table 2.11. First Creek ^{90}Sr fluxes pre-action and in FY 2010

Month	CY 1994 (pre-action) ^{90}Sr (pCi/L)	Flow volume (liters)	^{90}Sr flux (Ci)	Month	FY 2010 ^{90}Sr (pCi/L)	Flow volume (liters)	^{90}Sr flux (Ci)
January 1994	124.4	102,893,891	0.0128	October 2009	302	53,731,915	0.0162
February 1994	95.6	126,569,038	0.0121	November 2009	200	50,691,787	0.0101
March 1994	89.2	228,699,552	0.0204	December 2009	146	188,833,219	0.0276
April 1994	105.4	166,982,922	0.0176	January 2010	169	131,082,941	0.0222
May 1994	236.5	41,437,632	0.0098	February 2010	136	127,592,165	0.0174
June 1994	297.3	32,963,337	0.0098	March 2010	121	43,962,653	0.0053
July 1994	324.4	25,585,697	0.0083	April 2010	72.5	81,431,453	0.0059
August 1994	378.4	30,919,662	0.0117	May 2010	78	86,370,408	0.0067
September 1994	364.9	26,586,673	0.0097	June 2010	106	31,091,674	0.0033
October 1994	133.6	24,700,599	0.0033	July 2010	150	23,783,990	0.0036
November 1994	260.9	37,178,996	0.0097	August 2010	164	44,393,242	0.0073
December 1994	179.8	66,740,823	0.012	September 2010	154	35,716,594	0.0055
Total		911,258,822	0.137	Total		898,682,040	0.1310

Table 2.12. ^{90}Sr flux changes at First Creek Weir, 1993–2010

Year	^{90}Sr flux (Ci)	Percent reduction from CY 1994[a]
CY 1993	0.13	
CY 1994	0.137	
CY 1995	0.067	51.1
FY 1996	NA	NA
FY 1997	0.036[b]	73.7
FY 1998	0.044[c]	67.9
FY 1999	0.044[c]	67.9
FY 2000	0.026	81.0
FY 2001	0.035	74.8
FY 2002	0.034	75.0
FY 2003	0.016	88.0
FY 2004	0.016	88.5
FY 2005	0.019	86.2
FY 2006	0.011	92.0
FY 2007	0.014	89.2
FY 2008	0.022	84.0
FY 2009	**0.119**	12.9
FY 2010	**0.131**	5.0

[a]Remedy effectiveness (20—50% reduction from 1994 flux).
[b]Represents 10 months of data.
[c]Represents 11 months of data.
Bold table entries indicate years when the remedy has not achieved the performance goal.
NA = not applicable

Figure 2.15 shows the historical ^{90}Sr and $^{233/234}$U activities measured in groundwater at well 4411 and Corehole 8 Zone 2. Well 4411 is a plume extraction well that intersects the plume at a depth of approximately 90 ft bgs in a location approximately 120 ft south of Tank W-1A, where leakage from a broken LLLW pipeline created the plume source. Samples from well 4411 are taken at the wellhead and represent contaminant concentrations in extracted groundwater that is being pumped to the PWTC for treatment. Corehole 8 is a 50 ft deep well in which a Westbay® multizone sampling system was installed

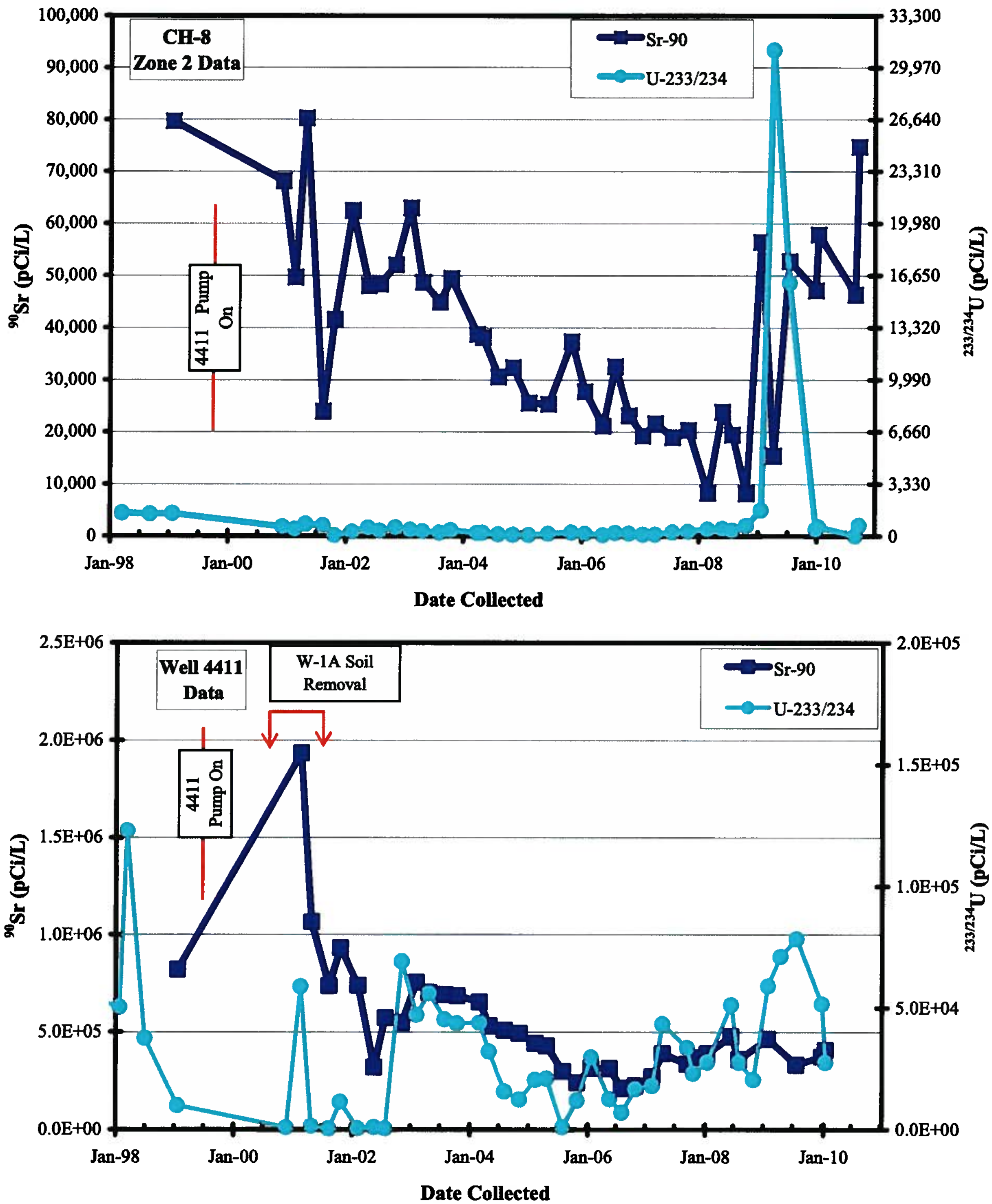

Figure 2.15. Contaminant activities in well 4411 and Corehole 8 Zone 2.

to allow sampling of discrete intervals in the well. Zone 2 is the second zone from the bottom of the well and its sampling interval spans the depth of 41.2–43.2 ft bgs. During well installation and initial sampling, this zone was found to produce the highest activities of contaminants in the well and for that reason it has become the focal point for ongoing monitoring at that location. Data presented in

Figure 2.15 show that during FY 2010 at Corehole 8, ^{90}Sr activities remained high with a value greater than 70,000 pCi/L near the end of the year. Activity levels of $^{233/234}$U decreased from the high level spike observed in FY 2009. Strontium-90 activities for well 4411 remained relatively stable, while the activity level of $^{233/234}$U decreased.

Figure 2.16 shows the Corehole 8 groundwater collection sump ^{90}Sr and alpha activity data from system startup in 1995 through FY 2010. Notations on the figure show approximate dates when extraction of contaminated groundwater via well 4411 started, as well as the approximate dates during which contaminated soil was excavated from the NTF. The data demonstrate that both actions had visible benefits in reducing contaminant activities in the plume collection system that is located in the western end of the plume. Table 2.13 includes Corehole 8 collection system monthly and year-end total flow volumes collected and ^{90}Sr flux captured and sent to the PWTC for FY 1997 and FY 2010. Figure 2.17 shows the annual flux of ^{90}Sr collected by the Corehole 8 groundwater collection system along with total annual rainfall measured at the ORNL site. The long-term average annual rainfall for Oak Ridge is approximately 54 inches per year. As shown on Figure 2.17, FY 2003–FY 2005, and FY 2009 were years of above average rainfall. FY 2003 was an especially unusual year in that the annual rainfall was approximately 35% above the long-term average. Although mass of ^{90}Sr captured in the plume collection system increased during FY 2009 and 2010, the system's ability to control the plume, as it had during previous periods of above-average rainfall, was overwhelmed by added water volume from potable and/or fire water leaks.

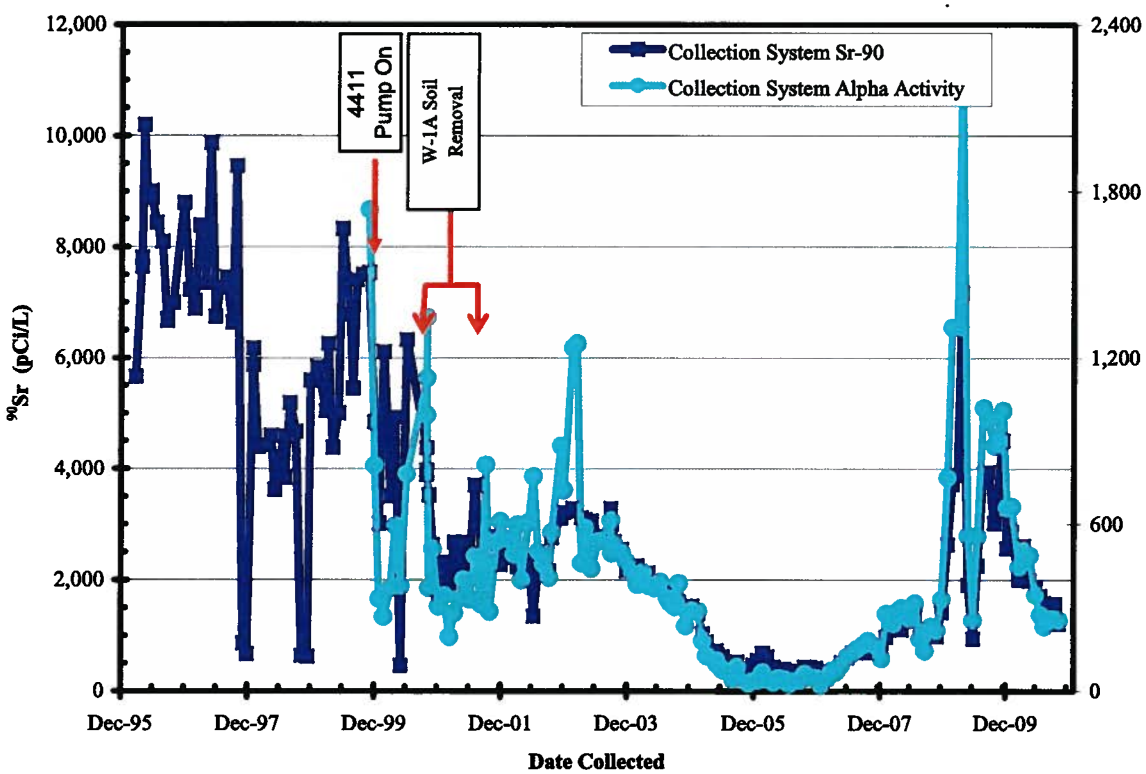

Figure 2.16. ^{90}Sr and alpha activity in collected Corehole 8 Plume groundwater.

Table 2.13. Corehole 8 groundwater collection system ^{90}Sr flux

Month	FY 1997 ^{90}Sr (pCi/L)	FY 1997 Flow volume (liters)	FY 1997 ^{90}Sr flux (Ci)	Month	FY 2010 ^{90}Sr (pCi/L)	FY 2010 Flow volume (liters)	FY 2010 ^{90}Sr flux (Ci)
October 1996	8700	933,000	0.0081	October 2009	4520	1,259,179	0.006
November 1996	8800	1,845,000	0.0162	November 2009	2570	2,740,147	0.007
December 1996	7230	2,595,000	0.0188	December 2009	2870	3,790,714	0.011
January 1997	6890	1,711,000	0.0118	January 2010	2870	2,981,390	0.009
February 1997	8390	1,858,000	0.0156	February 2010	2010	2,932,661	0.006
March 1997	7350	2,162,000	0.0159	March 2010	2620	3,345,149	0.009
April 1997	9870	1,946,000	0.0192	April 2010	1860	2,647,454	0.005
May 1997	6750	1,697,000	0.0115	May 2010	1720	2,927,995	0.005
June 1997	7280	2,631,000	0.0192	June 2010	1590	3,298,219	0.005
July 1997	7463	1,705,000	0.0127	July 2010	1440	2,652,278	0.004
August 1997	6647	1,131,000	0.0075	August 2010	1580	2,734,502	0.004
September 1997	9465	953,000	0.009	September 2010	1220	3,144,830	0.004
Total		21,167,000	0.1655	Total		34,454,520	0.0740

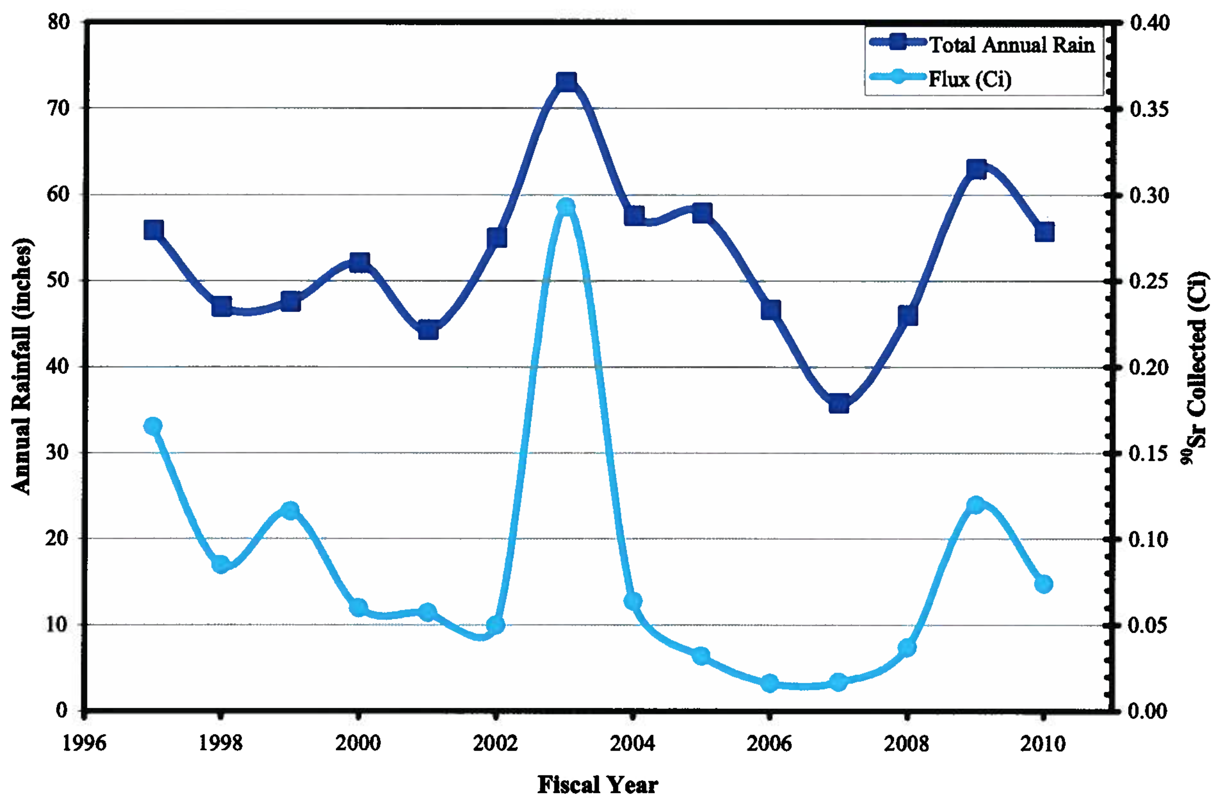

Figure 2.17. Corehole 8 Plume groundwater collector annual intercepted ^{90}Sr flux and rainfall.

Figure 2.18 shows ^{90}Sr and $^{233/234}U$ activities measured at well 4570 (see Figure 2.13) since its installation as part of the BV Groundwater Engineering Study. Contaminant activities have generally declined since the beginning of monitoring this well. The contaminant level increases noted in FY 2008 and FY 2009 decreased in FY 2010 with ^{90}Sr reaching the lowest level measured to date while $^{233/234}U$ still remains somewhat elevated compared to levels measured during the drought years of 2006-7. Wells 4571 and 4572 are also monitored to evaluate the potential extension of the plume west of First Creek. Strontium-90 was not detected in well 4571 (9.7 ft deep) or well 4572 (48.8 ft deep) in either of two sampling events during FY 2010. Strontium-90 has not been detected in either well since the start of monitoring in 2005.

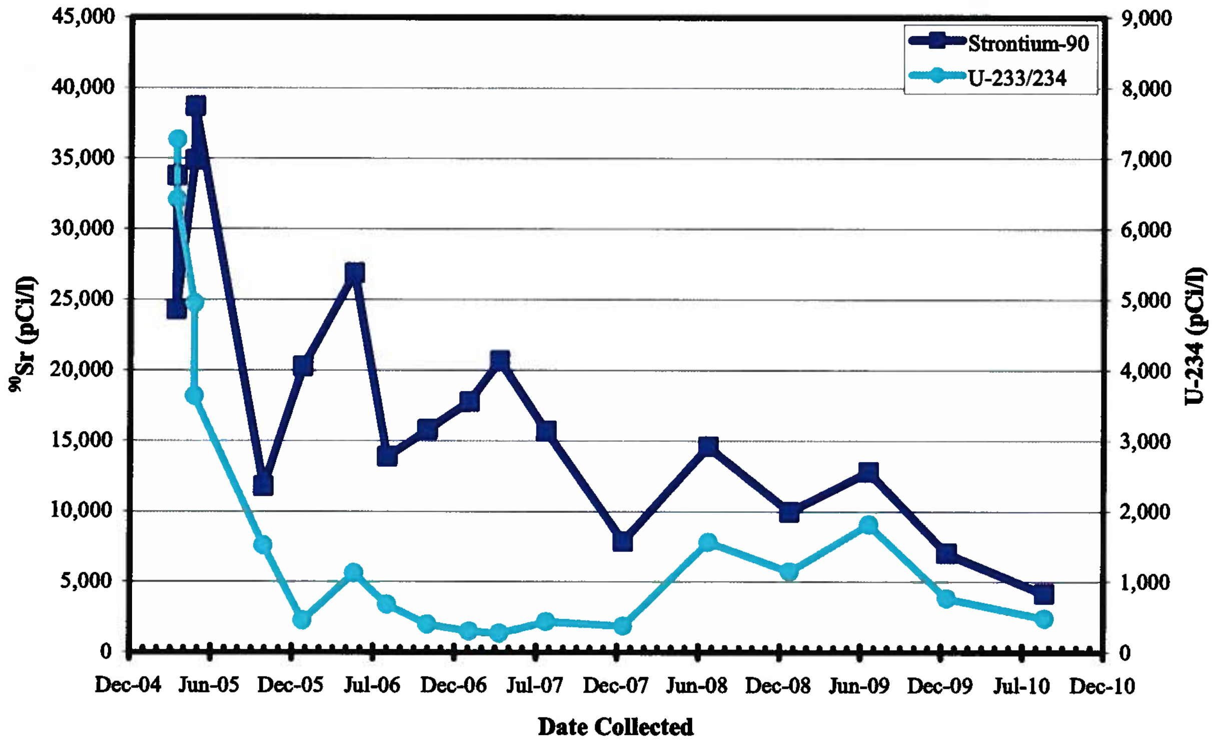

Figure 2.18. ^{90}**Sr and** ^{234}**U activities in well 4570.**

2.3.1.3 Performance Summary

The Corehole 8 Plume collection system did not meet its performance goal during FY 2010.

During FY 2010, the increase in contaminant mass transport that started during FY 2009 continued, although during the latter part of the year contaminant levels and discharge fluxes decreased. The increased source release translated throughout the plume and, although the collection system did capture a large mass of the contaminant, a relatively large amount of contamination discharged to First Creek via plume infiltration into storm drains to Outfall 341. Mechanical problems with the plume collection system also impaired plume capture during FY 2010.

The problems with the Corehole 8 Plume collection system were identified as an issue in the 2010 RER. Water line leaks were repaired in FY 2010 with repairs continuing as leaks are identified. In response to the deficiencies with the plume collection system, DOE is installing additional plume extraction wells to allow more robust hydrologic control of the plume in its bedrock seepage pathway. In addition to installation of additional wells, the mechanical system in the existing shallow lift stations is being upgraded and replaced to be compatible with the new controls system. This work is being conducted as a groundwater action as part of under the authority of the BV ROD and the project design is documented in the RDR/RAWP (DOE 2010d) which was submitted for regulatory approval September 22, 2010.

2.3.1.4 Compliance with LTS Requirements

2.3.1.4.1 Requirements

LTS requirements are not specified in the decision document pertaining to this site.

2.3.1.4.2 Status of Requirements for FY 2010

Although no LTS requirements are specified, the Corehole 8 groundwater collection system underwent monthly inspections in FY 2010 by the BJC Facility Manager as a Best Management Practice to monitor the condition of the system and note any extended downtimes (>1 day) or major operational problems. Operational checks of the pumping and treatment system were conducted by Energy*Solutions*, routine maintenance was performed as required, and the system was monitored by the BJC Waste Operations Control Center (WOCC) via the automated alarm for pump malfunctions. Additionally, the ORNL site was subject to access controls (badge required to pass through security checkpoints), and "Contamination Area" signs were clearly in place.

Operational problems during FY 2010 included frequent high water level alarm status at Lift Station 3 indicating the pump was not able to maintain the target water level in that area. In addition, high water level alarm situations were noted at Lift Station 1 (the main lift station that pumps water to the PWTC). Although these conditions are within the normal operational expectations, the frequency of high water level alarm status indicates that the plume extraction system was not able to control the plume discharge, as also indicated by the plume contaminant releases to First Creek. Additionally, the pump controller for the plume extraction pump in well 4411 failed during the year, which disabled the pump.

The ongoing BV plume extraction wells project is installing additional plume extraction wells both near the source and near Lift Station 3 to better control the plume and increase contaminant mass removal. The well 4411 pump controller is being replaced to allow resumed plume extraction.

Maintenance in FY 2010 included replacing a portion of the perforated drain pipe from the French drain connected to Lift Station #3 after it was damaged during nearby construction. This repair did not affect lift station performance and the system was operable after 4 hours. Additionally, Lift Stations #1 and #3 continue to go into high alarm occasionally during rain events. Although this is considered "normal" operations, it was also noted that Lift Station #3 seems to be struggling to keep up with the water flow. The groundwater collection system is discussed in Sect. 2.3.1.2.

2.3.2 Tank W-1A Removal Action

Location of the Corehole 8 Plume Source (Tank W-1A) Removal Action is shown on Figure 2.1. The scope of this action included removal of contaminated soils, along with associated piping, valve pits, and appurtenances within the area of excavation; backfilling; and site restoration. Some soils and the tank have been left in place due to potential transuranic (TRU) waste that would require special handling and disposition. The tank interior was cleaned; however, excavation of the contaminated soil from around the tank and tank removal require completion. In FY 2010, sampling and characterization were completed to delineate the extent of remaining contamination. The removal action is scheduled to be completed in FY 2011. This site has only LTS requirements. A review of compliance with these requirements is included in Sect. 2.3.2.1. Background information on this remedy and performance standards are provided in Chap. 2 of Vol. 1 of the 2007 RER (DOE 2007a).

No surface water or groundwater monitoring is required to verify the effectiveness of the removal action; however, the Corehole 8 Plume groundwater recovery and monitoring continue at well 4411 and the Corehole 8 sump (Sect. 2.3.1).

2.3.2.1 Compliance with LTS Requirements

2.3.2.1.1 Requirements

LTS requirements specified in the RmAR (DOE 2002b) include S&M activities to be performed routinely to ensure that the clean backfill is not undergoing excessive subsidence or erosion. The RmAR also requires that the area be posted as "Soil Contamination Area–Contact Radiation Protection before disturbing surfaces." The site is being prepared to complete the removal action at Tank W-1A. Prior to start of the removal action the perimeter of the site will be re-posted as a Radiological Area. Upon project completion the site will be posted with the appropriate signs in accordance with the BJC Radiation Protection Plan.

2.3.2.1.2 Status of Requirements for FY 2010

The site is being prepared to complete the removal action at Tank W-1A. A Documented Safety Analysis is being prepared and will identity the site controls. Until then, the site will be monitored to note the condition of the backfill and excessive subsidence or erosion. In FY 2010 the site access controls, general housekeeping, and condition of the signs were also inspected and maintained. In preparation for the removal action, construction fencing has been installed around the site.

2.3.3 Surface Impoundments Remedial Action

The location of the SIOU RA is shown on Figure 2.1. The scope of this action involved the removal of contaminated water, sediment, and the upper 0.1 to 0.2 ft of subimpoundment soil (clay) and was implemented in two phases. The first phase involved contaminated water and sediment removal and backfilling of impoundments C and D, which were small, lined impoundments. The second phase involved removal and treatment of discrete batches of contaminated sediment and backfilling of impoundments A and B, which were larger, unlined impoundments. Upon completion of the RA, all four impoundments were covered with gravel and asphalt and are currently used as parking areas. This site has only LTS requirements. A review of compliance with these LTS requirements is included in Sect. 2.3.3.1. Background information on this remedy and performance standards are provided in Chap. 2 of Vol. 1 of the 2007 RER (DOE 2007a).

No post-action performance monitoring of groundwater or surface water was specified in the decision documents.

2.3.3.1 Compliance with LTS Requirements

2.3.3.1.1 Requirements

The RAR (DOE 2003b) states that no institutional controls are needed at the site. However, it does state that institutional controls that limit excavation will remain in place for potential residual subsurface contamination around the site.

2.3.3.1.2 Status of Requirements for FY 2010

The site underwent an annual inspection in FY 2010 by the ORNL S&M Program to check for evidence of unauthorized excavation/penetration without a valid permit. No unacceptable activity was noted.

In addition, both primary workgroups of this area, UT-Battelle and BJC, have an EPP program with procedures that do not allow for unauthorized excavations/penetrations in this area.

2.3.4 Metal Recovery Facility Removal Action

Location of the Metal Recovery Facility (MRF) Removal Action is shown on Figure 2.1. The scope of this action included removal of surface structures to slab, leaving in place the concrete floor slab, foundation, and other subsurface structures. The floor slab area was sealed and the slab and surrounding yard areas were covered with a minimum two inches of gravel. Final disposition of the slab and subsurface structures has been deferred to the BV ROD. This site has only LTS requirements. A review of compliance with these LTS requirements is included in Sect. 2.3.4.1. Background information on this remedy and performance standards are provided in Chap. 2 of Vol. 1 of the 2007 RER (DOE 2007a).

No surface water or groundwater monitoring is required to verify the effectiveness of the removal action.

2.3.4.1 Compliance with LTS Requirements

2.3.4.1.1 Requirements

LTS requirements specified in the RmAR (DOE 2003c) include S&M activities to ensure that the gravel cover is not grossly disturbed in a manner that might expose subsurface contamination. In the event that the gravel cover is disturbed, the minimum two inches gravel protective cover over the epoxy barrier coating will be restored. The RmAR also requires that the site be posted as an underground contamination area.

2.3.4.1.2 Status of Requirements for FY 2010

The site underwent an annual inspection in FY 2010 performed by the ORNL S&M Program to monitor the condition of the gravel cover and ensure that the signs denoting that the area has underground contamination are present and visible and firmly in place. No maintenance was required.

2.4 BETHEL VALLEY MONITORING CHANGES AND RECOMMENDATIONS

Table 2.14 summarizes recommendations for the BV Watershed and carries forward the issue of ungauged flux in BV from the 2006 RER/CERCLA FYR (DOE 2007b) for tracking purposes until final resolution.

In FY 2010, the Corehole 8 Plume collection system did not meet RmAR goals (Sect. 2.3.1.2). ORNL's water leaks (adding excess water to the system) were repaired in FY 2010, with repairs continuing into FY 2011. Installation of additional extraction wells and an upgrade of the extraction system are in progress. The recommendations are included in Table 2.13.

Table 2.14. Summary of BV Watershed technical issues and recommendations

Issue[a]	Action/ Recommendation
2011 Current Issue	
None.	
Issue Carried Forward	
1. Corehole 8 Plume collection system performance does not meet RmAR performance goals. (2010 RER)[b]	1. (1) UT-Battelle is identifying and repairing potable water lines in vicinity of contaminant source areas to lessen contaminant release and migration from soils. (2) RDR/RAWP for the BV Corehole 8 Extraction System was submitted and approved. Work was started on the drilling of additional extraction wells and an upgrade of the extraction system.
2. The ^{90}Sr contamination from non-point sources has become the dominant contributor to ^{90}Sr flux at the 7500 Bridge location. SWSA 3 may also be contributing to increased flux seen at Raccoon Creek. (2006 FYR)[b]	2. During FY 2010, non-point ^{90}Sr sources comprised less than 10% of the 0.33 Ci measured at 7500 Bridge compared to the 40% comprised by Corehole 8 Plume discharges to First Creek. Sampling will occur during FY 2011 to determine if excess ungauged ^{90}Sr impacts BV ROD goals. SWSA 3 capping was initiated in FY 2010 along with additional extraction wells to capture the Corehole 8 plume.
Completed/Resolved Issues	
None.	

[a] An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

[b] The year in which the issue originated is provided in parentheses, e.g., (2006 FYR).

3. CERCLA ACTIONS IN MELTON VALLEY WATERSHED

3.1 INTRODUCTION AND OVERVIEW

This chapter provides an update of the effectiveness of ongoing and completed CERCLA actions in MV Watershed during FY 2010. Table 3.1 lists CERCLA actions within the watershed and Figure 3.1 shows the locations of those actions. Only sites that have performance monitoring and LTS requirements, as noted in Table 3.1, are included in the performance evaluations provided herein. In subsequent sections, performance goals and objectives, monitoring results, and an assessment of the effectiveness of each completed action are presented. RAOs that form the basis for the interim RAs conducted as part of the MV ROD are based on future land uses outlined on Figure 3.2. These future land uses require certain restrictions regarding site access and allowable activities within the area as summarized in the LTS requirements.

A summary of LTS requirements is provided in Table 3.2, and a review of compliance with these requirements is included in Sect. 3.2.5, Sect. 3.3.1.1, Sect. 3.3.2.1, and Sect. 3.3.3.1.

For background information on each remedy and performance standards, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chap. 3 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated in the annual RER and republished every fifth year at the time of the CERCLA FYR.

3.1.1 Status and Updates

The PCCR (DOE 2008a) documenting the completion of the Fuel Salt Disposition (FSD) project conducted at the Molten Salt Reactor Experiment (MSRE) facility was approved in October 2008. This FSD action included the sequential processing of each of the three MSRE drain tanks to: (1) melt and chemically treat the salts, (2) fluorinate the salt to remove uranium, (3) trap the uranium on cold traps and transfer the uranium to chemical traps (NaF), and (4) ship the uranium loaded traps to ORNL Bldg. 3019A for storage. Per agreement with the three parties to the FFA, the ROD requirements relative to the MSRE uranium were considered completed when the uranium was delivered to Bldg. 3019A. The ROD commitment to transfer the residual TRU salts to shielded canisters and interim storage at the ORNL SWSA 5 has been delayed and will be addressed in the MSRE RAR due in FY 2011. No monitoring or LTS activities are required by the PCCR.

In FY 2010, a series of offsite monitoring wells were installed across the Clinch River to the west of MV. The purpose for offsite well installation is to evaluate potential groundwater communication beneath the Clinch River between DOE land and an area of offsite groundwater use. A total of 16 sampling points were installed in new wells and existing residential wells. Initial sampling was conducted from all new sampling points and from additional nearby residential wells. The new sampling points are now included in the MV monitoring network and will be sampled quarterly. In FY 2011, the Core Team will discuss the sampling results. Sampling will be revised accordingly and documented in the MV Monitoring Plan.

Table 3.1 CERCLA actions in MV Watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
		Watershed-scale actions		
MV Interim Actions	ROD (DOE/OR/01-1826&D3): 09/21/00	RAR (DOE/OR/01-2343&D1) 09/5/07 (DOE/OR/01-2343&D1/A1) 06/25/09 (DOE/OR/01-2343&D1/A2) submitted 08/5/09, pending approval MV Monitoring Plan Addendum (DOE/OR/01-1982&D1/R4/A1/R2), approved 05/12/10	Yes/Yes	3.2
	ROD (DOE/OR/01-2170&D1): 09/7/04 Amendment to change remediation approach for Trenches 5 & 7 to ISG. ESD (DOE/OR/01-2040&D2): 03/12/04 Add Tumulus 1 and 2 and the Intermediate Waste Management Facility to the scope of the Interim ROD. ESD (DOE/OR/01-2165&D1): 09/7/04 Modify requirements for 11 waste units. ESD (DOE/OR/01-2249&D1): 09/13/05 Remove seven facilities from MSRE D&D. ESD: DOE/OR/01-2333&D1): 12/27/06 Remove five STTs from D&D scope. LUCIP (DOE/OR/01-1977&D6): 05/24/06 AM (Time Critical) for Corrective Actions at White Oak Dam (DOE/OR/01-2460&D1): 10/13/10	PCCRs approved: Hydrofracture Well Plugging & Abandonment (DOE/OR/01-2138&D1) 07/14/06 New Hydrofracture Facility D&D (DOEOR/01-2306&D1) 07/31/06 Trenches 5 and 7 and HRE Fuel Wells In Situ Grouting (DOE/OR/01-2302&D1) 08/14/06 Hydrologic Isolation at SWSA 6 (DOE/OR/01-2285&D1) 09/6/06 SWSA 4 and Intermediate Holding Pond (DOE/OR/01-2300&D1) 09/11/06 Old Hydrofracture Facility D&D (DOE/OR/01-2014&D2) 09/26/06 Hydrologic Isolation at Seepage Pits and Trenches (DOE/OR/01-2310&D1) 10/2/06 Soils and Sediments (DOE/OR/01-2315&D1) 10/2/06 HRE Ancillary Facilities D&D (DOE/OR/01-2307&D1) 10/4/06 7841 Equipment Storage Area and 7802F Storage Shed D&D (DOE/OR/01-2323&D1) 10/5/06 Hydrologic Isolation at SWSA 5 (DOE/OR/01-2286&D1) 11/6/06		

Table 3.1. CERCLA actions in MV Watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
		Single-project actions		
WOCE	AM (Letter): 11/9/90	RmAR (ORNL/ER/Sub/91-KA931/4) approved 09/30/92.	No/Yes	3.3.1
WAG 13 Cesium Plots	IROD (DOE/OR/01-1059&D4): 10/6/92	RAR Postclosure report (DOE/OR/01-1218&D2) approved 8/25/94.	No/Yes	3.3.2
WAG 5 Seep C	AM (DOE/OR/02-1235&D2): 03/30/94	RmAR Postclosure Report (DOE/OR/01-1334&D2) approved 06/22/95. System shutdown prior to capping.	Discontinued	--
WAG 5 Seep D[b]	AM (DOE/OR/02-1283&D2): 07/26/94	RmAR Postclosure Report (DOE/OR/01-1334&D2) approved 06/22/95. Collection of contaminated groundwater ongoing.	Superseded	--
WAG 4 Seep Control	AM (DOE/OR/02-1440&D2): 02/12//96	RmAR (DOE/OR/01-1544&D2) approved 03/5/98.	Discontinued	--
MSRE D&D Reactive Gas	AM (Letter): 06/12/95	RmAR (DOE/OR/01-1623&D2) approved 02/12/98.	No/No	--
MSRE D&D Uranium Deposit Removal	AM (DOE/OR/02-1488&D2): 08/6/96	RmAR (DOE/OR/01-1918&D2) approved 12/18/01.	No/Yes	3.3.3
OHF Tank Sludges	AM (DOE/OR/02-1487&D2): 09/12/96	RmAR (DOE/OR/01-1759&D1) approved 12/15/98.	No/No	--
OHF Tanks and Impoundment	AM (DOE/OR/01-1751&D3): 05/14/99 AM Addendum (DOE/OR/01-1866&D2): 03/31/00	RmAR (DOE/OR/01-1908&D2) approved 05/11/2001.	Discontinued	--
MSRE D&D Fuel Salt Removal	ROD (DOE/OR/02-1671&D2): 07/7/98 ESD (DOE/OR/01-2088&D2) approved: 01/19/07 Delete requirement to convert MRSE ^{233}U to an oxide.	PCCR [DOE/OR/01-2256&D1 (removal and transfer of uranium from the MSRE Facility)] 10/10/08.	No/No	--

[a] Detailed information on the status of actions is from Appendix E of the FFA. The most up-to-date status of schedule information is available at <http://www.bechteljacobs.com/ettp_ffa_appendices.shtml>.

[b] The Seep D treatment system was dismantled during MV ROD RAs. The groundwater collection sump was incorporated into the MV ROD groundwater collection system.

ESD = Explanation of Significant Difference
HRE = Homogeneous Reactor Experiment
IROD = Interim Record of Decision
ISG = *in situ* grouting
OHF = Old Hydrofracture Facility
STT = Shielded Transfer Tanks
TBD = to be determined
WOCE = White Oak Creek Embayment

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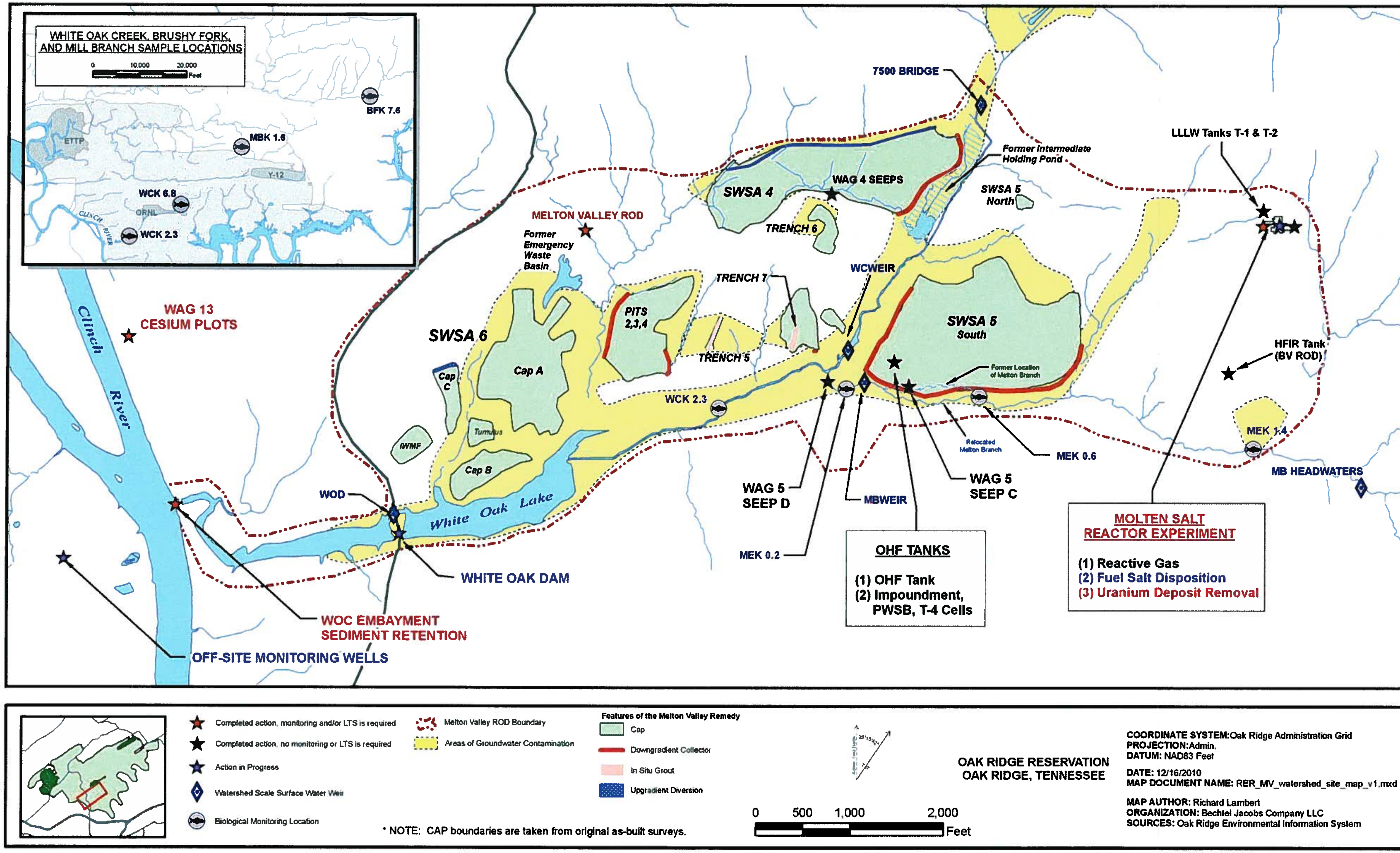

Figure 3.1 MV Watershed site map.

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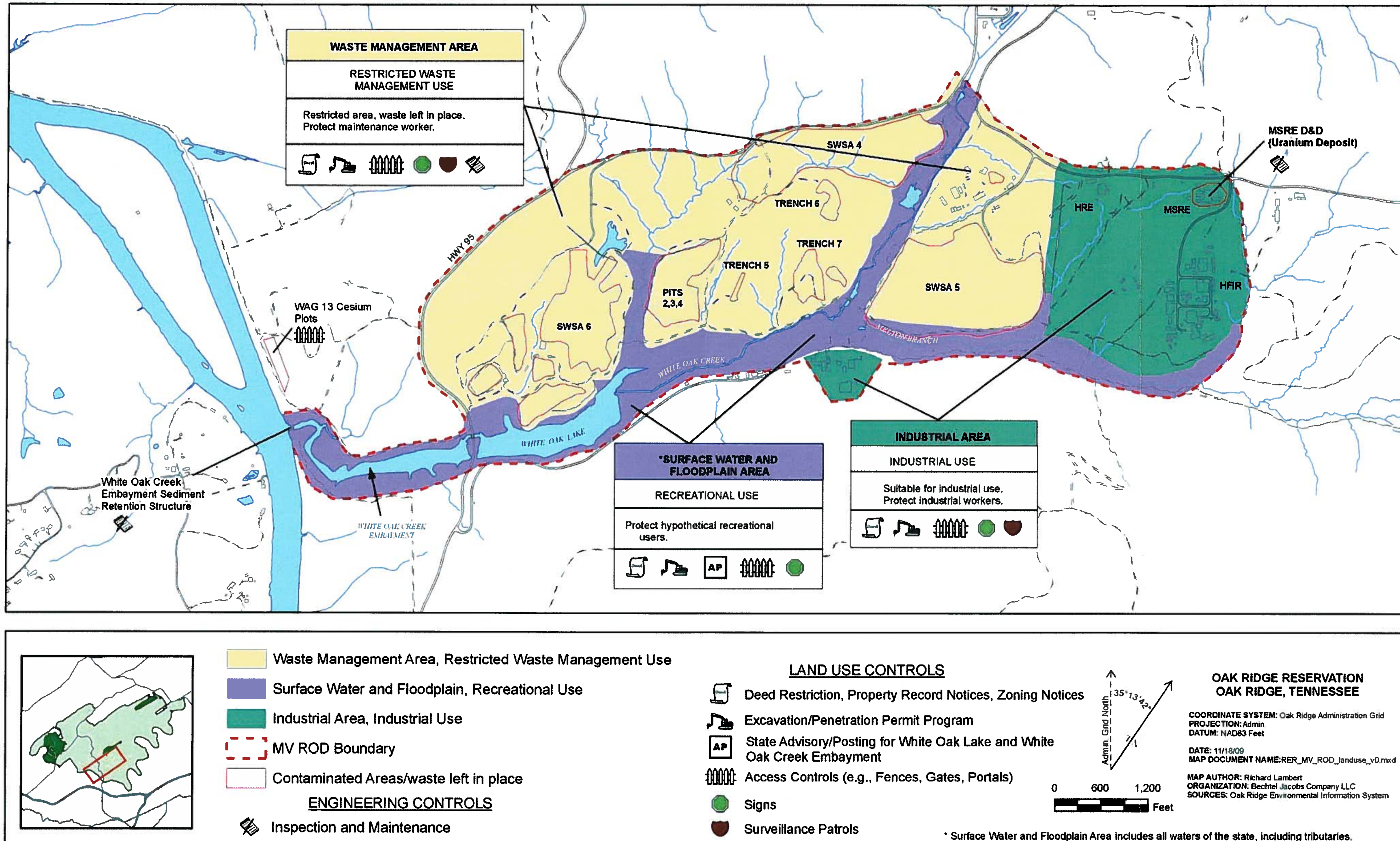

Figure 3.2. MV ROD-designated land use and interim controls.

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Table 3.2. LTS requirements for CERCLA actions in MV Watershed

Site/Project	LTS Requirements		Status	RER section
	LUCs	Engineering controls		
Watershed-scale actions				
ROD for Interim Actions for the MV Watershed ▪ SWSA 4 and IHP PCCR ▪ SWSA 5 PCCR ▪ SWSA 6 PCCR ▪ Seepage Pits and Trenches PCCR ▪ Trenches 5 and 7 PCCR ▪ Soils and Sediments PCCR ▪ Hydrofracture Well P&A PCCR ▪ NHF D&D PCCR ▪ OHF D&D PCCR ▪ HRE Ancillary Facilities D&D PCCR ▪ 7841 Equipment Storage Area and 7802F Storage Shed D&D PCCR	Watershed LUCs Administrative: ▪ land use and groundwater deed restrictions ▪ property record notices ▪ zoning notices ▪ permits program Physical: ▪ state advisory / postings ▪ access controls ▪ signs ▪ security patrols	Hydrologic Isolation Projects[a] PCCRs specific: ▪ Maintain caps ▪ Maintain groundwater collection systems	Watershed LUCs implemented under LUCIP: ▪ Physical LUCs in place. ▪ Administrative LUCs in place.[b] ▪ RCRA required notices complete. Hydrologic Isolation Projects[a,b] PCCRs specific: ▪ Engineering controls remain protective.	3.2.5
Completed single project actions				
White Oak Creek Embayment Sediment Retention Structure		▪ Inspection and maintenance of SRS	▪ Engineering controls remain protective.	3.3.1.1
WAG 13 Cesium Plots Interim Remedial Action	▪ Long-term S&M of the fenced enclosure		▪ LUCs in place.	3.3.2.1
MSRE D&D (Uranium Deposit) Removal Action		▪ Ongoing S&M	▪ Engineering controls remain protective.	3.3.3.1

[a]Hydrologic Isolation Projects include SWSA 4, SWSA 5, SWSA 6, and Seepage Pits and Trenches area.
[b]Zoning Notices will be filed with the City Planning Commission if/when areas are to be transferred out of DOE federal control.

HRE = Homogeneous Reactor Experiment
IHP = Intermediate Holding Pond
NHF = New Hydrofracture Facility
OHF = Old Hydrofracture Facility
P&A = plugging and abandonment
SRS = Sediment Retention Structure

An AM for a Time-Critical Removal Action for Corrective Actions at White Oak Dam (WOD) (DOE 2010f) received regulatory approval on September 13, 2010. The goal of this action is to mitigate the potential failure of WOD and the potential for future releases of contaminants to the environment and potential human exposure to these contaminants. Actions to be undertaken include grout-fill of the existing box culvert; fill, extend and armor the downstream slope of the dam; and fill and armor upstream of the dam. Construction activities were ongoing on September 30, 2010.

3.2 RECORD OF DECISION FOR INTERIM ACTIONS IN MELTON VALLEY WATERSHED

This section presents the remediation goals, performance metrics, and progress toward achieving the goals in the MV Watershed. Annual performance measurements obtained during FY 2010 are presented along with historic monitoring results.

3.2.1 Performance Goals and Monitoring Objectives

The MV ROD (DOE 2000b) specified surface water quality, surface water risk goals, and groundwater controls to be achieved within specified periods after completion of the RAs. The ROD also included specific performance objectives that would be used as the metrics to evaluate the effectiveness of the remediation. These goals and metrics are presented below. The evaluation of performance during FY 2010 is presented in Sect. 3.2.2.

The MV ROD stipulated a RAO for MV based on the industrial use area (east of SWSA 5), the Waste Management Area, the Surface Water and Floodplain Area, and for human receptors and ecological populations (Table 3.3). Yellow highlighted portions of the RAO are supported by ongoing monitoring and are discussed in detail in subsequent sections for this RER. Pink highlighted portions of the RAO are supported by LTS requirements as described in Sect. 3.2.5.

Table 3.3. ***RAO for the MV Watershed selected remedy, ORNL, Oak Ridge, Tennessee***[a]

Area/receptor	*Goal*
Waste management area (includes SWSA 4, 5, and 6 and Seepage Pits and Trenches)	• *Manage waste disposal sites as a restricted waste management area* • *Protect maintenance workers* • *Meet AWQC in surface water in a reasonable amount of time* • *Mitigate further impact to groundwater*
Industrial use area (generally the area east of SWSA 5)	• *Manage areas generally east of SWSA 5 as an industrial area* • *Protect industrial workers* • *Meet AWQC in surface water in a reasonable amount of time* • *Mitigate further impact to groundwater*
Surface water and floodplain area	• *Achieve numeric and narrative AWQC for waters of the state in a reasonable amount of time* • *Remediate contaminated floodplain soils to 2500 μR/hour*[b] • *Protect an off-site resident user of surface water at the confluence of White Oak Creek with the Clinch River from contaminant sources in Melton Valley* • *Make progress toward meeting Clinch River's stream use classification as a drinking water source at confluence of White Oak Creek with the Clinch River*
Human receptors	• *Protect maintenance workers, industrial workers, and off-site resident users of surface water (at the confluence of White Oak Creek with the Clinch River) to a* 10^{-4} *to* 10^{-6} *excess lifetime cancer risk and an HI of 1* • *Protect hypothetical recreational users of waters of the state*[c]
Ecological receptors	• *Protect ecological populations*[d]

[a]Source: MV ROD Table 1.1.
[b]*A future CERCLA decision will be prepared to determine whether additional actions are required for floodplain soil <2500 μR/hour.*

Table 3.3. ***RAO for the MV Watershed selected remedy, ORNL, Oak Ridge, Tennessee***[a] **(cont.)**

[c]This remedy addresses water quality but does not fully address fish consumption or sediment/floodplain soil contact or exposure under the recreational scenario. This remedy protects the hypothetical recreational user through a combination of remedial actions including land use controls. A future CERCLA decision will be prepared to assess whether any additional actions are required. Additional data collection and evaluation will be conducted as part of this remedy to further assess the status of ecological receptors in these areas. Results of this ecological monitoring and any additional actions, as necessary, will be included in a future remedial decision.

[d]The selected remedy enhances overall protection of valleywide ecological populations and subbasin-level populations over a majority of the valley. However, portions of the valley that are not addressed by the selected remedy may pose potential unacceptable risks to ecological receptors.

HI = hazard index

The MV ROD included specific performance objectives and performance measures that form the basis of remediation effectiveness monitoring. These performance objectives provide a quantitative basis to evaluate the effectiveness of hydrologic isolation at limiting contaminant releases from buried waste by monitoring groundwater fluctuation within hydrologic isolation areas. Additionally, the performance measure for surface water quality is to achieve the AWQC numeric and narrative goals related to contaminant discharges originating from MV areas within two years after completion of RAs. Table 3.4 includes the ROD performance objectives and performance measures for those elements of the remedy that specified post-remediation monitoring. Also, included in Table 3.4 are goal attainment dates and references to sections in this RER where the annual status of performance for each metric is discussed.

During the design process for *in situ* grouting (ISG) of Liquid Waste Seepage Trenches 5 and 7, a groundwater quality monitoring plan was prepared and implemented to monitor 13 wells in the vicinity of those two units for water quality evaluation. Results of that sampling and analyses are included in Sect. 3.2.2.2.3.

Groundwater emanating from capped waste areas is collected by downgradient interceptor trenches at SWSA 5; along the eastern edge of SWSA 4; southeast of Trench 7; along the eastern and western sides of Pits 2, 3, and 4; and at Seep D. The system includes some 30+ pumps that are operated based on automated level controls in the groundwater collection areas. The collected groundwater is all routed to an equalization tank located at SWSA 4 before transfer to the ORNL PWTC in BV. Water at the equalization tank is sampled to verify that the wastewater meets the facility waste acceptance criteria (WAC).

Table 3.4. *Performance measures for major actions in the Melton Valley Watershed, ORNL, Oak Ridge, Tennessee*[a]

Unit type/ unit names project scope	***Performance objectives***	***Performance measure[b]* (Attainment schedule) [RER section]**
SWSA 4 • *SWSA 4* • *Liquid Seepage Pit 1 & Secondary Media* • *Inactive Waste Transfer Lines @ Lagoon Rd.* • *Pilot Pits Area* • *Shallow Well P&A*	• *Contain disposed & contaminated materials* • *Meet RAO for the waste management use area* [soil]	• *Prevent releases from SWSA 4 from causing AWQC exceedances in waters of the state within 2 years after SWSA 4 construction is complete* (Fall 2008).[c] [See Sect. 3.2.2.1.3] • *Reduce SWSA 4 contaminant releases to surface water by approximately 80% to meet computed 1 X 10^{-4} total residential risk at the confluence of White Oak Creek with Clinch River in ~10 years after all ROD actions are complete* (2016).[c] [See Sect. 3.2.2.1] • *Reduce groundwater through flow in buried waste units by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area* [See Sect. 3.2.2.2]
SWSA 5 South • *SWSA 5 South* • *Stabilized OHF Pond and Tanks* • *Stabilized subsurface OHF facilities* • *Contaminated soils at OHF site* • *Shallow Well P&A*	• *Contain disposed materials* • *Meet RAO for the waste management use area* [soil]	• *Prevent releases from SW 5 South from causing AWQC exceedances in waters of the state in Melton Branch, Lower HRE Tributary, and SWSA 5 D1 within 2 years after SWSA 5 South construction is complete* (Fall 2008).[c] [See Sect. 3.2.2.1.3] • *Reduce SWSA 5 contaminant releases to surface water by approximately 80% to meet computed 1 X 10^{-4} total residential risk at the confluence of White Oak Creek with Clinch River in ~10 years after all ROD actions are complete* (2016).[c] [See Sect. 3.2.2.1] • *Reduce groundwater throughflow in buried waste units by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area* [See Sect. 3.2.2.2]
• ***SWSA 5 North 4 trenches***	• *Contain disposed materials* • *Meet RAO for the waste management use area* [soil]	• *Verify that groundwater does not contact the buried waste through water level monitoring in and adjacent to the trenches after capping.* [See Sect. 3.2.2.2]
SWSA 6 • *SWSA 6* • *Shallow Well P&A*	• *Contain disposed materials* • *Meet RAO for the waste management area* [soil]	• *Prevent releases from SWSA 6 from causing AWQC exceedances in waters of the state within 2 years after SWSA 6 construction is complete* (Fall 2008).[c] [See Sect. 3.2.2.1.3] • *Comply with RCRA postclosure requirements for designated RCRA areas* (Ongoing). [See Sect. 3.2.2.2.3]

Table 3.4. *Performance measures for major actions in the Melton Valley Watershed, ORNL, Oak Ridge, Tennessee*[a] (cont.)

Unit type/ unit names project scope	***Performance objectives***	***Performance measure*[b] (Attainment schedule) [RER section]**
		• *Reduce groundwater throughflow in buried waste units by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area.* [See Sect. 3.2.2.2]
Pits 2, 3, and 4 and Trench 6 • *Liquid seepage pits* • *Inactive waste pipelines* • *Shallow well P&A*	• *Contain disposed materials* • *Meet RAO for the waste management use area* [soil]	• *Prevent releases from Liquid Waste Seepage Pits 2, 3, and 4, and Trench 6 from causing AWQC exceedances in waters of the state within 2 years after construction is complete* (Fall 2008).[c] [See Sect. 3.2.2.1.3] • *Reduce groundwater throughflow in the contained area by >75% as measured by >75% decrease in water level fluctuations in selected monitoring locations inside the contained area* [See Sect. 3.2.2.2]
Trenches 5 and 7 • *Liquid seepage trenches* • *Inactive waste pipelines* • *Shallow well P&A*	• *Immobilize disposed materials.* • *Meet RAO for the waste management use area* [soil]	• *Prevent releases from Seepage Trenches 5 and 7 from causing AWQC exceedances in waters of the state within 2 years after ISV is complete* (Fall 2008).[c] [See Sect. 3.2.2.1.3] • *Vitrify any additional contaminated soils that cause contamination of groundwater leading to surface water exceedances.*
Surface water quality	• *Meet TDEC numeric AWQC and narrative (risk-based) water quality criteria in all waters of the state for specified uses.* • *Meet risk levels for hypothetical recreational water use (contact and consumption under the recreational exposure scenario)*	• *Achieve numeric AWQC and narrative (risk-based) water quality criteria in waters of the state within 2 years after completion of all actions that are part of the selected remedy. Meet recreation use criteria for water contact and consumption, excluding fish consumption* (Fall 2008).[c] [See Sect. 3.2.2.1.3] • *Reduce contaminant releases to meet water quality conditions that would allow hypothetical residential use (risk level of 1×10^{-4} for water only – no fish consumption or sediment contact scenarios) at confluence with the Clinch River in ~10 years after completion of all ROD actions. Reductions in ^{90}Sr and tritium of 75-80% are required.* [See Sect. 3.2.2.1]

[a]Source: MV ROD Table 2.17. NOTE: Non-italicized text within table is referencing sections in the current document.

[b] *To meet a target post-remediation risk level of 1×10^{-4} for surface water under the residential scenario at the mouth of White Oak Creek an 80% reduction of risk from the sum of individual contaminants from combined sources in Melton Valley is required. This calculation includes anticipated reductions in surface water contaminant risk that originate in Bethel Valley. Reduction of releases from individual source areas in Melton Valley as a result of remedial actions may vary somewhat. For all remediated areas, post-construction surveillance and maintenance monitoring will be implemented, which includes inspection of cap integrity, proper functioning and maintenance of surface water and groundwater flow control features, and conformance with land use control requirements.*

[c]Indicates date by which goal is to be attained.

HRE = Homogeneous Reactor Experiment
OHF = Old Hydrofracture Facility
P&A = plugging and abandonment

3.2.2 Evaluation of Performance Monitoring Data

3.2.2.1 Surface Water Monitoring Data

This section presents the results of remedy effectiveness evaluation surface water monitoring in MV. Section 3.2.2.1.1 summarizes the remediation goals for surface water. Section 3.2.2.1.2 presents information concerning major radionuclide concentrations and fluxes at the surface water IP monitoring stations. Section 3.2.2.1.3 presents data obtained at the tributary sampling locations.

3.2.2.1.1 Surface Water Quality Goals and Monitoring Requirements

Surface water goals include protection of the Clinch River to meet its stream use classification (e.g., as a domestic water supply), and to achieve AWQC in waters of the state. The ROD includes specific surface water remediation levels (RLs), as outlined in Table 3.5. Locations where surface water monitoring occurs to evaluate the remedy performance are shown on Figure 3.3. The following excerpts from the MV ROD (Sect. 2.11.7.3.1 Remediation Levels for Surface Water) include the specific concentration goals for the principal surface water COCs in MV.

Table 3.5. ***Surface water remediation levels for the Melton Valley Watershed ORNL, Oak Ridge, Tennessee***[a]

Melton Valley watershed	***Goal: AWQC in waters of the state***		***Residential risk***
	Numeric AWQC	***Narrative AWQC/ recreational risk***	
Receptor	*Hypothetical recreational user; fish and aquatic life*	*Hypothetical recreational user*	*Hypothetical off-site resident*
Areas affected	*All waters of the state*	*All waters of the state*	*Confluence of White Oak Creek with Clinch River*
Anticipated compliance locations	See Figure 3.3 of RER	See Figure 3.3 of RER	*Confluence of White Oak Creek with Clinch River*
Remediation level	*Levels established in Rules of the TDEC Chapter 1200-4-3-.03*	See Table 3.7 of RER	See Table 3.4 of RER
Exposure scenarios	*N/A (numeric criteria tabulated in regulation; no separate calculation using exposure scenarios needed)*	*Hypothetical recreational swimming for White Oak Lake and White Oak Creek Embayment; recreational wading for White Oak Creek, Melton Branch, and other waters of the state. The exposure scenarios do not take into account fish ingestion and sediment contact*	*Hypothetical residential (i.e., general household use)*

[a]Source: MV ROD Table 2.18. NOTE: Non-italicized text within table is referencing figures and tables in the current document.

N/A = not applicable

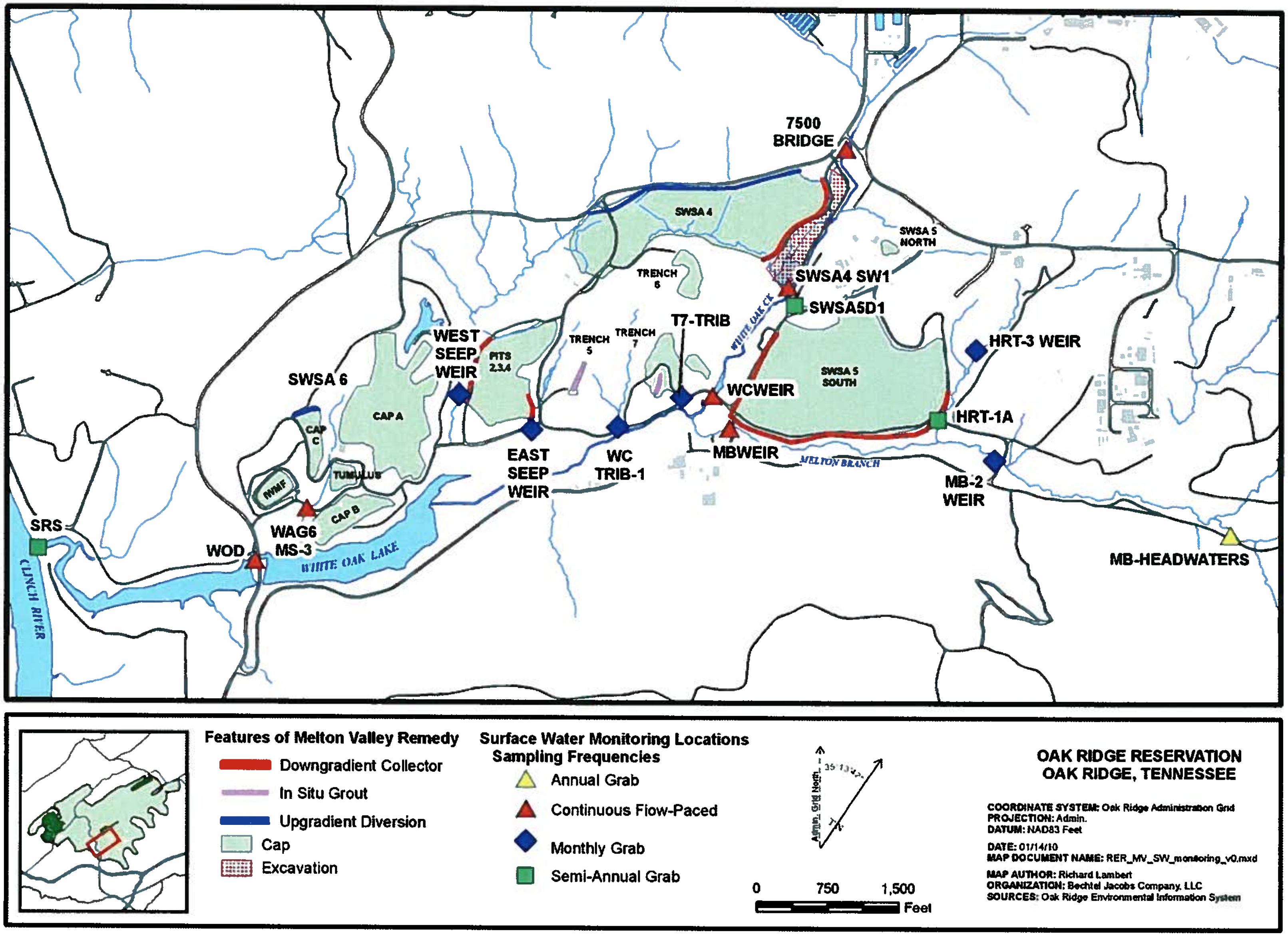


Figure 3.3. MV surface water monitoring locations.

Protect Clinch River to meet its stream use classification

This goal protects Clinch River as a domestic water supply [i.e., meets Safe Drinking Water Act of 1974 (SDWA) MCLs*] from contaminated surface water coming from MV. This goal provides residential risk-based limits for surface water at the confluence of WOC with Clinch River. This goal will be met within ten years from completion of actions in MV and BV. Remediation levels at the confluence of WOC with Clinch River will achieve an annual average excess lifetime cancer risk (ELCR) less than 1×10^{-4} and an hazard index (HI) less than one for a residential exposure scenario (i.e., general household use). Samples to demonstrate compliance with these RLs may be taken from the White Oak Creek Embayment (WOCE) and/or WOD. Table 3.6 lists the RLs for the contaminants contributing to residential risk at WOD.

Table 3.6. ***Residential risk-based surface water remediation concentrations for the Melton Valley Watershed, ORNL, Oak Ridge, Tennessee***[a]

Contaminants at White Oak Dam[b]	*Units*	*Reference concentration*[c]	*Minimum detection limit*[d]	*Concentrations based on a residential scenario*[e] *(for White Oak Creek Embayment and/or White Oak Dam)*
Arsenic	*mg/L*	*ND*	*0.003*	*0.0056*
Chloroform	*mg/L*	*ND*	*0.001*	*0.021*
1,2-dichloroethane	*mg/L*	*ND*	*0.001*	*0.016*
PCBs	*mg/L*	*ND*	*0.001*	*0.011*
Cesium-137+D	*pCi/L*	*40*	*10.0*	*150*
Cobalt-60	*pCi/L*	*ND*	*10.0*	*250*
Strontium-90+D	*pCi/L*	*ND*	*2.0*	*85*
Tritium	*pCi/L*	*1626*	*300*	*58,000*

Note: The remediation levels are calculated at 1×10^{-4} ELCR or HI of 1 using standard risk assessment protocols for a general household use scenario. These values apply to single contaminants only. To account for the total risk from multiple contaminants, sum of ratios calculations may be applied to all contaminants that are present above background. Actual remediation concentrations when multiple contaminants are present will therefore likely be lower than the single contaminant concentrations listed in the table. Concentrations for other contaminants not listed in the table will be determined as necessary and in a manner similar to that followed above.

[a]Source: MV ROD Table 2.20.

[b]*Beryllium was identified as a COC in the FS but was not included here because EPA has since revised its position on the carcinogenicity of beryllium* (see MV ROD Table 2.5). *Also, some of these contaminants have SDWA MCLs. The selected remedy will make progress toward protecting Clinch River as a drinking water source (i.e., meet SDWA MCLs).*

[c]*Reference concentrations equal twice the arithmetic mean of the background; these concentrations were used for surface water analyte screening in the MV watershed risk assessment.*

[d]*The minimum detection limits are based on existing regulatory methodology and current laboratory instrument capabilities.*

[e]*The residential scenario assumes a 70-kg adult receptor, an exposure frequency of 350 days/year, an exposure duration of 30 years, an ingestion rate of 2 L/day, and a skin surface area (for dermal exposure) of 1.94 m^2.*

D = daughter products
ND = not detected or analyzed

* *MCLs refer to the Safe Water Drinking Act of 1974 maximum contaminant levels for drinking water.*

Achieve AWQC in waters of the state

White Oak Creek and Melton Branch (MB) are classified for Fish and Aquatic Life, Recreation, and Livestock Watering and Wildlife uses, but not for Domestic or Industrial Water Supply or Irrigation. All other named and unnamed surface waters in the watershed are also classified for Irrigation by default under the Rules of the TDEC Chapter 1200-4-4. Numeric AWQC and narrative criteria for the protection of human health (based on ELCR of 1 X 10^{-4} and HI less than 1 for recreational exposure scenario) and aquatic organisms will be met for site-related contaminants in all waters of the state in MV in ~10 years from completion of source actions in MV. Numeric AWQC exist for selected compounds under the Recreation and Fish and Aquatic Life Classifications. Consistent with EPA guidance, compliance with numeric AWQC for Recreation and Fish and Aquatic Life Classifications is sufficiently stringent to ensure protection of other uses for which there are narrative, but not numeric, criteria (i.e., Irrigation or Livestock Watering and Wildlife). A recreational risk scenario considered representative of the surface water classifications is used to calculate cumulative risk from measured concentrations of surface water contaminants or conversely to derive allowable concentrations from risk-based limits.

AWQC in Waters of the State—Numeric AWQC

The numeric AWQC for (1) Fish and Aquatic life and (2) Recreation (organisms only) apply to waters of the state in MV and are tabulated in Rules of the TDEC Chapter 1200-4-3-.03 for most of the COCs. Compliance will be based on statistically valid data assessments, and take into account frequency of detection and data trends. The sampling locations for the selected remedy will be finalized in a post-ROD sampling plan. The locations are generally at the downstream end of individual reaches but upstream of any confluence with other major streams. Samples taken from such locations would essentially integrate contamination entering the reach from any sources upstream of the sampling location.

AWQC in Waters of the State—Narrative Criteria

In accordance with EPA guidance, the CERCLA risk assessment process is used to address the narrative criteria for waters of the state. A recreational risk scenario considered representative of the surface water classifications is used to calculate cumulative risk from measured concentrations of surface water contaminants or conversely to derive allowable concentrations from risk-based limits. However, DOE does not reasonably foresee actual recreational use of MV surface water in the future.

Waters of the state containing COCs that do not have numeric AWQC will achieve an annual average ELCR less than 1 X 10^{-4} and an HI less than 1 for a recreational exposure scenario. This goal applies only to surface water and only to those contaminants of concern that do not have numeric AWQC, such as radionuclides. The numeric AWQC for individual contaminants is generally equivalent to risk levels ranging up to 10^{-5}. The annual average risk goal of 1 X 10^{-4} meets the intent of the AWQC because when multiple contaminants are present in the surface water, as is likely, their individual risk levels would be roughly equivalent to the AWQC-equivalent risk of 10^{-5}. A lower risk goal could routinely require individual contaminant risks to be below the AWQC-equivalent risk of 10^{-5}.

Under this ROD, the recreational scenario is defined as a swimming scenario for the impounded water bodies, such as White Oak Lake and the WOCE, and a wading scenario for streams such as WOC and MB. Since contaminated sediments are left in place under the remedy in this ROD, the swimming or wading scenarios do not include external exposure to or contact with sediment. Also, the scenarios do not include fish consumption because some contaminants in fish may be linked to contaminated *sediments.* Table 3.7 *[sic] lists the remediation levels for the recreational surface water COCs identified in the FS. The sampling locations for the selected remedy will be finalized in a post-ROD sampling plan.*

Table 3.7. *Recreational risk-based surface water remediation concentrations for the Melton Valley Watershed, ORNL, Oak Ridge, Tennessee*[a]

COCs identified in the FS[b]	Units	Reference Concentration[c]	Minimum Detection Limit[d]	Concentrations based on a recreational swimming scenario[e] (for White Oak Lake and White Oak Creek Embayment)	Concentrations based on a recreational wading scenario[f] (for White Oak Creek, Melton Branch, and other waters of the state)
Arsenic	*mg/L*	*ND*	*0.003*	*NA*[g]	*NA*[g]
Tetrachloroethylene	*mg/L*	*ND*	*0.001*	*NA*[g]	*NA*[g]
Vinyl chloride	*mg/L*	*ND*	*0.001*	*NA*[g]	*NA*[g]
Cesium-137+D	*pCi/L*	*40*	*10.0*	*4.69E+04*	*2.37E+05*
Cobalt-60	*pCi/L*	*ND*	*10.0*	*7.84E+04*	*3.92E+05*
Radium-228+D	*pCi/L*	*ND*	*0.5*	*5.97E+03*	*2.99E+04*
Strontium-90+D	*pCi/L*	*ND*	*2.0*	*2.65E+04*	*1.33E+05*
Tritium	*pCi/L*	*1,626*	*300*	*2.07E+07*	*1.04E+08*
Uranium-234	*pCi/L*	*ND*	*0.5*	*3.34E+04*	*1.67E+05*

Note: The remediation levels are calculated at 1 X 10^{-4} ELCR or HI of 1 using standard risk assessment protocols for a swimming or wading scenario. These values apply to single contaminants only. To account for the total risk from multiple contaminants, sum of ratios calculations may be applied to all contaminants that are present above background. Actual remediation concentrations when multiple contaminants are present will therefore likely be lower than the single contaminant concentrations listed in the table. Concentrations for other site-related contaminants not listed in the table will be determined as necessary and in a manner similar to that followed above.

[a]Source: MV ROD Table 2.19.

[b]*Beryllium was identified as a COC in the FS but was not included here because EPA has since revised its position on the carcinogenicity of beryllium* (see MV ROD Table 2.5).

[c]*Reference concentrations equal twice the arithmetic mean of the background; these concentrations were used for surface water analyte screening in the MV watershed risk assessment.*

[d]*The minimum detection limits are based on existing regulatory methodology and current laboratory instrument capabilities.*

[e]*The recreational swimming scenario assumes a 70-kg adult receptor, an exposure frequency of 45 hours/year, an exposure duration of 30 years, an ingestion rate of 0.05 L/hour, and a skin surface area (for dermal exposure) of 1.94 m^2.*

[f]*The recreational wading scenario assumes a 70-kg adult receptor, an exposure frequency of 45 hrs/yr, an exposure duration of 30 years, an ingestion rate of 0.01 L/hour, and a skin surface area (for dermal exposure) of 0.632 m^2.*

[g]*Risk-based concentrations to meet the narrative criteria were not derived for these COCs since numeric AWQC exists for them.*

D = daughter products
NA = not applicable
ND = not detected or analyzed

3.2.2.1.2 IP Monitoring Results

This section provides an evaluation of the surface water quality data collected at surface water IPs on WOC and Melton Branch during FY 2010 compared to the MV ROD (DOE 2000b) goals and performance metrics. Surface water monitoring locations are shown on Figure 3.3.

The principal IP surface water monitoring station in MV is at WOD where WOC discharges from WOL. Continuous, flow-paced sampling is conducted at WOD to provide an ongoing record of radiological discharges from the watershed. The monitoring integrates measurements of radionuclide activities on samples collected during each month and the flow volume passing through the monitoring station to derive a flux value. Similar monitoring is conducted at three upstream IP surface water monitoring stations in MV – the WOC Weir (WCWEIR), the Melton Branch Weir (MBWEIR), and at the 7500 BRIDGE.

Table 3.8 includes the activities of ^{137}Cs, ^{90}Sr, and ^{3}H from the monthly flow-paced composite samples obtained at main stem IPs including 7500 BRIDGE, WCWEIR, MBWEIR, and WOD.

Comparison of ^{137}Cs, ^{90}Sr, and ^{3}H activities measured at WOD (Table 3.8) with the ROD goal (Table 3.6) is the basis for remedy effectiveness evaluation for protection of the Clinch River.

Figure 3.4 shows the annual average and average plus one standard deviation activities of ^{137}Cs, ^{90}Sr, and tritium at WOD for FY 2001 through FY 2010. Total annual rainfall at the ORNL site is provided to enable long-term comparison of contaminant activities response to rainfall. ROD goals for these three contaminants for protection of the Clinch River as a public water supply are also shown. The monthly flow-paced sampling provides continuous sampling of surface water at each sample station, thus providing a reliable measure of the time-averaged contaminant activity. During FY 2010, all flow-paced composite sample results from samples collected at WOD were below the risk-based activity goals.

Comparison of ^{137}Cs, ^{90}Sr, and ^{3}H activities (Table 3.8) measured at 7500 Bridge, WCWEIR, and MBWEIR, which are upstream integration monitoring locations, with the ROD goal for a recreational scenario (Table 3.7) indicates that all results for FY 2010 are well below the risk-based goals for these constituents. Additional information concerning CERCLA contaminant monitoring at the 7500 Bridge is presented in Chap. 2, as applicable to BV ROD goals.

Figure 3.5 shows the annual radionuclide flux for ^{137}Cs, ^{90}Sr, and ^{3}H measured at WOD and the ORNL site total annual rainfall from FY 2001 through FY 2010. During FY 2010, the ORNL site rainfall was slightly greater than the long-term average of 54 inches. The total fluxes of ^{137}Cs, ^{90}Sr, and ^{3}H remained low and comparable to the FY 2007 through FY 2009 values.

Table 3.8. Summary of FY 2010 radiological contaminant levels at surface water IPs in MV

Monthly FPC date	7500 BRIDGE			WCWEIR			MBWEIR			WOD		
	^{90}Sr	^{3}H	^{137}Cs	^{90}Sr	^{3}H	^{137}Cs	^{90}Sr	^{3}H	^{137}Cs	^{90}Sr	^{3}H	^{137}Cs
28-Oct-09	45	18,000	9.9	38.8	29,000	63	50	8,800	5.5 (U)	70	20,000	21
25-Nov-09	64	20,000	32	33.2	20,000	32	35	8,600	4.2(U)	78	11,000	27
30-Dec-09	24	13,000	9.1	104.5	6,500	38	30	4,900	6.7	59	12,000	19
27-Jan-10	36	17,000	9.8	62.8	22,000	14	23	5,500	4.2(U)	55	15,000	21
24-Feb-10	60	9,700	10	52.4	11,000	13	40	5,600	4.5	56	12,000	20
31-Mar-10	40	9,500	8.2	124.9	14,000	9.2	46	7,000	4.3(U)	57	12,000	9.5
28-Apr-10	38	17,000	11	17.5	12,000	13	24	11,000	4.3 (U)	67	8,400	18
26-May-10	25	12,000	12	33.8	24,000	8.2	34	24,000	4 (U)	54	13,000	9.4
30-Jun-10	43	22,000	12	17.2	28,000	10	32	7,700	3.9 (U)	55	21,000	17
28-Jul-10	42	44,000	5.9	25.7	41,000	7.6	31	7,900	6.1	61	30,000	4.8
25-Aug-10	43	47,000	8.7	24.4	33,000	14	24	5,200	3.8 (U)	41	28,000	9.6
29-Sep-10	47.9	32,100	6.26 (U)	27.7	24,000	76	42	18,000	4.2(U)	59	37,000	8
Average concentration (pCi/L)	42	22,000	< 11.2	47	22,000	25	34	9,500	< 4.6	59	18,000	15

Activity values are pCi/L.

U = reported activity was below the minimum detectable activity – analyte was not detected.

MV ROD radiological contaminant activity goals for ^{137}Cs, ^{90}Sr, and ^{3}H are met at all IP locations.

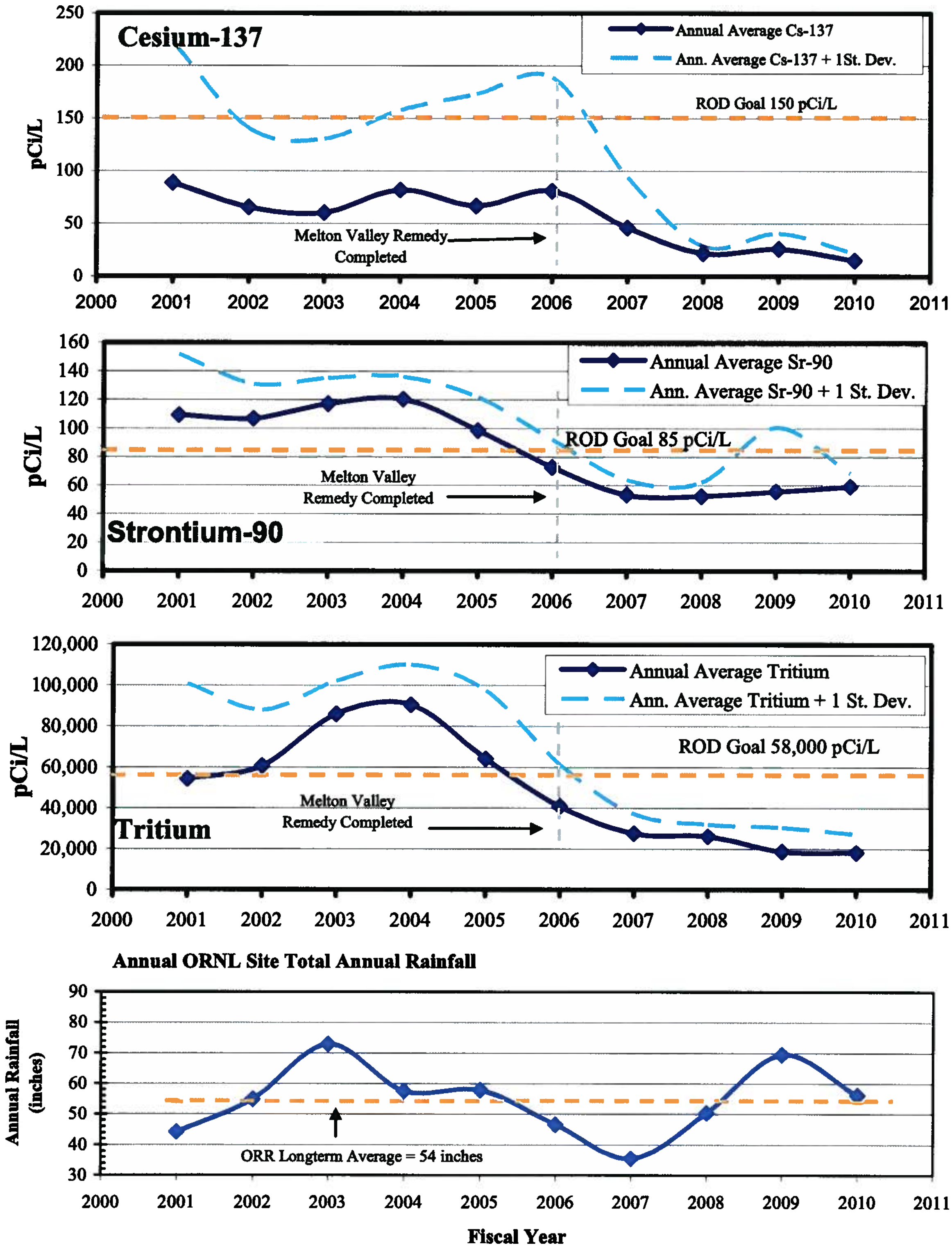


Figure 3.4. Annual average surface water activities of ^{137}Cs, ^{90}Sr, and tritium at WOD.

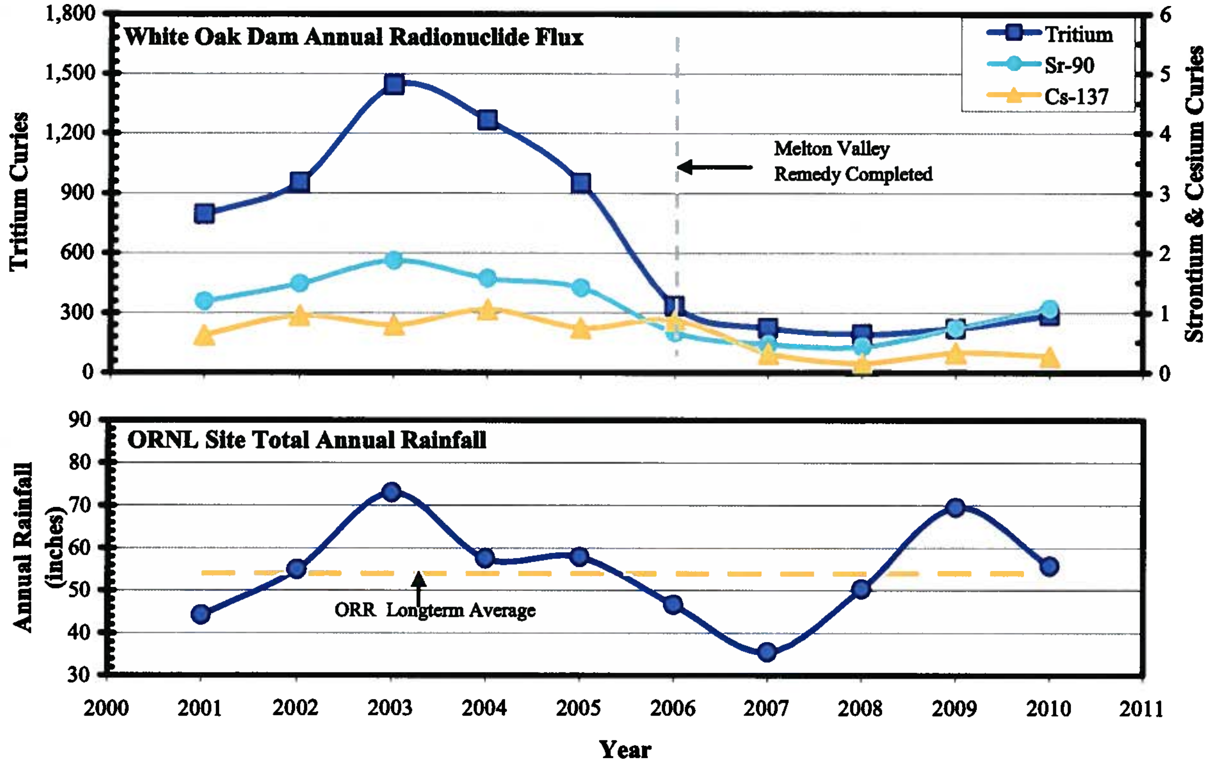


Figure 3.5. Annual radionuclide fluxes at WOD and annual rainfall at ORNL.

3.2.2.1.3 Tributary Surface Water Monitoring Results

Tributary monitoring locations are sampled to evaluate the effect of RAs on water quality in tributaries to WOC and Melton Branch. Tributary sample locations are shown on Figure 3.3 and samples are obtained by the grab method, except at WAG6 MS-3 and SWSA4 SW1 where flow-paced sampling is performed. Radiological RLs for surface water in the MV tributaries are presented in Table 3.7. Table 3.9 includes annual average and standard deviations of the principal radiological COCs in surface water for the tributary sampling locations.

All results are well below the ROD recreational goals for surface water and, therefore, trend graphs are not included in this RER. Examination of the annual average concentration values at most locations indicates that in most areas principal radiological contaminant levels are decreasing.

Table 3.9. Average annual radionuclide activities at tributary surface water monitoring locations in MV (pCi/L)

Location	Year	Alpha activity			Beta activity			Cobalt-60			Strontium-90			Tritium			U-233/234		
		N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD
	2004	12	280	170	12	230	110	12	18	7.2	12	5	0.7	12	7,100	2,500	12	146	96
	2005	12	110	65	12	160	40	12	12	4.1	12	5.3	1	12	5,400	2,100	12	69	24
EAST SEEP WEIR	2006	13	44	28	11	190	69	13	9.9	3.9	13	6.6	2.8	13	6,200	2,800	11	35	28
	2007	10	18	6	10	120	40	10	5.4	2.5	10	41	103	10	4,400	1,600	9	16	4.5
	2008	7	19	15	7	180	73	1	11		7	3.7	0.6	7	3,400	2,100	7	13	7
	2009	11	16	12	11	130	42	11	ND		11	4.3	2.4	11	3,100	1,900	11	16	11
	2010	12	11	5	12	79	18	12	ND		12	3.8	0.9	12	2,800	450	12	14	5
	2006	2	3.67	1.63				2	ND		2	145	82	2	1360	1080	2	0.87	0.59
	2007	2	ND		2	288	84.9	2	ND		2	131	36	2	<666	473	2	0.41	0.19
HRT-1A	2008	2	ND		2	198	103	2	ND		2	91.3	51.9	2	<384	37.5	2	<0.8	
	2009	2	ND		2	248	8.5	2	ND		2	124	7.8	2	596	74	2	<0.3	
	2010	2	ND		2	200	15	2	ND		2	112	17	2	<645		2	<0.4	
	2000	12	7.29	8.5	12	461	75	12	ND		12	200	36.3	12	1658	3684			
	2001	12	20	39.2	12	382	165	12	ND		12	184	50	12	164	448			
	2002	12	5.32	4.6	12	385	160	12	ND		12	137	57	12	454	1160			
	2003	13	5.2	14.4	13	519	121	13	ND		13	207	52	13	269	237			
HRT-3 WEIR	2004	14	3.94	2.3	14	658	253	14	ND		14	293	132	14	311	156			
	2005	12	11.15	24.3	12	584	225	12	ND		12	248	89	12	1180	3630			
	2006	13	2.17	1.5	12	317	151	13	ND		13	144	65	13	<293	49			
	2007				13	254	158	13	ND		13	114	73	13	ND				
	2008	12	<3.16	2.02	12	220	117	12	ND		12	187	274	12	<379	122			
	2009	12	ND		12	283	128	12	ND		12	140	63	12	<358				
	2010	12	<2		12	278	89	12	ND		12	136	44	12	ND		2	ND	
	2001	2	ND																
	2002	12	<2.55	1.55				12	ND		12	<1.81		12	4254	4970			
	2003	1	ND					1	ND		1	2.11		1	2848				
	2004																		
MB-2 WEIR	2005							12	<5.4		13	3.3	0.98	12	719	261			
	2006	1	6.11					13	ND		13	15.4	35.9	13	651	263			
	2007	3	ND		12	<16	23	13	ND		13	<2.23	1.2	12	<407	113			
	2008	12	<2.4	1. 1	12	9.2	4.9	12	ND		12	<2.2	0.57	12	<247	69			
	2009	12	<2.2		12	8.5	3.3	12	ND		12	<2.4	0.69	12	<990	1,900			
	2010	12	<2.5		12	12.5	6	12	ND		12	<3.9	1.9	12	<470	280	2	ND	

Table 3.9. Average annual radionuclide activities at tributary surface water monitoring locations in MV (pCi/L) (cont.)

Location	Year	Alpha activity			Beta activity			Cobalt-60			Strontium-90			Tritium			U-233/234		
		N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD
MB-HEAD-WATERS	2002	1	1.02		1	1.36		1	ND		1	14.34		1	383				
	2003	1	ND					1	ND		1	ND		1	361				
	2004	2	<2.31	0.3	2	3.66	0.40	2	ND		2	<0.94	0.3	2	272	128			
	2005	2	ND		2	ND		2	<4.18	1.94	2	ND		2	ND				
	2006	2	<1.35	0.39	2	3.35	1.56	2	ND			<1.27	0.18	2	365	116			
	2007		dry			dry			dry			dry			dry				
	2008	1	<0.41		1	2.7		1	ND		1	1.48		1	ND				
	2009	1	ND		1	5.4		1	ND		1	ND		1	ND				
	2010	2	ND		2	ND		2	ND		2	ND		2	ND				
SWSA4 SW1[a]	2006	7	3.83	2.08	7	515	337	7	<6.1	1.22	7	222	163	7	36,000	38,800			
	2007	6	3.85	2.32	6	454	186	6	ND		6	204	97	6	11,200	5,580			
	2008	11	<3.73	0.69	11	396	168	11	ND		11	181	82	11	6,130	5,900	2	1.01	0.26
	2009	13	<2.9		13	269	95	13	ND		13	123	46	13	4,700	3,300	2	ND	
	2010	10	< 1.5		10	180	71	10	ND		10	88	40	10	2,700	1,400	2	<1	
SWSA5 D-1	2004	11	197	68	11	150	46				11	24	5	11	166,800	62,900			
	2005	11	250	114	11	179	82				11	26	7	11	81,100	32,200			
	2006	10	97	59	9	74	43				10	12	5	10	40,900	50,400			
	2007	9	36	12	9	46	61				9	8	4	9	11,800	6,800	1	14.9	
	2008	8	56	23	8	40	23				8	9	3	8	11,400	11,300	8	27	13
	2009	13	38	17	13	32	11	11	ND		13	8	2	13	10,700	12,900	13	22	10
	2010	12	21	12	12	25	16	12	ND		12	7	3	12	6,700	4,100	12	13	7
WAG6 MS-3[a]	2002	12	27	24	12	714	309				12	224	103	12	977,600	695,800			
	2003	12	10	12	12	829	247				12	253	84	12	693,900	271,300			
	2004	12	6.3	4.3	12	883	200				12	338	67	12	905,500	355,500			
	2005	12	14	13	12	841	193				12	299	659	12	613,400	349,600			
	2006	10	24	57	9	550	167				12	211	81	10	338,600	147,000			
	2007	9	4.1	1.7	9	402	48				10	166	19	10	292,900	95,600			
	2008				12	290	67				12	113	33	12	162,000	78,400			
	2009	13	ND		13	230	57	13	ND		13	115	31	13	100,000	35,000			
	2010	12	< 4		12	290	70	12	ND		23	132	34	12	88,300	24,600	2	ND	
WEST SEEP WEIR	2001	12	281	252	12	428	133	12	4.4	5.4	12	153	43	12	12,300	3,600			
	2002	13	363	322	13	457	140	13	5.1	5.6	13	116	36	13	10,600	3,800	1	142	
	2003	13	159	150	13	312	121	13	2.5	3.1	13	101	33	13	20,200	45,100			

Table 3.9. Average annual radionuclide activities at tributary surface water monitoring locations in MV (pCi/L) (cont.)

Location	Year	Alpha activity			Beta activity			Cobalt-60			Strontium-90			Tritium			U-233/234		
		N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD	N	Avg	StD
	2004	12	85	82	12	176	120				12	68	33	12	16,900	29,000			
	2005	12	112	124	12	132	87				12	33	13	12	7,500	4,800			
	2006	14	107	83	12	122	57	14	1.7	1. 6	14	38	12	14	12,200	4,000			
	2007	13	41	25	13	82	45	13	ND		13	29	7	13	10,200	4,200			
	2008	13	37	28	13	82	37	13	ND		13	30	12		12,300	8,100			
	2009	14	32	30	14	61	17	14	ND		14	25	7	14	8,000	5,000	12	38	42
	2010	14	24	26	14	49	25	14	ND		14	20	10	14	4,300	2,500	14	26	26

[a]Flow-paced continuous sample result. All other results are based on grab samples.
< = One or more sample during the year reported ND values. Average and standard deviations based on average of detected results and detection limits for ND results.
Avg = average
N = number of samples
ND = not detected
StD = standard deviation

3.2.2.2 Groundwater Monitoring Data

3.2.2.2.1 Groundwater Quality Goals and Monitoring Requirements

The MV ROD RAO for groundwater is to mitigate further impact to groundwater in the waste management and industrial land use areas (Table 3.3). Mitigation of further groundwater impacts from the MV CERCLA units was a goal of hydrologic isolation of buried waste, ISG of Liquid Waste Seepage Trenches 5 and 7, and excavation of contaminated soils and pond sediment per the ROD. The performance metric for hydrologic isolation effectiveness is based on reduction of groundwater contact with principal threat source materials in shallow land waste burial units (Table 3.4). Groundwater level control in hydrologic isolation areas is discussed in Sect. 3.2.2.2.2.

The ROD stipulates that groundwater be monitored in the exit pathway along the western edge of the valley, in the vicinity of the hydrofracture waste injection sites, and in the vicinity of contaminant source control areas. Monitoring of groundwater at SWSA 6 is conducted under the requirements of the SWSA 6 Post-Closure Permit Application [pending approval by TDEC–Division of Solid Waste Management (DSWM)]. Data obtained from the SWSA 6 RCRA monitoring is used to evaluate the post-remediation groundwater quality conditions at the site perimeter. Monitoring results obtained to date in these areas are discussed in Sect. 3.2.2.2.3.

3.2.2.2.2 Groundwater-Level Control in Hydrologic Isolation Units

Minimization of surface water infiltration and groundwater inflows into buried waste to reduce contaminant releases is key to the concept of hydrologic isolation. Prior to remediation, groundwater levels were observed to rise into waste burial trenches in many areas of MV. In some areas waste trenches were known to completely fill with water during winter months. Contact of this water with buried waste materials was the source of contaminated leachate that subsequently seeped downward and laterally to adjacent seeps, springs, and streams.

The MV remedy utilizes multilayer caps to prevent vertical infiltration of rainwater into buried waste or other hydrologic isolation units as well as upgradient storm flow interceptor trenches, where necessary, to prevent shallow subsurface seepage from entering the areas laterally. Downgradient seepage collection trenches were constructed in several locations along downgradient perimeters of buried waste units. Seepage that is pumped from these trenches is piped to the ORNL PWTC for treatment prior to discharge.

The MV ROD included the performance goal of reducing groundwater-level fluctuations within hydrologically isolated areas by >75% from preconstruction fluctuation ranges (Table 3.4). The performance goal of attaining a >75% reduction in groundwater-level fluctuations created a design requirement to minimize, as much as possible, the contact of groundwater with buried waste to reduce the contaminated leachate formation process. As such, the fluctuation range is most relevant in cases where groundwater levels rise into the waste burial elevation zone. Groundwater-level fluctuations at elevations below the contaminant sources have less importance to the overall remedy effectiveness. During the remedial design of each hydrologic isolation area, wells were selected for monitoring the post-remediation groundwater-level fluctuations. Existing baseline fluctuation ranges were evaluated for the wells and target post-remediation groundwater elevations were determined to indicate that groundwater levels had dropped to below the 75% fluctuation range elevation.

Figure 3.6 shows the locations where groundwater-level monitoring is conducted to evaluate hydrologic isolation performance. Symbol shape and color indicate locations where the maximum observed groundwater elevation attains (is lower than) or exceeds (is greater than) the target groundwater-level specified in the ROD. General observations concerning the nature of groundwater level fluctuations in the

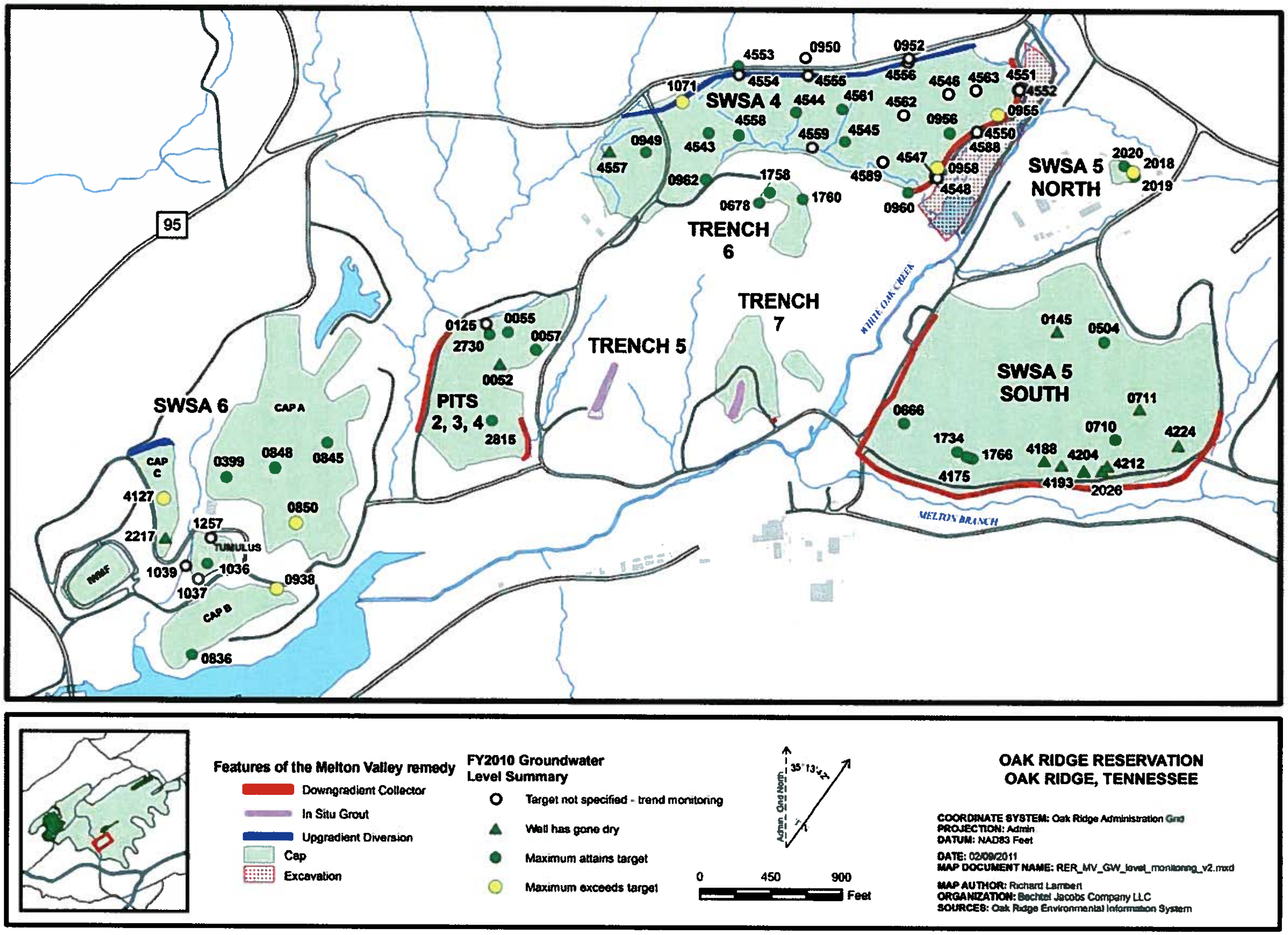


Figure 3.6. Summary of groundwater-level monitoring results for FY 2010.

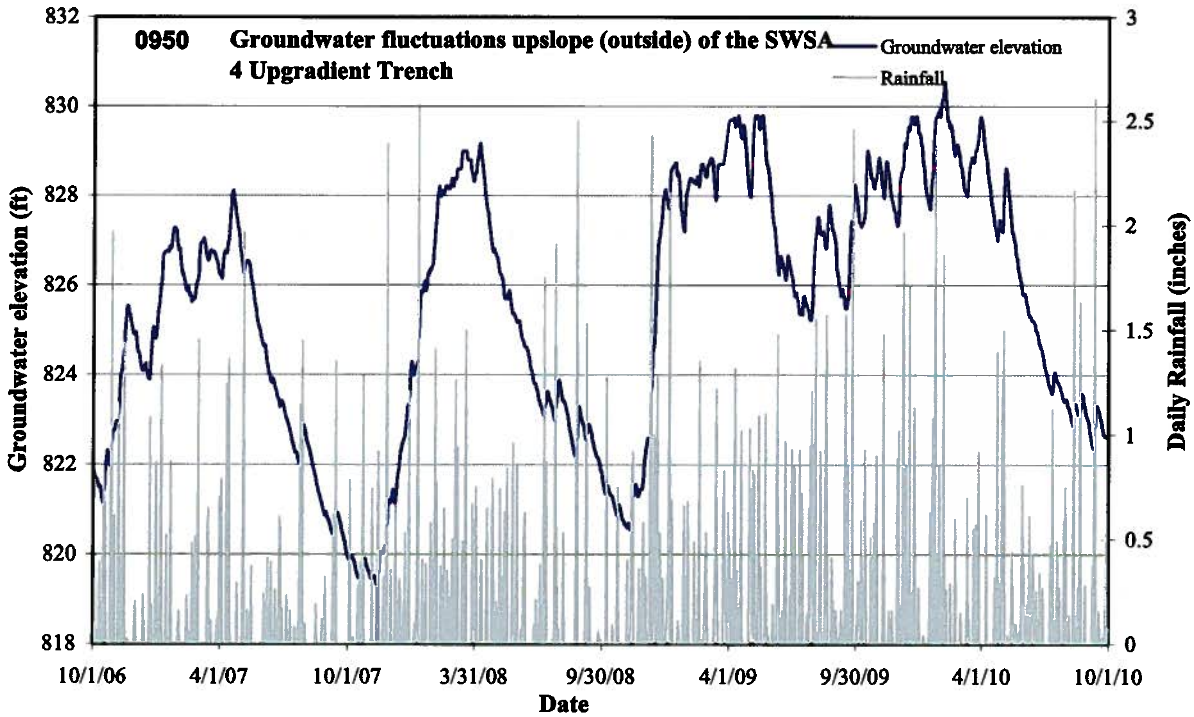
hydrologically isolated areas and specific discussions regarding wells that have not attained their target elevations are included in this section. Appendix B contains a tabular summary of groundwater level monitoring results along with well hydrographs showing groundwater level responses during FY 2007 through FY 2010.

During FY 2010, groundwater-level fluctuations observed in the MV monitoring behavior showed some changes compared to previous years. As noted in Chap. 1, FY 2010 experienced slightly greater than average rainfall and, during the first half of the year, precipitation levels were very high. This meteorologic condition created prolonged hydrologic stress on the hydrologic isolation systems. Groundwater level response characteristics may be categorized in several groups. Water level responses observed in shallow wells outside hydrologically isolated areas respond quickly to rainfall events and may undergo large short-term and annual fluctuation ranges (Figure 3.7). Wells located inside hydrologically isolated areas show very subdued water level fluctuations compared to wells outside caps or may exhibit continuing water level decline as seepage drains the area (Figures 3.7 and 3.8). The prolonged hydrologic stress along boundaries of hydrologically isolated areas is well exemplified in Figure 3.7. The upslope area monitored in well 0950 has experienced a 10+ foot total fluctuation range since monitoring started. During the summer of 2009 water levels remained high because of continued high rainfall, although levels did decline during summer of 2010. Just inside the SWSA 4 cap and downslope of the upgradient stormflow diversion trench, where piezometer 4555 is located, the prolonged hydrologic stress was exemplified by a very slight water-level increase and the absence of a decline during the summer of 2009. The total fluctuation measured upslope and downslope of the upgradient diversion trench demonstrates a 90% damping of the hydrologic stress in that area.

Some shallow wells inside the hydrologically isolated areas have gone dry as a result of area capping and water level decline. Some shallow wells inside hydrologically isolated areas exhibit continuing water level declines as gradual drainage of groundwater toward collector trenches or adjacent surface water bodies occurs (Figure 3.8). Bedrock wells are observed to respond to head changes from areas outside hydrologic isolation structures which can cause target groundwater level exceedances. This condition is observed at SWSA 6.

During FY 2010, the maximum measured groundwater elevation in seven wells inside or along the cap edges of hydrologically isolated areas of MV exceeded the design target groundwater elevation in comparison to the six wells that exceeded target elevations in FY 2009 (Figure 3.6). In FY 2008 and 2009, two of the wells that exceeded the target elevation in FY 2009 are in SWSA 6.In FY 2010, three wells in SWSA 6 exceeded target elevations. Three wells within the SWSA 4 hydrologically isolated area exceeded target elevations. During FY 2009 and FY 2010, one well at SWSA 5 North (well 2018) exceeded its target elevation slightly (by 0.07 ft in FY 2009 and by 0.23 ft in FY 2010). The reasons for these wells not attaining the design target elevations are related to the well construction characteristics, location very near edges of caps, location with respect to pre-remediation topography, or location near a downgradient trench.

Well 4127 in western SWSA 6 is a bedrock well that extends more than 20 ft below waste burial trench floor elevations in the adjacent capped area. Groundwater elevation is measured monthly and the hydrograph for well 4127 is shown in Figure 3.9. This well monitors groundwater level fluctuation beneath a fairly narrow cap that lies between two surface water drainages. The groundwater elevation measured in well 4127 shows a strong seasonal fluctuation signature and wet season levels are similar to the ground surface elevations in the adjacent ravines where wet-weather streams exist. The groundwater levels measured in well 4127 are probably controlled by the shallow groundwater levels in areas adjacent to the cap. A well (2217) further downslope beneath the same cap monitors groundwater levels in a shallow waste burial trench and that well was dry during all measurements during FY 2008 through 2010, indicating that the cap is preventing trench flooding.



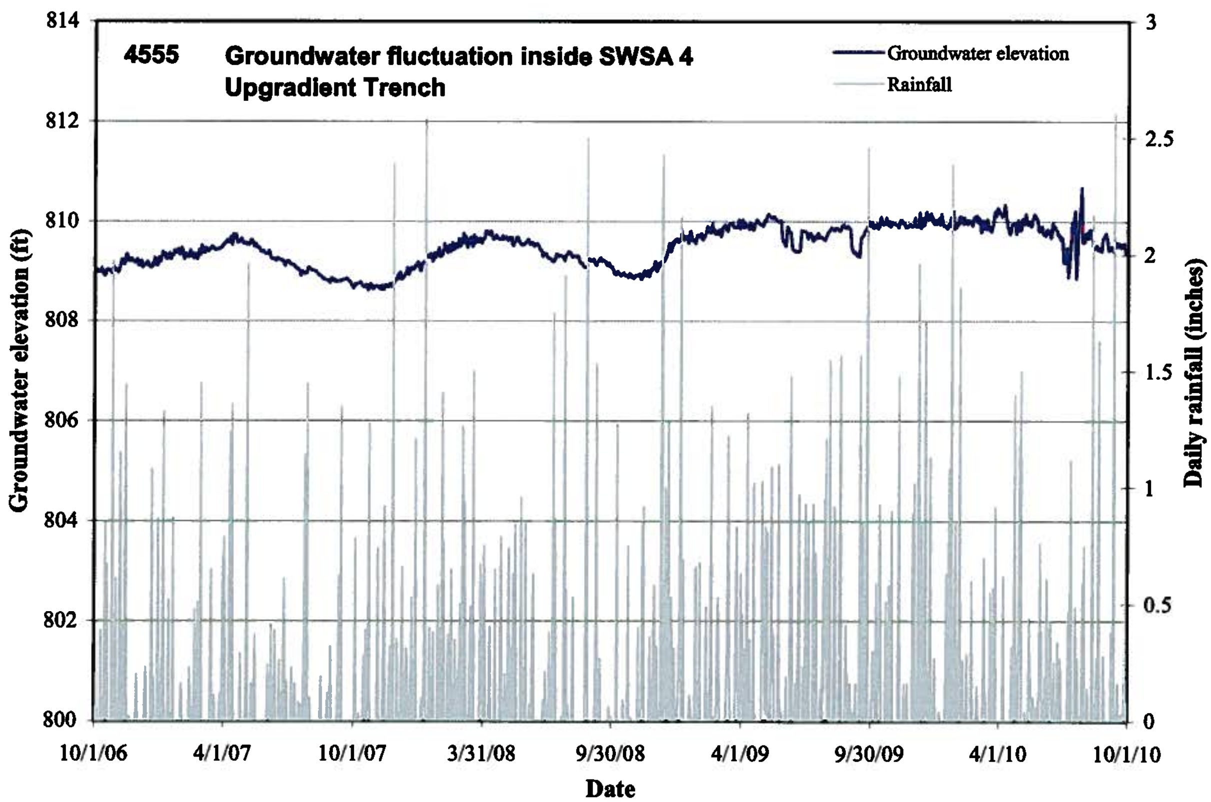
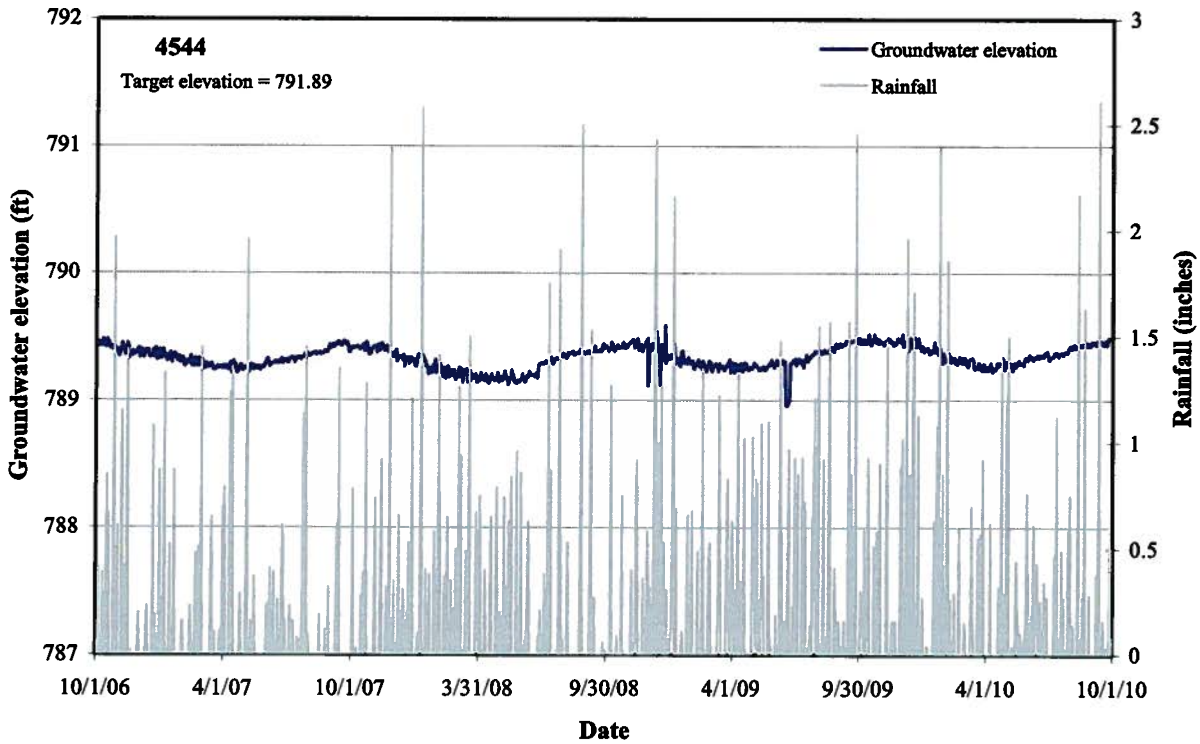


Figure 3.7. Examples of groundwater-level fluctuations upslope (outside) and inside the SWSA 4 Upgradient Diversion Trench.



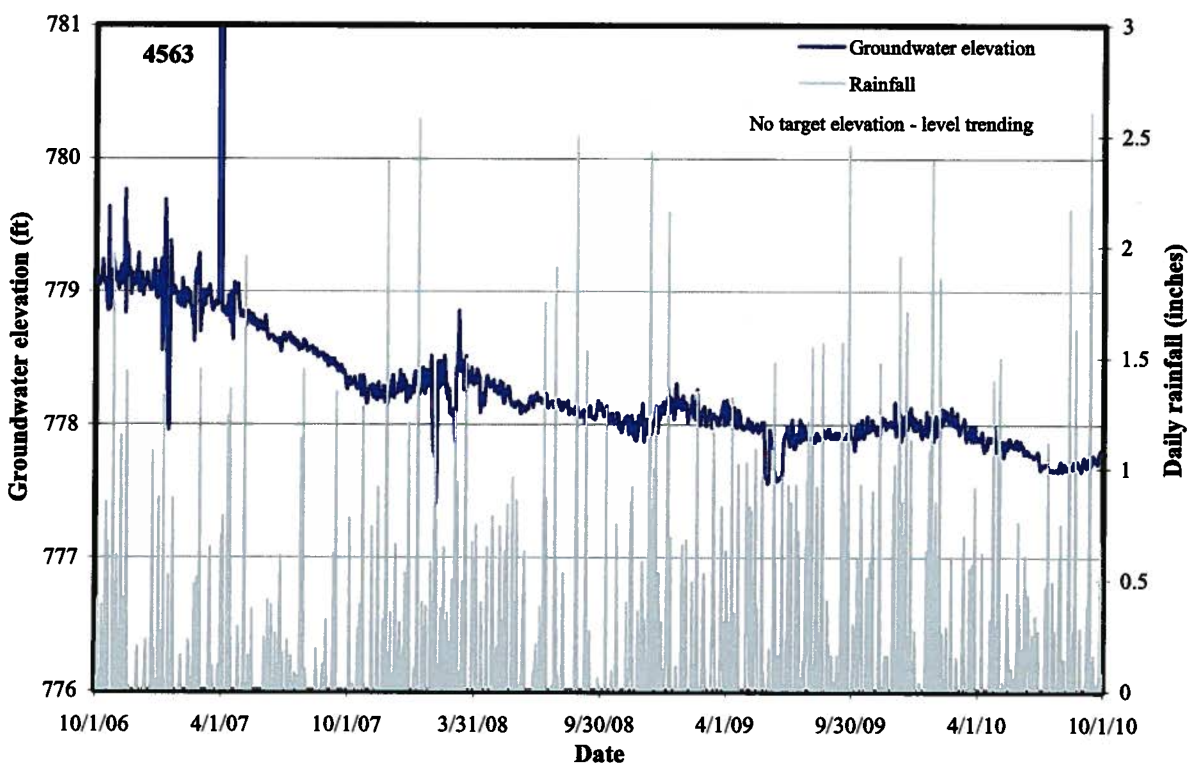


Figure 3.8. Examples of groundwater level responses in shallow wells inside the SWSA 4 hydrologically isolated areas FY 2007 through FY 2010.

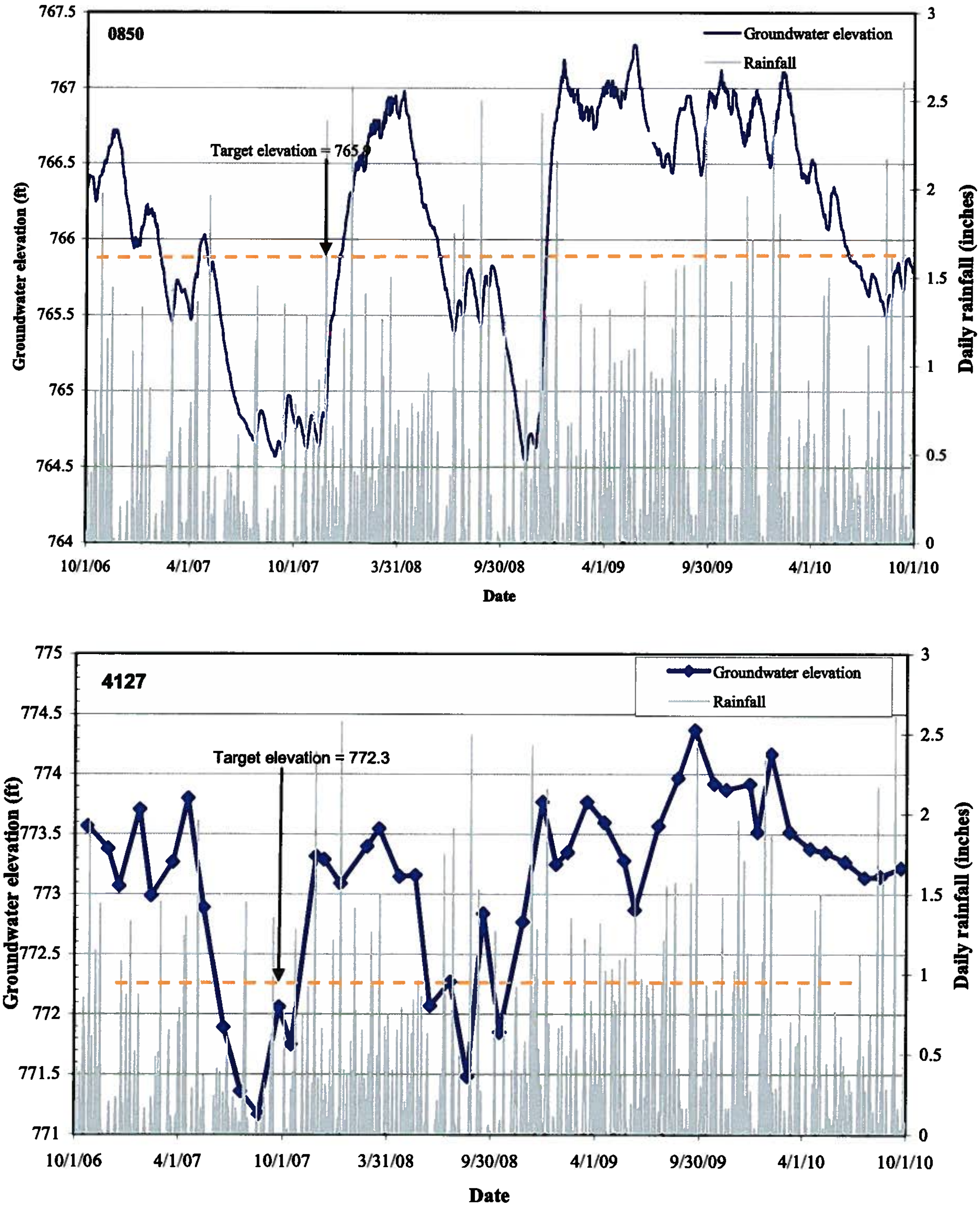


Figure 3.9. Hydrographs for wells 4127 and 0850 for FY 2007 through FY 2010.

Well 0850 is located in the central portion of SWSA 6 in a former ravine area. The well extends approximately 13 ft below the estimated floor elevations of nearby waste burial trenches beneath the adjacent capped area. Water-level monitoring data indicate that during the wet season the groundwater level in the well rises above the target groundwater elevation. The hydrograph response for well 0850 (Figure 3.9) shows a muted response to rainfall events and a strong seasonal fluctuation signature suggesting that the well is responding to groundwater level variations caused by recharge to areas outside the capped area. As shown in Figure 3.9 the water level in well 0850 remained high through the summer of 2009 and into the summer of 2010 when levels again declined. Water quality data from well 0838, which is located downgradient from well 0850, was reviewed to determine if contaminant levels from that portion of SWSA 6 are adversely affected by the groundwater levels near well 0850. VOCs are not detected at well 0838, nor are alpha and beta activity. Tritium is detected in well 0838, as it was in surface water from the area prior to remediation, and since FY 2004 the tritium concentrations have decreased exponentially from more than 200,000 pCi/L to less than 10,000 pCi/L. This decrease in tritium concentration in this area is a continuation of tritium concentration reduction observed since about FY 2003 and suggests that the groundwater levels observed at well 0850 are not causing mobilization of contaminants from the area. Well 0938 is the other well in SWSA 6 that did not meet its water elevation target during FY 2010. This well is located at the edge of a capped area and is a bedrock well that extends down to the elevation of an adjacent ravine where surface water is usually present. The combination of well location near the cap edge and its depth dispose well 0938 to respond to groundwater levels outside the capped area. The water levels in this well are far below the nearby waste burial trenches.

Three wells in SWSA 4 did not attain their target elevations in FY 2010 – well 1071 in the western part of the burial ground and wells 0955 and 0958 located near the SWSA 4 downgradient trench (Figure 3.6). Well 1071 is located near a former surface water drainage feature that crossed SWSA 4 from northwest to southeast. This area formerly carried runoff from an upslope area of about 16.5 acres. During construction of the SWSA 4 Upgradient Diversion Trench, a clay plug was constructed in conjunction with the installation of the SWSA 4 Upgradient Diversion Trench to prevent continued seepage into the hydrologically isolated burial ground. The well 1071 hydrograph (Figure 3.10) shows that there is water level fluctuation within a range of approximately 0.7 ft and the August and November 2009 levels exceeded the target elevation by 0.14 ft. At well 4558, further downslope and also in the former drainage area, groundwater levels continue to fluctuate within a range of about 0.17 ft, with an average elevation of 789.79. This behavior is presumed to be caused by a small amount of groundwater seepage that originates from the slope of Haw Ridge to the north of the Upgradient Diversion Trench. The groundwater-level behavior of other wells within the former SWSA 4 tributary area to the east and downgradient of well 1071 do not indicate that a large amount of water is moving through the former surface drainage features because their water levels are stable or continuing to decrease gradually. Based on the above average rainfall during FY 2009 and 2010, DOE recommends continued monitoring of water levels to determine the long-term trend.

The other two wells in SWSA 4 that did not meet target groundwater levels during FY 2010 were wells 0955 and 0958, which are located near the downgradient groundwater collection trench inside the hydrologically isolated area. Figure 3.11 includes hydrographs of wells 0955 and 0958 and several other wells in the downgradient trench and former Intermediate Holding Pond (IHP) area. The SWSA 4 downgradient trench was excavated in three segments of nearly equal length with short (about 10 ft) unexcavated soil breaks separating the southern (A segment) and northern (C segment) from the mid section (the B segment). Water levels are monitored continuously in piezometers installed in each trench segment and in the former IHP area to measure the head gradient imposed by pumping in the trench segments. The water-level measurements at well 0955 (monthly) and 0958 (quarterly) are made manually.

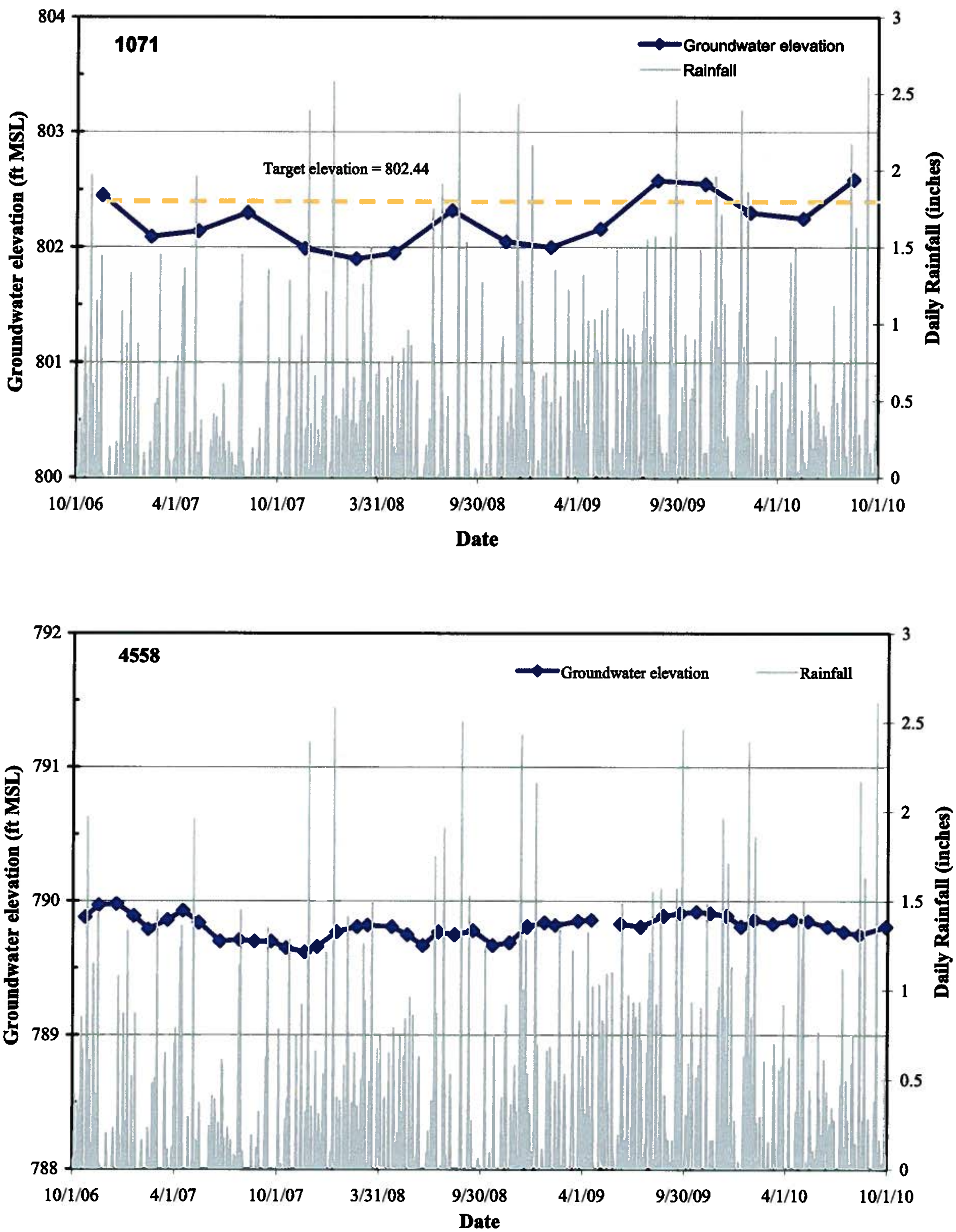


Figure 3.10. Hydrographs of wells 1071 and 4558 in SWSA 4 for FY 2007 through FY 2010.

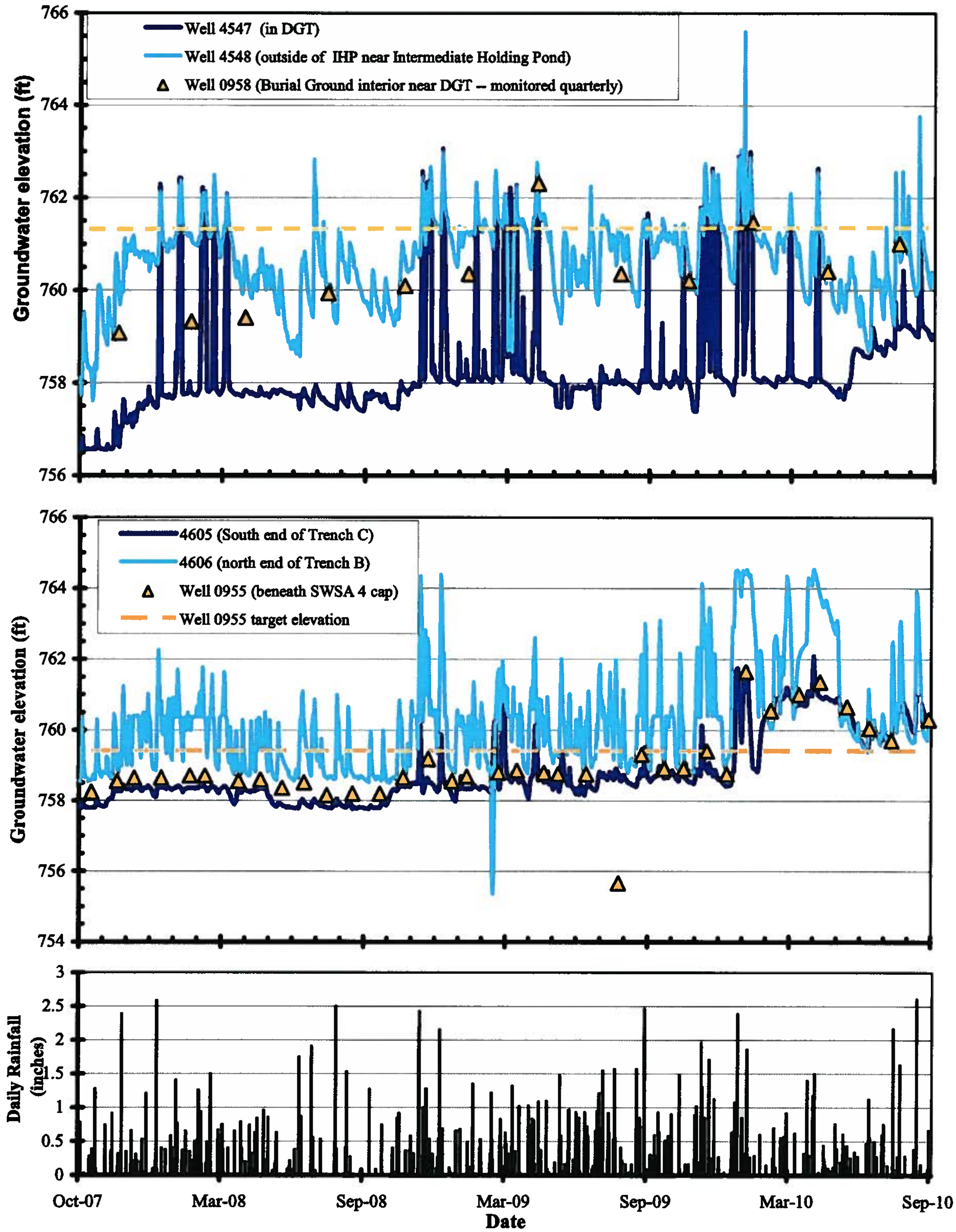


Figure 3.11. Hydrographs of wells in SWSA 4, the downgradient trench, in the former Intermediate Holding Pond area.

Well 0955 is located at the boundary between the mid section (B segment) and northern (C segment). The hydrograph of well 0955 (Figure 3.11) indicates periodic conditions when the northern (C segment) pumps have difficulty maintaining drawdown in the trench and the pumps in the mid segment (B segment) have experienced more chronic difficulty maintaining drawdown. These data are indicative of deterioration in performance of the SWSA 4 downgradient system during FY 2010. Figure 3.12 shows the hydrographs for the water level monitoring of the downgradient trench from the beginning of FY 2007 through FY 2010. The hydrographs show periods when water levels in the trenches spike in response to heavy and/or prolonged rainfall. Intense rainfall causes water levels outside the hydrologically isolated area (in the IHP) to rise, which can cause water to flow into the downgradient trench more rapidly than the pumping system can remove. Data through FY 2009 showed that this condition was observed to occur for periods of 3 to 4 days, after which the storm runoff subsided and the downgradient trench pumps would draw the trench groundwater levels back down. However, during FY 2010 the hydrograph for the B segment shows that conditions appear to have changed and the pumps are drawing down head less than during previous years. A similar condition appears to affect the A trench segment as well.

This condition is identified as an issue and additional monitoring will be conducted during winter of 2011 to determine if contaminated water is being discharged to surface water outside of the SWSA 4 containment system.-Similar conditions are not observed at the other downgradient collection trenches in MV because a different design was used that prevents groundwater in-leakage from outside the collection trench. Winter months are the season during which most groundwater recharge occurs because the dormant vegetation cannot lower soil moisture levels through evapotranspiration. DOE will collect seepage samples in the winter of 2011 from the IHP adjacent to SWSA 4 downgradient trench during or soon after large rainfall events to determine if SWSA 4 contaminants are being discharged to surface water in the IHP. DOE will evaluate the performance of the SWSA 4 downgradient trench extraction wells to determine if well maintenance may improve system performance.

3.2.2.2.3 Groundwater Quality

Groundwater monitoring is conducted for CERCLA remediation effectiveness evaluation in MV Exit Pathway wells, near the Seepage Pits and Trenches, and around the Tumulus low-level solid waste disposal facility in SWSA 6. Additionally, groundwater monitoring is conducted at SWSA 6 in compliance with the SWSA 6 proposed RCRA permit requirements and results are reported annually to the TDEC DSWM and are summarized in this section.

Seepage Pits and Trenches Area Groundwater Quality

Groundwater monitoring is conducted in wells located around the perimeter of the Seepage Pits and trenches area (formerly referred to as WAG 7), as well as in the immediate proximity to LLLW Seepage Trenches 5 and 7.

Figure 3.13 shows the locations of wells that are monitored at the Pits and Trenches area. Table 3.10 includes a summary of radiological contaminants detected in the area. Principal radiological groundwater contaminants detected at Trenches 5 and 7 include ^{14}C, ^{60}Co, ^{90}Sr, ^{99}Tc, ^{3}H, ^{232}U, $^{233/234}U$, and ^{238}U. Carbon-14 was a constituent of the LLLW disposed in the seepage trenches, and because the chemical treatment used to immobilize strontium and cesium had little affect on carbon, this contaminant is detected in most wells near these trenches. The highest levels of groundwater contamination in the Seepage Pits and Trenches area occur in the immediate vicinity of Trenches 5 and 7. Groundwater contaminant activities in wells near Trenches 5 and 7 are generally decreasing compared to activities measured during FY 2005 and 2006.

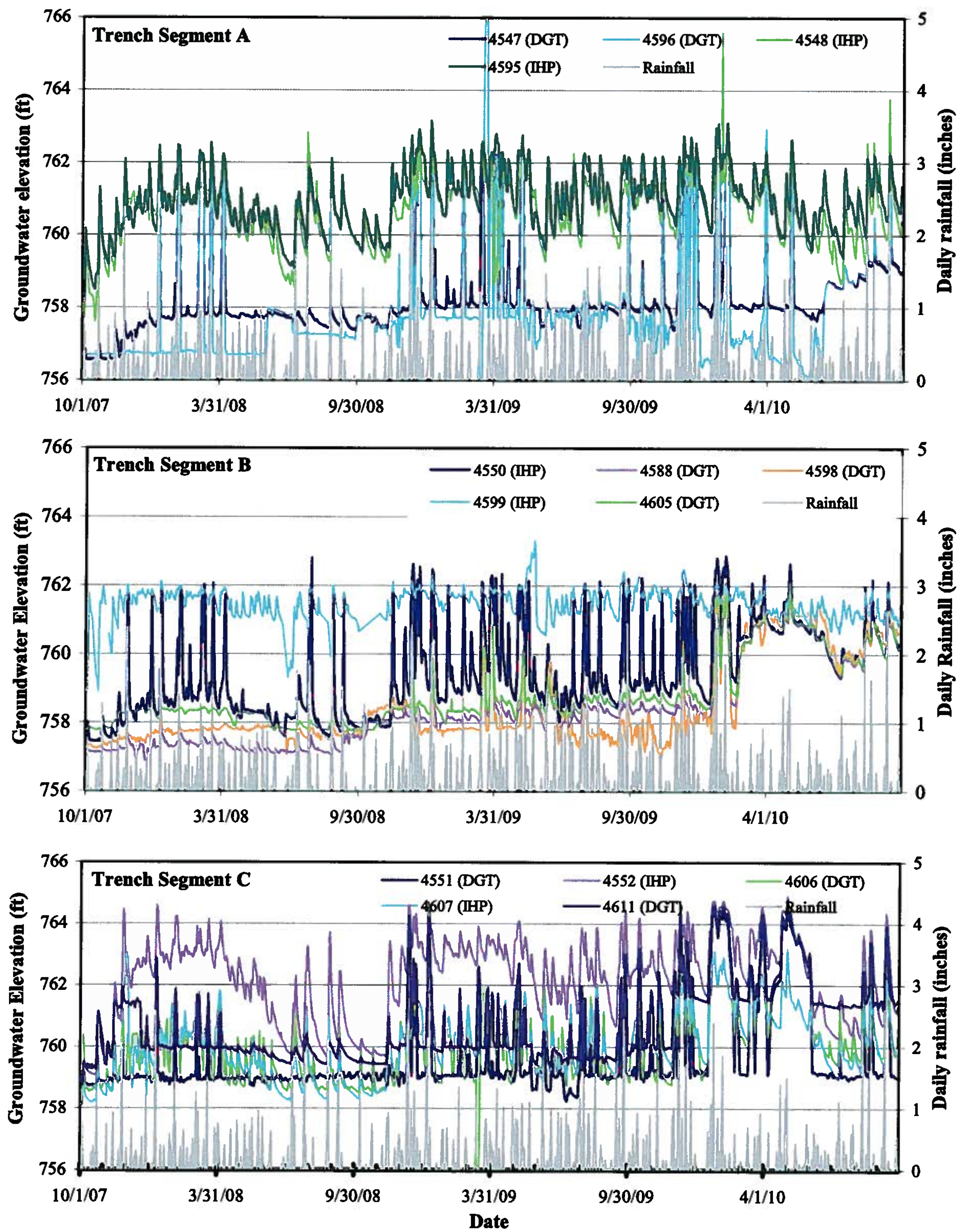


Figure 3.12. Hydrographs from piezometers monitoring the SWSA 4 downgradient trench performance.

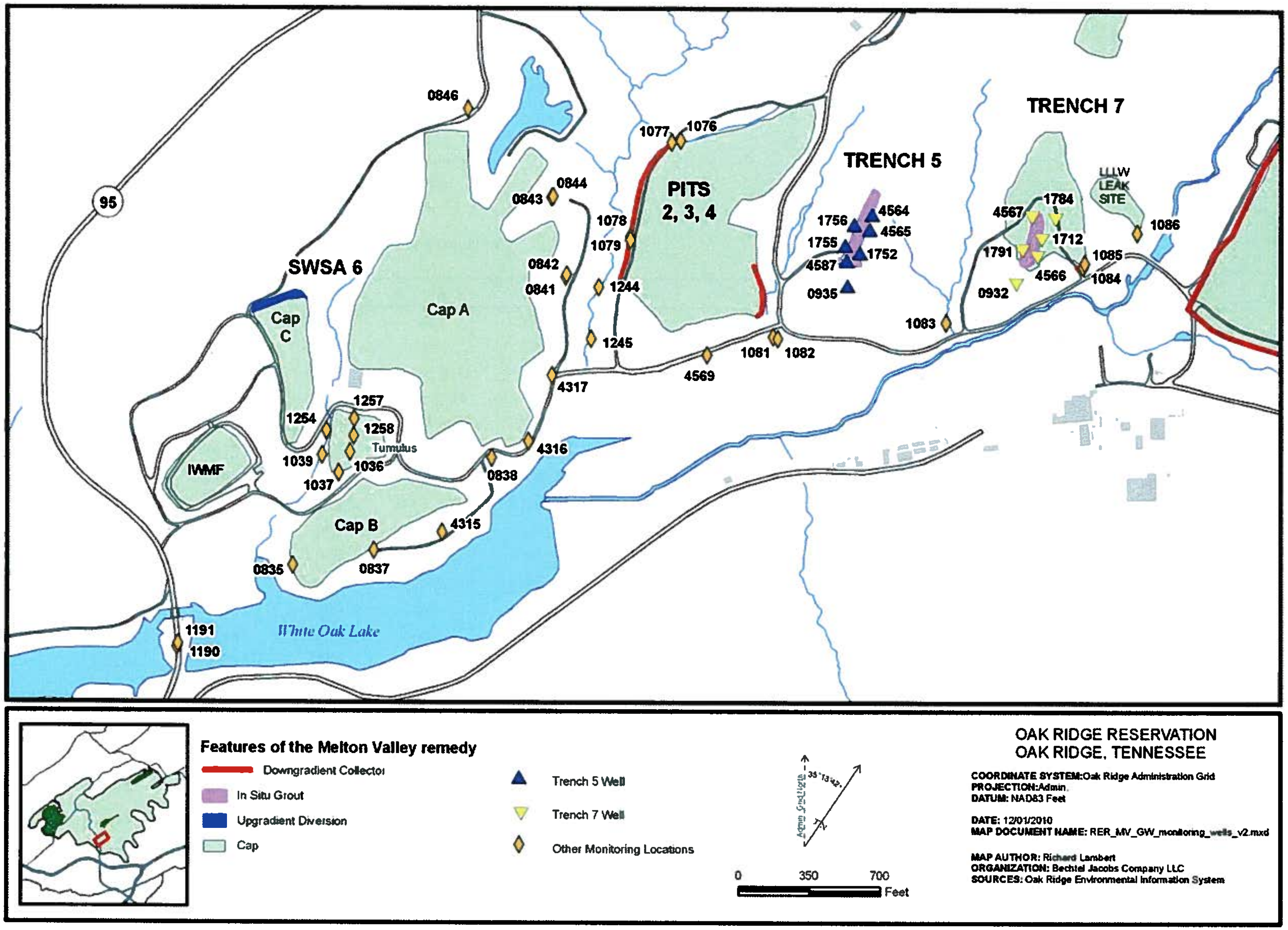


Figure 3.13. Locations of wells monitored in the vicinity of the Seepage Pits and Trenches and SWSA 6.

Table 3.10. Summary of radiological groundwater contaminants detected at Seepage Trenches 5 and 7

Well	Alpha	^{14}C	^{60}Co	^{3}H	^{90}Sr	^{99}Tc	^{232}U	$^{233/234}U$	^{235}U	^{238}U
0932	ND	ND	ND	<MCL	ND	ND	ND	<I<R↔	ND	ND
0935	ND	<I<R↔	ND	<I>R↑	ND	ND	ND	ND	ND	ND
1076	ND	ND	ND	<MCL	<I<R↓	ND	ND	<I<R↔	ND	ND
1077[a]	--	--	--	--	--	--	--	--	--	--
1078[a]	--	--	--	--	--	--	--	--	--	--
1079	↓	<I<R↔	ND	<I>R↓	ND	<MCL	ND	>I>R↔	<I<R↓	<I<R↔
1081	ND	ND	ND	ND	ND	ND	ND	<I<R	ND	ND
1082	<MCL	ND	ND	<MCL	ND	ND	ND	<I<R↔	ND	ND
1083	ND	ND	ND	<MCL	ND	<MCL	ND	<I<R↔	ND	<I<R
1084	<MCL	<I>R↓	ND	<MCL	ND	<MCL	ND	ND	ND	ND
1085	ND	ND	ND	ND	ND	ND	ND	<I<R	<I<R	<I<R
1086	ND	ND	ND	<MCL	<I<R↔	ND	--	<I<R↓	ND	ND
1244	<MCL	<I<R↓	ND	<MCL	ND	<MCL	ND	<I<R↔	<I<R	<I<R
1245	ND	ND	ND	ND	ND	ND	ND	<I<R↔	ND	ND
1712	↓	>I>R↔	<I<R↔	<MCL↑	<I<R↑	<MCL↔	ND	<I<R↔	<I<R↔	<I<R↓
1752	↓	>I>R↓	<I>R↓	<MCL	~MCL	>I>R↓	>I>R↔	>I>R↔	<I<R↔	<I<R↔
1755	↔	>I>R↓	<I<R↓	<MCL	<MCL	<I>R↓	>I>R↔	>I>R↑	<I<R↓	<I>R↔
1756	↓	>I>R↓	<I<R↓	<MCL	<MCL	<I<R↓	<I>R↔	>I>R↓	<I<R↔	<I<R↓
1784	~MCL	>I>R↓	ND	<MCL	<I<R↓	<MCL	ND	<I<R↓	ND	<I<R↓
1791	>MCL	>I>R↓	<I>R↓	<MCL↑	ND	>I>R↑	ND	ND	ND	<I<R
4564	↓	>I>R↓	<I<R↓	<MCL	ND	<MCL	ND	<I<R↔	<I<R↔	<I<R↔
4565	ND	>I>R↓	<I<R↔	<I<R↔	ND	<I<R↔	ND	<I<R↔	ND	<I<R↓
4566	~MCL↔	>I>R↓	>I>R↓	<MCL	ND	<I<R↔	ND	<I<R↓	<I<R	<I<R↓
4567[a]	--	--	--	--	--	--	--	--	--	--
4569	ND	ND	ND	<MCL	ND	ND	ND	<I<R	ND	<I<R
4587	↑	>I>R↔	<I<R↓	<MCL	ND	<I>R↓	<I<R↑	<I<R↑	<I<R↑	<I<R↑

[a]Well dried up following hydrologic isolation of source area.

I = industrial scenario 1 x 10^{-4} risk-based activity
R = residential scenario 1 x 10^{-4} risk-based activity
↓ = pre-remedy vs. post-remedy activity trend downward
↑ = pre-remedy vs. post-remedy activity trend upward
↔ = trend indeterminate
ND = constituent not detected
^{3}H MCL EDE = 20,000 pCi/L, ^{99}Tc MCL EDE = 900 pCi/L, and ^{90}Sr MCL EDE = 8 pCi/L are individual EDEs to the 4 mrem/yr MCL for beta particle and photon activity.

Table 3.10 provides the FY 2010 levels of radiological contaminants present in the groundwater compared to risk-based criteria of 1 x 10^{-4} levels for industrial and residential exposure scenario activities. Activity trend direction for the pre-remediation through FY 2010 data is also indicated in Table 3.10 for radionuclides. The 1 x 10^{-4} risk level was selected as a screen since that level is commonly used as the upper bound of a target risk range. Appendix B includes graphs for wells with elevated radionuclide concentrations. Some of the trends are obvious by inspection of the data while others are less obvious. In cases where trends were not obvious the Mann-Kendall trend evaluation method was used to determine if significant changes are occurring. As summarized in Table 3.10, most of the radionuclide levels are stable to decreasing. Some wells throughout the area showed slight increases during FY 2010 in response to continued elevated rainfall during the year; however, the long-term trend remains stable or decreasing.

In general, groundwater contaminant activities in the Seepage Pits and Trenches area have decreased since levels measured prior to RA. Contaminant levels in wells at the perimeter of the Pits and Trenches area have decreased since the MV remedy was completed. Several shallow wells have become dry since they lie within areas that were hydrologically isolated. Contaminant levels in some wells near Trenches 5 and 7 continue to decline while others have apparently reached relatively stable activities and tend to fluctuate somewhat with seasonal changes.

A couple of areas near the trenches do show increasing levels of contamination activity. Near the southern end of Trench 5 and the HRE Fuel Wells uranium levels are increasing. At well 1755 the levels are above screening levels while at well 4587 the levels are below screening levels but show an increasing trend. At Trench 7, two wells show increasing trends. Well 1791, located at the southwest end of the trench, shows increasing ^{99}Tc at levels above the screening values and tritium is gradually increasing at levels below the MCL. On the eastern side of Trench 7 (well 1712), tritium and ^{90}Sr are present at levels below screening values but both show increasing trends. Overall, groundwater contaminant levels are lower since remedy completion.

SWSA 6 Groundwater Monitoring Results

The RCRA monitoring program samples 10 wells around the perimeter of SWSA 6 (Figure 3.13). Well 0846 is the designated upgradient well. The principal detected RCRA contaminants are VOCs, carbon tetrachloride and its degradation product chloroform, and TCE and its degradation products cis-1,2-DCE and 1,2-DCA. These constituents are detected regularly in wells 0841 and 0842, located on the eastern boundary of SWSA 6. RCRA monitoring data indicate that the concentrations of regulated hazardous constituents in groundwater at SWSA 6 are generally stable to gradually decreasing. CERCLA radiological monitoring of groundwater is also conducted in these wells. The principal and most mobile radionuclide detected in groundwater at SWSA 6 is tritium. The highest tritium activities in the RCRA well network are measured in wells 0842, 0843, and 0844 along the eastern site boundary. Tritium activity trends are generally decreasing, although tritium in well 0844 continues to follow a long-term increasing trend. Trend graphs of the contaminants noted above are included in Appendix B.

Tritium is also monitored in groundwater around the Tumulus low-level solid waste disposal facility where historic discharges from containerized waste created a groundwater tritium plume. Six wells (Figure 3.13) at the Tumulus are sampled to measure the groundwater tritium trends. Trend plots for tritium in these wells are included in Appendix B. Wells 1036 and 1039 exhibit the highest tritium levels. Well 1039 has shown a significant decline in tritium activity subsequent to the 2006 remedy completion. Wells 1036 and 1258 have exhibited increases in tritium activity following area capping, possibly as a result of seepage pattern changes beneath the hydrogically isolated area.

The reduction in tritium discharges from the Tumulus is a significant component of the decrease in tritium measured in surface water at WAG6 MS3 which is located nearby (Figure 3.3). The reader is referred back to Sect. 3.2.2.1.3 and Table 3.9 where the surface water data for this location is presented.

Melton Valley Exit Pathway and Hydrofracture Area Groundwater Quality Results

Exit pathway groundwater monitoring includes monitoring of wells 1190 and 1191 that are located on WOD (Figure 3.13), monitoring of six deep groundwater wells between the Clinch River and the western edge of SWSA 6, and monitoring of offsite wells located southwest of the Clinch River. This section also includes hydrofracture well monitoring.

Wells 1190 and 1191 are about 47 and 26 ft deep, respectively, and are located near the centerline of WOD. Well 1190 is constructed to monitor groundwater in bedrock at elevation 708 – 718 ft msl, which is approximately equivalent to the bed of the Clinch River located about 2,500 ft to the west. Well 1191 samples water from the interface between the bedrock surface and the sediment/soil fill beneath the dam at elevations from 724 – 743 ft msl, which is approximately equivalent to elevations of the WOC embayment and the channel of the Clinch River. Tritium and ^{90}Sr are the principal contaminants detected in these wells and Figure 3.14 shows the activity histories from about 1990 through FY 2010. Contaminant levels are greater in the shallow well (1191) than in the bedrock well and both contaminants continue a long-term decline in activity. During FY 2010, ^{90}Sr levels were below detection limits (< 2 pCi/L) in well 1190.

As part of the MV ROD (DOE 2000b), six groundwater monitoring wells were installed in the western end of MV to serve as sentinel wells to detect site-related contaminants that may seep toward the Clinch River. These six deep, multizone monitoring wells were constructed in a line extending from the toe of Haw Ridge southward to the south side of the WOCE near WOD. Locations of these wells are shown on Figure 3.15.

In MV, relatively fresh groundwater extends to depths of approximately 300 ft bgs. Beneath the fresh water zone, groundwater contains elevated sodium chloride and sulfate that are components of the naturally occurring ancient waters contained in the bedrock. At depths greater than about 500 ft in MV, the groundwater is saline brine that contains extremely high concentrations of chloride, sulfate, sodium, and calcium. This deep groundwater is non-potable because of natural salinity and wells constructed in the bedrock at such depths produce very little water. The exit pathway wells were designed and installed to sample groundwater above the brine zone.

Each well was drilled to a depth of 500 ft and was tested to determine the locations of water-bearing fractures that could be instrumented for sampling. Based on the results of testing, a total of 37 sampling zones were created by installation of Westbay® multizone sampling systems. Subsequent to installation, each zone was purged in preparation for sampling. Over FY 2005 and 2006, baseline samples were collected and analyzed to evaluate the stabilization of groundwater quality in the sampled wells.

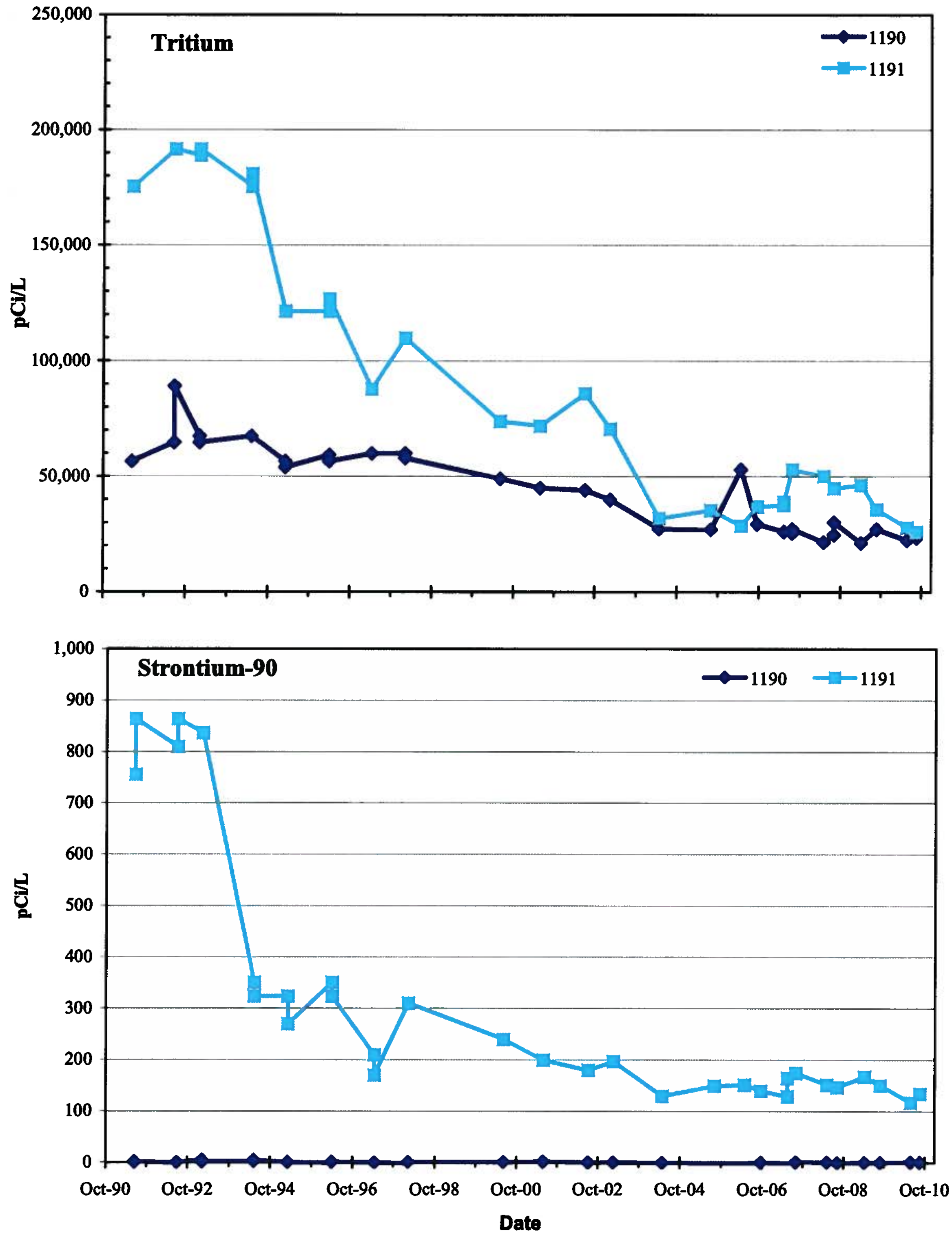


Figure 3.14. WOD groundwater tritium and ^{90}Sr activity histories.

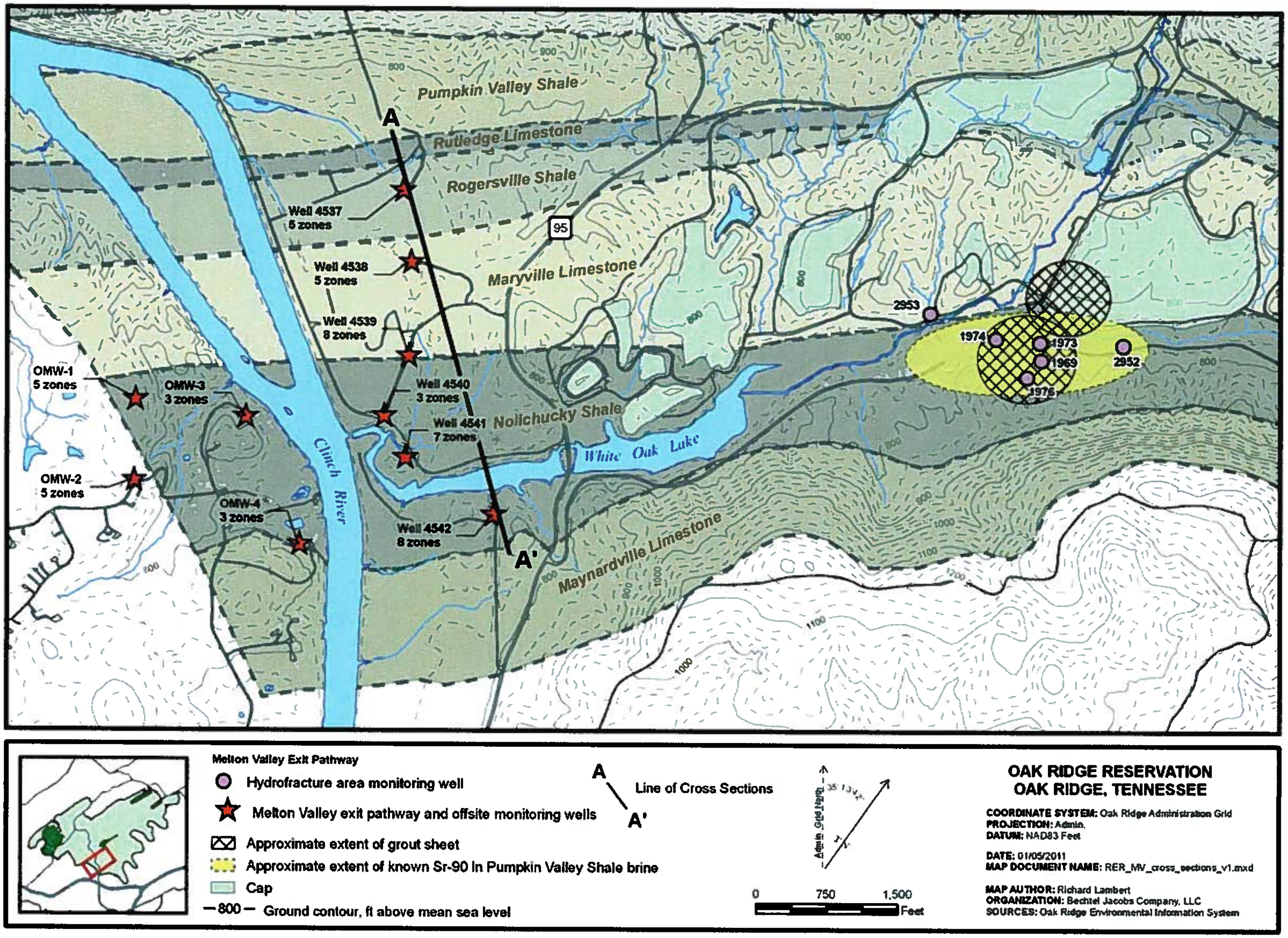


Figure 3.15. Locations of MV exit pathway wells, deep groundwater monitoring wells, and hydrofracture area monitoring wells.

In response to detections of site-related contaminants in some of the exit pathway monitoring zones in 2007 through 2009, DOE obtained agreements with offsite land owners to the southwest of the Clinch River to establish an offsite groundwater monitoring system. The locations of these wells are shown on Figure 3.15. The offsite monitoring system includes two clusters of newly drilled wells (OMW-1 and OMW-2) on the ridgecrest that contain five sampling zones each designed to measure hydraulic head and allow groundwater sampling to depths similar to those monitored on the DOE property. Additionally, two existing wells closer to the river (OMW-3 and OMW-4) were re-configured to provide three monitoring zones each. The hydraulic head monitoring is necessary to evaluate potential groundwater flow paths in the vicinity of the river.

Figure 3.16 provides a cross-sectional view of the location, depth of sample zones, and indicates MV picket well zones sampled during FY 2010. Sampling was conducted consistent with the requirements of the MV RAR. Field measurements included pH, specific conductance, and redox. Samples were analyzed for major anions (fluoride, chloride, sulfate), metals (including major dissolved cations, minor and trace metals), radiological constituents (alpha and beta activity, measurable radionuclides using gamma spectroscopy, tritium, and uranium in selected samples), and VOCs. Many of the lab analyses of samples from the exit pathway wells yielded non-detected results and the following discussion focuses on results of general chemistry (anions and metals), radionuclides, and VOCs.

Table 3.11 summarizes the results of analyses for samples collected during FY 2010 and compares results to the Safe Drinking Water Act of 1974 (SDWA) primary and secondary drinking water standards. During FY 2010, 33 of the 36 available zones were sampled and a total of 36 samples were collected. Three zones (4539-01, 4539-02, and 4539-04) were sampled twice during this year. Results are the maximum concentrations detected for cases in which more than one laboratory analysis was performed for a specific parameter from one sample zone for a particular sample event. Total dissolved solids in many of the sampled zones were greater than the secondary drinking water standard screening value and are attributable to naturally occurring chloride, sulfate, calcium, and sodium. Water pH in many of the zones is elevated. However, during FY 2009 and 2010, pH values tended to be lower than during previous years. Possible reasons for the lower pH may be higher levels of precipitation and groundwater recharge and/or ongoing geochemical reactions related to maturation of the local chemical environment surrounding the boreholes. As was observed during baseline monitoring, many of the sample zones continue to produce water with significant turbidity and measurable suspended solids that apparently contribute significantly to the measured concentrations of aluminum, iron, and manganese. Samples for metals analysis have historically been acid-preserved in the field without filtration to remove solids which can allow dissolution of fine-grained and colloidal oxy-hydroxides of aluminum, iron, and manganese and can dissolve metals adsorbed to suspended clay particles. During FY 2010, samples for metals analysis were collected in duplicate and one aliquot was field filtered prior to acid preservation. With the exception of the lead results, screening results included in Table 3.11 are from the field filtered aliquot and represent dissolved or colloidal metals. Lead results in Table 3.11 are from the unfiltered sample aliquot. Chloride and sulfate in some of the sampled zones were greater than the secondary drinking water standards. Chloride and sulfate originate from natural bedrock minerals and native geologic brines. Fluoride was detected at concentrations greater than the secondary drinking water standard but less than primary standard in two zones and exceeded the primary standard in 17 samples. The likely origin of fluoride in the wells is not yet known but may be associated with natural mineral dissolution. Barium was detected at concentrations greater than the drinking water reference concentrations in five of the deepest sample zones where the samples are obtained from the transition zone near the top of the deeper connate brine. Barium concentrations in the deeper brine are quite high as is typical of ancient brines. Lead was detected in one sample zone at 13.1 mg/L in one sample; however, in the filtered aliquot lead was not detected. One other unfiltered sample showed the presence of lead at an estimated concentration of 1.2 μg/L.

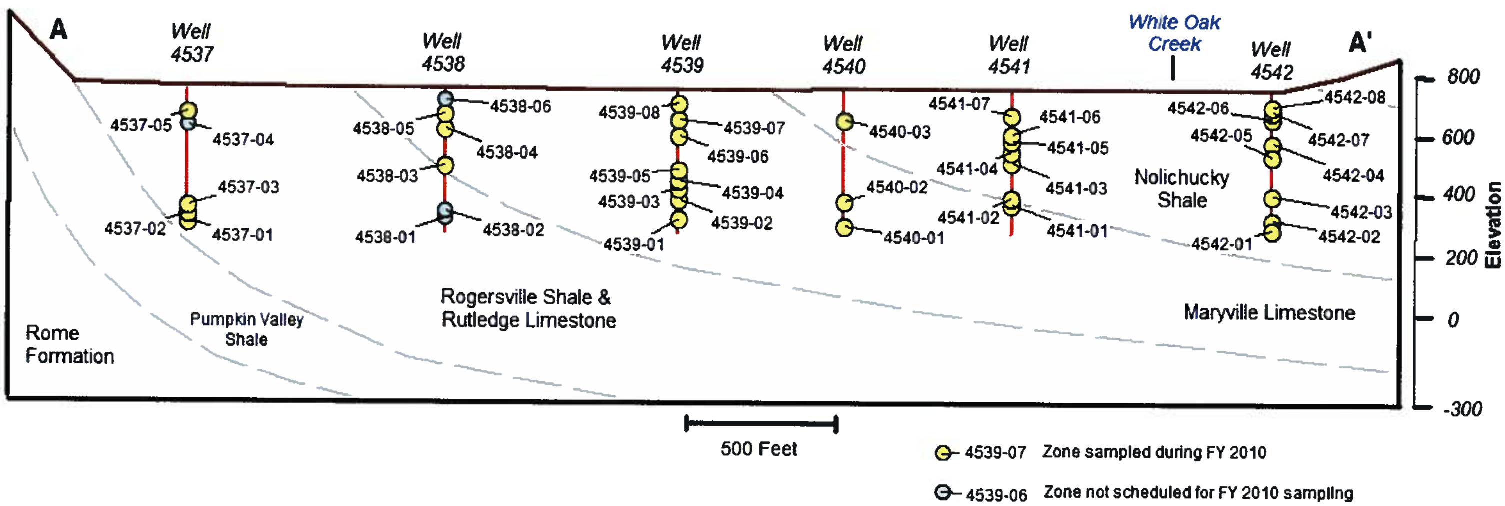


Figure 3.16. Locations of exit pathway sampling zones.

Table 3.11. Summary of FY 2010 groundwater analyses from MV exit pathway wells

Sample zone	Spec. cond. (µS/cm)	TDS[b] (500 mg/L)	pH (6.6 - 8.5[a])	Redox (mV)	Turbidity (NTU)	Alpha activity (15[b] pCi/L)	Beta activity (pCi/L)	^{90}Sr (8[d] pCi/L)	Al (0.2[a] mg/L)	Ba (2[b] mg/L)	Fe (0.3[a] mg/L)	Pb (15[c] ug/L)	Mn (50[a] ug/L)	Cl (250[a] mg/L)	F (2[a], 4[b] mg/L)	SO_4 (250[a] mg/L)
4537-01	1,324	**1260**	7.16	-44	2	9.76	< 4.79	< 2.84	0.12	0.028	**1.26**	< 2.5	**124**	18.8	0.684	**648**
4537-02	840	**784**	6.85	-32	3	< 3.76	< 2.64	< 4.4	< 0.075	0.0246	< 0.66	< 2.5	38.8 J	5.25	0.312	**365**
4537-03	1,177	**583**	7.06	55	2	< 3.93	< 3.78	< 0.554	< 0.015	0.0338	**0.418**	< 0.5	25.7	3.44	0.423	**252**
4537-05	1,315	**1070**	8	-157	10	< 3.47	< 2.96	< 4.5	< 0.075	0.0153	< 0.66	< 0.5	<20	14.8	**5.23**	**313**
4538-03	5,841	**4150**	6.6	-3	5	11.6	< 7.87	< 2.9	< 0.015	0.0178	< 0.033	0.575 J	32.5	**1100**	1.98	**1470**
4538-04	1,936	**1500**	7.62	-91	1	5.04	< 3.41	< 2.95	< 0.015	0.0162	< 0.033	< 0.5	4.58 J	119	**4.14**	**320**
4538-05	1,917	**991**	**8.67**	47	3	2.98 J	< 4.54	< 0.65	< 0.015	0.0296	< 0.033	< 0.5	3.48 J	75.3	**4.52**	152
4539-01	14,582	**14000**	6.94	-35	6	< 4.75	34.5 J	< 4.64	< 0.015	**11.3**	0.296	< 10	**207**	**1560**	1.65	0.736
4539-01	26,182	**15700**	7.98	154	21	< 4.71	< 4	< 0.718	< 0.015	**12.3**	**0.901**	< 0.5	**190 J**	**8820**	1.95	< 2
4539-02	1,633	**1240**	7.69	-80	9	< 4.45	< 3.16	< 4.4	0.0285 J	0.139	< 0.165	< 10	2.34 J	87.6	**4.87**	4.03
4539-02	1,923	**1290**	8.5	-86	20	< 4.77	< 3.96	< 0.61	0.0227 J	0.14	0.101	1.21 J	2.01 J	74.6	**4.85**	3.16
4539-03	1,609	**1180**	8.09	-141	6	< 2.77	< 3.95	< 5	0.022 J	0.156	< 0.165	< 10	2.17 J	36.7	**5.26**	4.74
4539-04	1,447	**1040**	8.28	-101	8	< 3.58	< 3.27	< 4.49	0.0265 J	0.152	< 0.165	< 10	1.75 J	41.6	**5.47**	5.24
4539-04	1,749	**1110**	**8.65**	-75	6	< 5.75	4.63 J	< 0.484	0.0303	0.098	0.0703 J	< 0.5	1.75 J	48.9	**5.66**	4.01
4539-05	1,455	**947**	8	233	4	< 4.93	< 4.07	< 0.891	< 0.015	0.147	0.0391 J	< 0.5	1.05 J	4.6	**10.1**	18.3
4539-06	1,086	**570**	8.37	-5	6	< 4.67	< 3.4	< 0.867	0.0446	0.0958	0.0337 J	< 0.5	< 1	1.78	**5.23**	16.5
4539-07	430	300	8	-61	4	< 3.2	< 3.09	< 3.98	0.0209 J	0.184	< 0.165	< 10	1.36 J	2.26	0.914	10.6
4539-08	398	255	7.34	212	4	< 3.91	< 4.26	< 0.621	< 0.015	0.185	0.0434 J	< 0.5	2.29 J	1.64	0.896	7.51
4540-01	30,606	**18200**	7.77	33	48	**< 27.1**	< 26.5	< 0.821	< 0.075	**22.1**	**1.09**	< 0.5	**145**	**9780**	< 33	3.08
4540-02	2,511	**1860**	8.19	39	132	13.6	28.6 J	< 0.901	< 0.075	0.221	< 0.165	13.1	< 5	245	**4.88**	2.37
4540-03	1,244	**660**	**8.82**	-47	22	< 4.51	< 3.44	< 0.857	< 0.075	0.0368	< 0.165	< 0.5	< 5	1.8	**6.05**	6.31
4541-01	3,276	**2270**	7.59	29	331	< 3.39	< 3.31	< 6.44	0.0174 J	0.447	< 0.165	< 10	2.25 J	**763**	**4.22**	6.78
4541-02	5,711	**2120**	8.3	-2	6	< 4.86	< 4.96	< 0.864	< 0.015	0.305	0.033 J	< 0.5	3.89 J	**713**	**3.81**	2.59
4541-03	1,889	**891**	**8.58**	129	3	< 4.87	< 3.5	< 0.516	< 0.015	0.0616	< 0.033	< 0.5	1.39 J	156	**4.03**	27.7
4541-04	1,616	**659**	**9.15**	-15	6	< 4.64	< 3.44	< 0.582	0.0454	0.0317	< 0.033	< 0.5	1.19 J	7.35	**2.4**	35.5
4541-05	1,578	**786**	8.36	8	3	4.02	< 4.98	< 0.592	0.227 J	0.0414	0.0346 J	< 0.5	< 1	59.3	1.56	19.5
4541-06	879	**629**	**8.88**	-14.8	13	< 4.91	8.04 J	< 0.536	0.0798 J	0.0332	0.0393 J	< 0.5	1.32 J	7.53	0.999	16.7
4541-07	369	284	6.34	27	4	< 3	< 4.4	< 5.34	0.0923 J	0.0301	< 0.165	< 10	< 1	4.42	0.32	7.5
4542-01	26,956	**16800**	7.16	106	39	**< 28.5**	< 35.6	< 3.94	< 0.075	**9.78**	**1.13**	< 2.5	**121**	**9450**	0.89	2.28
4542-02	28,011	**15300**	7.15	30.9	6	**< 24.7**	< 26.8	6.77	< 0.075	**7.78**	**1.15**	< 2.5	**114**	**8070**	0.843	4.84
4542-03	2,127	**1750**	8.17	-47	16	< 3.09	< 3.4	< 5.79	0.0377	0.0605	< 0.165	< 10	4.63 J	451	**5.64**	46.3
4542-04	1,484	**735**	8.4	53	4	< 4.17	5.1 J	< 0.72	0.0343	0.0517	< 0.033	< 0.5	1.28 J	18	**6.56**	43.6

Table 3.11. Summary of FY 2010 groundwater analyses from MV exit pathway wells (cont.)

Sample zone	Spec. cond. (µS/cm)	TDS[b] (500 mg/L)	pH (6.6 - 8.5[a])	Redox (mV)	Turbidity (NTU)	Alpha activity (15[b] pCi/L)	Beta activity (pCi/L)	^{90}Sr (8[d] pCi/L)	Al (0.2[a] mg/L)	Ba (2[b] mg/L)	Fe (0.3[a] mg/L)	Pb (15[c] ug/L)	Mn (50[a] ug/L)	Cl (250[a] mg/L)	F (2[a], 4[b] mg/L)	SO_4 (250[a] mg/L)
4542-05	1,386	**869**	**8.76**	-99	3	< 4.81	< 4.29	< 0.743	0.0318	0.025	< 0.033	< 0.5	1.07 J	15.3	**7.23**	47.4
4542-06	1,125	**605**	**8.93**	-73	2	< 4.99	< 4.87	< 0.771	< 0.015	0.0268	< 0.033	< 0.5	< 1	3.15	1.03	7.34
4542-07	744	**525**	**8.73**	-99	4	< 2.91	< 3.16	< 4.81	0.032	0.0256	0.165	< 10	1.06 J	1.37	0.553	11.3
4542-08	826	384	7.64	7.4	2	4.62	6.86	< 0.802	< 0.015	0.459	0.228	< 0.5	9.03	1.84	0.195	7.74

[a] Reference concentration is a secondary drinking water standard.
[b] Reference concentration is a primary drinking water standard.

Bold value indicates result exceeded standard.

During FY 2010, ^{90}Sr was detected in only one of 36 samples as indicated in Table 3.11, at a value less than the 8 pCi/L drinking water standard equivalent level. None of the detected alpha activity values exceeded the drinking water quality standard. However, because of high dissolved solids content, the minimum detectable alpha activity was greater than the drinking water standard in three of the 36 analyses. Uranium isotopes were analyzed in thirteen of the samples during FY 2010. The results for uranium isotopes indicated that $^{233/234}$U was detected in sample zone 4542-04 at an activity of 0.97 pCi/L. U-233/234 was estimated to be present at about 0.7 and 0.4 pCi/L, respectively, in zones 4541-06 and 4542-05. U-238 was estimated to be present in zone 4541-06 at about 0.5 pCi/L. The uranium detected in these wells is below a 1.2 x 10^{-5} risk level for ^{234}U and below a 1 x 10^{-6} risk level for ^{238}U assuming a residential groundwater use. None of the samples contained detectable ^{137}Cs or ^{60}Co. None of the 25 samples analyzed for tritium, a radionuclide that is common in several of the MV waste disposal areas, contained measureable tritium activity.

During FY 2010, 27 samples were analyzed for VOCs. Several VOC compounds were detected for the first time in some of the sample zones. A summary of the VOC analytical results is presented in Table 3.12. TCE and its transformation products cis-1,2-DCE and vinyl chloride were detected in several sample zones, including several in wells 4537, 4539, and 4541. These wells monitor groundwater in the Maryville Limestone, which is the host formation for several closed waste disposal sites in MV including SWSA 6, the Liquid Waste Seepage Pits and Trenches, and SWSA 5. TCE and its transformation products are known contaminants in SWSA 6, as previously discussed. SWSA 6 is the closest of the mixed waste disposal sites to the MV exit pathway wells and seepage of VOC liquids into bedrock beneath the disposal area may be a source for the detected chlorinated organics. Low concentrations of petroleum hydrocarbons including benzene and toluene were present, as they have been in previous years. These petroleum hydrocarbons may be of natural origins based on occurrences of petroleum crude oil noted in other parts of the ORNL site.

In addition to the parameters discussed previously, samples were analyzed for metals. Arsenic was detected at about 83, 50, and 10 µg/L respectively in sample zones 4539-01, 4540-01, and 4542-01 that sample water from the top of the saline groundwater zone. These values are greater than the 10 µg/L drinking water standard. Selenium was detected at levels above its MCL (50 µg/L) in the filtered and unfiltered aliquots from zones 4539-01 and 4540-01 during FY 2010. Antimony, beryllium, cadmium, chromium, copper, and thallium were not detected at concentrations greater than their respective drinking water standard screening levels.

During FY 2010 two sample sets were collected from the new offsite monitoring wells located southwest of the Clinch River (Figure 3.15). The wells were aggressively pumped during the development process to remove residual fine rock particles that are created during drilling and this resulted in extreme water level drawdown in the wells. One of the wells is constructed in extremely low permeability bedrock at a depth of 600 to 650 ft bgs. Because its water level is recovering very slowly (< 2 ft/day), it will take many months to reach equilibrium water level.

The groundwater chemistry in the new wells is expected to take some time to reach stability. During FY 2010 sampling, the pH levels were high in the newly drilled wells and were near neutral in the reconfigured pre-existing wells. The high pH levels in the newly drilled wells may in part be related to drilling and well construction activities. Turbidity levels in the samples tended to be lower during the second sampling event than in the first as the wells equilibrated. Suspended solids in the samples varied among the wells and levels typically decreased from the first to the second sampling event similar to the field turbidity behavior. Levels of alpha activity are low. Man-made radionuclides (tritium, ^{90}Sr, ^{99}Tc, ^{14}C) were not detected in the offsite wells. Low levels of uranium isotopes were detected in 11 of the 16 offsite sampling zones and the activity levels tended to decrease from the first to the second sampling event.

Table 3.12. VOCs detected in groundwater analyses from MV exit pathway wells FY 2010

Well	Sample Date	1,1-DCE	Benzene (MCL=5)	Chloroform (MCL=70)	cis-1,2-DCE (MCL=70)	Toluene (MCL=1,000)	trans-1,2-DCE (MCL=100)	TCE (MCL=5)	VC (MCL=2)
4537-03	9/14/2010	0.7 J		1	47.5	0.34 J	0.74 J	**113**	**7.49**
4538-05	9/7/2010							0.39 J	
4539-01	8/5/2010		0.61 J						
4539-02	8/6/2010		0.49 J		4.16			**7.02**	
4539-05	8/11/2010								
4539-08	8/13/2010				50.8			**30.9**	1.15
4540-01	8/18/2010		3.8						
4540-02	8/18/2010		1.93	0.96 J	0.38 J			0.38 J	
4540-03	8/18/2010			13.5		0.26 J			
4541-02	8/23/2010		0.37 J		7.99			**40.2**	
4541-04	8/24/2010			0.94 J					
4541-05	8/20/2010							0.29 J	
4541-06	8/20/2010							0.54 J	
4542-01	8/25/2010			0.74 J					
4542-02	8/25/2010			1.5					

All results are in µg/L.
Bold value indicates exceedance of standard.
J = estimated result

Arsenic was present at greater than its 10 μg/L MCL in the first sampling event in two of the deeper sample zones (one each at the OMW-1 and OMW-2 clusters), but concentrations decreased to less than the MCL in the second event. Similarly, cadmium was detected at greater than its MCL (5 μg/L) in the first sampling round from one of the deep zones at the OMW-1 cluster, but was not detected in the second event. Lead was detected above its MCL (15 μg/L) in the two deeper wells in the OMW-1 cluster during the first sampling event, but its level decreased at one and was not detected in the other during the second event. Selenium was detected in the deeper two zones at cluster OMW-1 during both sampling rounds but did not exceed its MCL.

Low levels of petroleum related hydrocarbons (BTEX) were detected in some of the samples. During the second sampling event TCE, cis-1,2-DCE, and vinyl chloride were detected above their MCLs (5, 70 and 2 μg/L, respectively) in the second deepest zone in the OMW-1 cluster, which samples between elevation 507 and 587 ft msl. Although this sampling location is along geologic strike from well 4539 on the DOE side of the river where similar contaminants were observed during the same time period, the hydrologic head in the OMW-1 sampling zone is much higher than that measured at 4539. The movement of groundwater is controlled by the head pressure gradients and moves from areas of higher pressure to those of lower pressure. It is possible that the aggressive well development pumping may have pulled groundwater into the vicinity of the monitoring well and it is also possible that the continuing slow recovery of the deep well in the OMW-1 cluster is pulling water in from a distance.

Figure 3.15 shows the location of hydrofracture waste disposal sites and deep groundwater monitoring wells included in the MV Monitoring Plan. The hydrofracture waste disposal areas lie slightly more than one mile to the east of the Clinch River. Figure 3.15 shows the approximate extent of grout sheets based on monitoring conducted during the disposal operations. The extent of known ^{90}Sr contamination in the connate brine within the Pumpkin Valley Shale is also shown. Six hydrofracture area wells were sampled during FY 2010. Locations of the hydrofracture monitoring wells are shown on Figure 3.15. The first sample event occurred during the winter season and the other event occurred in late summer. Constituents analyzed included anions and cations, VOCs, and radionuclides. The hydrofracture monitoring wells sample groundwater from depths of 600 ft or more below ground surface in the upper brine zone. Because of the very high levels of natural dissolved salts (predominantly sodium chloride) laboratory analysis of the samples is difficult. Dissolved solids content of the samples ranged from a low of about 34,000 mg/L at well 1969-01 to a high of about 234,000 mg/L at well 2952-01. VOC analyses did not show the presence of chlorinated ethanes or ethenes; however, very low concentrations (< 1 ppb) of benzene, toluene, and xylene were detected. A low concentration of chloroform was detected in well 2953-01 during the summer sampling event but none was detected during the winter event. Many major cationic metals (such as barium, calcium, iron, lithium, magnesium, manganese, sodium, and elemental strontium) are present at very high concentrations because of the nature of connate brines. Trace metals (including regulated heavy metals) that were detected in filtered aliquots during FY 2010 include: antimony in wells 1974-01, 1976-01, and 2953-01; and arsenic and selenium in wells 1969-01, 1074-01, 2952-01, and 2953-01. Cobalt, copper, nickel, and zinc were detected in all samples. Cadmium and lead were not detected in any of the samples. Nitrate was detected at < 1 mg/L at well 2952-01 during the summer sampling event and was estimated to be present at < 0.01 mg/L in the winter sampling event. Nitrate was also estimated to be present at < 0.01 mg/L in well 1973-01 during the summer sampling event.

Radionuclides were the principal wastes disposed in the hydrofracture grout sheets. Radionuclide analyses included gross alpha and beta, ^{14}C, ^{90}Sr, ^{99}Tc, tritium, radionuclides detectable by gamma spectroscopy, and thorium and uranium isotopes. Tritium and ^{14}C, ^{137}Cs, and ^{235}U were not detected in any of the samples. Table 3.13 contains results for the other radiological analyses for which analyses resulted in isotope detections for principal radionuclides. The gamma spectroscopy analysis detected daughter products of the ^{232}Th series (^{228}Ac, ^{212}Bi, ^{212}Pb) and the uranium series (^{214}Bi, ^{214}Pb). Although

Table 3.13. Selected radiological results from hydrofracture area groundwater monitoring during FY 2010

Well	1969-01		1973-01		1974-01		1976-01		2952-01		2953-01	
Analyte	**3/11/2010**	**9/1/2010**	**1/26/2010**	**8/31/2010**	**1/28/2010**	**8/27/2010**	**2/23/2010**	**8/25/2010**	**2/3/2010**	**8/19/2010**	**2/1/2010**	**8/26/2010**
Gross Alpha	< 4.99	40.3	544	266	449	500	1010 J	1170	721	360	432	442
Gross Beta	< 53	< 514	< 319	< 411	< 270	427	< 229	< 307	342	1170	408	< 299
^{60}Co	< 3.91	< 1.82	< 2.37	< 1.75	< 2.58	< 2.33	< 3.45	< 2.07	3.05	2.28	3.37	2.34
^{90}Sr	< 7.44	< 4.85	7.04	9.24	63.9	49.4	< 2.88	20.9	55.1	< 0.912	4.12	5.76
^{99}Tc	< 4.53	< 6.28	< 9.46	< 8.4	< 8.3	< 13.7	< 5.94	< 15.1	< 11.6	32.8 J	< 9.8	< 8.52
^{228}Th	<0.796	<0.733	1.17	2.85	8.8	9.44	6.7	18.5	5.5	11.2	7.49	6.09
^{230}Th	0.417	0.701	< 0.296	< 0.317	< 0.968	< 0.287	< 1.12	1.08	< 0.964	< 0.382	< 1.3	0.745
Total Radium Alpha	< 48.2	3.6	153	18.1	215	25	244	23.5	<121	15.8	184	15.6
$^{233/234}U$	< 1.07	< 0.307	8.08	< 0.311	1.65	< 0.315	< 0.612	< 0.792	0.836	< 1.13	0.773	< 0.57
^{238}U	< 0.577	< 0.307	0.452	< 0.731	< 0.365	< 0.616	< 0.542	< 0.298	< 0.775	< 0.557	< 0.26	< 0.57

All results are in pCi/L.

the alpha and beta results are elevated, these indicator parameters have been shown to provide high-biased results in the analysis of high salinity waters such as these connate brines. The relatively consistent low level results for ^{60}Co at wells 2952 and 2953 suggest that waste-related fluid may be slowly permeating the bedrock overlying the waste disposal zone. Similarly, the continued detections of low levels of ^{90}Sr at wells 1973, 1974, and 2953 are consistent with a gradual increase in radionuclides within the brine. The ^{228}Th results possibly reflect natural thorium content of the brines because they are less than results obtained from a brine sample collected approximately four miles to the north in the BCV area. The uranium isotopic data do not provide a consistent indication of contaminant movement thus far because of the intermittent detection of nuclides.

MV Exit Pathway Summary

Groundwater analyses conducted on samples from the picket wells since their construction in 2004 have resulted in a number of radionuclides and VOCs being detected periodically in different monitoring locations. In response to this observation DOE has undertaken an offsite groundwater monitoring program that includes construction of monitoring wells and sampling and analysis of water from offsite residential wells. Monitoring results obtained during FY 2010 show that contaminants continue to be detected in exit pathway wells (identified as an issue carried forward from the 2008 RER). Additionally a new issue has been identified that includes the presence of VOCs and some metal contaminants in the new offsite wells. The Core Team has agreed on four quarters of sampling at which time they will determine a path forward.

3.2.2.2.4 PWTC WAC Compliance for Collected Groundwater

Groundwater collected in the downgradient seepage interceptor systems at Seepage Pits and Trenches, SWSA 4, and SWSA 5 is pumped to the equalization tank located at SWSA 4 prior to being pumped via pipeline to the PWTC in BV for treatment. Samples of the collected groundwater are obtained monthly at the equalization tank and analyses include metals, radionuclides, and VOCs. WAC for the PWTC have been developed for radionuclides and metals. The only constituent detected near or above the PWTC WAC was tritium. The PWTC WAC for tritium is $2 \times 10^{+6}$ pCi/L and the average and maximum tritium concentrations measured in FY 2010 in the collected groundwater were about $1.4 \times 10^{+6}$ and $3.25 \times 10^{+6}$, respectively, which are both slightly lower than the values measured during FY 2009. During FY 2010, three of the monthly samples contained tritium at concentrations greater than the WAC compared to three during FY 2009 and six during FY 2008 that contained tritium above the WAC level. Although the maximum tritium concentrations in the collected groundwater were greater than the WAC, the PWTC discharge was compliant with the required discharge limit for tritium in all of the continuous, flow-paced samples collected and analyzed at the point of discharge.

3.2.3 Other Watershed Monitoring

3.2.3.1 Ambient Water Quality Criteria Summary

During FY 2010, surface water samples were collected twice from 16 locations in MV. The locations include all the sample sites shown on Figure 3.3. The only metals exceedance that was detected during FY 2010 was one mercury exceedance at the WCWEIR location. PCBs were not detected in water although they are known to be present in fish in the main stem of WOC and in WOL. The presumed location of the PCBs in these areas is in contaminated stream and lake sediment and in the contaminated floodplain soils of WOC. 4,4-DDE and chlordane (gamma-chlordane) were detected above their criterion for organism only in both the regular sample and a duplicate sample during the March sampling at WOD. These pesticides were not detected in the summer sampling event. The source of the 4,4-DDE is suspected to be sediment in WOL or on the lower WOC floodplain since it was only detected at the dam. Gamma chlordane was present at low concentrations in several areas including 7500 Bridge, East Seep, HRE tributary, WAG MS-3, and SWSA5D1 tributary. Very low levels of dioxins/furans were detected at various locations in MV, however, their sum did not attain the 1 pg/L criterion considering the Toxicity Equivalency Factor (TEF) adjustments for their toxicity. The results of FY 2010 AWQC sampling show an improvement in water quality in MV with respect to the reduction in total mercury concentrations attributable to the BV Building 4501 mercury actions discussed in Chap. 2. The next CERCLA FYR scheduled for FY 2011 will incorporate these data in the ecological risk re-evaluation.

3.2.3.2 Instability and Erosion Assessment for Melton Branch and HRE Tributary Relocations, ORNL

Portions of two streams were relocated to facilitate the SWSA 5 cap construction. A portion of Melton Branch was relocated to facilitate construction of the southwestern corner and allow for optimizing the location of the downgradient groundwater collection trench in that area (Figure 3.1). Two short reaches of the HRE tributary on the east side of SWSA 5 measuring a total of 250 ft were also relocated. The two reaches had infringed upon the cap boundary.

Melton Branch

Potential stream instability and erosion problems within the relocated portion of the Melton Branch were analyzed through the evaluation of habitat metrics collected yearly as part of the routine Biological Monitoring and Abatement Program (BMAP) monitoring of fish and benthic communities. Metrics evaluated include sediment embeddedness (amount of silt, etc., between rocks), water depth, and pool/riffle ratios, genera descriptions and photo documentation of bank stability, coverage of bank vegetation and percent canopy. These parameters are measured using rapid bioassessment protocols for use in wadeable streams and rivers (Barbour et al. 1999). Fish and benthic community monitoring results were also evaluated as an indicator of whether the restored stream section is functioning as suitable habitat for in-stream organisms. Additional data on the use of the riparian habitat by wildlife (mainly birds) was also recorded along the relocated reach during the evaluation.

The stream is rated using 10 main categories, with a grading scale ranging from 0 to 20. The ratings are then tallied to come up with an overall score, which is used to determine whether or not it is considered to be impaired. Table 3.14 shows individual ratings for each of the 10 main categories and the overall habitat assessment score for this relocated portion of Melton Branch (BMAP Sampling Site MEK 0.6) reach over a five year period. The overall rating given to this site places it in the category of **non-impaired** for each of the five years of evaluation. The Melton Branch Reach compared favorably with other locations in the WOC watershed for the 2009 evaluation year (Table 3.15).

Table 3.14. Habitat Assessment for Melton Branch Reach (BMAP Sampling Site MEK 0.6)

Parameter	Date				
	08/23/06	08/21/07	08/20/08	08/20/09	08/26/10
Epifaunal Substrate/Available Cover	16	14	19	15	19
Embeddedness	14	16	13	13	13
Velocity/depth regime	15	15	18	16	18
Sediment deposition	15	14	15	18	15
Channel flow	18	19	20	20	16
Channel alteration	8	15	17	10	10
Frequency of Riffles	14	17	13	13	7
Bank Stability – Left	5	4	5	8	8
Bank Stability – Right	5	4	5	8	5
Vegetative Protection – Left	5	7	9	7	10
Vegetative Protection – Right	5	7	9	7	4
Riparian Width – Left	6	8	9	9	10
Riparian Width – Right	9	5	6	2	5
Score (Goal ≥ 131)	**135**	**145**	**158**	**146**	**140**
Narrative Rating	**Non-Impaired**	**Non-Impaired**	**Non-Impaired**	**Non-Impaired**	**Non-Impaired**

Table 3.15. Habitat assessment results for BMAP sampling sites in WOC watershed, 2009

Habitat parameter	Sampling site/habitat score					
	FCK 0.1	FFK 0.2	MEK 0.6	WCK 2.3	WCK 3.9	WCK 6.8
1.Epifaunal substrate/available cover	11	12	15	12	12	20
2. Embeddedness	8	11	13	11	7	18
3. Velocity/depth regime	14	14	16	20	20	20
4. Sediment deposition	13	13	18	14	10	20
5. Channel flow	15	20	20	20	20	20
6. Channel alteration	15	13	10	20	15	20
7. Frequency of riffles	14	11	13	11	10	20
8. Bank stability						
Left	4	9	8	6	6	8
Right	5	9	8	7	1	8
9. Vegetative protection						
Left	5	3	7	8	3	9
Right	5	3	7	8	9	9
10. Riparian vegetative zone width						
Left	3	2	9	10	2	2
Right	10	2	2	10	5	10
Total score	**122**	**122**	**146**	**157**	**120**	**184**
Ecoregion 67f habitat goal (≥131)	**Fail**	**Fail**	**Pass**	**Pass**	**Fail**	**Pass**

FCK = First Creek kilometer; FFK = Fifth Creek kilometer (reference site); MEK = Melton Branch kilometer; WCK = White Oak Creek kilometer

The majority of this reach provides habitat adequate or favorable for epifaunal colonization and fish cover. This includes the presence of gravel and cobble with available surface area, large rocks, fallen trees, logs and branches, and undercut banks. The maximum number of velocity/depth combinations (slow-deep, slow-shallow, fast-deep, fast-shallow) are present within this reach of Melton Branch. This is an important indicator of a stream's ability to maintain a stable aquatic environment.

The maximum number of velocity/depth combinations (slow-deep, slow-shallow, fast-deep, fast-shallow) are present within this reach of Melton Branch. This is an important indicator of a stream's ability to maintain a stable aquatic environment.

Some sediment deposition exists along this reach, especially in pooled areas near stream diversion structures. This may result in these areas being of low suitability for certain aquatic organisms. Other areas with good flow (especially in shallow zones) show very little sediment deposition at all. In fact, the reach shows very good channel flow with water reaching bank to bank in many areas, thereby, adequately covering available habitat substrate for aquatic organisms.

A decrease in the number of riffles has become an issue for this area. Riffles are typically a source of high quality habitat and diverse fauna. Decreased frequency results in less diversity in the stream community.

Bank stability is similar to the reference site in 2009, but there is evidence of poor stability on the north side of the stream adjacent to the SWSA 5 cap.. Steep, unvegetated banks with exposed soil and root systems are present in certain areas. The lack of adequate vegetative cover significantly impacts the suitability of habitat for macroinvertebrates and fish. The narrowness of the riparian vegetative zone on this same side of the stream could be adding to the problem. Adequate riparian buffers can be instrumental in preventing runoff and controlling erosion into a stream.

The reason for the recent decrease in the number of riffles is unknown. Riffles are typically a source of high quality habitat and diverse fauna. Decreased frequency results in less diversity in the stream community. However, the Melton Branch reach has provided a favorable and diverse substrate for benthic macroinvertebrates. The site was rated as "non-impaired" based on benthic macroinvertebrate community metric values, biotic index scores and biological condition narrative ratings for 2009 (Table 3.16). Only one other tributary in the WOC watershed rated as "non-impaired" during that sampling year (Table 3.17).

This Melton Branch reach has provided a favorable and diverse substrate for benthic macroinvertebrates. The site was rated as "non-impaired" based on benthic macroinvertebrate community metric values, biotic index scores and biological condition narrative ratings for 2009 (Table 3.16). Only one other tributary in the WOC watershed rated as "non-impaired" during that sampling year (Table 3.17).

The site continues to maintain suitable habitat for fish populations. The reach had the highest average fish density and biomass (averaged over seven years of sampling between 2004 and 2010) of any ORR tributary sampled during that time period, including the reference site (Table 3.18). The site has maintained the same species from the original sampling conducted in 2004 and two species introduced in 2008 continue to be present in the area.

A number of bird species were recorded using the riparian zone at this site. This area provides a significant habitat mix that includes forest, edge, and the riparian zone. There are certain specific species that benefit from such riparian zones. Of significance is the sighting of a Louisiana waterthrush (*Parkesia motacilla*) at the site. This warbler species has only been recorded in a few other areas on the ORR.

Table 3.16. Benthic macroinvertebrate community metric values, Biotic Index scores, and biological condition narrative ratings based on TDEC standard protocols, MV Branch (MEK 0.6), 2006-2009 [a,b,c]

	Metric values							Metric scores								
Date	EPT	TAXA	%OC	%EPT	NCBI	% NUTOL	% CLING	EPT score	TAXA score	%OC score	%EPT score	NCBI score	% NUTOL score	%CLING score	INDEX score	Narrative rating
08/23/06	8	27	15.020	43.874	4.57	45.059	46.245	4	4	6	4	6	4	4	32	Non-Impaired
08/21/07	6	23	5.263	18.660	4.29	55.981	61.722	2	4	6	2	6	4	6	30	Slightly-Impaired
08/20/08	6	26	6.8376	24.79	3.92	53.4188	61.9658	2	4	6	2	6	4	6	30	Slightly-Impaired
08/18/09	9	34	8.0	30.4	4.44	64.1	57.0	4	6	6	2	6	2	6	32	Non-Impaired

[a]EPT = EPT taxa richness; TAXA = total taxa richness; %OC = % oligochaetes and chironomids; %EPT = % EPT abundance; NCBI = North Carolina Biotic Index; % NUTOL = % nutrient tolerant taxa; %CLING = % abundance of clinger taxa.
[b]MEK = Melton Branch kilometer.
[c]Metric scoring and narrative ratings for Ecoregion 67f (TDEC 2006).

Table 3.17. Benthic macroinvertebrate community metric values, Biotic Index scores, and biological condition narrative ratings based on TDEC standard protocols, WOC watershed, August, 2009[a,b,c]

	Metric values							Metric scores								
Site	EPT	TAXA	%OC	%EPT	NCBI	% NUTOL	% CLING	EPT score	TAXA score	%OC score	%EPT score	NCBI score	% NUTOL score	%CLING score	INDEX score	Narrative rating
FCK 0.1	2	13	3.7	5.8	2.77	36.8	89.5	0	2	6	0	6	4	6	24	Slightly-Impaired
FFK 0.2	1	23	17.1	8.3	3.98	39.0	83.9	0	4	6	0	6	4	6	26	Slightly-Impaired
MEK 0.6	9	34	8.0	30.4	4.44	64.1	57.0	4	6	6	2	6	2	6	32	Non-Impaired
WCK 2.3	5	19	1.4	65.3	5.20	56.2	42.5	2	2	6	6	4	4	4	28	Slightly-Impaired
WCK 3.9	3	15	7.2	75.8	4.62	82.5	13.5	0	2	6	6	6	0	0	20	Moderately-Impaired
WCK 6.8	11	34	18.5	55.1	2.73	20.5	74.1	6	6	6	6	6	6	6	42	Non-Impaired

[a]EPT = EPT taxa richness; TAXA = total taxa richness; %OC = % oligochaetes and chironomids; %EPT = % EPT abundance; NCBI = North Carolina Biotic Index; % NUTOL = % nutrient tolerant taxa; %CLING = % abundance of clinger taxa.
[b]FCK = First Creek kilometer; FFK = Fifth Creek kilometer (reference site); MEK = Melton Branch kilometer; WCK = White Oak Creek kilometer.
[c]Metric scoring and narrative ratings for Ecoregion 67f (TDEC 2006).

Table 3.18. Comparison of Average Species, Density and Biomass Numbers for MEK 0.6 and other tributary sampling sites

Fish Sampling Site[a]	Number of Species[b]	Density(fish/m^2)[b]	Biomass(g/m^2)[b]
FCK 0.1	6.17	.82	3.59
FCK 0.8	2.42	2.40	3.98
FFK 0.2	2.17	1.43	4.18
FFK 1.0	1.83	1.50	3.79
MEK 0.6	4.75	4.12	10.25
MEK 1.4	3.92	2.41	5.12
ISK 1.0[c]	8.92	1.77	5.20

[a]FCK = First Creek kilometer; FFK = Fifth Creek kilometer; MEK = Melton Branch kilometer; ISK = Ish Creek kilometer.
[b]averaged over the 2004-2010 sampling period (based on a total of 12 sampling events, except for FFK 1.0 which is only sampled once a year).
[c]reference creek

The sighting of the red-headed woodpecker (*Melanerpes erythrocephalus*) in this riparian zone is also notable. This woodpecker species has also only been recorded in a few other areas on the ORR. They are considered to be in decline in Tennessee due to loss of nesting habitat and competition for nest holes from the European starling (*Sturnus vulgaris*) (Nicholson 1997). Both the Louisiana waterthrush and red-headed woodpecker are on the Partners In Flight list of birds of "regional importance".

The following conclusions are drawn regarding the assessment of this relocated reach of Melton Branch:

1. This reach of Melton Branch successfully provides habitat for epifaunal colonization and fish cover.
2. The reach provides favorable and diverse substrate for benthic macroinvertebrates, with conditions more favorable then most other tributaries in the WOC watershed.
3. The site provides suitable habitat for fish populations with similar fish species diversity, and higher densities and biomass, than several other ORR tributaries.
4. The adjacent riparian zone on the south side is of sufficient width and habitat quality to support a number of bird species, including species specifically dependent on riparian zone habitat.

HRE Tributary

The relocated portion of the HRE tributary was evaluated by visual surveys of stream instability and erosion features, along with measurement of habitat parameters. Additional data on the use of the riparian habitat by wildlife (mainly birds) along the relocated reach was also recorded during the evaluation.

A habitat assessment was conducted within this relocated portion of the HRE tributary in 2010 using the same 10 criteria used for the relocated Melton Branch reach. Table 3.19 shows individual ratings for each of the 10 main categories and the overall habitat assessment score for this reach. The overall rating given to this site places it in the category of **non-impaired** for the 2010 evaluation.

Table 3.19. Habitat assessment for HRE Tributary

Parameters	09/24/10
Epifaunal Substrate/Available Cover	14
Embeddedness	15
Velocity/depth regime	10
Sediment deposition	13
Channel flow	14
Channel alteration	13
Frequency of Riffles	13
Bank Stability – Left	8
Bank Stability – Right	7
Vegetative Protection – Left	8
Vegetative Protection – Right	7
Riparian Width – Left	5
Riparian Width - Right	5
Score (Goal ≥ 131)	**132**
Narrative Rating	**Non-Impaired**

Much of this reach provides habitat adequate for epifaunal colonization and fish cover. This includes the presence of gravel and cobble with available surface area and large rocks. There is limited presence of fallen trees, logs and branches, and undercut banks. This results in a less optimal habitat structure for aquatic organisms.

Only two of the four velocity/depth combinations (slow-shallow, fast-shallow) are present within this reach of the HRE tributary. This is an important indicator of a stream's ability to maintain a stable aquatic environment. Specifically, there are no deep pools present in this stretch of the tributary.

Some sediment deposition exists along this reach, especially in the north end around the stream diversion structures. This may result in this area being of low suitability for certain aquatic organisms. Other areas with good flow (especially in shallow zones) show very little sediment deposition at all. In fact, the reach shows very good channel flow with water reaching bank to bank in many areas, thereby adequately covering available habitat substrate for aquatic organisms.

The relocated reach has an area with good riffles just downstream from the stream diversion structures. Bank stability and vegetative protection is also adequate to good from this point all the way downstream to the large culvert to the south. The presence of all these attributes combined significantly enhances the quality of the habitat in the tributary in this area.

The narrowness of the riparian vegetative zone on both sides of the reach increases the potential for runoff and erosion into the stream. The potential for runoff into the tributary is further increased by the presence of roads on three sides.

A number of bird species were recorded either adjacent to or using the riparian zone at this site. This area provides a good habitat mix that includes forest, edge and the riparian zone. However, the narrowness of the riparian zone in this area decreases habitat suitability. The record of the yellow-throated warbler (*Dendroica dominica*) at this site, a riparian zone species, is notable. This indicates that some of the habitat requirements of typical riparian zone species are being met at this site.

The following conclusions are drawn regarding the assessment of this relocated reach of the HRE tributary:

1. This reach of the HRE tributary successfully provides habitat for epifaunal colonization and fish cover.
2. Bank stability and vegetative cover is good along most of the reach, enhancing the quality of habitat in the tributary.
3. Although habitat is fragmented in the area, the riparian zone is being utilized by a number of bird species in the area. This includes at least one species known specifically for riparian habitats.

3.2.3.3 Surveillance and Performance Assessment: Former Emergency Waste Basin (SWSA 6) and Former IHP (SWSA 4), ORNL

Wetlands were constructed to provide mitigation for impacts to several small wetlands in MV due to construction activities. The replacement wetlands were constructed at the former Emergency Waste Basin near SWSA 6 and in the former IHP at SWSA 4 (Figure 3.1). An environmental survey was conducted in order to determine whether or not these replacement wetlands have maintained characteristics of jurisdictional wetlands, based on their ability to satisfy Army Corps of Engineers (ACOE) wetland criteria. Successful mitigation was determined by the ability of the created wetland to provide functions similar to the impacted wetlands. Multiple locations within each wetland were surveyed and deviations from the proposed boundaries were noted. Observations of percent plant cover and survival of plantings were also evaluated, along with any signs of erosion. Biological conditions within the wetlands were also evaluated by surveying certain indicator wildlife populations (i.e., birds, reptiles and amphibians).

Former Emergency Waste Basin

Data gathered during the survey showed that the created wetland at the Former Emergency Waste Basin wetland is maintaining a self-perpetuating hydrologic regime and has been fully colonized by wetland plants. Approximately 90-100% of the plant species found within most boundaries of the flagged wetland area were wetland indicator species. These plants included species present from a successful supplememental planting effort. Sericea lespedeza (*Lespedeza cuneata*), a highly invasive non-native plant species, is encroaching from the northern side of the wetland. The presence of Eurasian watermilfoil (*Myriophyllum spicatum*), another aggressive non-native invasive plant species, in the pond is also notable. The wetland boundary for this site is depicted in Figure 3.17.

Due to the young age of this created wetland, the typical characteristics that define wetland soils were generally not fully developed at this site. Most soils evaluated within the flagged wetland boundary showed only borderline characteristics.

Although the bird species list for this created wetland included mainly terrestrial species, the juxtaposition of converging habitats (forest, old field, and wetlands) results in greater bird species diversity over other areas that contain no wetland component. Three bird species typical of wetland sites, the wood duck (*Aix sponsa*), belted kingfisher (*Megaceryle alcyon*) and red-winged blackbird (*Agelaius phoeniceus*), were recorded on the site in the wetland.

This wetland was found to be inhabited by several of the common aquatic reptile and amphibian species found on the ORR. Both larval and adult amphibian stages were found in the wetland, confirming that successful breeding was occurring. Amphibians and reptiles are important bioindicators and biomonitors (Jensen et. al. 2008).

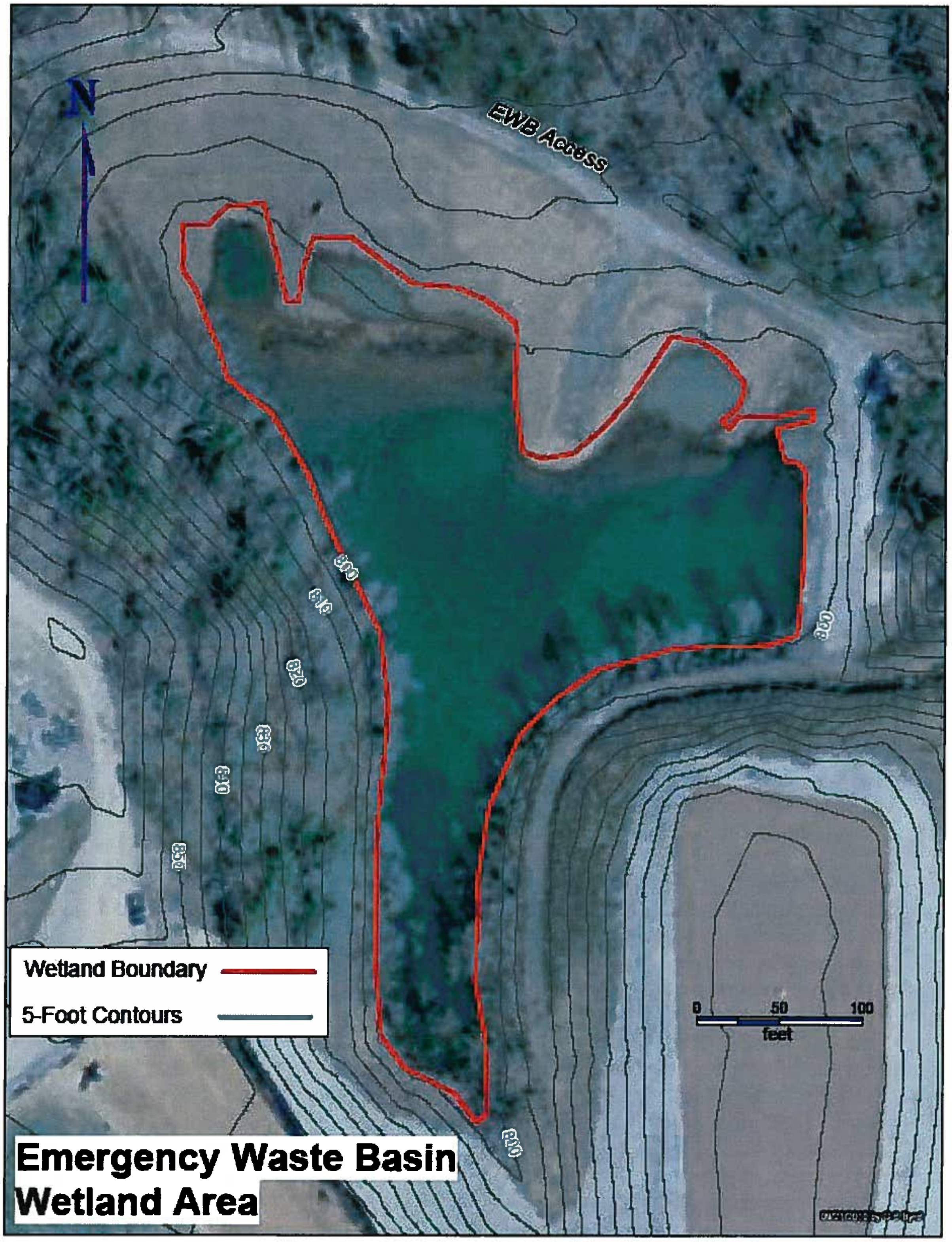


Figure 3.17. Former Emergency Waste Basin Wetland Boundary.

The following conclusions were drawn regarding the success of this wetland creation:

1. The wetland exhibits characteristics that meet ACOE wetlands criteria very strongly for vegetation and hydrology; however, the recent nature of the wetland creation has not provided enough time for development of classic wetland soils.

2. Proper landscape positioning and contour design has resulted in a successful wetland creation.

3. The site provides a self-perpetuating hydroperiod that supports a diversity of wetland plants and is used by a number of wetland fauna species, as documented by site-specific sampling and monitoring.

4. Successful seeding, planting and colonization has resulted in the establishment of a site dominated by wetland plant species.

Certain other considerations are taken into account regarding the overall success of wetland mitigation. The actual area of the delineated wetland (1.78 acres) is somewhat smaller than shown in original plans for the site and the encroachment/spread of non-native invasive plant species (i.e., sericea lespedeza and Eurasian water-milfoil) is a threat to the quality of the wetland. The ORNL Natural Resources Group is planning to spray the area to control non-native plants in the spring of 2011.

Former Intermediate Holding Pond

The survey showed that the created wetland at the Former IHP wetland is maintaining a self-perpetuating hydrologic regime and has been colonized by wetland plants. Approximately 90-100% of the plant species found within most boundaries of the flagged wetland area were wetland indicator species. These plants included species from a successful supplemental seeding and planting effort. Encroachment of sericea lespedeza around current wetland boundaries in the central/south-central portion of the site is notable. The wetland boundary for this site is depicted in Figure 3.18.

Due to the young age of this created wetland, the typical characteristics that define wetland soils were generally not fully developed at this site. Most soils evaluated within the flagged wetland boundary showed only borderline characteristics. In certain areas, soils were almost 100% clay, and indicative of soils introduced in order to achieve an impermeable layer to maintain wet conditions.

Wooded, shrub/herbaceous and open water habitat are all present in this created wetland. The juxtaposition of these converging habitats increases bird species diversity over single habitat areas that provide little structure. The presence of shallow water and mudflats in the pond adds to the value of the habitat at this site. The consistent presence of wading birds is indicative of abundant prey populations (i.e., green sunfish, crayfish).

Only one species of reptile and three species of amphibians were recorded in the wetland. This site being surrounded by roads could be a contributing factor to the low species diversity, by making access more difficult. It is also suspected that the presence of the green sunfish (*Lepomis cyanellus*) in high numbers is impacting the ability of amphibian populations to become established. Any pond that has fish is not ideal for amphibians. Ponds that have fish are not good for frogs. Green sunfish are known to be voracious eaters, eating a variety of prey items (Etnier 1971) and are believed to be responsible for the decline of certain frog and salamander species (Porej and Hetherington 2005).

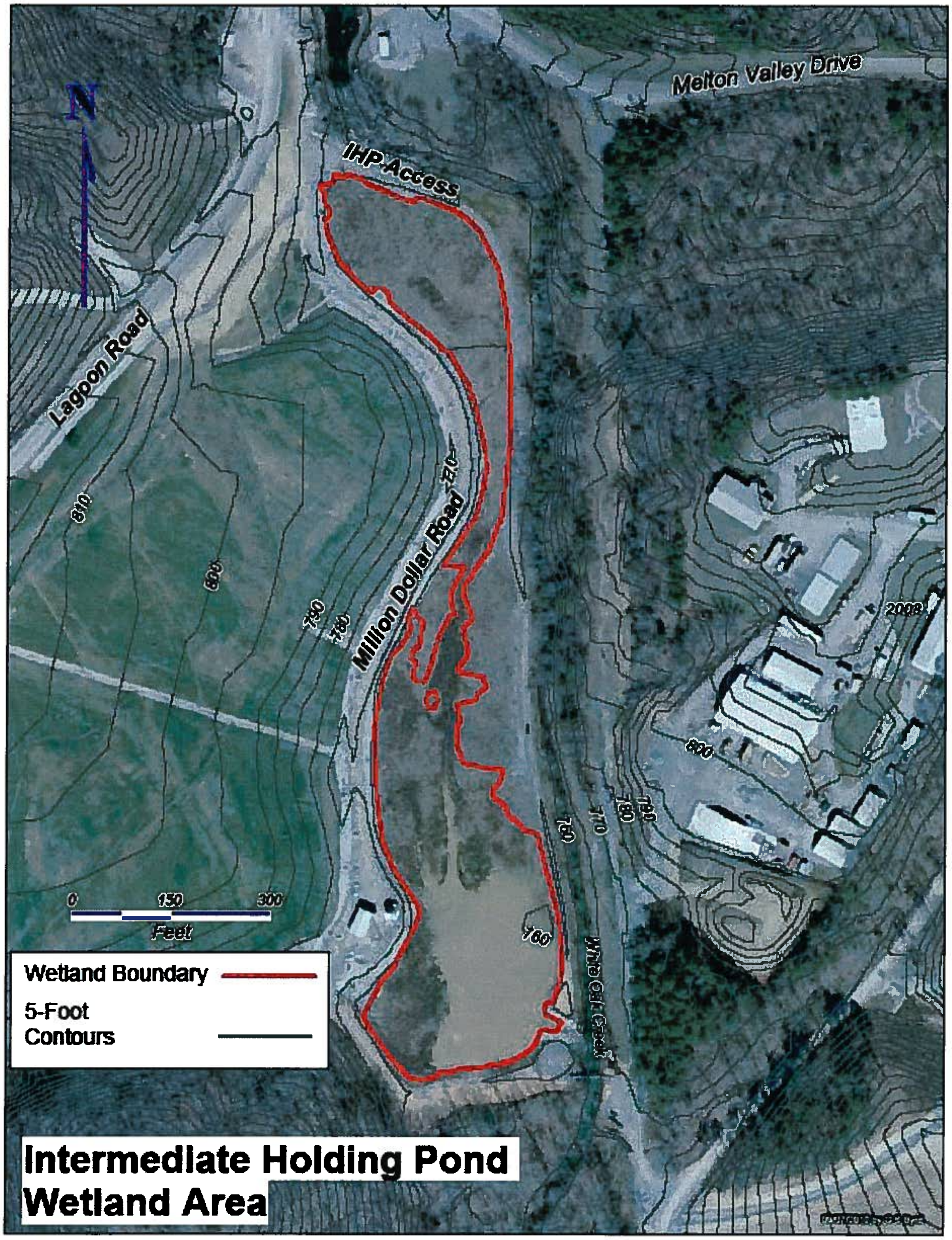


Figure 3.18. Former IHP Wetland Boundary.

The following conclusions were drawn regarding the success of this wetlands creation:

1. The wetland exhibits characteristics that meet ACOE wetlands criteria very strongly for vegetation and hydrology; however, the recent nature of the wetland creation has not provided enough time for development of classic wetland soils.

2. Proper landscape positioning and contour design has resulted in a successful wetland creation.

3. The site provides a self-perpetuating hydroperiod that supports a diversity of wetland plants and is used by a number of wetland fauna species, as documented by site-specific sampling and monitoring.

4. Successful seeding, planting and colonization has resulted in the establishment of a site dominated by wetland plant species.

Certain other considerations are taken into account regarding the overall success of wetland mitigation. The actual area of the delineated wetland (4.43 acres) is smaller than shown in original plans for the site and the encroachment/spread of non-native invasive plant species (i.e., *Sericea lespedeza*) is a threat to the quality of the wetland. The ORNL Natural Resources Group is planning to spray the area to control non-native plants in the spring of 2011.

3.2.3.4 Aquatic Biological Monitoring

The monitoring of fish and benthic macroinvertebrate communities provides a useful measure of watershed trends and whether watershed ROD goals of achieving narrative AWQC and protecting ecological populations are met. Aquatic biological monitoring locations used to gauge the conditions of the MV Watershed, as well as their reference sites, are shown on Figure 3.1. As is the case for most watershed units, biological monitoring data in Melton Branch include: (1) contaminant accumulation in fish, (2) fish community surveys, and (3) benthic macroinvertebrate surveys. In addition to Melton Branch, fish and benthic macroinvertebrate monitoring results include a site in WOC just downstream of the Melton Branch confluence (Figure 3.1).

Redbreast sunfish were collected in 2010 from lower Melton Branch [Melton Branch kilometer (MEK) 0.2] and fillets analyzed for mercury, PCBs, metals, and ^{137}Cs. Mean (± SE) mercury concentrations in these fish increased significantly in 2010 (average 0.15 ± 0.02 μg/g), and were approximately two-fold higher than typical of reference site concentrations in this species. PCBs concentrations were near background levels, averaging 0.04 ± 0.01 μg/g in the six redbreast sunfish analyzed. As expected, most metals (As, Se, Be, Cd, Cr, Cu, Pb, Ni, Ag, and Tl) were below detection limits or at levels similar to those in fish from the Hinds Creek reference site. Zinc, with an average of 21 mg/kg, was higher than observed in fish collected previously at MEK 0.2 and reference sunfish. Cesium-137 was not detected in sunfish samples from MEK 0.2.

The monitoring results for Melton Branch and WOC below the Melton Branch confluence continue to indicate slight to moderate impacts to fish and benthic communities relative to uncontaminated sites, but most stream sites are much improved relative to their ecological status in the mid-1980s (Figure 3.19). Although the number of species of fish has been fairly stable for many years, in 2009-2010 some improvement in number of species has occurred at the downstream sites as a result of a fish introduction program. Two darter species are now commonly found at MEK 0.6 and at WCK 2.3 three introduced fish species are common. In the most recent samples at both WCK 2.3 and MEK 0.6, fish species richness values were the highest ever seen. The apparent success of these introduced sensitive species is additional evidence that the watershed has improved since the 1980s.

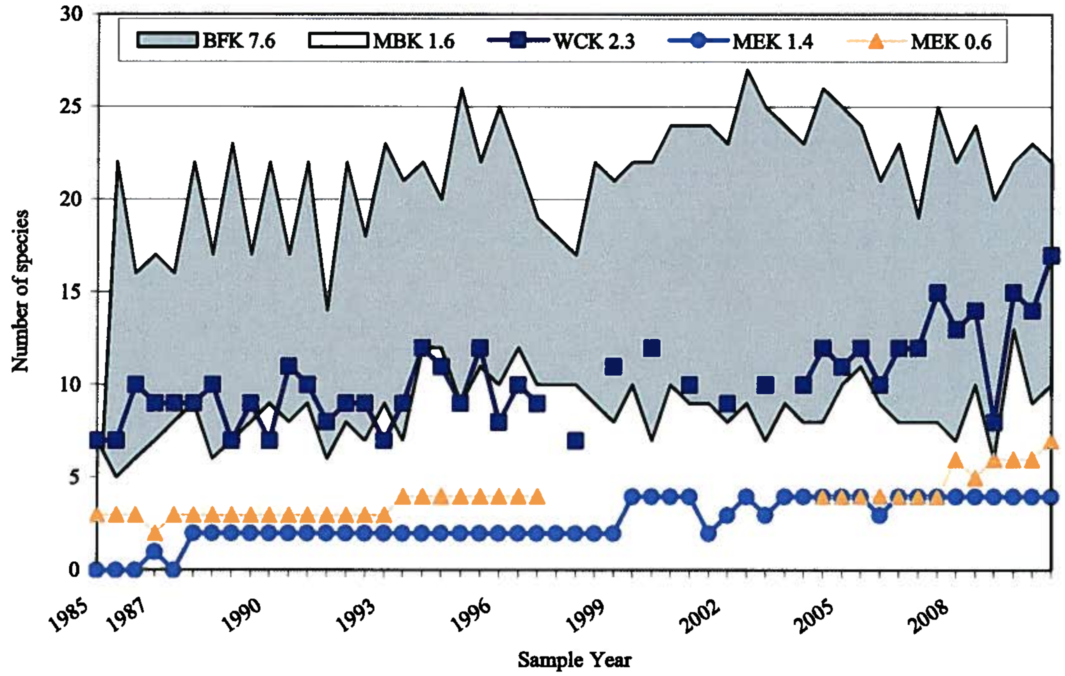


Figure 3.19. Species richness (number of species) in samples of the fish community in MV (WCK and MEK) and reference streams, Brushy Fork (BFK) and Mill Branch (MBK), 1985–2010[a].
[a]Reduction of sampling frequency at WCK 2.3 from biannual to annual between 1998 and 2005 is indicated by the discontinuation of the line for this period.

Relative to reference (MBK 1.6) and near-reference (WCK 6.8) conditions, long-term trends for the benthic macroinvertebrate community in lower WOC (WCK 2.3) indicate that there has been no major change in temporal trends since 2001 (Figure 3.20). Although invertebrate community results indicate that conditions are degraded at this site, the results also suggest that the modest improvements that occurred after 2001 have persisted. The number of pollution intolerant macroinvertebrate taxa in lower Melton Branch (MEK 0.6) remained similar to reference sites. Although taxonomic richness of the pollution-intolerant taxa was the only metric evaluated, because this metric is generally reliable at detecting significant ecological degradation, these results suggest that the condition of the invertebrate community is within or at least similar to typical conditions in nearby reference streams (Figure 3.20).

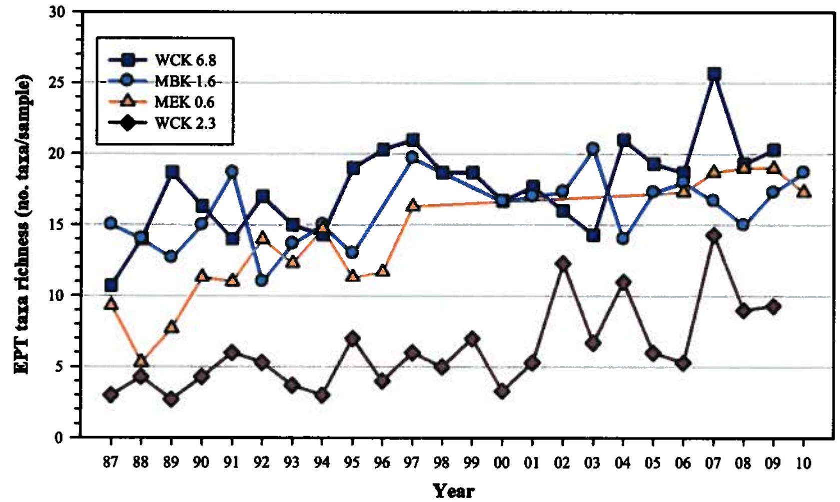


Figure 3.20. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrates communities in lower WOC (WCK 2.3), lower Melton Branch (MEK 0.6), and reference sites in upper WOC (WCK 6.8) and Mill Branch (MBK 1.6), April sampling periods, 1987–2010.[a]

[a]Samples collected from WCK 2.3 and WCK 6.8 in 2010 have not yet been processed.

3.2.4 Performance Summary

Radiological goals for ^{137}Cs, ^{90}Sr, and tritium, which are the principal surface water contaminants in MV, were met at WOD. Concentration trends for these contaminants were stable or decreasing during FY 2010. Principal contaminant concentrations at tributary and mainstem monitoring locations remained compliant with ROD goals. Although a slight increase in the ^{90}Sr was observed during FY 2010, the contaminant fluxes from MV remained low relative to the responses observed during wet years prior to remediation.

An assessment of relocated stream reaches in Melton Branch and the HRE tributary was conducted in FY 2010 and determined that the reaches in both streams were categorized as non-impaired. Additionally, the Former Emergency Waste Basin and Former Intermediate Holding Pond, both wetlands mitigation activities were evaluated and both were identified as successfully supporting a wetland habitat.

Groundwater contaminant concentrations around the shallow land burial sites are generally decreasing or stable compared to concentrations measured before completion of the MV remedy.

Groundwater level monitoring of the hydrologic isolation areas in MV showed that performance criteria were met at 37 of 44 locations. Three of the wells not meeting the performance criteria are located in SWSA 4. Two of those are located near the downgradient trench which, based on these wells performance, show evidence of deteriorated performance during FY 2010. This is identified as an issue in Table 1.1. Additional seepage sampling will be instituted in FY 2011 to determine if well maintenance will enhance performance.

Groundwater analyses conducted on samples from the picket wells since their construction in 2004 have resulted in a number of radionuclides and VOCs being detected periodically in different monitoring locations. In response to this observation, DOE has undertaken an offsite groundwater monitoring program that includes construction of monitoring wells and sampling and analysis of water from offsite residential wells. Monitoring results obtained during FY 2010 show that contaminants continue to be detected in exit pathway wells. Continued monitoring of the exit pathway wells and the offsite wells will be conducted consistent with the approach presented in the Addendum to the MV Monitoring Plan (DOE 2010g) which entails four quarters of sampling to be collected, at which time the results will be discussed with the Core Team.

3.2.5 Compliance with MV ROD LTS Requirements

3.2.5.1 Requirements

Watershed-wide Requirements

The ROD requires implementation of LUCs to protect against unacceptable exposures to contamination during the RAs, as well as after completion of all RAs in MV (see Table 3.2). During RAs, interim LUCs were imposed and will remain until permanent LUCs are established in future remedial decisions for this area. The LUC objectives stated in the ROD are as follows:

1. ***Industrial area:*** prevent unauthorized access to or use of groundwater; control excavations or penetrations below prescribed contamination cleanup depths; prevent unauthorized access; and preclude uses of the area that are inconsistent with LUCs.
2. ***Waste management area:*** prevent unauthorized access to or use of groundwater; prevent unauthorized contact, removal, or excavation of source material; prevent unauthorized access; and preclude alternate uses of the area (e.g., additional waste disposal or development).
3. ***Surface water and floodplain area:*** prevent unauthorized access to surface water, sediment, floodplain soils, or underlying groundwater; prevent fish consumption; and preclude uses of the media that are inconsistent with planned LUCs.

The implementation and maintenance of these LUC objectives identified in the ROD are specified in the MV LUCIP (DOE 2006a), which was approved in May 2006, and revised through errata to the MV RAR in 2009 (DOE 2009f and DOE 2009g). Because of the similarity in interim LUC objectives among the three remediation areas (i.e., industrial, waste management. and surface water/floodplain) identified in the ROD, most of the LUCs specified in the LUCIP apply generally throughout the watershed. The LUCs are defined as follows:

1. DOE land notation (property record restrictions) on land use and groundwater use in areas where waste is left in place.
2. Property record notices to provide records about existence and location of areas where wastes are left in place.
3. Zoning notices to provide notice to the city of Oak Ridge of existence and locations where wastes are left in place.
4. EPP program.
5. State advisories/postings (e.g., no fishing or contact advisories at WOL and WOCE).
6. Access controls (fences, gates, portals).
7. Signs at designated locations throughout the valley, to provide warning to prevent unauthorized access.
8. Surveillance patrols.

These LUCs can be grouped into administrative controls (land use and groundwater deed restrictions, property record notices, zoning notices, permits program) and physical controls (state advisories/postings, access controls, signs, and security patrols), as provided in Table 3.2.

The requirements of the MV LUCIP are presented in a tabular summary in Appendix A, along with the required certification.

PCCR Specific Requirements

The MV LUCIP also states that, as individual remediation projects are undertaken within the MV Watershed, project-specific LUCs, if any, will be identified in the project construction completion report. None of the MV PCCRs contain project-specific LUCs.

While the PCCRs may not require additional LUCs, the hydrologic isolation projects PCCRs do require engineering controls that are to be maintained at the 13 separate waste caps in MV. Details of the S&M of the engineering controls at the caps are addressed in the S&M Plan (DOE 2007c) that is attached to the RAR. This plan covers the S&M required by all RAs performed in MV; however, only the hydrologic isolation caps constructed at SWSA 5, SWSA 4, Seepage Pits and Trenches, and SWSA 6 and the groundwater collection system at Seepage Pits, Trench 7, Seep D, and SWSAs 4 and 5 require long-term maintenance. No other RA performed in MV required long-term S&M after completion of the construction activities. Inspections of the engineering controls and maintenance began immediately upon closure and were implemented in accordance with the ORNL Facility Inspection and Training (FIT) Manual (BJC 2006).

3.2.5.2 Status of Requirements for FY 2010

Watershed-wide Requirements

Appendix A of the RER contains the Certification of Land Use Controls for FY 2010. The LUCAP requires that the Manager, DOE ORO, annually verify in the RER that LUCIPs are being implemented on the ORR. Below are summaries of the implementation verification and status of all eight LUCs specified in the LUCIP and in Table A.1 (Appendix A).

DOE Land Notation (Property Record Restrictions)

The ROD requires that deed restrictions (e.g., land and groundwater use) be drafted and implemented by DOE for all waste management areas and other areas where hazardous substances are left in place to restrict use of property by imposing limitations and prohibiting uses of groundwater. The land notation is to be recorded by DOE in accordance with state law at the County Register's of Deeds office upon completion of RAs and/or transfer of affected areas.

The LUCIP states that the DOE Realty Officer will file the Land Notation in the applicable county records and that it is to include a survey plat executed by a registered land surveyor and will depict the relevant restricted areas subject to LUCs, including contamination/waste disposal areas. The LUCIP requires that a DOE official (or its contractor) verify annually that the information is properly recorded at the County Register of Deeds office in the event of a records search.

The DOE Realty office filed the MV Land Notation with the Roane County Register's of Deeds office on August 21, 2008. It is titled, "Notation on Ownership Record for Notification of Closure of Melton Valley Burial Grounds," and was filed as an Environmental Notation in Books 1290, Pages 727-748. The Notation includes the principal contaminants left in place and restrictions on the property, including EPP program and access controls (i.e., postings/signs). Survey plats for each of the waste units were attached to the Notation and delineated property that will be restricted in its future use. For FY 2010, the WRRP verified this information had been properly filed electronically at the Roane County Register's of Deeds office.

Property Record Notices

The ROD requires that a deed notice/RCRA postclosure notice be recorded by DOE for all waste management areas and other areas where hazardous substances are left in place to provide notice to anyone searching records about the existence and location of a hazardous waste landfill(s). This deed notice is to be recorded by DOE in accordance with state law at the County Register's of Deeds office upon completion of RAs and/or transfer of affected areas.

The LUCIP calls this LUC a Property Record Notice and states that DOE Environmental Management (EM) will prepare a property record notice that will include the purpose of the notice, a brief summary of the main COCs, a listing of the LUCs and LUC objectives, available maps and figures, an explanation of DOE's assumptions of future use of the property and the LUC and an ORR program contact. The applicable LUC information, including the available figures and maps identified, will be posted on the DOE EM web home page, a hardcopy of the property record notice placed at the publicly accessible DOE Information Center, and added to the Appendix A of the LUCIP. At the completion of the ROD remediation activities, this property record notice will be replaced within the DOE EM web page and the DOE Information Center by the above DOE Realty Officer-prepared land notation and survey plat described in the previous section. Both the DOE Realty Officer-prepared land notice and survey plat will also be filed by the DOE Realty Officer in the Register's of Deeds records of the pertinent county. The LUCIP requires that a DOE official (or its contractor) verify annually that the information is properly recorded at the County Register's of Deeds office in the event of a records search.

The DOE Realty office placed the MV Property Record Notice, officially titled, "Notice of Land Use Restrictions in Melton Valley Area Department of Energy – Oak Ridge Reservation," in the *Roane County News* (December 10, 2007), *Oak Ridger* (December 11, 2007), *Knoxville News Sentinel* (December 11, 2007), *Loudon County News Herald* (December 13, 2007), and the *Oak Ridge Observer* (December 13, 2007). This same notice was also placed on the EM website and filed at the DOE Information Center. The notice includes the predominant COCs; future use limitations of the areas within MV; lists the LUCs including signs, surveillance patrols, and the EPP program; and additional contact information. A figure depicting the three land use zones was also included. For FY 2010, the WRRP verified this information had been posted electronically on the EM web site and that the hard copy had been placed at the DOE Information Center. In addition to the MV Property Record Notice, the DOE Land Notation and survey plat were also filed on the DOE EM web page and at the DOE Information Center. The WRRP also verified that the DOE Land Notation was properly recorded at the Roane County Register's of Deeds office (see previous section).

Zoning Notices

In FY 2010, requirements for Zoning Notices were changed through an erratum that replaced Chap. 7 (LUCs) of the RAR (DOE 2009g), and were added to Appendix A of the LUCIP. These changes represent how the City of Oak Ridge is to handle zoning information provided by the DOE for land on the ORR. The RAR now states that the ORR, including the MV-wide area, is currently zoned as a federal controlled industrial/research (FIR) area with the City Planning Commission. Zoning notice, use limitations information, and boundary survey plat will be filed with the City Planning Commission if/when areas are to be transferred out of DOE federal control. RCRA Subtitle C hazardous waste landfill(s) Property Record notice(s) will be filed according to TDEC Chapter 1200-1-11.05 and/or 1200-

1-11.06 with the City Planning Commission. This replaces the requirement from the LUCIP that DOE EM will file a zoning notice with the City Planning Commission upon completion of all ROD remediation activities.

The ROD requires that a zoning notice be recorded by DOE for all waste management areas and other areas where hazardous substances are left in place to provide notice to the city about the existence and location of a hazardous waste landfill(s) for zoning/planning purposes. A survey plat of SWSA 6 Interim Corrective Measure Areas/Hillcut Test Facility (ICMAs/HTF) is to be filed by DOE with the City Planning Commission.

The LUCIP states that DOE EM will submit to the City Planning Commission a survey plat (at least four copies) indicating the location and dimensions of landfill cells or other disposal units (i.e., the SWSA 6 ICMAs and the HTF) with respect to permanently surveyed benchmarks as well as a record of the type, location, and quantity of hazardous wastes disposed to the best of DOE's knowledge based upon any kept records. This zoning notice information is similar to the property record notices discussed above. The LUCIP requires that a DOE official (or its contractor) verify annually that the information is properly maintained and assessable at the City Planning Commission.

Excavation/Penetration Permit Program

The ROD requires that an EPP program be in place throughout the MV remediation areas (i.e., Waste Management Area Industrial Area, and Surface Water and Floodplain Area) to provide notice to the worker/developer (i.e., permit requestor) on the extent of contamination and to prohibit or limit excavation/penetration activity, as appropriate. The LUCIP requires a DOE official (or its contractor) to verify no less than annually the functioning of the permit program against existing procedures.

Verification was provided by the BJC MV Project Engineer stating that the EPP program was functioning during FY 2010 in accordance with existing procedures listed in Appendix B of the MV LUCIP and also in accordance with the BJC MV EPP procedure OR-1010, *Excavation/Penetration Permit for ORNL Site.* Excavations conducted by the UT-Battelle when operating as the prime workgroup were performed in accordance with the UT-Battelle procedure titled *Initiating and Issuing an Excavation or Penetration Permit,* which requires the BJC MV Project Engineer signature on every excavation permit before work can begin. The UT-Battelle ORNL excavation permit form (ORNL-211) also requires that the BJC MV Project Environmental Compliance Lead review the area to determine if any CERCLA LUCIPs are established, and if so, specify the relevant details. In FY 2010, there were no UT-Battelle excavation permits requested for MV remediation areas.

Excavations conducted by BJC at MV were performed in accordance with BJC procedure OR-1010, which requires that a BJC ORNL EPP Log be maintained and that all EPPs for the ORNL be entered into the log and maintained by one person. The procedure also requires that an Environmental Compliance Review Form (BJCF-147b) be completed by MV Environmental Compliance for all excavations and that Environmental Compliance review existing information sources to determine if the area is covered by a LUCIP to ensure that the activity will not unknowingly violate CERCLA LUCs. In FY 2010, there were no BJC excavation permits requested for MV remediation areas.

State Advisories/Postings

The LUCIP states that advisories established by the TDEC Division of Water Pollution Control that provide notice to potential resource users of contamination and prohibit fishing/swimming in WOCE and WOL on signs and in the fishing regulations published by the Tennessee Wildlife Resources Agency (TWRA) will be effective immediately upon LUCIP approval. Although adequate warning signs have been established and maintained by the DOE on the WOL and WOCE, current state advisories and published fishing regulations do not address the WOL and WOCE. Changes made through the FY 2010 erratum to the RAR state that DOE will continue to place appropriate signs at the WOL and WOCE. These changes do not prevent future postings of these waters by the State, but allow DOE to fully meet the intent of this requirement.

Per the LUCIP, the purpose of the advisories/postings is to provide the public with important warnings that seek to limit/restrict incompatible uses and prevent unsafe exposure to contaminants. There are DOE established signs posted along the WOL dam access areas at HWY 95 and at the access gate and on fencing along WOCE that state, "Warning, No Fishing, No Water Contact, Area Contaminated."

These signs have been added to the MV Access Controls and Signs map in the RAR through an erratum that replaced Chap. 7 (LUCs) of the RAR (DOE 2009g). The changes incorporated the additional signs around the WOL and WOCE at six of the twenty major access points in MV to provide notice to potential resource users of contamination and prohibit fishing/contact. These changes allow DOE to meet the intent of the State Advisories/Postings requirements with the continued placement of appropriate signs at WOL and WOCE to prevent the unauthorized use of these waters.

The LUCIP also requires that a DOE official (or its contractor) verify the information in the fishing regulations with a TWRA official to ensure that fishing regulations accurately describe impacted streams. TWRA receives guidance from the TDEC on publishing these advisories in their annual fishing regulations. Currently, there are no TDEC-established advisories on WOL and WOCE because the DOE ORR property does not afford public access and, therefore, no information has been published in the TWRA fishing regulations for these areas.

Access Controls

The ROD requires that access controls (e.g., fences, gates, portals) be maintained by DOE throughout MV remediation areas to control and restrict access to workers and the public to prevent unauthorized uses. A map depicting the location of access controls that are necessary to ensure protectiveness of the remedy is included in the RAR. In FY 2008, this map was revised through an erratum that replaced Chap. 7 (LUCs) of the RAR (DOE 2009g). The revision increased the number of access control locations from 16 to 20 to better cover WOD while also removing interior MV access control locations that are no longer necessary.

The LUCIP states that any selected access controls will be monitored and maintained by DOE and its contractors as part of its S&M program indefinitely or for as long as needed. The LUCIP requires that a DOE official (or its contractor) conduct a field survey no less than annually of all controls to assess their condition and ensure fences are erect or intact and gates/portals are functioning properly. In addition to routine site inspections conducted by the BJC MV S&M Program according to the FIT manual of all remediated areas in MV, a field survey was conducted by the WRRP and the BJC MV S&M facility manager to verify access controls designated in the revised RAR (with proposed errata sheets incorporated) were in place, in good condition and functioning properly. All major access points as identified in the pending revised RAR (e.g., portals, exterior gates) remain guarded or locked at all times, and interior gates are selectively locked. Specifically, access is restricted by the DOE ORR perimeter fence and security portals at the east and west ends of BV Road. There also is a locked gate at the junction of the haul road and the MV Access Road. Perimeter roads around MV have gates that allow access for maintenance activities.

Signs

The ROD requires that signs be maintained by DOE at select locations throughout MV to provide notice or warning to prevent unauthorized access. A map depicting the location of the signs that apply to the MV Watershed is included in the RAR (DOE 2009g). This map was revised through an erratum that replaced Chap. 7 (LUCs) of the RAR. The revision increased the number of sign locations from 13 to 20 to better cover WOD while also removing interior MV sign locations that are no longer necessary. In addition to location changes, wording of the signs was updated to more appropriately represent the current site conditions and restrictions. This revision allows DOE to meet the intent of the State Advisories/Postings requirements with the continued placement of appropriate signs at WOL and WOCE to prevent the unauthorized use of these waters.

The LUCIP requires that, within six months of approval of the LUCIP, signs will be in place at designated locations throughout MV Watershed near major access points to provide notice or warning to prevent unauthorized access. Any signs that are LUCs will be monitored and maintained, until the concentration of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure or as long as needed. The LUCIP requires that a DOE official (or its contractor) conduct a field survey no less than annually of all signs to assess their condition and ensure they remain erect, intact, and legible. In addition to routine site inspections conducted by the BJC MV S&M Program according to the FIT manual of all remediated areas in MV, a field survey was conducted by the WRRP and the BJC MV S&M facility manager to verify signs designated in the revised RAR were in place, in good condition and legible. All signs as identified in the revised RAR (e.g., prevent unauthorized access, prohibit fishing/swimming) were in place and meeting their intended purpose. Specifically, 20 signs were in place around the MV Watershed and at the WOL and WOCE to provide notice of contamination or warning to prevent unauthorized access. There were also six additional signs posted at locations around WOL and WOCE and on the Sediment Retention Structure (SRS) to provide notice to potential resource users of contamination and prohibit fishing/swimming.

Surveillance Patrols

The LUCIP requires that surveillance patrols of selected areas in MV be effective immediately upon LUCIP approval and conducted no less frequently than once a quarter as part of the routine S&M site inspections that are required for units/areas. The LUCIP requires a DOE official (or its contractors) to verify no less than annually against approved procedures/plans that routine patrols are conducted to ensure that incompatible uses have not occurred for units/areas requiring land use restrictions. In FY 2010, surveillance patrols were performed by the BJC ORNL S&M Program as part of routine S&M site inspections. The BJC ORNL S&M Program developed the FIT manual to initiate routine S&M inspections as a means to monitor, maintain and enforce the LUC compliance requirements of the MV LUCIP. Inspections of the capped areas within MV were performed on a quarterly basis. In addition, ORR security personnel also perform required daily patrols of various areas within MV.

PCCR Specific Requirements

In addition to implementing the physical LUCs (i.e., access controls, signs, surveillance patrols) as detailed above, the BJC MV S&M Program also performed inspections of the MV hydrologic isolation areas to inspect each of the engineering controls listed below as applicable at each site:

- Vegetative cover on compacted fill or isolation cap,
- Compacted fill cover or isolation cap outslopes,
- Rock buttress outslopes,
- Surface drainage features,

- Monitoring wells (including well interior conditions),
- Weirs at surface water monitoring locations,
- Groundwater (leachate) collection equipment,
- Gas vents,
- Wetlands,
- Melton Branch relocation area, and
- Cover/cap maintenance roads, fences, gates, and signs.

The RAR states that for the first two years after installation of a hydrologic isolation cap, an engineer familiar with the cap design shall inspect each cap and associated features quarterly and after any precipitation that is greater than or equal to a five-year, 24-hour storm event (4.1 inches in a 24-hour period). After a minimum two-year period or until the hydrologic isolation cap and surface drainage features remain stable, the inspection schedule will revert to twice per year and after any precipitation that is greater than or equal to a 25-year, 24-hour storm event (5.5 inches in a 24-hour period).

In FY 2010, engineering controls were inspected quarterly by the MV S&M Program according to the ORNL FIT Manual at the following sites:

- SWSA 4,
- SWSA 5 North 4-Trench Area,
- SWSA 5 South,
- SWSA 6 Capped Area – CAP A,
- SWSA 6 Capped Area – CAP B,
- SWSA 6 Capped Area – CAP C,
- SWSA 6 Capped Area – CAP D,
- SWSA 6 Capped Area – CAP E,
- SWSA 6 Capped Area – HTF,
- Pits 2, 3, and 4,
- Trench 5,
- Trench 6 and Trench 6 Leak Sites,
- Trench 7 and Trench 7 Leak Sites Cap, and
- Trench 7 East Leak Site.

Minor maintenance included the repair of a small area of erosion at SWSA 4 and mowing all caps a minimum of once during the year.

3.3 COMPLETED SINGLE ACTIONS IN MELTON VALLEY WITH MONITORING AND/OR LTS REQUIREMENTS

3.3.1 White Oak Creek Embayment Sediment Retention Structure

Location of the WOC SRS is shown on Figure 3.1. The scope of this action involved the construction of a sediment retention structure, referred to as the SRS, at the mouth of WOC to contain the sediments in lower WOCE and minimize transport off-site to the Clinch River and Watts Bar Reservoir. The SRS uses rip-rap-filled wire gabions to slow water movement, preventing scour of sediment out of the embayment during changes in WOC flow and fluctuation of Watts Bar Reservoir levels. This site has only LTS requirements (Table 3.2). A review of compliance with these LTS requirements is included in Sect. 3.3.1.1. Background information on this remedy and performance standards are provided in Chap. 3 of Vol. 1 of the 2007 RER (DOE 2007a).

No surface water or groundwater monitoring is required to verify the effectiveness of the removal action.

3.3.1.1 Compliance with LTS Requirements

3.3.1.1.1 Requirements

LTS requirements for this action include inspection and maintenance of the SRS.

3.3.1.1.2 Status of Requirements for FY 2010

The site was inspected monthly in FY 2010 by the ORNL S&M Program to check the fence and gate to ensure they were preventing access, inspect the condition of the warning signs, determine if excessive debris or vegetation had built up on the SRS, and identify any evidence that there had been any movement or shift of the embayment structure. No maintenance was required.

3.3.2 WAG 13 Cesium Plots Interim Remedial Action

Location of the WAG 13 Cesium Plots Interim RA is shown on Figure 3.1. The scope of this action involved excavation of contaminated soil from the plots, placement of a permeable liner in each excavated plot and backfill with clean, compacted fill material and topsoil layer. This site has only LTS requirements (Table 3.2). A review of compliance with these LTS requirements is included in Sect. 3.3.2.1. Background information on this remedy and performance standards are provided in Chap. 3 of Vol. 1 of the 2007 RER (DOE 2007a).

No surface water or groundwater monitoring is required to verify the effectiveness of the removal action.

3.3.2.1 Compliance with LTS Requirements

3.3.2.1.1 Requirements

LTS requirements specified in the completion documents for this site includes long-term S&M of the fenced enclosure.

3.3.2.1.2 Status of Requirements for FY 2010

The site underwent monthly inspections in FY 2010 conducted by the ORNL S&M Program to verify that all gates to the site were closed and locked, the fence was not damaged, vegetation within the fenced area was cut, vegetation growth along fence line was acceptable, radiological postings were in place, point-of-contact signs were in place, and the site was clear of unauthorized materials. As an improvement to the site, the ORNL S&M Program removed sheet metal barriers in the control plots so it is easier to mow and maintain areas.

3.3.3 MSRE D&D Uranium Deposit Removal

Location of the MSRE D&D Uranium Deposit Removal is shown on Figure 3.1. The scope of this action involved the break up and removal of nongranular uranium-laden charcoal and vacuuming of the remaining loose charcoal and chips from the auxiliary charcoal bed (ACB) to ensure that less than a critical mass remains. This site has only LTS requirements (Table 3.2). A review of compliance with these LTS requirements is included in Sect. 3.3.3.1. Background information on this remedy and performance standards are provided in Chap. 3 of Vol. 1 of the 2007 RER (DOE 2007a).

No surface water or groundwater monitoring is required to verify the effectiveness of the removal action.

3.3.3.1 Compliance with LTS Requirements

3.3.3.1.1 Requirements

LTS requirements specified in the RmAR (DOE 2001a) include S&M activities for the interim storage of the collector canister holding the uranium-laden charcoal removed from the ACB, specifically, periodic pressure measurements (daily checks of the pressure gauge and hourly recorder data) and venting of the canister, as necessary, to maintain a pressure of less than 50 psig.

3.3.3.1.2 Status of Requirements for FY 2010

Inspections were conducted daily of the uranium-laden charcoal canister, in accordance with MSRE procedures. These inspections included periodic pressure measurements and periodic venting of the canister to reduce pressure when needed. No maintenance was required during FY 2010.

3.4 MELTON VALLEY MONITORING CHANGES AND RECOMMENDATIONS

Table 3.20 provides a summary of technical issues and recommendations for the MV Watershed. Evaluation of FY 2010 monitoring data revealed new issues dealing with possible low levels of groundwater contamination in initial sampling events in new off-site wells and the apparent diminishing of effectiveness of the downgradient groundwater collection trench at SWSA 4.

Table 3.20. Summary of MV Watershed technical issues and recommendations

Issue[a]	Action/ Recommendation
2011 Current Issue	
1. Initial sampling of new offsite wells (2 events) yielded indication of the presence of VOCs and some metal contaminants. (2011 RER)[a] 2. During FY 2010 groundwater level control at the SWSA 4 downgradient trench deteriorated as indicated by water level measurements in the trench, within the nearby portion of SWSA 4, and the former IHP area. (2011 RER)[a]	1. Continue sampling in FY 2011 to confirm presence of contaminants, establish existence of any trend, and establish on-site vs off-site hydrologic head relationship. Consolidate offsite well sampling with that specified in MV Monitoring Plan after four quarters of sampling and with agreement of sampling specifics (parameters and locations) with the core team. 2. (a) During winter of 2011 DOE will collect seepage samples from the IHP adjacent to the SWSA 4 downgradient trench during or soon after large rainfall events to determine if SWSA 4 contaminants are being discharged to surface water in the IHP. (b) DOE will evaluate the performance of SWSA 4 downgradient trench extraction wells to determine if well maintenance may improve the system performance.
Issue Carried Forward	
1. Monitoring results for some zones in the MV exit pathway wells yield elevated alpha and beta activity results that are apparently the result of elevated suspended and/or dissolved solids. These results raise concern over possible migration of contamination across the DOE property boundary in western MV. (2008 RER)[b]	1. Monitoring will continue to establish baseline conditions. In 2010, DOE established an offsite monitoring system including two clusters of newly drilled wells and two reconfigured wells. Monitoring of the new system was agreed upon for four quarters. After which the Core Team will discuss the monitoring results (see Action/Recommendation from Melton Valley Issue #1 above).
Completed/Resolved Issues	
None.	

[a] An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

[b] The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2008 RER).

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4. CERCLA ACTIONS IN BEAR CREEK VALLEY WATERSHED

4.1 INTRODUCTION AND OVERVIEW

This chapter provides an update to CERCLA activities ongoing and completed in BCV Watershed. Only sites that have performance monitoring and/or LTS requirements on a watershed scale are included in the performance evaluations; those sites are noted on Table 4.1. Figure 4.1 shows the location of each of the CERCLA actions. Table 4.2 provides a summary of LTS requirements, and Figure 4.2 shows BCV Phase I ROD-designated land uses and interim controls in BCV. In this chapter, performance goals and objectives, monitoring results, and an assessment of the effectiveness of each completed action are presented. A review of compliance with any LTS requirements is also included (Sect. 4.2.3 and Sect. 4.3.1.1).

Several single-project decisions within BCV predate the ROD for Phase I activities. These earlier actions do not contain specific performance criteria for reduction of contaminant flux or risk reduction at the watershed scale. The Phase I ROD, a watershed-scale decision, incorporates the preceding single-project actions and sets specific performance standards for contaminant flux and risk reduction for the entire watershed. The Phase I ROD also includes expected outcomes for the selected remedy against which effectiveness of individual actions is measured. The Phase I ROD addresses groundwater and surface water by dividing the valley into three zones and establishing performance standards for each zone in terms of resource uses and risks.

Completed CERCLA actions in the BCV Watershed are gauged against their respective action specific goals. However, CERCLA actions have yet to be fully implemented within the watershed. Therefore, monitoring of baseline conditions is conducted against which the effectiveness of the actions can be evaluated in the future. The collected data provides a preliminary evaluation of the early indicators of effectiveness at the watershed scale.

For background information of each remedy and performance standards, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chap. 4 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated each year in the annual RER and republished every fifth year at the time of the CERCLA FYR.

4.1.1 STATUS AND UPDATES

The draft Focused Feasibility Study (FFS) (DOE 2008b) and draft Proposed Plan (PP) (DOE 2008c) for remediation of the Bear Creek Burial Grounds (BCBGs) were submitted to the regulators in FY 2008. Review was suspended in FY 2009 pending resolution of issues related to long-term institutional controls in FY 2009. Issues remain unresolved as of September 30, 2010. Future decision documents and their respective implementation have not been formalized at this time.

Table 4.1. CERCLA actions in BCV Watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
		Watershed-scale actions		
BCV Phase I ROD	ROD (DOE/OR/01-1750&D4): 06/16/00	Actions complete		
		• BYBY PCCR (DOE/OR/01-2077&D2) approved (01/12/04).	Yes/Yes	4.2
		• OLF Soils Containment Pad RAR (DOE/OR/01-1937&D2) approved 07/16/01.	No/No	
	LUCIP (DOE/OR/01-2320&D1) submitted 09/29/06	Actions not yet implemented		
		• S-3 Site Pathway 3	No/Yes	
		• DARA Facility	No/Yes	
BCV Phase II ROD	ROD: TBD[b]			
		Single-project actions		
BCV OU 2 RA (Spoil Area 1, SY-200 Yard)	ROD (DOE/OR/02-1435&D2): 01/23/97	No additional actions required; institutional control and S&M ongoing.	No/Yes	4.3.1
S-3 Site Tributary Interception (Pathways 1 and 2)	AM (DOE/OR/01-1739&D1): 06/25/98	RmAR (DOE/OR/01-1945&D2): 02/11/02	Terminated	--
	AM Addendum (DOE/OR/01-1739&D1/A1): 10/20/00	RmAR Addendum (DOE/OR/01-1836&D1/A1): 06/20/07 (shutdown Pathways 1 and 2 system)		
BCBGs Unit D-East	AM (DOE/OR/01-2036&D1): 08/05/02	RmAR (DOE/OR/01-2048&D2): 05/09/03	No/No	--

[a]Detailed information of the status of actions is from Appendix E of the FFA and is available at <http://www.bechteljacobs.com/ettp_ffa_appendices.shtml>.
[b]D1 FFS and PP for remediation of the BCBGs submitted in FY 2009. Future decision documents and their respective implementation have not been formalized at this time.

DARA = Disposal Area Remedial Action

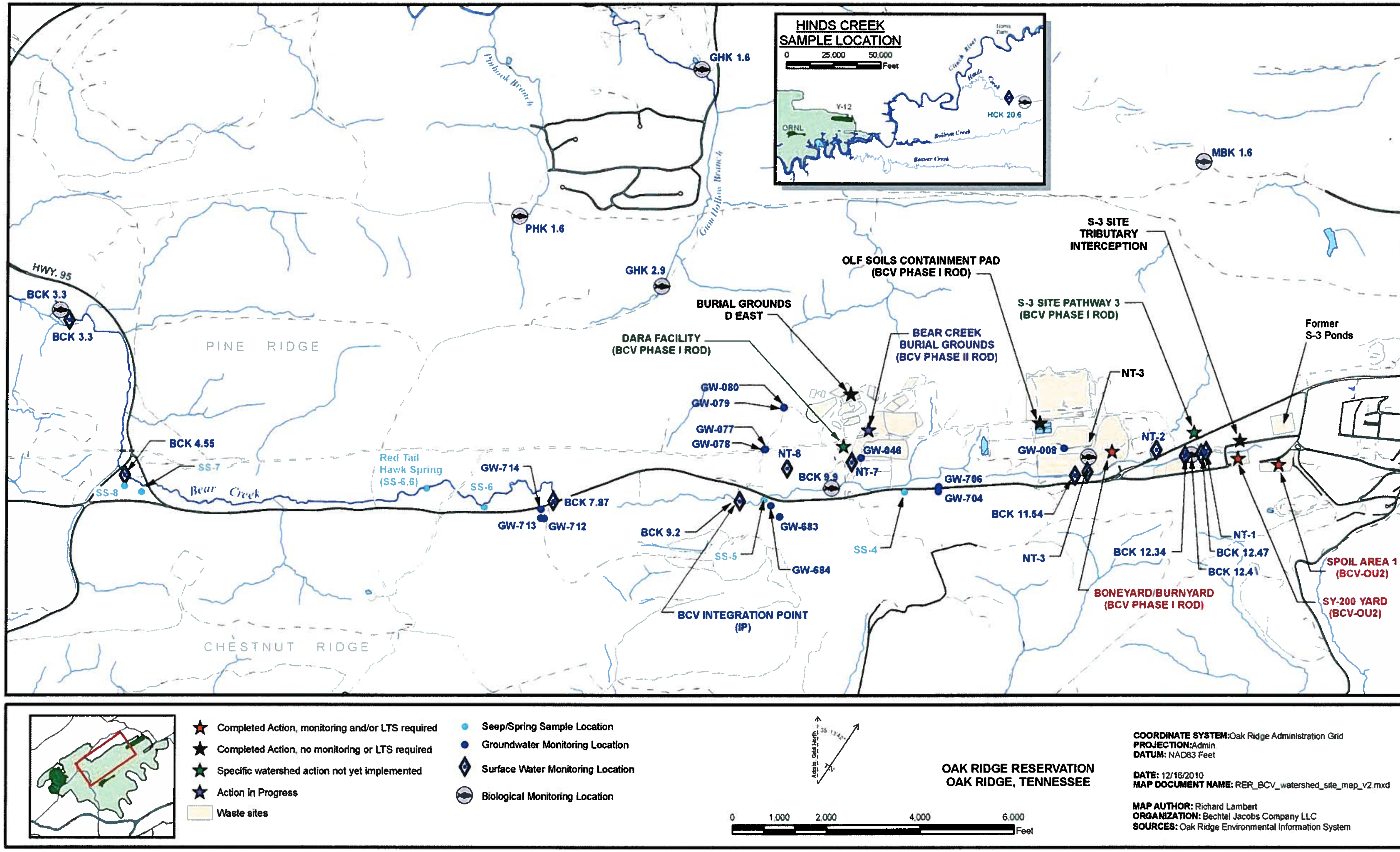

Figure 4.1. CERCLA actions in the BCV Watershed.

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Table 4.2. LTS requirements for CERCLA actions in BCV Watershed

<table>
<tr><th rowspan="2">Site/Project</th><th colspan="2">LTS Requirements</th><th rowspan="2">Status</th><th rowspan="2">RER section</th></tr>
<tr><th>LUCs</th><th>Engineering controls</th></tr>
<tr><td colspan="5">Watershed-scale actions</td></tr>
<tr><td>BCV Phase I ROD[a]
▪ BYBY PCCR</td><td><u>Watershed LUCs</u>
Administrative:
▪ land use and groundwater deed restrictions[b]
▪ property record notices
▪ zoning notices
▪ permits program

Physical:
▪ access controls
▪ signs
▪ security patrols

<u>BYBY PCCR specific:</u>
▪ Access controls
▪ Signs</td><td><u>BYBY PCCR specific</u>:
▪ Maintain cap at BYBY</td><td><u>Watershed LUCs</u>
▪ Physical LUCs in place.
▪ Administrative LUCs required at completion of actions.

<u>BYBY PCCR specific:</u>
▪ LUCs in place.
▪ Engineering controls remain protective.</td><td>4.2.3</td></tr>
<tr><td colspan="5">Completed single project actions</td></tr>
<tr><td>BCV OU2 RA (Spoil Area 1, SY-200 Yard)</td><td>▪ Deed restrictions
▪ Access controls (fencing)
▪ Signs</td><td>▪ Maintain vegetated soil cover</td><td>▪ LUCs in place.
▪ Engineering controls remain protective.</td><td>4.3.1.1</td></tr>
</table>

[a]Remaining actions have not been implemented but require interim access controls [e.g., S-3 Site Pathway 3 and Disposal Area Remedial Action (DARA) Facility].

[b]Includes restrictions on surface water use.

BYBY = Boneyard/Burnyard

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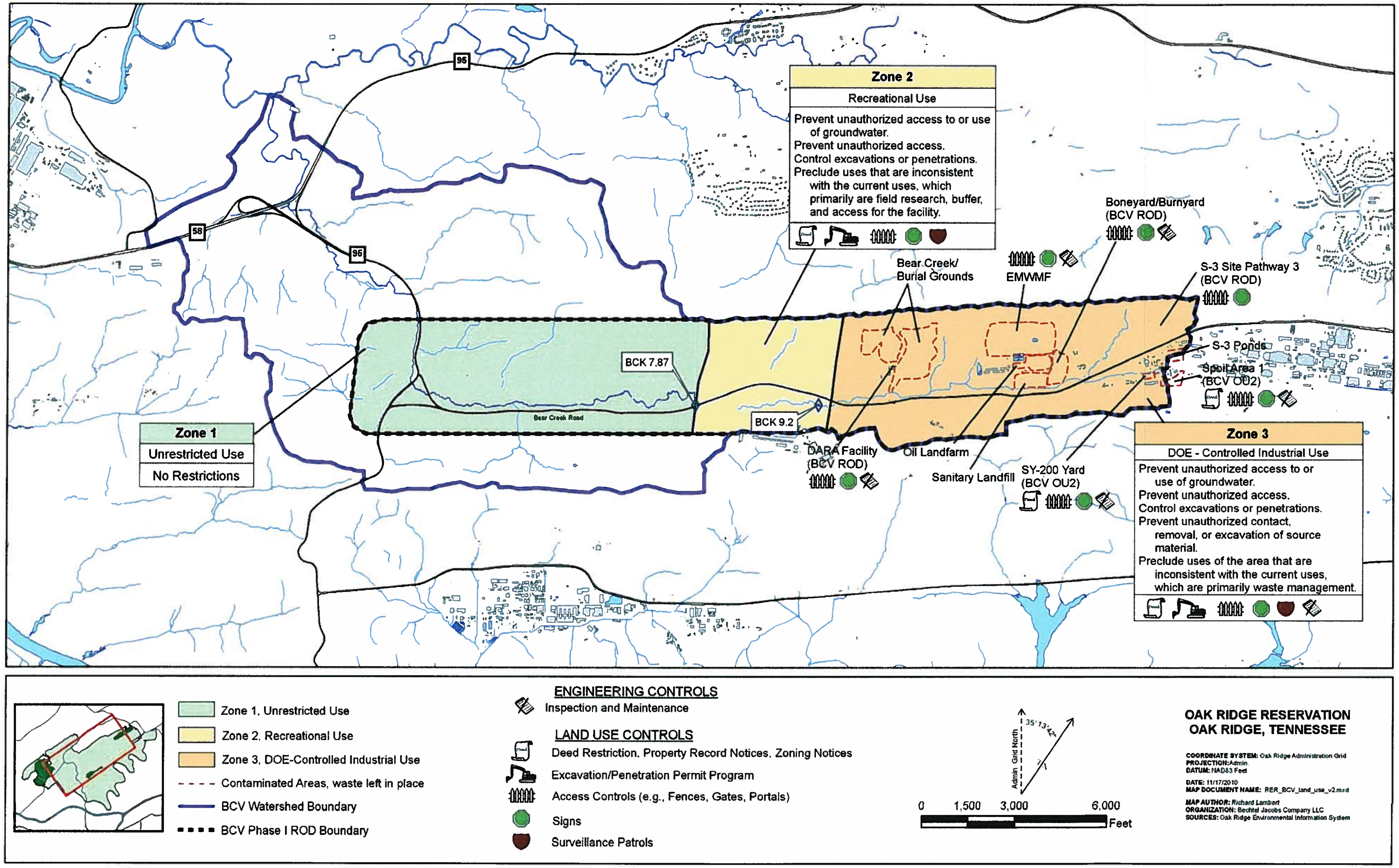

Figure 4.2. BCV Phase I ROD-designated land use and interim controls.

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4.2 BEAR CREEK VALLEY PHASE I RECORD OF DECISION

The selected remedy cited in the Phase I BCV ROD (DOE 2000c) involves source control and migration control strategies that reduce contaminant migration in shallow groundwater and surface water. These actions are expected to result in a reduction of contamination levels in groundwater and surface water downstream of the waste areas over time.

4.2.1 Performance Goals and Monitoring Objectives

The RAO for the BCV ROD (DOE 2000c) is to:

- *protect future residential users of the valley in Zone 1 from risks from exposure to groundwater, surface water, soil, sediment, and waste sources;*
- *Protect a passive recreational user in Zone 2 from unacceptable risks from exposure to surface water and sediment;*
- *And protect industrial workers and maintenance workers in Zone 3 from unacceptable risks from exposure to soil and waste.*

The three land use zones in BCV were identified previously on Figure 4.2. Consistent with the RAO, water quality goals are also established in the ROD for each zone as stated in Table 4.3.

Table 4.3. ***Groundwater and surface water goals, Bear Creek Valley Y-12 Plant, Oak Ridge, Tennessee***[a]

Area of the valley **(see Figure 4.2)**	***Current situation***	***Goal***
Zone 1 – western half of Bear Creek Valley	*No unacceptable risk posed to a resident or a recreational user. AWQC and groundwater MCLS are not exceeded.*	*Maintain clean groundwater and surface water so that this area continues to be acceptable for unrestricted use.* *Land use: unrestricted*
Zone 2 – a 1-mile-wide buffer zone between zones 1 and 3	*No unacceptable risk posed to a recreational user. Risk to a resident is within the acceptable risk range except for a small area of groundwater contamination. Groundwater MCLs are exceeded, but AWQC are not.*	*Improve groundwater and surface water quality in this zone consistent with eventually achieving conditions compatible with unrestricted use.* *Land use: recreational (short-term); unrestricted (long-term)*
Zone 3 – eastern half of Bear Creek Valley	*Contains all the disposal areas that pose considerable risk.* *Groundwater MCLS and AWQC are exceeded.*	*Conduct source control actions to (1) achieve AWQC in all surface water, (2) improve conditions in groundwater to allow Zones 1 and 2 to achieve the intended goals, and (3) reduce risk from direct contact to create conditions compatible with future industrial use.* *Land use: controlled industrial*

[a]Source: Table 2.1 of BCV ROD (page 2-13).

In addition to the watershed-wide water quality goals, the ROD provides site-specific water quality goals for the S-3 Site Pathway 3 and for the Boneyard/Burnyard (BYBY) actions, as presented in Table 4.4.

Table 4.4. Site-specific goals for remedial actions at the S-3 Site Pathway 3 and the BYBY[a]

Remedial action goals for S-3 Site Pathway 3	Remedial action goals for BYBY
• *Prevent expansion of the nitrate plume into Zone 1.*	• *Reduce flux of uranium in NT-3 at confluence with Bear Creek to 4.3 kg/yr.*
• *Reduce concentration of cadmium in NT-1 and upper Bear Creek to meet AWQC.*[b]	• *Reduce concentration of mercury in NT-3 to meet AWQC (12 ng/L at the time – now 51 ng/L).*
• *Prevent future increase in release of uranium to Bear Creek to maintain annual flux below 27.2 kg total U at BCK 12.34.*	
• *Reduce seasonal nitrate flux at NT-1/Bear Creek confluence by 40%. The seasonal nitrate flux benchmark will be defined by the FFA parties in remedial design.*	

[a]Source: Table 2.2 of BCV ROD (page 2-14).
[b]*The Phase I ROD originally established the cadmium concentration performance standard as 3.9 µg/L. This standard changed to 0.25 µg/L due to change in the promulgated AWQC.*

The source removal actions related to principal threat source materials and groundwater control actions specified in the ROD comprise the actions that were envisioned to attain the stated water quality goals. The following components of the selected remedy are listed in the ROD:

- **S-3 Site**. Install trench at Pathway 3 for passive *in situ* treatment of shallow groundwater (DOE 2001b).
- **Oil Landfarm Area**. Actions in the Oil Landfarm Area include:
    - Remove waste stored in Oil Landfarm Soil Containment Pad (OLFSCP) for commercial off-site disposal, and dismantle structure.
    - Excavate source areas in BYBY and contaminated floodplain soils and sediments. Excavated materials meeting the WAC of the EMWMF will be disposed on-site; materials exceeding EMWMF WAC will be disposed off-site. Install clay cap over uncapped disposal areas at BYBY, and maintain existing caps.
    - Implement hydraulic isolation measures at BYBY, including reconstruction of North Tributary (NT)-3, elimination of stagnation points, and installation of drains or well points.
- **Other Sites**. Remove waste stored in the Disposal Area Remedial Action (DARA) facility for off-site disposal, and dismantle structure.

Field implementation of actions under the Phase I ROD was initiated in FY 2000. RAs in the Oil Landfarm Area are complete (BYBY and OLFSCP). Other key components of the remedy (S-3 Pathway 3 and DARA) have not yet been implemented.

The ROD included expected outcomes, target risk levels, and timeframes for attainment of goals for each of the BCV land use zones as outlined in Table 4.5.

Table 4.5. *Expected outcome of the selected remedy, Bear Creek Valley, Y-12 Plant, Oak Ridge, Tennessee*[a]

	Zone 1	Zone 2	Zone 3		
			S-3 Site/Pathway 3	BYBY/OLF Area	BCBGs
Available land use and time frame	*Unrestricted use (compatible with residential use), available immediately.*[b]	*Presently restricted use (compatible with recreational use); compatible with unrestricted use in 50 years.*	*Restricted use, long-term waste management area/controlled industrial use*	*Restricted use; long-term waste management area/controlled industrial use*	*N/A*
Available groundwater use and time frame	*Unrestricted use (compatible with residential use) available immediately (MCLs met)*	*Presently restricted use (MCLs not met for nitrates, compatible with recreational use); with unrestricted use in 50 years.*	*Restricted use*	*Restricted use*	*N/A*
Available surface water use and time frame	*Unrestricted use (compatible with residential use) available immediately (AWQC met)*	*Unrestricted use(compatible with recreational use); available immediately (AWQC met)*	*Recreational use, AWQC met in 5 years following implementation*	*Recreational use, AWQC met in 5 years following implementation*	*N/A*
Cleanup levels, residual risk	- *MCLS in groundwater* - *AWQC in surface water* - *risk to residential receptor below RAO of 1 x* 10^{-5}	- *TBD for groundwater* - *AWQC in surface water* - *risk to residential receptor below RAO of 1 x* 10^{-5}	- *TBD for groundwater* - *AWQC in surface water* - *direct exposure risk to industrial/terrestrial receptors eliminated* - *risk to industrial receptor below RAO of 1 x* 10^{-5} - *Reduce seasonal nitrate flux at the NT-1/Bear Creek confluence by 40%*	- *TBD for groundwater* - *AWQC in surface water* - *risk to industrial receptor below RAO of 1 x* 10^{-5}	*N/A*
Anticipated socioeconomic and community revitalization impacts	*Property will meet conditions for residential/recreational/ industrial use*	*Property will meet conditions compatible with recreational/industrial use*	*Waste area is capped and used as a parking lot to support Y-12 Plant activities; surrounding area available for additional controlled industrial use*	*Area devoted to waste management; proposed onsite disposal facility provides potential to create new jobs*	*N/A*
Anticipated environmental and ecological benefits	*Media not impacted*	*Slightly impacted groundwater will be restored*	*Impacted surface water will be restored*	*Impacted surface water will be restored, capping will protect terrestrial species*	*N/A*

[a]Source: BCV ROD Table 2.22.
[b]*Although the selected remedy will allow unrestricted land use for this zone, there are no plans to transfer ownership of this property.*

N/A = not applicable
S-3 = Pathway 3
OLF = Oil Landfarm
TBD = to be determined

4.2.2 Evaluation of Performance Monitoring Data

This section presents the monitoring data that evaluates progress toward meeting the goals of the BCV ROD. Performance monitoring for the ROD includes surface water and groundwater monitoring, as well as biological monitoring. Monitoring locations are shown on Figure 4.1 and Figure 4.2. The performance metrics and monitoring parameters for each location are outlined in Table 4.6.

4.2.2.1 Surface Water Monitoring

4.2.2.1.1 Surface Water Quality Metrics and Monitoring Requirements

As identified in Section 4.2.1, the ROD goals include AWQC compliance, annual mass (flux) reductions for nitrate and uranium at several locations throughout the watershed, and carcinogenic risk to a receptor of 1×10^{-5} at the IP. Monitoring is keyed to the boundaries between the three zones defined in the ROD. Key surface water monitoring locations in BCV include BCK 9.2, BCK 12.34, NT-3, SS-5, and NT-8 (Figure 4.1). BCK 9.2 is the IP which lies between Zones 2 and 3. BCK 12.34 is located near the Bear Creek headwater and serves as an IP for surface water contaminant discharges from the S-3 Ponds area. NT-3 was historically heavily impacted by contaminant discharges from the BYBY which has been remediated. NT-8 carries runoff and contaminants from the western end of the BCBGs to Bear Creek a short distance above the BCK 9.2 IP.

Zone 1

Zone 1 of BCV constitutes the valley area west of BCK 7.87 (Figure 4.2). Surface water quality is monitored at BCK 7.87. For Zone 1 surface water, results are compared to AWQC (part of the FYR), consistent with the unrestricted use goal. In addition, risk-based concentrations (RBCs) for residential exposure to surface water (1×10^{-5}) are included as part of the evaluation. The AWQC comparison includes quarterly grab samples for metals and anions during the FYR year sampling in FY 2010.

Zone 2

Zone 2 of BCV constitutes the section of the valley located between BCK 7.87 and BCK 9.2 (Figure 4.2). As stated in Table 4.5, the ROD goal for Zone 2 is to improve groundwater and surface water quality consistent with eventually achieving unrestricted use in 50 years. The monitoring location for Zone 2 surface water is at BCK 9.2, which lies between Zones 2 and 3. BCK 9.2 has continuous flow monitoring and is sampled for ^{234}U, ^{235}U, and ^{238}U, with quarterly samples for metals, VOCs and nitrate during the FYR period. Zone 2 surface water results at BCK 9.2 are compared to a flux goal annually and to AWQC during the FYR sampling in FY 2010. In addition, RBCs for residential exposure to surface water (1×10^{-5}) are included as part of the evaluation.

Zone 3

Zone 3 of BCV is the section of the valley east of BCK 9.2 (Figure 4.2) that contains a currently operating CERCLA waste disposal facility (EMWMF) and former waste disposal sites. The remedial goals for Zone 3 are to attain AWQC in all surface water (short-term), and reduce risks from direct contact to achieve conditions compatible with a long-term, controlled industrial land use. Surface water is monitored at a number of surface water locations within Zone 3. These locations include BCK 11.54 and BCK 12.34 with continuous flow monitoring and weekly surface water samples analyzed for nitrates, ^{234}U, ^{235}U, and ^{238}U. There are also quarterly grab samples for metals including mercury at BCK 12.34 and NT-1 with semiannual grab samples at NT-2 and NT-3 during the FYR period sampling.

Table 4.6. BCV Watershed CERCLA performance monitoring[a]

Area/Site	Media	Monitoring location	Schedule	Parameters	Performance standard
Zone 1/Zone 2 Boundary (Performance measurement for Zone 1)	Surface water	BCK 7.87	Quarterly grab samples (in year prior to FYR)	Metals, including total and isotopic uranium, and mercury; VOCs; and nitrate[f]	AWQC, risk-based[e]
	Groundwater	GW-712, GW-713, GW-714	Semiannual grab samples	Nitrate; metals, including uranium; and VOCs	MCLs
Zone 2/Zone 3 Boundary (Performance measurement for Zone 2)	Surface water	IP (BCK 9.2)	Quarterly grab samples (in year prior to FYR)	Metals, including total and isotopic uranium, and mercury; VOCs; and nitrate[f]	AWQC, risk-based[e]
			Continuous flow-proportional monitoring	Uranium (isotopic)	U flux ≤ 34 kg/yr
	Groundwater	GW-683, GW-684 (Picket A)	Semiannual grab samples	Metals, including uranium; nitrate	TBD[b] trend monitoring
Zone 3	Surface water	BCK 12.34	Quarterly grab samples (in year prior to FYR)	Metals, including Cd, Hg, and isotopic and total U (with an MDL of 0.004 mg/L); VOCs, nitrates[f]	AWQC, risk-based[e] – within five yrs, U ≤27kg/yr, Cd ≤0.25µg/L, Nitrates – 40% seasonal reduction, Nitrate trend
		NT-1	Quarterly grab samples (in year prior to FYR)	Metals, including total and isotopic uranium, and Cd; VOCs, and nitrate[f]	AWQC, risk-based[e]
		NT-2	Quarterly grab samples (in year prior to FYR)	Metals, VOCs, and nitrate[f]	AWQC, risk-based[e]
		NT-3	Quarterly grab samples (in year prior to FYR)	Metals, including mercury; VOCs[f]	AWQC, risk-based[e] – within five yrs; Hg ≤51 ng/L
		BCK 11.54	Quarterly grab samples (in year prior to FYR)	Metals, including total and isotopic uranium, and mercury; and nitrate[f]	AWQC, risk-based[e]
			Continuous flow-proportional monitoring	Uranium (isotopic)	U trend
		NT-8	Continuous flow-proportional monitoring	Uranium (isotopic)	Determine relative contribution of the BCBGs to uranium flux at BCK 9.2

Table 4.6. BCV watershed CERCLA performance monitoring (cont.)

Area/Site	Media	Monitoring location	Schedule	Parameters	Performance standard
Boneyard/Burnyard (BYBY)	Surface water	NT-3	Monthly grab samples with instantaneous flow measurement	Uranium (isotopic)	U flux ≤ 4.3 kg/yr
			Quarterly grab samples (in year prior to FYR)	Metals, including mercury; VOCs	AWQC Hg ≤ 51 ng/L
	Biota	NT-3	Annually (until recovery complete)	In-stream sampling of fish and benthic macroinvertebrate communities	Aquatic community data compared to data available for similar reference streams on the ORR
	Vegetation[h]	NT-3	Annually (until recovery complete)	Riparian recovery monitoring	Percent plant recovery, species diversity, stream vegetation overhang, percent shading, growth and survival of planted species compared to results of networks of similar riparian restoration sites monitored.
	Stream channel stability	NT-3	Recovery complete. Survey terminated 2009	Stream channel stability	Qualitative field measurements
S-3 Ponds Pathway 3[c]	Surface water	BCK 12.34	Weekly flow-proportional composite samples	Isotopic uranium and nitrate	U flux ≤ 27.2 kg/yr; Nitrate – 40% seasonal reduction
			Quarterly grab samples (in year prior to FYR)	Metals, including Cd	Cd ≤ 0.25 µg/L; AWQC – within five years
		NT-1	Quarterly grab samples	Metals, including Cd	Cd ≤ 0.25 µg/L
		NT-2	Weekly flow-proportional composite samples	Nitrate (flux)	Nitrate – 40% seasonal reduction in flux

Table 4.6. BCV watershed CERCLA performance monitoring (cont.)

Area/Site	Media	Monitoring location	Schedule	Parameters	Performance standard
S-3 Pathways 1 and 2[g]	Monitoring to evaluate the effectiveness of the treatment systems is discontinued.				
	Surface water	BCK 12.34	Weekly flow-proportional composite samples	Nitrate, uranium isotopes	No additional performance measures imposed with documentation of the treatment system shutdown.
		BCK 12.34	Quarterly grab samples (in year prior to FYR)	Metals, including total uranium and Hg	
		BCK 9.2	Continue weekly flow-proportional composite samples	Uranium isotopes	
	Biota	BCK 3.3 BCK 9.9 BCK 12.4	Continue biological monitoring as before P1 and P2 treatment system shutdown	Hg and PCBs[d]	Measure changes in quality of aquatic habitat as compared to reference sites.

[a]This table represents current requirements for monitoring that have been agreed upon by all FFA parties at the BCV Core Team Meeting held November 18, 2008. Currently recommended monitoring per this RER is not included on this table.

[b]Cleanup levels for groundwater are to be determined under future decisions for the BCV Watershed.

[c]RAs for the S-3 Pathway 3 have not been implemented; data are collected to establish a baseline against which performance of the action will be gauged.

[d]Correspondence from regulators (DOE 2007d) granting permission to shut down treatment system at S-3 Pathways 1&2 inadvertently included uranium as the parameter analyzed for the biota; however, the correct parameters should include mercury and PCBs. The correct parameters will be approved in the SAP/Quality Assurance Program Plan that will be submitted to the regulators for review and approval.

[e]RBC of 1×10^{-5} residential receptor for Zones 1 and 2 and industrial for Zone 3.

[f]Sampling will be conducted for COCs identified from the BCV RI for risk-based comparisons.

[g]Correspondence from regulators (DOE 2007d) granting permission to shut down treatment system at S-3 Pathways 1&2 requires continuation of monitoring at BCK 12.34, BCK 9.2, BCK 3.3, BCK 9.9, BCK 12.4, as indicated.

[h]Vegetation riparian survey has been recommended to be discontinued (see Table 4.15, Summary of BCV Watershed technical issues and recommendations).

BCV Phase I ROD includes uranium flux goals which include:

- ≤34 kg/yr at the BCK 9.2 IP,
- ≤27.2 kg/yr for S-3 Ponds discharge at BCK 12.34, and
- ≤4.3 kg/yr at the mouth of NT-3.

Additionally, AWQC for Zone 3 surface water results are compared to AWQC (during each FYR).

Effectiveness of RAs at the BYBY is measured by water quality in the NT-3 stream. Monitoring at Bear Creek main stream station Bear Creek kilometer (BCK) 11.54, downstream of NT-3 (see Table 4.6 and Figure 4.1), now performs as an upstream IP for the BCBGs.

BCV Phase I ROD requires BYBY to meet AWQC in surface water at NT-3 and that surface water risk to an industrial receptor is below 1×10^{-5}. During the FYR years, grab samples are collected, at a minimum, monthly from NT-3 and analyzed for mercury and uranium with semiannual grab samples for metals analysis. This RER includes the data collected in FY 2010 specifically for the 2011 FYR evaluations.

4.2.2.1.2 Surface Water Monitoring Results

The discussion of surface water results is presented in this section in sequence of land use zone. The monitoring emphasis is on measuring remediation related reductions of COCs that are indicative of potential exposure risk for future land users. The status of BCV Watershed-scale long-term CERCLA decision making is provided in Figure 1.5 of the 2007 RER (DOE 2007a).

Zone 1

Surface water results are compared to AWQC, and evaluated against the RBCs for residential exposure to surface water (1×10^{-5}) consistent with the unrestricted land use goals.

During FY 2010, AWQC samples were collected on a quarterly frequency at BCK 4.55 and further downstream (below Zone 1) at BCK 3.3. Sampling is also conducted at four springs in Zone 1 and these monitoring results are included in the Zone 1 groundwater discussion. The AWQC analytical suite includes analysis of metals, VOCs, semivolatile organic compounds (SVOCs), pesticides, PCBs, and dioxins/furans. Radionuclides are also analyzed to evaluate human health risk from site related uranium and ^{99}Tc.

No TDEC AWQC exceedances were measured in the Zone 1 surface water samples during FY 2010, although a number of site-related compounds were detected at very low levels. Lead and mercury were detected at both Zone 1 sampling locations at levels below criteria. No chlorinated VOCs were detected in Zone 1 surface water. Beta-BHC, a pesticide, was detected in one of three samples collected at BCK 3.3 but was not detected further upstream at BCK 4.55. Beta-BHC is also detected in surface waters affected by the S-3 Ponds plume and Bear Creek Burial Grounds discharges. These areas are discussed in the Zone 3 surface water discussion. Dioxin/furan compounds are detected at concentrations below the TDEC AWQC at BCK 3.3 and BCK 4.55. Like the detected metals, the dioxin/furan compounds are also detected in discharges from the S-3 Ponds plume and the BCBGs.

Technetium-99 was detected at both BCK 3.3 and BCK 4.55 in the December 2009 sample at 12.6 and 9.44 pCi/L, respectively. These activities are approximately 1% of the MCL effective dose equivalent for ^{99}Tc. Total uranium levels were less than the 30 µg/L primary drinking water limit in Zone 1 surface water during FY 2010.

Zone 2

During FY 2010, surface water monitoring was conducted at two locations in Zone 2 – BCK 9.2, where upstream flow from Zone 3 source areas enters Zone 2; and BCK 7.87, near the downstream end of the Zone 2 reach of Bear Creek. The BCK 9.2 sample location serves a dual function. It is used to assess both the water quality in Zone 2 because this location measures water quality of the inflowing stream, and it serves as the IP for surface water being discharged from sources in Zone 3.

Uranium isotopes measured at BCK 9.2 represent those constituents as they migrate from Zone 3 into Zone 2. The FY 2010 average activities of ^{234}U, ^{235}U, and ^{238}U were **7.9**, 0.75, and **17.0** pCi/L, respectively. The values for ^{234}U and ^{238}U exceeded the RBCs of 7.5 and 6.1 pCi/L <http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search>, respectively. These RBC goals are equivalent to the ROD hypothetical residential exposure goal of a 1 x 10^{-5} ELCR attributable to the uranium isotopes. Table 4.7 and Figure 4.3 present the historic average activity of isotopes of uranium and concentration of nitrate since the ROD was implemented. Over the period of monitoring, ^{235}U has been less than the 6.6 pCi/L RBC in Zone 2. Additional discussion of contaminant transport from Zone 3 into Zone 2 is presented below.

Table 4.7. Historic average activity of uranium isotopes and concentration of nitrate at the IP (BCK 9.2)

FY	Uranium 234 pCi/L	Uranium 235 pCi/L	Uranium 238 pCi/L	Nitrate mg/L	Average ORR rainfall[a]
RBC[b]	6.7	6.6	5.5	58	-
2001	**13.7**	0.7	**28.5**	9.9	45.9
2002	**12.4**	0.8	**24.8**	12.9	52.7
2003	**9.4**	1.2	**18.4**	11.1	73.7
2004	**8.5**	1.1	**17.7**	8.4	56.4
2005	**7.3**	0.7	**15.9**	6.6	58.9
2006	**9.9**	0.9	**21.3**	9.8	46.4
2007	**8.8**	0.9	**18.8**	-	36.8
2008	**9.1**	0.9	**21.0**	-	49.3
2009	**8.8**	0.8	**21.6**	4.8	62.5
2010	**7.9**	0.8	**17.0**	5.9	55.8

Bold values indicate the RBC goal is exceeded.

[a]Average rainfall in inches for rain gauges at Y-12, ETTP, ORNL, and DOE town site.
[b]RBC from EPA, regional screening tables <http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm>, <http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search>.

Nitrate concentrations measured at BCK 9.2 since ROD approval are compared to the RBC. Since FY 2000 the nitrate concentrations in surface water at the IP (BCK 9.47 prior to FY 2006 and BCK 9.2 thereafter) have not exceeded the residential drinking water non-carcinogenic HI level of 58 mg/L <http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm>. Since FY 2003, the average nitrate concentrations measured at BCK 9.2 have been below the 10 mg/L MCL. The principal source of nitrate contamination is legacy disposal of acid liquids in the S-3 Ponds in the headwaters of Bear Creek. Nitrate has been monitored historically at a number of locations in BCV. Concentrations are highest near the S-3 source and decrease with distance downstream to the west. Table 4.7 shows the average concentration of nitrate at BCK 9.2 for years since the ROD was implemented. Figure 4.3 shows the average nitrate concentration in surface water at BCK 9.2 along with the annual average ORR rainfall.

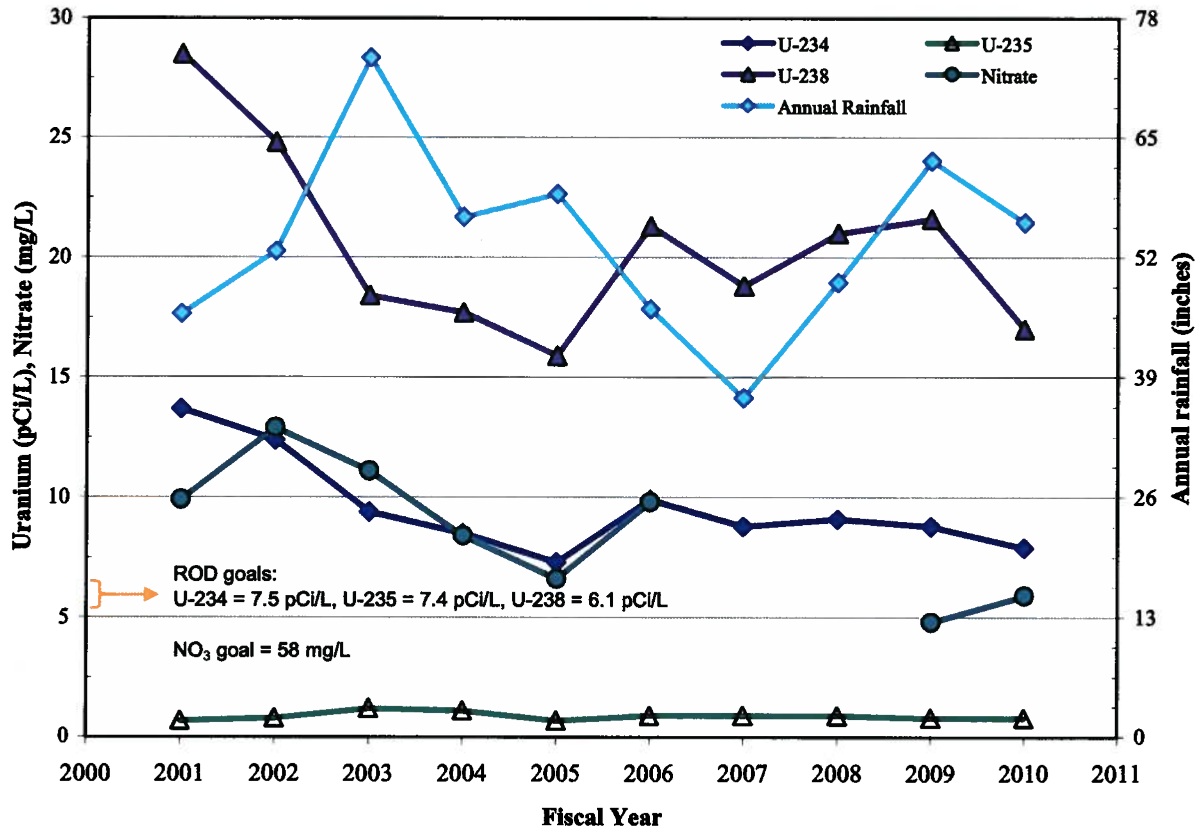


Figure 4.3. Average annual uranium isotope activity, nitrate concentration at BCK 9.2, and annual rainfall.

AWQC monitoring was conducted at the two Zone 2 surface water monitoring locations quarterly during FY 2010 to support the CERCLA FYR. The AWQC analytical suite includes analysis of metals, VOCs, SVOCs, pesticides, PCBs, and dioxins/furans. Radionuclides are also analyzed to evaluate human health risk from site related uranium and ^{99}Tc. No TDEC AWQC parameter exceedances were measured in the Zone 2 surface water samples during FY 2010 although a number of site-related compounds were detected at very low levels.

Cadmium was detected at both BCK 7.87 and BCK 9.2 at least once during the year; however, the maximum detected concentrations were below the TDEC AWQC. Copper was detected once at BCK 9.2 at a concentration of 7.1 μg/L which is less than the current TDEC AWQC of 9 μg/L for protection of fish and aquatic life. Lead was detected once at BCK 7.87 at an estimated concentration of 0.27 μg/L, well below current TDEC criterion concentration of 2.5 μg/L for protection of fish and aquatic life. Mercury was detected in all the samples collected at the two Zone 2 monitoring locations at very low concentrations. Mercury was sampled four times at BCK 7.87 and six times at BCK 9.2 because the latter station is included in a semiannual mercury snapshot sampling suite that tracks mercury concentrations in various parts of the Bear Creek watershed. The maximum measured mercury concentration in Zone 2 surface water was 11.9 ng/L, which is less than the 51 ng/L criterion for recreational protection. Zinc was detected in one sample from BCK 7.87 at a concentration of 2.7 μg/L, much less than the 120 μg/L TDEC AWQC criterion for protection of fish and aquatic life.

At BCK 9.2, the chlorinated VOCs, PCE and TCE, and their degradation product, cis-1,2-DCE, were detected at low concentrations. PCE was detected twice at concentrations of 1.3 and 1.2 µg/L, TCE was detected twice at concentrations of 1.5 and 1.2 µg/L, and cis-1,2-DCE was also detected three times at concentrations of 7, 6.6, and 1.1 µg/L. At BCK 7.87 cis-1,2-DCE was detected once at a concentration of 1.2 µg/L. All of these detected concentrations are less than the respective AWQC. Two pesticides were detected in Zone 2 surface water – alpha-BHC and beta-BHC. The beta-BHC was detected twice at both locations at concentrations much lower than the AWQC and the alpha-BHC was detected once at BCK 9.2 at a level much lower than its AWQC. Analyses for dioxin/furan compounds in Zone 2 surface water showed the possible presence of very low concentrations of these compounds. Concentrations were below the TDEC AWQC.

Technetium-99 was detected in all the quarterly samples collected at the Zone 2 surface water locations. The measured activities ranged from 19.5 to 36.2 pCi/L with an average of about 27 pCi/L. This average activity is approximately 3% of the 900 pCi/L MCL effective dose equivalent based on a 4 mrem annual dose from drinking the water.

Zone 3

During FY 2010, surface water monitoring in Zone 3 included the ongoing monitoring of uranium flux at several locations, nitrate concentration monitoring near the S-3 Ponds area and at the BCK 9.2 IP, and AWQC monitoring. The AWQC monitoring is conducted to support the CERCLA FYR and results are summarized toward the end of this section.

Surface water monitoring includes sampling at the IP (BCK 9.2) and intermediate monitoring stations, including tributary monitoring of specific RA areas. Two key metrics were identified in the Phase I ROD for effectiveness of RAs in Zone 3—reduction of risk levels and uranium flux at the IP (BCK 9.2) to 34 kg/yr, and reduction of the uranium flux at BCK 12.34 to 27.2 kg/yr. As previously discussed, ^{234}U and ^{238}U activities at BCK 9.2 consistently exceed the RBC.

The post-ROD history of measured uranium fluxes at BCK 9.2 and BCK 12.34, along with annual rainfall, are summarized in Table 4.8 and Figure 4.4. The watershed flux goal (≤34 kg/yr) for the Zone 3 IP was not met in FY 2010 based on the 118.9 kg of uranium computed at BCK 9.2. The 2010 uranium flux at BCK 12.34 was 33.9 kg which is more than the flux goal of 27.2 kg/yr. Continuous, flow-paced sampling to measure the uranium flux at NT-3 was resumed in FY 2010 in response to the observation of increasing uranium concentrations. During FY 2010, a uranium flux of 14.5 kg was measured at the mouth of NT-3. This uranium discharge exceeds the 4 kg/yr flux goal for the stream following remediation of the BYBY. Additional discussion of the NT-3 uranium discharge is provided later in this section.

Review of Figure 4.4 shows the relationship between rainfall and total uranium flux at BCK 9.2 and BCK 12.34. The amount of uranium that is mobilized from buried waste sources and residual groundwater contamination in the S-3 Pond area depends on the amount of rainfall that occurs. Increased rainfall causes increased groundwater recharge, more leachate formation, higher groundwater levels, and more contaminant transport from buried/below-grade sources to the streams. The relationship between annual rainfall and annual uranium fluxes measured at BCK 9.2 and BCK 12.34 is strongly linear during the post-ROD monitoring period as demonstrated in Figure 4.5. The higher mass flux and the greater positive slope of the trend at BCK 9.2 than at BCK 12.34 reflects the presence of a significant uranium source that enters Bear Creek between the two stations. During FY 2007, data collection indicated that NT-8 was a significant contributor of uranium to Bear Creek, and during FY 2010 continuous flow-paced monitoring of NT-8 documented that about 61 kg of uranium was discharged directly to Bear Creek (Table 4.8).

Table 4.8. Uranium flux[a] at flow-paced monitoring locations in BCV

FY	BCK 9.2	SS-5	NT-8	BCK 11.54	NT-3	BCK 12.34	Average rainfall[b]
ROD Goal	34	–	–	–	4.3	27.2	–
2001	**88.7**	17.2	–	–	**79.9**	24.5	45.9
2002	**120.2**	13.1	–	158.2	**62.8**	25.4	52.7
2003	**165.4**	12.3	–	87.0	**4.6**	**44.3**	73.7
2004	**115.0**	9.5	–	45.8	1.2	**27.3**	56.4
2005	**115.4**	11.1	–	39.8	4.1	**40.3**	58.9
2006	**68.5**	–	–	25.2	1.7	21.3	46.4
2007	**59.5**	–	–	12.6	--[c]	15.8	36.8
2008	**73.2**	–	27.9	15.9	--[c]	23.0	49.3
2009	**147.7**	11.6	43.3[d]	27.2	--[c]	**32.9**	62.5
2010	**118.9**	9.9	61.0	32.5	**14.5**	**33.9**	55.8

Bold values indicate the Phase I ROD goal for uranium flux has not been met.

[a]All flux values are kilograms of uranium/year.

[b]Average rainfall in inches for rain gauges at Y-12, ETTP, ORNL, and DOE town site.

[c]Goal attained; flux monitoring discontinued FY 2007. Reinstituted in FY 2010.

[d]Uranium isotope mass balancing at BCK 9.2 suggests NT-8 contributed about 60 kg in FY 2009. Approximately 17 kg infiltrated into karst seepage pathways upstream of the NT-8 flume.

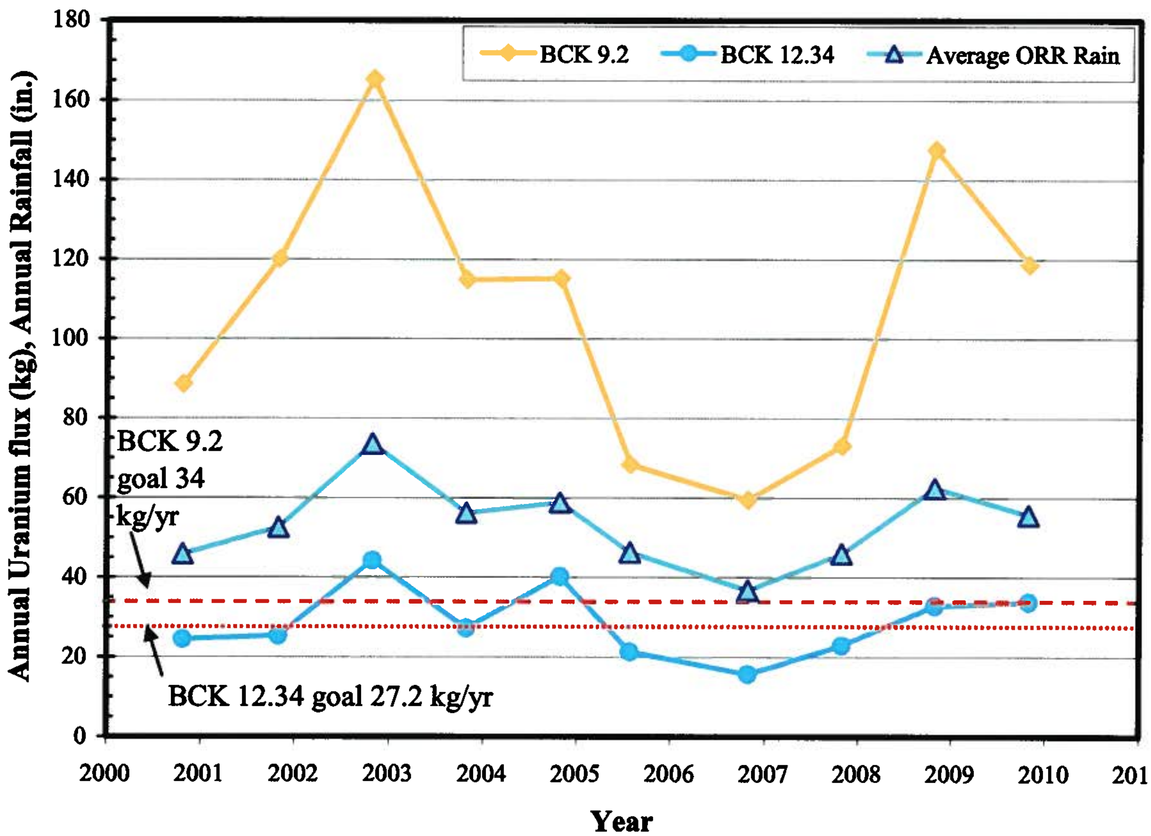


Figure 4.4. Post-ROD uranium flux at BCK 9.2 and BCK 12.34 and annual rainfall at the ORR.

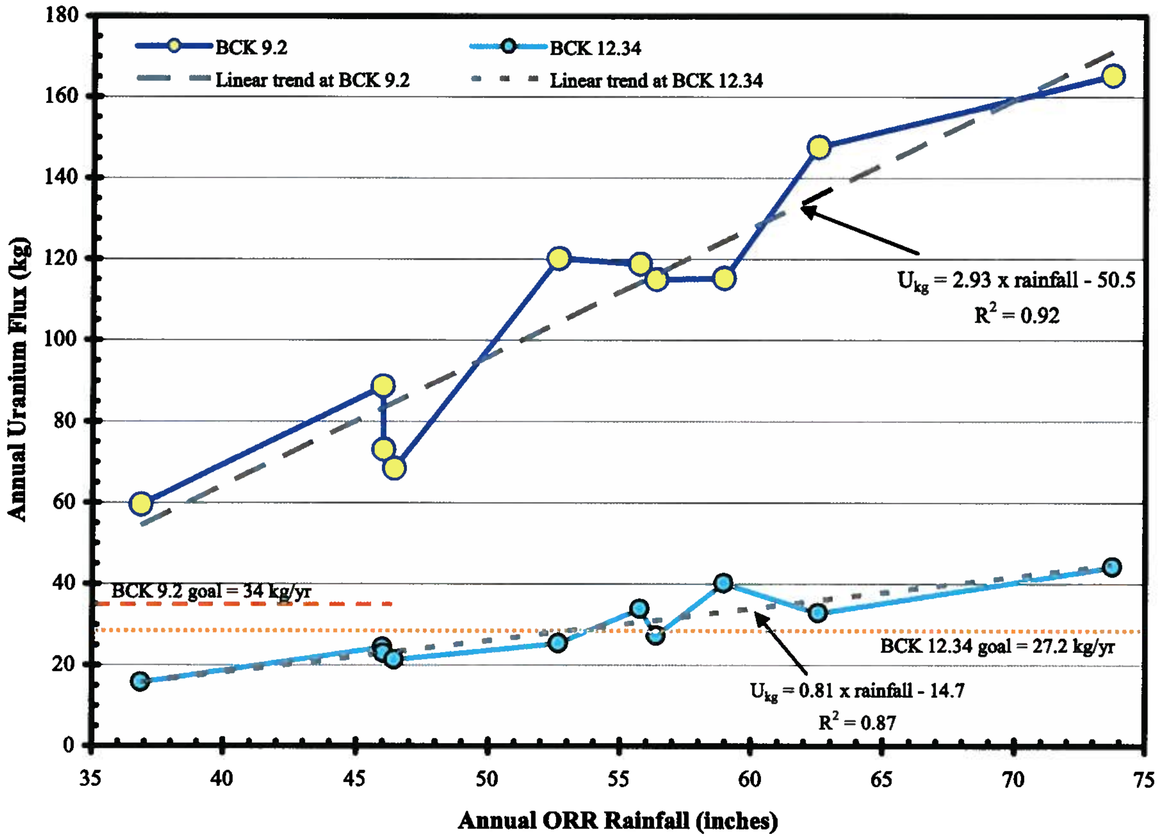


Figure 4.5. Average annual rainfall vs. annual uranium flux at BCK 9.2 and BCK 12.34.

Because of the levels of uranium, VOCs, and PCBs that discharge from NT-8 into Bear Creek, two lines of investigation of the sources will be conducted. First, to identify points of entry of contaminants into the stream, surface water samples will be collected and analyzed for uranium, VOCs, and PCBs along a transect from the NT-8 flume upstream to the BCBGs fence. In addition, engineering design and operational records for the non-CERCLA groundwater seepage collection system in the NT-8 headwaters associated with BCBGs D-West will be reviewed and the system performance will be evaluated to determine if system maintenance or modification could improve the capture of contaminants in an existing system.

Estimates were made of the uranium contributions from NT-5, and NT-7. These estimates suggest that NT-5 and NT-7 may have contributed approximately 2 kg of uranium each during FY 2010.

Including all directly measured and estimated uranium sources contributing to the stream, the mass balance of uranium in the Bear Creek system during FY 2010 shows that about 119.2 kg of uranium were measured or estimated to enter Bear Creek in Zone 3 and 118.9 kg of uranium were measured discharging from Zone 3 at BCK 9.2. These data indicate a mass balance difference of only 1% for the measure/estimated inputs and the measured discharge during FY 2010.

Within Zone 3, industrial exposure scenario comparisons were applicable since the ROD remediation goal for that area is controlled industrial use. At BCK 12.34, near the S-3 Ponds, the average ^{234}U, ^{235}U, and ^{238}U activities were about 19, 2, and 38 pCi/L, respectively. These results are based on analysis of continuous, flow-paced composite samples. The average activity level for ^{234}U met the industrial RBC goal of about 23 pCi/L. The activity level for ^{238}U exceeded the industrial RBC of about 18 pCi/L <http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search>, using exposure duration of 250 days/year, exposure frequency of 25 years and 1 L/d ingestion rate. The ^{235}U has been less than the 22 pCi/L industrial exposure goal since the ROD was implemented.

Nitrate and cadmium are also key COCs in surface water in BCV. The principal source of nitrate contamination is legacy disposal of acid liquids in the S-3 Ponds, which created nitrate plumes in groundwater that discharge in the headwaters of Bear Creek. Nitrate has been monitored historically at a number of locations in BCV. Concentrations are highest near the S-3 source and decrease with distance to the west and downstream. As stated previously, Zone 3 is designated for industrial land use. The preliminary remediation goal (PRG) for nitrate in an industrial land use scenario is 160 mg/L. Figure 4.6 shows the average nitrate concentration in surface water at BCK 12.34, along with the annual average ORR rainfall. The tendency for dilution of the nitrate concentrations during years of elevated rainfall is apparent in the graph with the mirror relationship between increased rainfall and decreased nitrate concentration. During FY 2010, the average nitrate concentration was 35 mg/L based on 52 weekly grab sample results. None of the grab samples collected during FY 2010 exceeded the PRG for nitrate. During the below average rainfall conditions of FY 2007 and 2008, the nitrate PRG was occasionally exceeded because of the absence of upstream runoff that dilutes groundwater seepage into NT-1 near the S-3 Ponds site.

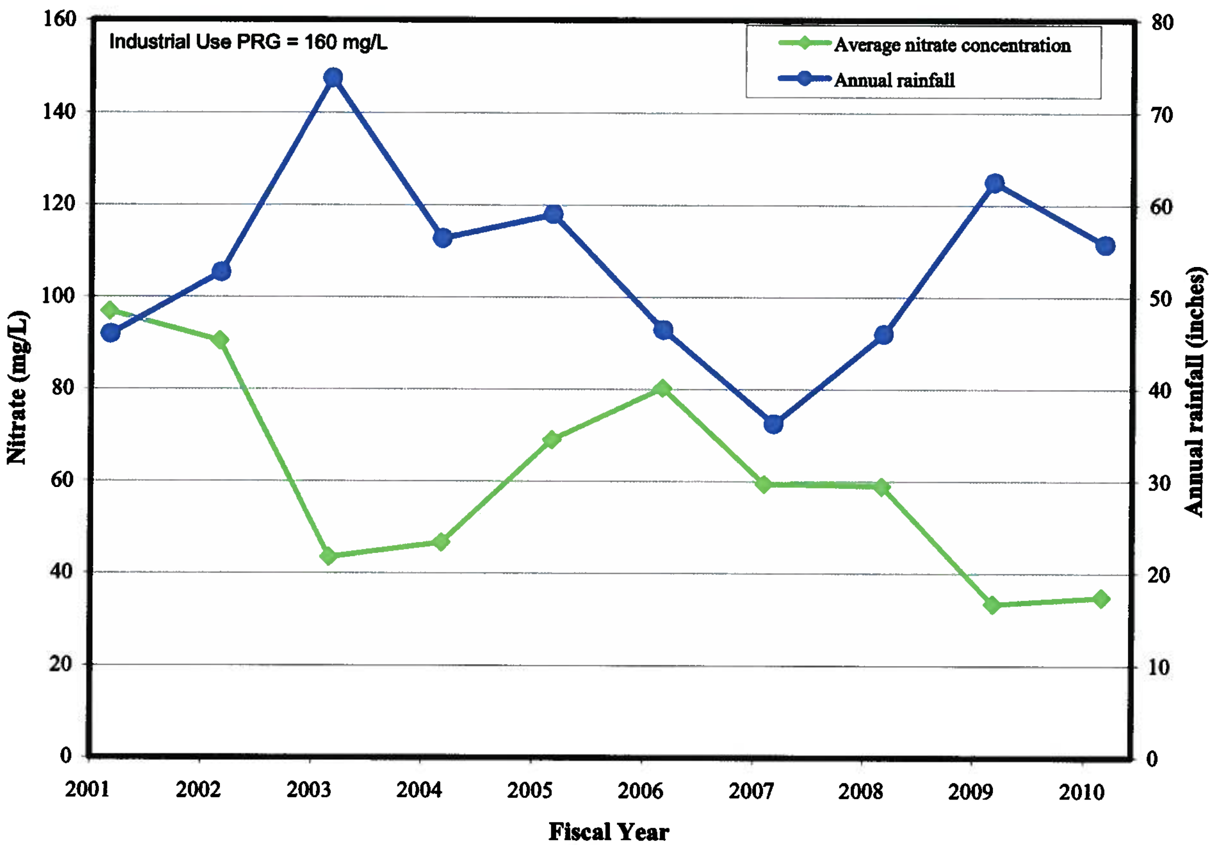


Figure 4.6. BCK 12.34 average nitrate concentration and annual ORR rainfall.

The principal source of cadmium is also disposed liquids from the S-3 ponds area. Cadmium concentrations in the Bear Creek headwaters continuously exceed the 0.25 µg/L AWQC in samples from the NT-01 and BCK 12.34 sampling locations. Samples obtained at BCK 12.34 during FY 2010 contained an average of 3.2 µg/L cadmium with a maximum measured concentration of 7 µg/L, which is a slight decrease from FY 2009 levels. Sampling data at the downstream IP for Zone 3, BCK 9.2 suggest that cadmium meets the AWQC before the stream enters Zone 2.

BYBY

Effectiveness of RAs at the BYBY is measured by water quality in the NT-3 stream (see tables 4.4 and 4.6, and Figure 4.1). In addition to surface water monitoring at the BYBY, the PCCR (DOE 2003d) specifies monitoring of benthic macroinvertebrate and fish communities in NT-3 and riparian vegetation monitoring of the restored channel. Stream channel stability monitoring along NT-3 is no longer conducted. Benthic macroinvertebrate and fish community monitoring are presented in Sect. 4.2.2.3 along with a discussion of riparian vegetation monitoring along NT-3.

The remediation goal for the BYBY excavation was to attain a flux of less than 4.3 kg/yr uranium from NT-3. The flux reduction goal was met and confirmed with sustained flux reduction in all years since the RA was completed in 2002 until recently. Regulatory approval to discontinue flow paced composite sampling at NT-3 and replace with monthly grab samples for uranium was granted in April 2007. Collection of grab samples on a monthly frequency continued except during prolonged dry weather when the stream is dry at the sampling station. Uranium activity levels gradually increased in FY 2007 through FY 2009 and flow-paced sampling was restarted at the beginning of FY 2010 to obtain reliable uranium flux data consistent with the recommendation in the 2010 RER.

Immediately following BYBY remediation, uranium activities in NT-3 decreased significantly and uranium isotope ratios also changed. Table 4.9 is a tabulation of annual average activities of ^{234}U and ^{238}U measured in NT-3. BYBY remediation was completed in summer of 2002 and the FY 2002 and 2003 uranium activities show the rapid decrease following remediation. An increase in uranium activities from 2004 through 2009 is apparent.

Table 4.9. Annual average ^{234}U and ^{238}U activities at NT-3

Year	Average ^{234}U (pCi/L)	Average ^{238}U (pCi/L)	Average $^{238}U/^{234}U$ ratio	Comments
FY 1999	208	450	2.16	
FY 2000	230	514	2.24	
FY 2001	196	476	2.43	
FY 2002	135	292	2.15	BYBY remediation completed
FY 2003	14	14	1.02	Continuous sampling
FY 2004	7	6	0.85	Continuous sampling
FY 2005	13	14	1.06	Continuous sampling
FY 2006	17	16	0.93	Continuous sampling
FY 2007	46	42	0.91	Continuous sampling
FY 2008	41	39	0.94	Monthly grab sampling
FY 2009	42	40	0.94	Monthly grab sampling
FY 2010	24	23	0.96	Continuous sampling resumed

NT-3 surface water uranium isotope ratios were examined to evaluate the significance of this increase with regard to the BYBY remedy. The data summary in Table 4.9 shows that along with the reduction in total uranium activity in NT-3 following remediation, there was also a shift in the $^{238}U/^{234}U$ ratio. The $^{238}U/^{234}U$ decreased from average values of 2 to 3 (indicative of a depleted uranium source having a high fraction of ^{238}U) downward to average values near 1. Along with the initial shift in $^{238}U/^{234}U$ ratio, the

^{235}U activities decreased to very low to undetectable levels. However, as uranium activities increased in 2007 the ^{235}U activities increased again as well. The $^{234}U/^{235}U$ ratios observed since 2007 suggest that the recurrent uranium discharge originates from a depleted uranium source having a different isotopic signature than the remediated BYBY source. These isotopic shifts in the NT-3 surface water suggest that the BYBY source contained isotopically depleted uranium and the increases in uranium activity observed starting in FY 2007 are related to a different contaminant source As shown on Figure 4.7, two other waste disposal units remain in the NT-3 watershed – the Hazardous Chemical Disposal Area (HCDA) and the Unit 6 Landfill. The uranium being measured in NT-3 surface water may be indicative of releases from one or both of these areas.

In March 2010 surface water samples were collected at several locations in NT-3 to measure the uranium isotopic composition, nitrate, ^{99}Tc, and VOCs. Nitrate and ^{99}Tc are both associated with portions of the S-3 Ponds plume that is known to discharge into NT-01 and NT-02. The sample locations are shown on Figure 4.7. The sample collected furthest upstream (NT3-1E) did not contain measureable uranium, nitrate, ^{99}Tc, or VOCs. Samples at NT3-1A, C, and D all contained measurable uranium (20 – 25 pCi/L ^{234}U and ^{238}U in NT3-1A and D) and the sample collected at NT3-1D contained a trace of nitrate (0.011 mg/L). Uranium isotopic ratios for the grab samples were consistent with those measured at the NT-3 integration point sampling. No ^{99}Tc or VOCs were detected in these samples. The sample from NT3-1B was collected about three weeks after the previous samples because the selected location was dry on the date of the first sampling visit. The NT3-1B sample contained much higher uranium (^{234}U = 143 pCi/L and ^{238}U = 106 pCi/L), nitrate at 0.048 mg/L, and also contained cis-1,2-DCE and TCE at 21 and 1.2 µg/L, respectively. The VOCs are thought to be associated with contamination at the HCDA. The uranium in the NT3-1B sample is also associated with a local source area based on dissimilarity in the uranium isotope ratio to that measured in the Bear Creek headwater area near the S-3 Pond plume.

Pesticides and PCBs were detected at several locations during FY 2010. Aldrin was detected above its criterion for organism protection in one of four samples at NT-01 and heptachlor was detected above its criterion in one of four samples collected at BCK 12.34 and NT-3. PCB contamination of surface water was significant at NT-8 with PCB-1248 exceeding the criterion in two of nine samples, PCB-1254 exceeding the criterion in one of eight samples, and PCB-1260 exceeding criterion in seven of eight samples. PCB-1248 was detected in the range of 0.08 – 0.2 µg/L, PCB-1254 was detected once at 0.13 µg/L, and PCB-1260 was detected in the range of 0.03 to 0.04 µg/L. The AWQC limit for total PCB is 0.00064 µg/L.

Analyses for dioxins and furans suggested the presence of these compounds in surface water in Zone 3. Most of the results of analyses were non-detect values with some estimated very low concentration results reported for others. Low levels of dioxins and furans are fairly ubiquitous in the environment since these compounds are dispersed in the environment from various combustion sources. From the surface water data obtained in BCV it is not clear that significant sources of dioxin/furans are affecting Bear Creek or its tributaries. The AWQC method for determination of a criterion exceedance includes use of TEFs that adjust detected concentrations based on constituent toxicity. The summation of adjusted concentrations in the BCV dataset did not show that total dioxin exceedances (the sum of regulated dioxin and furan compounds) were detected in Zone 3 surface water during FY 2010.

The BCV ROD also requires that AWQC in surface water be met in NT-3. AWQC goals for NT-3 have been achieved through the BYBY RA. Along with the other monitoring changes discussed above for NT-3, regulatory approval was granted in correspondence from EPA and TDEC to reduce frequency of AWQC monitoring at NT-3 to every five years corresponding to the FYR. This monitoring was conducted in FY 2010 and will be reported in the 2011 FYR.

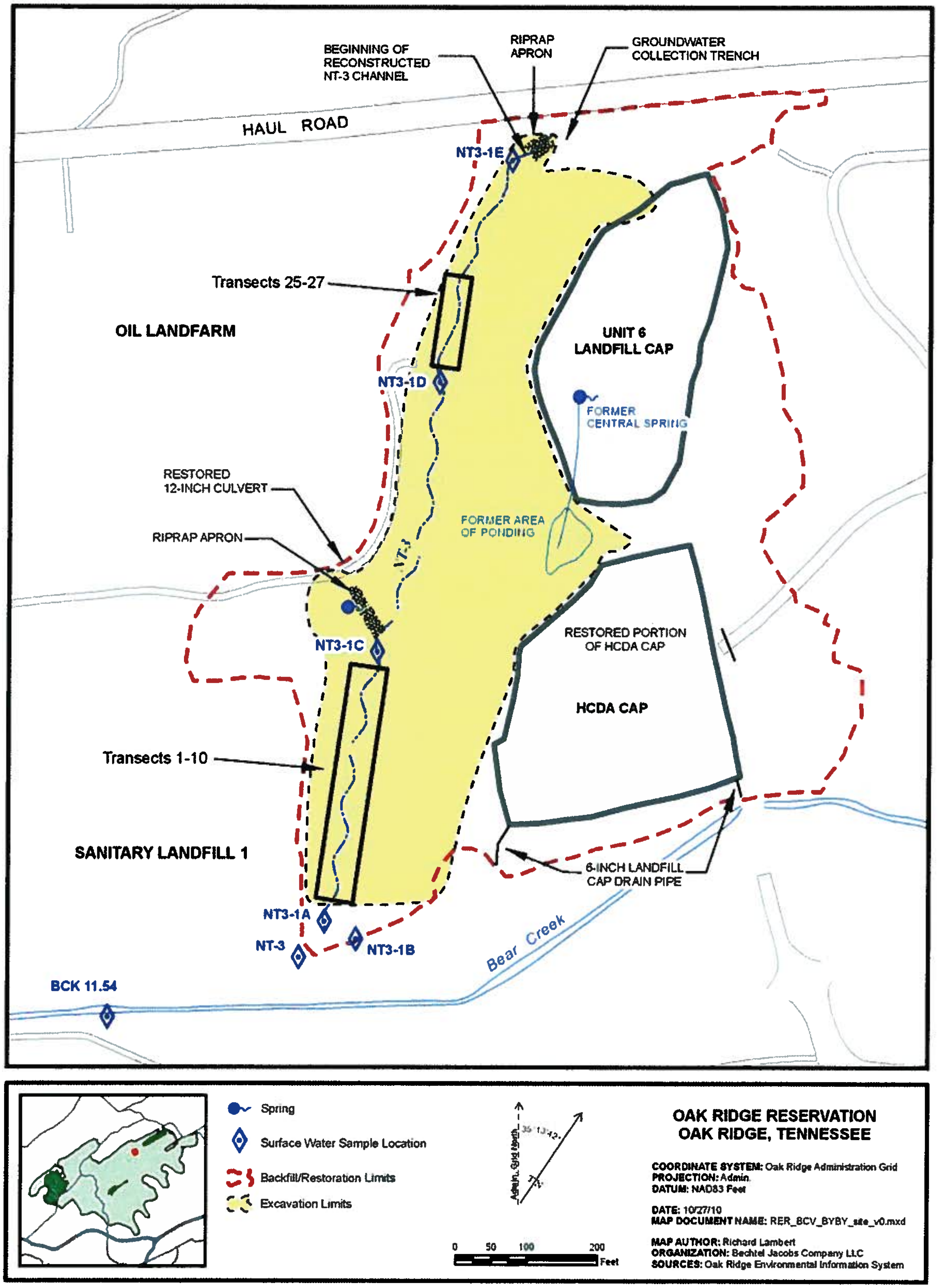


Figure 4.7. Location of Boneyard/Burnyard site and monitoring locations.

Zone 3 AWQC Monitoring

Ambient water quality parameter sampling was conducted on a quarterly frequency at eight locations in Zone 3 during FY 2010. Sampling locations include, from headwaters to downstream boundary of Zone 3: NT-1, BCK 12.34, BCK 11.84, NT3, BCK 11.54, NT7, SS-5, and NT8. AWQC monitoring results for BCK 9.2 were discussed in a preceding section of this report. Table 4.10 lists AWQC criteria that were exceeded one or more times in the Zone 3 surface water during FY 2010.

Metals contamination dominates the AWQC exceedance list in the eastern (upstream) portion of Zone 3 and these contaminants originate from the S-3 Ponds plume. Cadmium exceeded the AWQC criterion in all samples collected at stations NT-01 and BCK 12.34 and also exceeded the criterion in two of the four quarterly samples collected at BCK 11.84 and BCK 11.54. Mercury exceeded the criterion in one of four samples collected at NT-01 but no other stations exceeded the mercury criterion in any of the sampling events. Nickel exceeded the criterion in 2 of 12 metals samples collected at NT-01 and selenium exceeded the criterion in one of the 12 samples. Thallium was detected at levels exceeding the criterion in 2 of 17 metals analyses at BCK 12.34.

Chlorinated VOCs that exceeded their criteria for water and organisms protection included PCE from the S-3 Ponds plume at NT-01 and PCE from the BCBGs in NT-7 and NT-8.

No semivolatile compound AWQC exceedances were noted in BCV Zone 3 during FY 2010.

4.2.2.2 Groundwater Monitoring

RAOs for the BCV ROD, provided in Sect. 4.2.1, include "*protect future residential users of the valley in Zone 1 from risks from exposure to groundwater...*" Groundwater quality goals for each zone are described in Table 4.3, and Table 4.6 includes the BCV watershed CERCLA performance monitoring requirements that fulfill these objectives. Groundwater sampling locations are shown on Figure 4.8 At a minimum, wells GW-712, -713, and -714 (Picket W), located in the western portion of the valley at the Zone1/Zone 2 boundary, are monitored semiannually for nitrate; metals, including uranium; and VOCs. These three wells sample groundwater from the Maynardville Limestone. Wells GW-683 and GW-684 (Picket A) are located near the boundary of Zones 2 and 3 and are monitored semiannually for metals, including uranium, and nitrate. MCLs are used in Zone 1 as the screening criteria and concentration trends are used elsewhere to evaluate performance.

Zone 1

During 2010, groundwater monitoring in Zone 1 included sampling of four springs (SS-6, SS-6.6, SS-7, and SS-8) and three monitoring wells (GW-712, GW-713, and GW-714) located near the boundary with Zone 2. Well GW-712 is about 458 ft deep. VOCs have never been detected in well GW-712. Table 4.11 includes results of nitrate analyses for wells GW-712, GW-713, and GW-714 from FY 2000 through FY 2010. Nitrate has been intermittently detected in GW-712 at low (less than 1.4 mg/L) to trace concentrations and nitrate was detected at 0.018 mg/L in FY 2010. Uranium isotopes have been intermittently detected (maximum of 1.87 pCi/L ^{234}U in FY 2003); however, no uranium isotopes were detected in well GW-712 in FY 2010.

Table 4.10. AWQC parameter exceedance summary for BCV Zone 3 surface water in FY 2010

	Metals					VOCs	SVOCs	PCBs					Dioxin/ furans
Station	**Cd (0.25)**	**Hg (51 ng/L)**	**Ni (52)**	**Se (5)**	**Tl (0.47)**	**PCE (33)**		**Aldrin (0.0005)**	**Heptachlor (0.00079)**	**PCB-1248[a]**	**PCB-1254[a]**	**PCB-1260[a]**	--
NT-01	12/12 **(89.6)**	1/4 **(55.7)**	2/12 **(267)**	1/12 **(5.5)**	--	4/4 **(84)**	--	1/4 **(0.00225)**	--	--	--	--	--
BCK 12.34	17/17 **(7)**	--	--	--	2/17 **(2.5)**	--	--	--	1/4 **(0.001)**	--	--	--	--
BCK 11.84	2/4 **(2)**	--	--	--	--	--	--	--	--	--	--	--	--
NT-3	--	--	--	--	--	--	--	--	1/4 **(0.00405)**	--	--	--	--
BCK 11.54	2/4 **(0.82)**	--	--	--	--	--	--	--	--	--	--	--	--
NT-7	--	--	--	--	--	½ **(35)**	--	--	--	--	--	--	--
SS-5	--	--	--	--	--		--	--	--	--	--	--	--
NT-8	--	--	--	--	--	3/4 **(26)**	--	--	--	2/9 **(0.207)**	1/8 **(0.132)**	7/8 **(0.0823)**	--

All values in µg/L except Hg.
Criterion values shown in parentheses in column headers. Number of samples exceeding criterion shown per total number of samples per station. Maximum detected values exceeding criteria denoted in bold text

[a] Total PCB limit is 0.00064 ug/L.

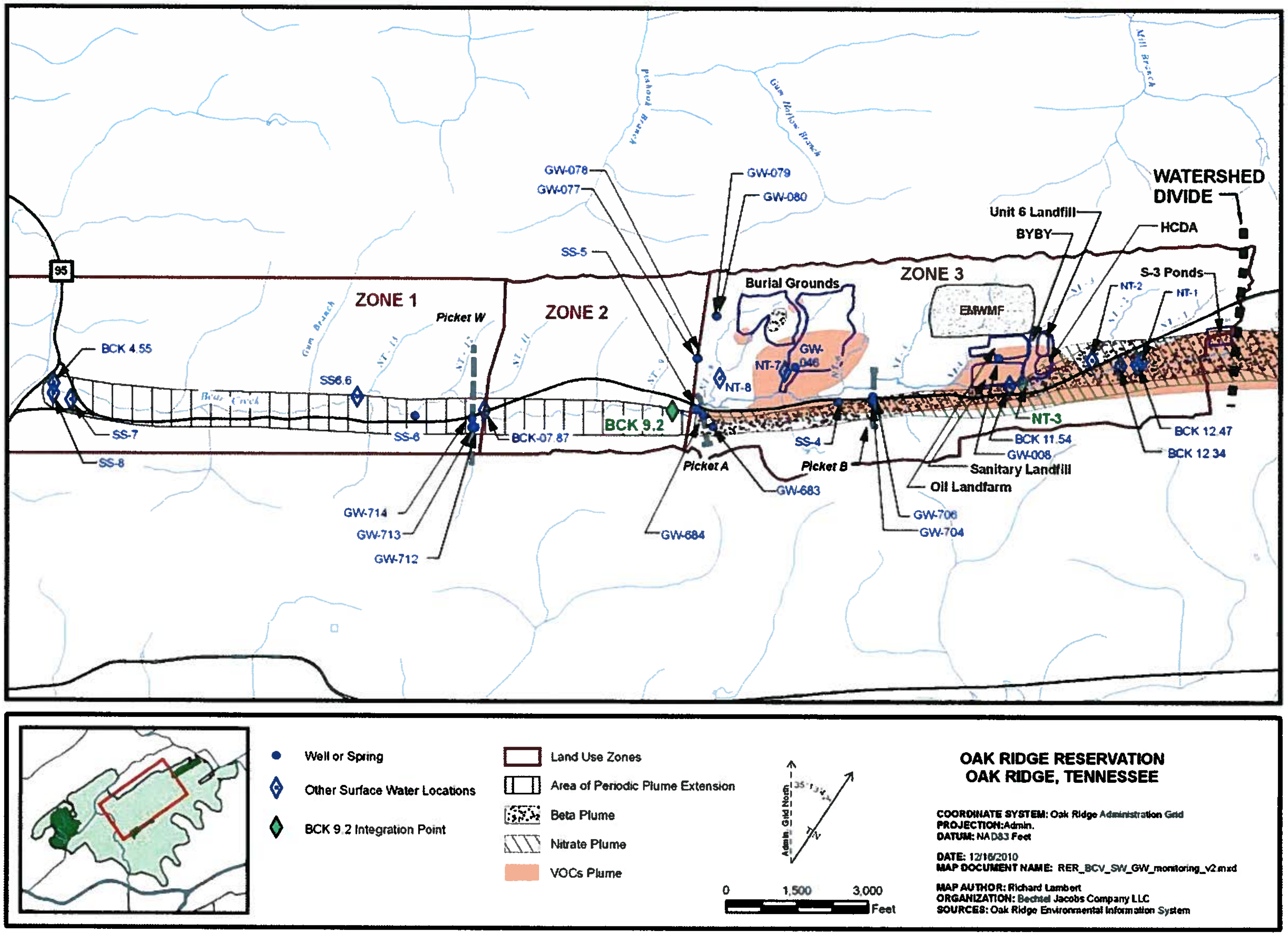


Figure 4.8. BCV Land Use Zones and surface water and groundwater monitoring locations.

Table 4.11. Nitrate concentrations measured in wells GW-712, GW-713, and GW-714[a]

GW-712 (458 ft deep)			GW-713 (314 ft deep)			GW-714 (145 ft deep)[b]	
Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)
1/10/2000	0.02		1/6/2000	0.67		1/5/2000	0.46
7/10/2000	1.4		7/10/2000	1.3		7/11/2000	4
1/2/2001	0.03		1/3/2001	0.33		1/2/2001	3.7
7/2/2001	0.02	U	7/10/2001	0.061		7/2/2001	1.8
1/3/2002	0.02	U	1/3/2002	0.02	U	1/2/2002	1.6
7/1/2002	0.034		7/1/2002	0.02	U	7/1/2002	1.7
1/6/2003	0.13		1/6/2003	0.16		1/6/2003	1.6
7/7/2003	0.22		7/7/2003	0.2		7/7/2003	1.3
1/6/2004	0.02	U	1/5/2004	0.02	U	1/5/2004	1.1
7/7/2004	0.02	U	7/7/2004	0.02	U	7/7/2004	0.78
1/10/2005	0.094		1/10/2005	0.02	U	1/10/2005	0.67
7/6/2005	0.021		7/7/2005	0.02	U	7/6/2005	0.56
1/3/2006	0.02	U	1/3/2006	0.02	U	1/3/2006	0.52
7/5/2006	0.02	U	7/5/2006	0.02	U	7/5/2006	0.42
1/2/2007	0.02	U	1/2/2007	0.02	U	1/2/2007	0.36
7/2/2007	0.02	U	7/3/2007	0.02	U	7/2/2007	0.24
1/2/2008	0.02	U	1/2/2008	0.02	U	1/2/2008	0.19
7/1/2008	0.02	U	7/7/2008	0.02	U	7/1/2008	0.22
1/7/2009	0.052		1/7/2009	0.028		1/6/2009	0.24
7/6/2009	0.01	U	7/7/2009	0.01		7/6/2009	0.34
1/5/2010	0.018		1/4/2010	0.015		1/5/2010	0.55
7/21/2010	0.01	U	7/19/2010	0.01	U	7/19/2010	0.36

[a]EPA drinking water MCL is 10 mg/L.
[b]Note nitrate detected at specified levels at all dates in this well.

Well GW-713 is about 315 ft deep. Well GW-713 has experienced periodic trace-to-low (maximum 14 μg/L) concentrations of PCE, TCE, 1,1,1-TCA, and 1,2-DCE, although no VOCs were detected in FY 2010. In the mid-1990s and in FY 2000, GW-713 experienced nitrate concentrations of about 1.3 mg/L. Nitrate has been detected intermittently at concentrations less than 1 mg/L subsequently, with a detected concentration of 0.015 mg/L in FY 2010. Uranium isotopes have been intermittently detected in well GW-713 at low concentrations (< 1.7 pCi/L), although no uranium isotopes were detected in FY 2010.

Well GW-714 is about 145 ft deep. Site related VOCs have not been detected in well GW-714. Nitrate has been detected throughout the monitoring history of GW-714 and exhibits a decreasing trend. In the early 1990s, nitrate was detected at almost 5 mg/L. In FY 2000, the nitrate concentration was about 4 mg/L and a steadily decreasing trend was observed with concentrations decreasing to about 1 mg/L in FY 2004. Since 2004 nitrate concentrations have varied at levels less than 1 mg/L. Nitrate was detected in GW-714 at concentrations of 0.55 and 0.36 mg/L in FY 2010. Uranium isotopes are also detected in well GW-714. Since FY 2000, both ^{234}U and ^{238}U have exhibited gradual increases from less than 1 pCi/L observed to maximum levels of about 4.5 pCi/L ^{234}U in FY 2003 and about 1.4 pCi/L ^{238}U in FY 2004. Following those observed maxima, uranium levels have decreased to levels of about 1 pCi/L or less. Uranium-235 is not routinely detected in well GW-714. The peak uranium isotope levels coincided with the FY 2003 and 2004 period of excess rainfall that affected groundwater and surface water contaminant levels across the ORR.

The four springs that are monitored in Zone 1 are SS-6, SS-6.6, SS-7, and SS-8 shown on Figure 4.8. Sampling of the springs is conducted semiannually during the high-flow wet season (typically during winter) and during the low-flow dry season (during summer months). All four springs discharge groundwater from bedrock flow pathways and all discharge into Bear Creek. The springs act as IPs for groundwater in the karst groundwater flow system in the Maynardville Limestone. This bedrock flow system is very complex. The system contains both components of deep, long-distance flow originating at the S-3 Ponds area in the Bear Creek headwaters as well as shallow components where surface water and groundwater comingle. This comingling occurs as seasonal flow volume and groundwater level variation allow surface water to sink into the bedrock karst with resurgences to the surface via springs further downgradient. The four Zone 1 springs are resurgence points for groundwater originating from within BCV and groundwater inputs from the northern slopes of ChR. Analyses are performed for a broad suite of parameters including metals (including uranium as a metal), VOCs, anions (including nitrate), and radionuclides (including uranium isotopes and ^{99}Tc). Nitrate, uranium isotopes, and ^{99}Tc are signature contaminants that originate in the S-3 Ponds plume and are focal points in the following discussion.

Figure 4.9 shows nitrate concentrations in the Zone 1 springs from 1995 through FY 2010. Nitrate is commonly detected at all four springs at concentrations less than 50% of the MCL (10 mg/L). Table 4.12 contains the results of uranium isotope analyses conducted on Zone 1 spring samples from FY 2000 through FY 2010. Also included in Table 4.12 is the total uranium calculated from the results of detected (unqualified) isotopic activities. Review of the calculated uranium mass and the measured uranium metal values shows that total uranium in the spring water has been below the 30 µg/L MCL with the exception of two results. The calculated total mass from isotopic activities for the June 28, 2010 result from SS-6.6 was 31.5 mg/L, although the uranium metal result for this sample date was 27.6 µg/L. This variation may represent variability in the uranium content of the discharging spring water. Neither the uranium isotopic activities or the uranium metal analyses corroborate an MCL exceedance.

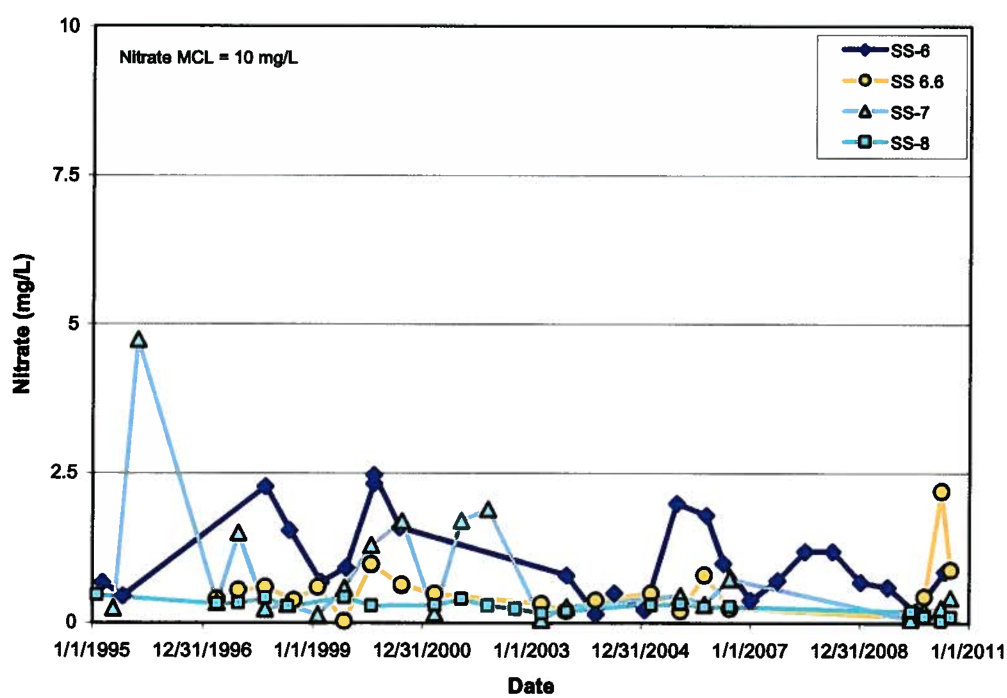


Figure 4.9. Nitrate concentrations in Zone 1 springs.

Table 4.12. Uranium isotope activities in Zone 1 Spring samples, 2000-2010

Uranium isotopic data for SS-6

Date	U-234 (pCi/L)	U-235(pCi/L)	U-238(pCi/L)	Total U µg/L
2/9/2000	5.87±2.94	0.94±1.25 U	8.32±3.53	25.2
8/3/2000	2.11±0.89	0.07±0.17 U	3.24±1.17	9.8
7/10/2002	1.57±0.82	0.11±0.22 U	3.28±1.23	9.9
8/19/2003	1.47±0.56	0.18±0.22 U	1.89±0.64	5.7
7/7/2004	1.21±0.56	0.33±0.31 J	1.72±0.68	5.2
1/24/2005	0.33±0.31 J	0.04±0.16 U	0.63±0.42 J	0
8/25/2005	2.12±0.73	0.15±0.22 U	3.72±1.02	11.3
3/13/2006	2.1±0.77	0.43±0.36 J	4.2±1.17	12.7
7/5/2006	2.88±0.91	0.18±0.24 U	4.07±1.12	12.3
1/3/2007	0.564±0.307	0.0482±0.168 U	0.932±0.393	2.8
7/2/2007	0.743±0.532	0.137±0.293 U	0.0617±0.293 U	1.20E-04
1/2/2008	2.23±0.876	0.153±0.296 U	2.85±0.982	8.6
7/1/2008	2.68±0.892	0.361±0.323	4.61±1.16	14.1
1/5/2009	2.23±0.842	0.247±0.329 U	2.42±0.888	7.3
7/6/2009	1.53±0.636	0.183±0.228 U	2±0.722	6.1
1/6/2010	0.57±0.442 U	-0.06750.22 U	0.911±0.504	2.8
7/22/2010	1.47±0.492	0.266±0.226 U	2.64±0.653	8

Uranium isotopic Data for SS-6.6

Date	U-234 (pCi/L)	U-235(pCi/L)	U-238 (pCi/L)	Total U µg/L
1/25/2000	1.91±0.73	0.09±0.18 U	2.57±0.89	7.8
1/25/2000	1.8±0.66	0.44±0.33 J	3.23±0.96	9.8
8/16/2000	3.13±1.82	0.6±0.81 U	1.99±1.42 J	5.00E-04
8/16/2000	2.25±1.4 J	0.12±0.56 U	0.14±0.34 U	0
3/22/2001	0.68±0.37 J	0.04±0.1 U	1.33±0.53	4
3/22/2001	0.93±0.43	0.09±0.13 U	1.45±0.55	4.4
3/4/2003	0.91±0.52 J	0.3±0.32 U	0.8±0.48 J	0
3/2/2004	2.42±1.79 J	0.48±0.93 U	0.9±1.2 U	0
3/8/2005	0.96±0.46	0.06±0.12 U	2.93±0.86	8.9
9/21/2005	1.18±0.58	0.23±0.27 U	1.56±0.67	4.7
2/28/2006	2.08±0.87	0.29±0.33 U	1.82±0.81	5.5
8/17/2006	1.93±0.83	0.33±0.38 U	1.25±0.67 J	3.10E-04
12/7/2009	0.54±0.394	0.0235±0.229 U	0.475±0.372	1.4
3/9/2010	0.449±0.458 U	0.786±0.512	1.58±0.675	5.1
6/28/2010	5.52±1.02	0.533±0.353	10.3±1.38	31.5[1]
8/30/2010	1.56±0.519	0.298±0.268 U	2.64±0.664	8

Uranium isotopic data for SS-7

Date	U-234(pCi/L)	U-235(pCi/L)	U-238(pCi/L)	Total U µg/L
1/25/2000	2.89±0.91	0.5±0.36 J	5.25±1.37	15.9
8/16/2000	3.68±1.24	0.41±0.39 J	5.58±1.67	16.9
3/22/2001	0.34±0.23 J	-0.01±0.01 J	0.64±0.33	1.9
9/18/2001	2.26±0.56	0.19±0.14 J	3.75±0.82	11.4[1]
3/12/2002	1.59±0.54	-0.01±0.01 U	3.77±0.97	11.4
3/4/2003	1.07±0.53	0.4±0.34 J	0.37±0.3 J	1.70E-04
8/19/2003	0.72±0.4	0.13±0.18 U	1.59±0.63	4.8
9/21/2005	2.69±0.83	0.16±0.22 U	3.4±0.96	10.3
2/28/2006	0.74±0.41	0.2±0.23 U	1.21±0.54	3.7
8/17/2006	2.76±0.98	0.07±0.17 U	6.13±1.6	18.6

Uranium isotopic data for SS-8

Date	U-234 (pCi/L)	U-235(pCi/L)	U-238 (pCi/L)	Total U µg/L
1/25/2000	0.15±0.23 U	0.04±0.11 U	0.2±0.23 U	
8/16/2000	0.7±0.47 J	0.12±0.21 U	0.45±0.37 J	
3/22/2001	0.27±0.35 U	-0.12±0.09	0.06±0.06 U	
9/18/2001	0.18±0.19 J	0.18±0.19 U	0.25±0.22 J	
3/12/2002	0.52±0.27	0 J	0.02±0.06 U	8.40E-05
9/9/2002	0.27±0.24 J	0.1±0.17 U	0 J	
9/9/2002	0.35±0.29 J	0.14±0.2 U	0.14±0.17 U	
3/4/2003	1.05±0.55	0.14±0.22 U	0.09±0.18 U	1.70E-04
3/4/2003	1.01±0.55	0.17±0.24 U	0.13±0.24 U	1.60E-04
8/19/2003	0.1±0.25 U	-0.04±0.04 U	0.03±0.09 U	

Table 4.12. Uranium isotope activities in Zone 1 Spring samples, 2000-2010 (cont.)

Uranium isotopic data for SS-7					Uranium isotopic data for SS-8				
12/7/2009	0.724±0.461	0.252±0.279 U	0.24±0.28 U	1.20E-04	8/19/2003	0.18±0.2 U	0 J	0.25±0.22 J	
3/9/2010	0.791±0.49	0.19±0.237 U	0.785±0.469	2.4	3/8/2005	1.25±0.73 J	0.42±0.47 U	1.71±0.86	5.2
6/28/2010	1.06±0.428	0.0723±0.147 U	1.34±0.47	4.1	3/8/2005	1.64±0.77	0.57±0.48 J	3.74±1.23	0.11
8/30/2010	1.16±0.47	0.346±0.255	1.81±0.576	5.6	9/21/2005	1.26±0.59	0.29±0.3 U	0.28±0.3 U	2.00E-04
					9/21/2005	0.26±0.24 J	-0.02±0.03 U	0.08±0.14 U	
					2/28/2006	0.52±0.38 J	0.15±0.23 U	0.33±0.3 J	
					2/28/2006	0.39±0.3 J	0.13±0.2 U	0.16±0.19 U	
					8/17/2006	0.98±0.53	0.34±0.36 U	0.17±0.22 U	1.60E-04
					8/17/2006	0.56±0.4 J	0.1±0.22 U	0.23±0.28 U	
					12/7/2009	0.55±0.367	0±0.215 U	0.183±0.215	5.50E-01
					12/7/2009	0.248±0.275 U	0.124±0.24 U	0.112±0.24 U	
					3/9/2010	0.343±0.363 U	0.0802±0.282 U	0.197±0.282 U	
					3/9/2010	0.37±0.347 U	0.217±0.286 U	0.109±0.253 U	
					6/28/2010	0.581±0.313	0.03±0.136 U	0.367±0.253	0.11
					6/28/2010	0.7±0.377	0.0361±0.163 U	0.339±0.278 U	1.10E-04
					8/30/2010	0.0598±0.211 U	0.0598±0.154 U	0.218±0.214 U	
					8/30/2010	0.566±0.328	0.192±0.189 U	0.136±0.196 U	9.10E-05

[1] Total uranium metal analysis indicated 27.6 ug/L.

Uranium isotopic ratios in the spring water discharges have been compared to those from other key source areas in BCV including the S-3 Ponds, discharge at BCK 12.34, NT-3 water, NT-08 water, and the combined discharge monitored at BCK 9.2. The cumulative distribution characteristics of the uranium isotope ratios in the spring water samples suggests uranium from any and all of the major BCV source areas may be present in the springs.

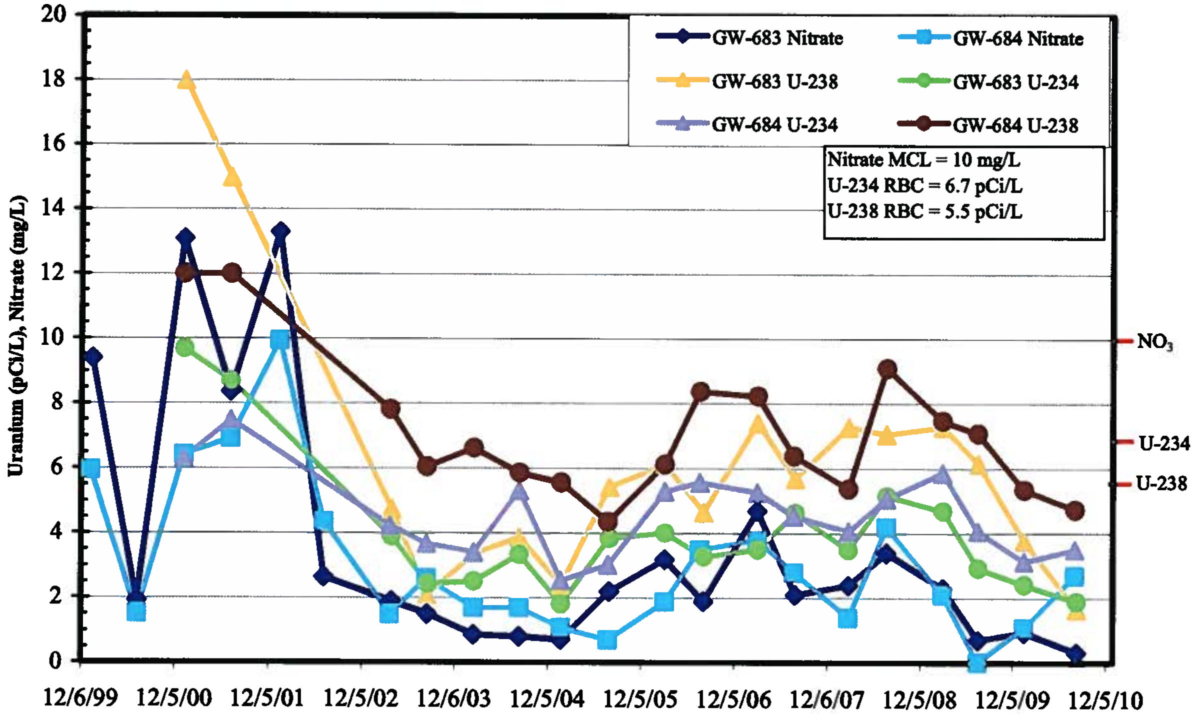
Analyses conducted since FY 2000 show the occasional presence of very low levels of ^{99}Tc in the springs. Like nitrate, ^{99}Tc is a signature contaminant that originates from the S-3 Ponds releases. The levels of ^{99}Tc measured in the Zone 1 springs are in the range of 10 – 30 pCi/L, which are approximately 1% of the MCL effective dose equivalent activity of 900 pCi/L. The majority of ^{99}Tc results are non-detect and nearly all the results that suggest the presence of ^{99}Tc are qualified as estimated values because the measured activities are very close to the detection limits.

During the 1990s, low to trace concentrations of PCE, TCE, and 1,2-DCE were detected in SS-6 springwater. Chlorinated VOCs have not been detected at SS-6 since FY 1998. Nitrate is detected in SS-6 springwater. Nitrate concentrations are variable and, since FY 2000, have fluctuated from a maximum of about 2.5 mg/L (in 2000) to a low of about 0.2 mg/L in 2005. In FY 2010, the highest observed nitrate concentration was 0.86 mg/L. Uranium isotopes (^{234}U and ^{238}U) are detected in SS-6 springwater. Measured activity levels are variable with a maximum ^{234}U level of about 5.9 pCi/L in FY 2000 and an FY 2010 value of about 1.5 pCi/L. Measured activity levels for ^{238}U were highest in FY 2000 (8.3 pCi/L), with an FY 2010 result of 2.64 pCi/L.

Because of the intermittent nature of contaminant detection at low levels in the Zone 1 groundwater, an area of intermittent plume extension in the Maynardville Limestone is shown on Figure 4.8.

Zone 2

Groundwater monitoring used to evaluate conditions in the eastern end of Zone 2 consisted of sampling six wells along the boundary with Zone 3 near the western end of the BCBGs. Six wells near the land use zone boundary are monitored to evaluate groundwater contaminants migrating into Zone 2. Two wells are constructed in the Maynardville Limestone along the transect designated as Picket A in Figure 4.8. The groundwater quality goal for Zone 2 is to eventually achieve unrestricted use and, therefore, MCLs and residential RBCs are used as screening comparison levels. Wells GW-683 and GW-684 sample groundwater upgradient of its discharge at spring SS-5. Well GW-683 is 197.5 ft deep and well GW-684 is 129.6 ft deep. The principal contaminants detected in these wells that presently or have historically exceeded the screening criteria are nitrate and uranium isotopes (Figure 4.10). Nitrate is compared to the MCL of 10 mg/L. Nitrate has been detected in wells GW-683 and GW-684 at concentrations less than half of the MCL since 2002. The only constituent that exceeded residential risk target levels at the Zone 2 boundary is ^{238}U. The FY 2010 ^{238}U activities measured at GW-683 were 3.76 pCi/L in January and 1.66 pCi/L in August. Both values were less than the ^{238}U RBC of 5.5 pCi/L. The activities of ^{238}U in GW-684 were higher, with 5.34 pCi/L measured in January and 4.73 pCi/L measured in August. Historic trends of nitrate and uranium isotopes show an apparent decrease in levels during 2003 through 2005, followed by an increase during 2006 through 2008. During 2003 through 2005, above normal rainfall appears to have caused dilution of contaminant concentrations in the Maynardville Limestone, followed by a gradual increase during the drought years of 2006 through 2008, and another decrease during FY 2009 and FY 2010 when rainfall was again above average. Consistent with this inferred rainfall and contaminant concentration pattern, the nitrate and uranium concentrations showed a decreasing trend during FY 2010 associated with the above average rainfall across the ORR. During FY 2010 nitrate and uranium in wells GW-683 and GW-684 were below their respective MCL and RBCs.



Sample Date

Figure 4.10. Constituents detected above RBC or MCL at wells GW-683 and GW-684.

Wells GW-683 and GW-684 sample groundwater contamination that originates from upgradient sources, such as the S-3 Ponds, and flows through karst conduits in the Maynardville Limestone prior to rising to discharge into Bear Creek as spring SS-5 (Figure 4.8). A portion of the groundwater contaminant plume shown on Figure 4.9 terminates at the known plume discharge point at SS-5. Groundwater sampling further to the west at the Picket W wells (Figure 4.8 shows the presence of nitrate and uranium, which are derived from upgradient sources. Transient episodes of groundwater contaminant migration must occur through bedrock groundwater flow pathways in Zone 2 in order for the observed deep groundwater contamination and low level contaminants measured in spring discharges in Zone 1 to exist. A scarcity of groundwater monitoring wells in Zone 2 makes it impossible to precisely map and track groundwater contaminant transport pathways in that area.

Wells GW-077 (100 ft deep), GW-078 (21 ft deep), GW-079 (65 ft deep), and GW-080 (30 ft deep) are sampled for metals, including uranium, and VOCs. Neither uranium nor VOCs were detected in any of these four wells during FY 2010. These are the only wells available to sample along the Zone 2/Zone 3 boundary at the western edge of the BCBGs. The possibility of deeper groundwater contamination migration from the DNAPL area beneath the BCBGs cannot be evaluated with the existing well network.

Zone 3

Existing CERCLA decision documents pertinent to BCV do not stipulate groundwater RAs or RLs to be attained within Zone 3. The ROD indicates source area RAs included in the ROD are intended to improve conditions in groundwater for protection of water quality in Zones 1 and 2. Groundwater monitoring in Zone 3 includes monitoring of wells GW-704 and GW-706, which sample groundwater in the S-3 plume, and RCRA post-closure permit sampling of wells GW-008 near the Oil Landfarm and GW-046 in the BCBGs (Figure 4.8).

Wells GW-704 and GW-706 are in Picket B and sample groundwater from bedrock in the Maynardville Limestone exit pathway downgradient from the former S-3 Ponds and other source areas. The wells sample groundwater from depths of 256 and 182 ft, respectively, and are located midway between BCK 11.54 and SS-5. These wells contain uranium, VOCs, nitrate, and ^{99}Tc. Contaminant levels in both wells have exhibited decreasing or stable contaminant signatures over the past several years. Principal contaminant concentration graphs for wells GW-704 and GW-706 are shown in Figure 4.11. During FY 2010, contaminant concentrations continued their seasonal fluctuations and were stable to somewhat lower than in FY 2009.

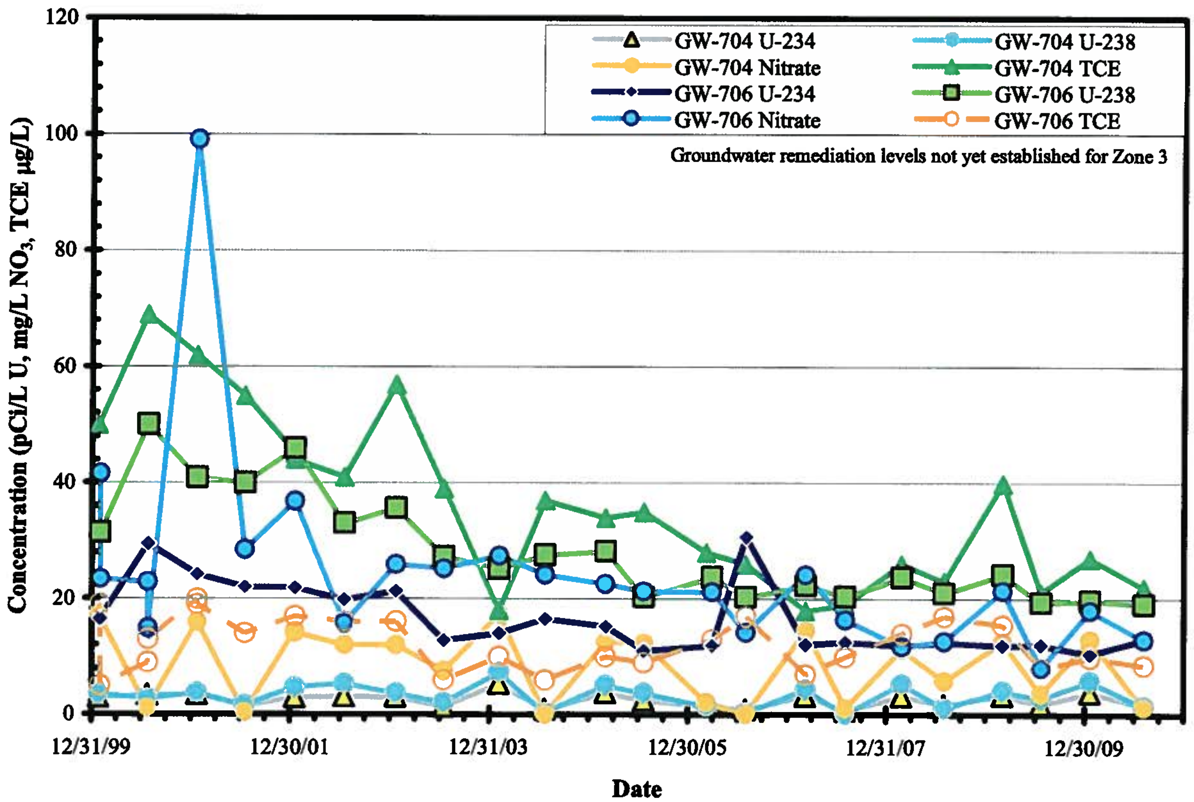
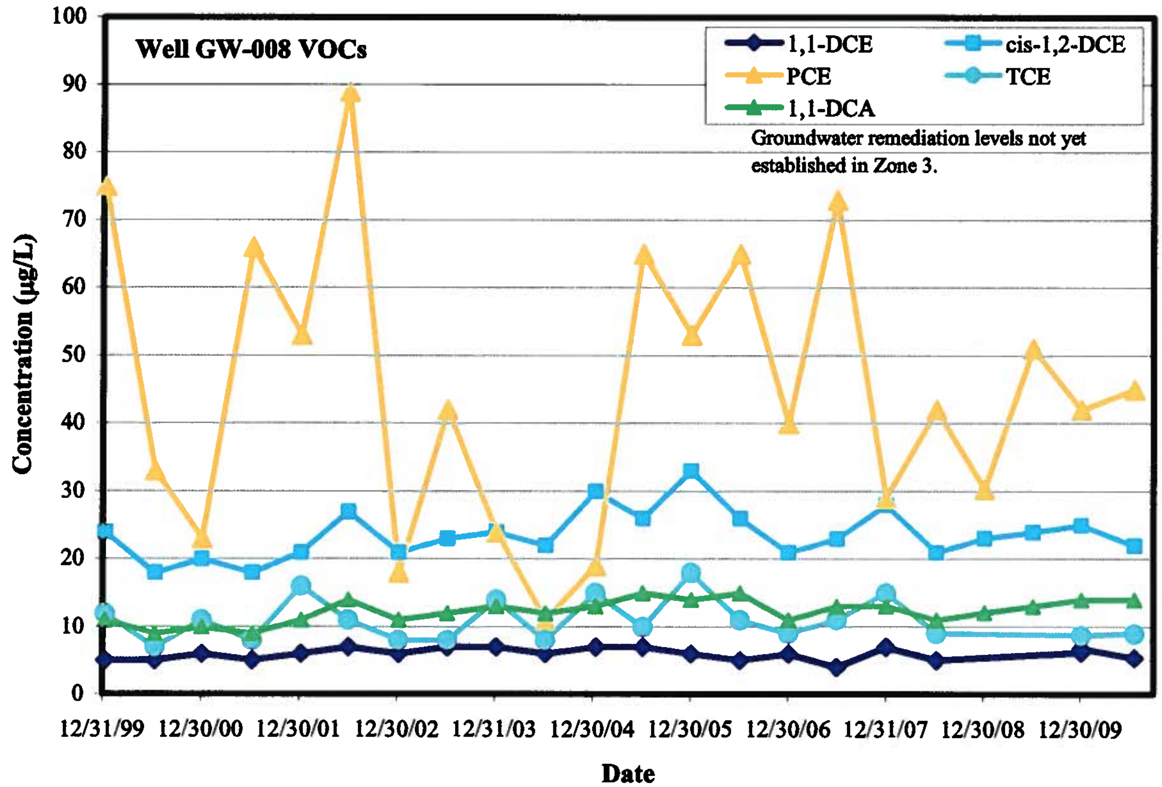


Figure 4.11. Principal contaminant trends in wells GW-704 and GW-706.

Wells GW-008 and GW-046 are located at the Oil Landfarm and BCBGs, respectively. Well GW-008 samples groundwater from a depth of about 25 ft and GW-046 samples groundwater from a depth of about 20 ft. Concentration trends for the principal COCs in these wells are shown in Figure 4.12. The relatively low VOC concentrations in GW-008 did not change greatly during FY 2010. VOC concentrations at well GW-046 showed increases during FY 2010. The increasing trend started during



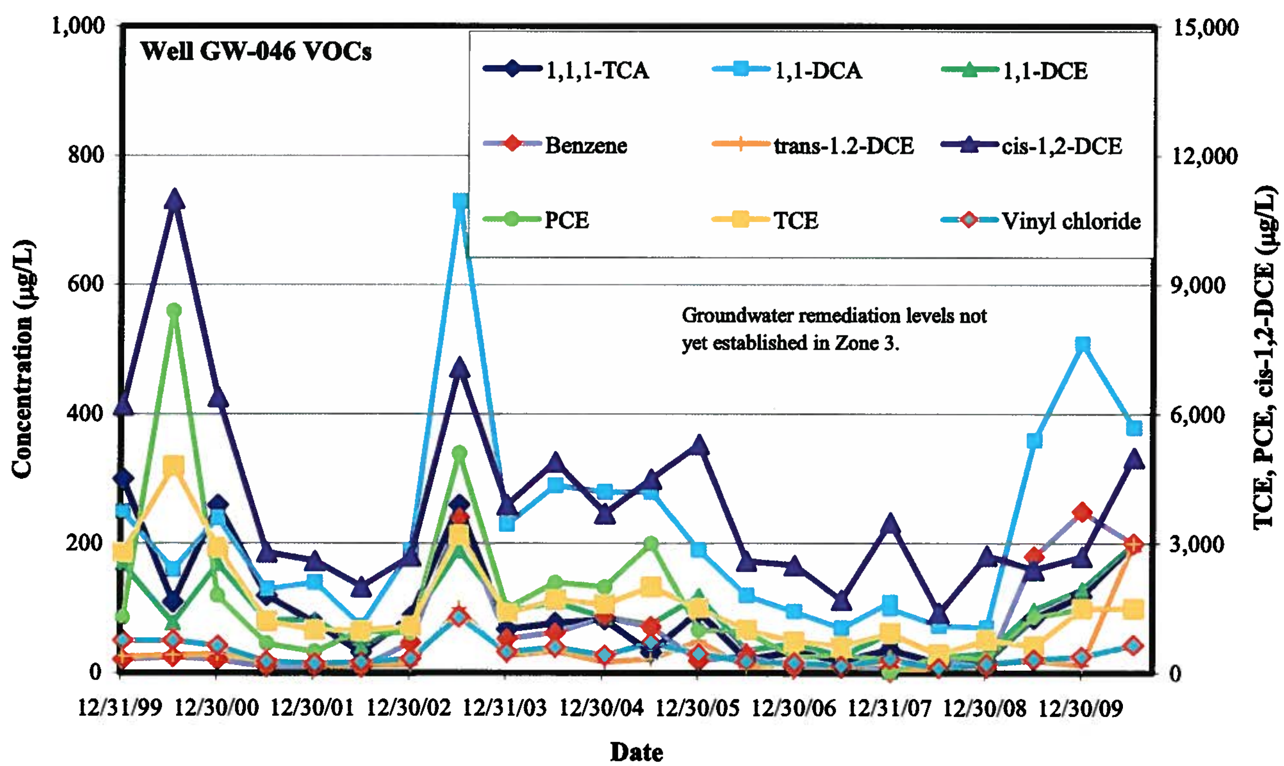


Figure 4.12. VOC concentration trends in wells GW-008 and GW-046.

during the period of above normal rainfall in FY 2009. The VOC concentration behavior in well GW-046 during FY 2009 and FY 2010 is similar to that observed in FY 2003, an earlier time period that experienced above average rainfall. This response in the groundwater system suggests that increased rainfall causes groundwater discharges from the capped burial ground area.

Groundwater surveillance monitoring of the BCBGs conducted by the Y-12 Groundwater Protection Program documents increasing VOC concentrations in the noncarbonate, fractured bedrock underlying the area. Contaminant plumes in BCV, as interpreted by the Y-12 Groundwater Protection Program, are depicted graphically in Figure 4.8. The concentration of PCE has exceeded 100 ppm at a depth of 270 ft in one well not shown in Figure 4.8 in the western BCBGs. PCE transformation products are also present at high concentrations in nearby wells and cis-1,2-DCE is routinely measured at >2 ppm concentrations in two nearby wells not shown in Figure 4.8. These contaminants are not detected to date in wells that lie further west of the burial grounds and Bear Creek Tributary NT-8. However, PCE, TCE, and cis-1,2-DCE are detected in surface water at the mouth of NT-8.

4.2.2.3 Other Watershed Monitoring

Aquatic biological monitoring of streams in BCV is used to measure the effectiveness of watershed-wide RAs. Additionally, stream habitat, and riparian vegetation are also monitored at the BYBY and Haul Road Mitigation sites to measure the effectiveness of specific restoration efforts at these sites. Biological monitoring data for streams in BCV, including NT-3 and the Haul Road Mitigation site, and for several reference streams (Figure 4.1) include results on (1) contaminant accumulation in fish, (2) fish community surveys, and (3) benthic macroinvertebrate community surveys. The aquatic biological monitoring, riparian monitoring and stream-channel monitoring discussed in the following sections presents the methodology and results of monitoring efforts in FY 2010.

4.2.2.3.1 Aquatic Biological Monitoring in Bear Creek Watershed

To evaluate instream contaminant exposure and potential human and ecological risks in the Bear Creek Watershed, fish are collected twice a year and analyzed for a suite of metals and PCBs at sampling locations BCK 3.3, BCK 9.9, and BCK 12.4 (Figure 4.1). An evaluation of overall ecological health of the streams is conducted by monitoring fish and benthic macroinvertebrate communities at BCK 3.3, BCK 4.6, BCK 9.9, BCK 12.4, and NT-3 (a tributary to Bear Creek).

Mean mercury concentrations in rockbass from lower Bear Creek increased in 2010, averaging 0.58 μg/g in fall 2009 and 0.72 μg/g spring 2010 (Figure 4.13). These mercury levels are over three-fold higher than those found in the same species from the Hinds Creek reference site (HCK 20.6) (Hinds Creek mean of 0.16 μg/g in 2010) and are above the EPA-recommended fish-based AWQC of 0.3 μg/g. In 2010, for the first time, monitoring of sunfish was planned at BCK 9.9 to monitor contaminant bioaccumulation in upper Bear Creek, but the upper portion of this creek is not good habitat for sunfish. Fish were collected along the stretch of Bear Creek between BCK 4.6 and BCK 9.9. Average mercury concentrations in redbreast sunfish from this stretch of the creek were 0.27 μg/g. While this number is lower than the levels seen in rockbass at BCK 3.3, redbreast sunfish feed on lower trophic level prey, and typically have between 15-40% lower Hg levels than in rockbass collected from the same site.

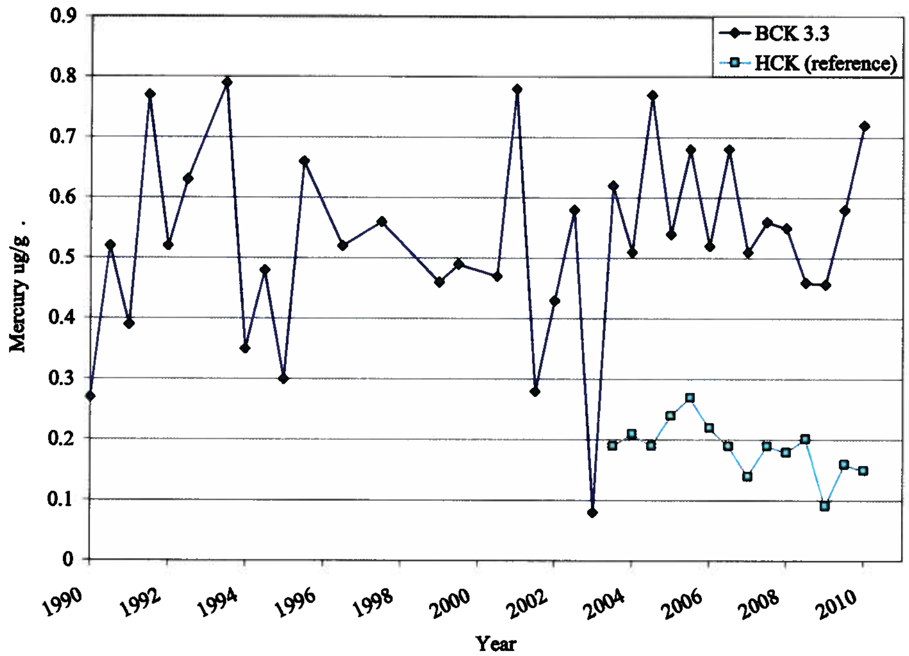


Figure 4.13. Mean concentrations of mercury in rockbass from lower Bear Creek, BCK 3.3, 1990–2010.

As in recent years, concentrations of nickel, cadmium, and uranium in stoneroller minnows were highest in upper Bear Creek and decreased with increasing distance downstream. With the exception of nickel concentrations that were similar to the reference site, cadmium and uranium concentrations in fish from the lower end of the creek were higher than reference values in 2010 (Figure 4.14, Figure 4.15, Figure 4.16).

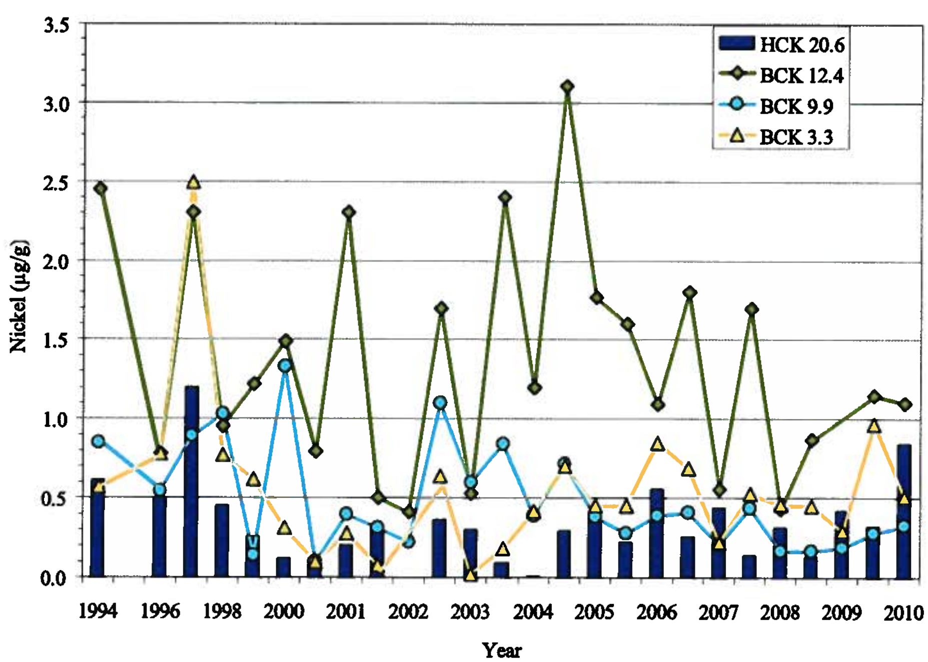


Figure 4.14. Mean nickel concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994–2010.

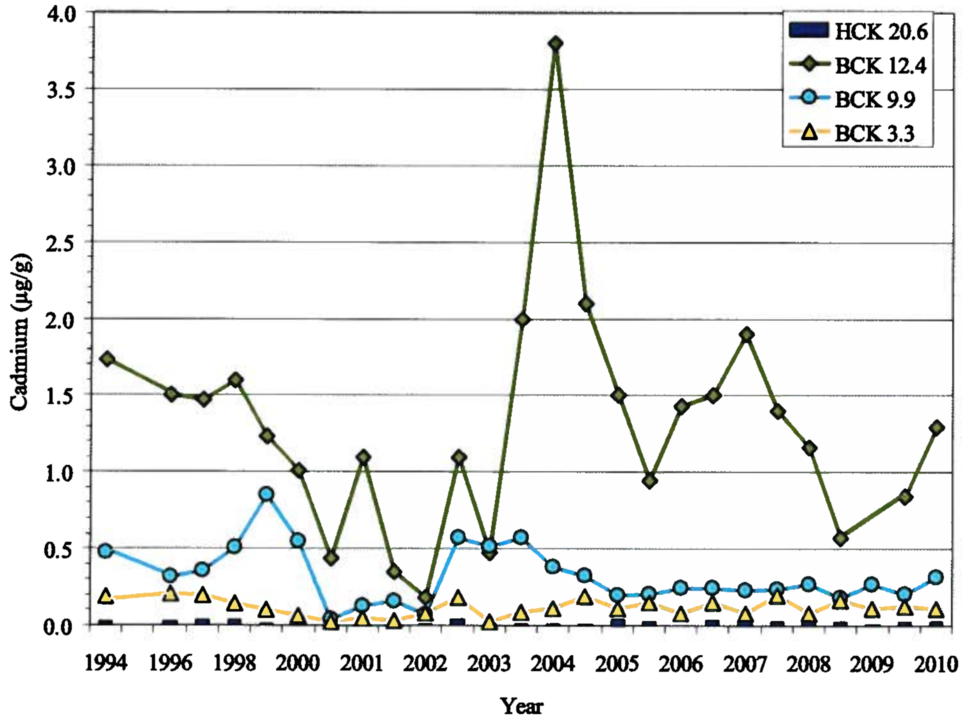


Figure 4.15. Mean cadmium concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994–2010.

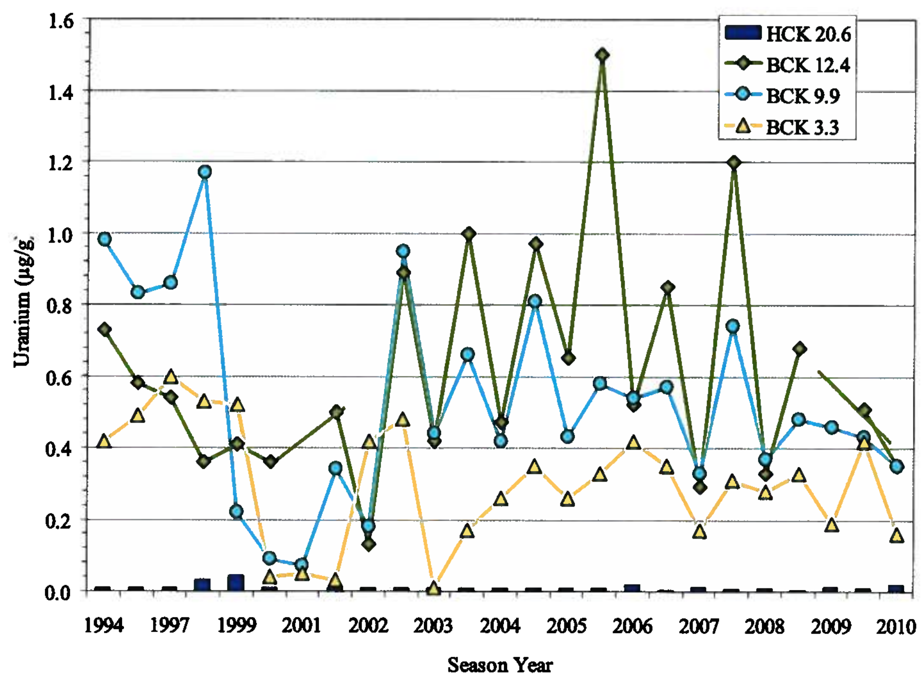


Figure 4.16. Mean uranium concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994–2010.

PCB concentrations in stoneroller minnows in fall 2009 and spring 2010 averaged between 2-4 µg/g, continuing the long-term trend of elevated levels in fish (Figure 4.17). PCB levels in minnows collected from upper Bear Creek (BCK 9.9) have historically been higher than at the downstream site (BCK 3.3). While levels at BCK 9.9 have fluctuated considerably from year to year, long-term trends suggest that PCBs in fish from this site have been decreasing overall, while levels in fish from BCK 3.3 have been slowly increasing since 2003 such that tissue concentrations were similar at both sites in spring 2010.

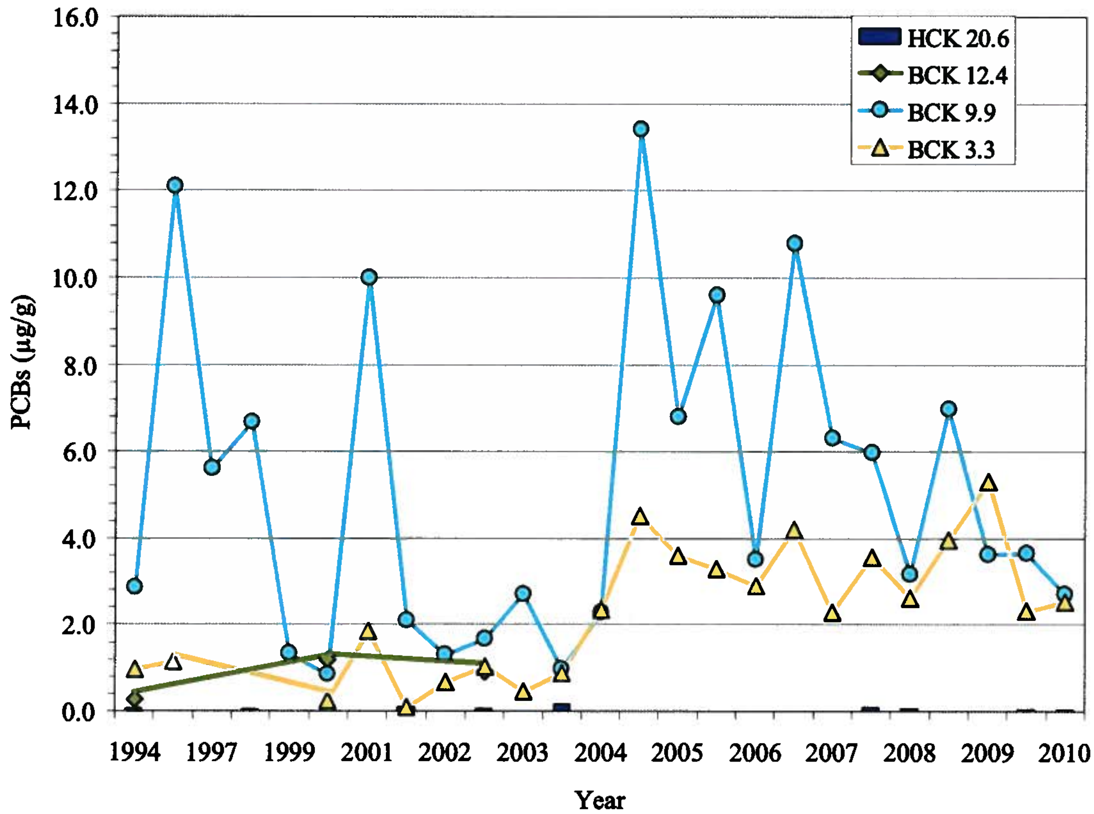


Figure 4.17. Mean PCB concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994–2010.

The fish communities in Bear Creek have generally been stable or display minor variation in terms of species richness in recent samples (Figure 4.18). The downstream sites (BCK 3.3 and BCK 4.6) have appropriate values for their size compared to a larger reference stream (BFK 7.6) and a smaller reference stream (MBK 1.6). This is especially encouraging for BCK 4.6, as it is located in the middle of the stream restoration section where a new stream channel and habitat were created. Because this site is now tracking at similar levels to BCK 3.3 and has been impounded by a large beaver dam, and the stream and wetland mitigation site has been monitored for five years, the 2010 samples will be the last taken at BCK 4.6. The sample site in the middle section of Bear Creek (BCK 9.9) had shown a steady increase in species richness, aided perhaps in recent years by the bypass of the downstream weir near BCK 4.6 which allowed more upstream migration of fish species. Samples in 2010 dropped slightly in richness, breaking the trend for improving species richness. BCK 12.4 and NT-3 fish communities are at or slightly below total richness values of comparable reference streams, (MBK 1.6 and PHK 1.6), suggesting they are more susceptible to stress, e.g., from below-normal rainfall, or limited by poor habitat.

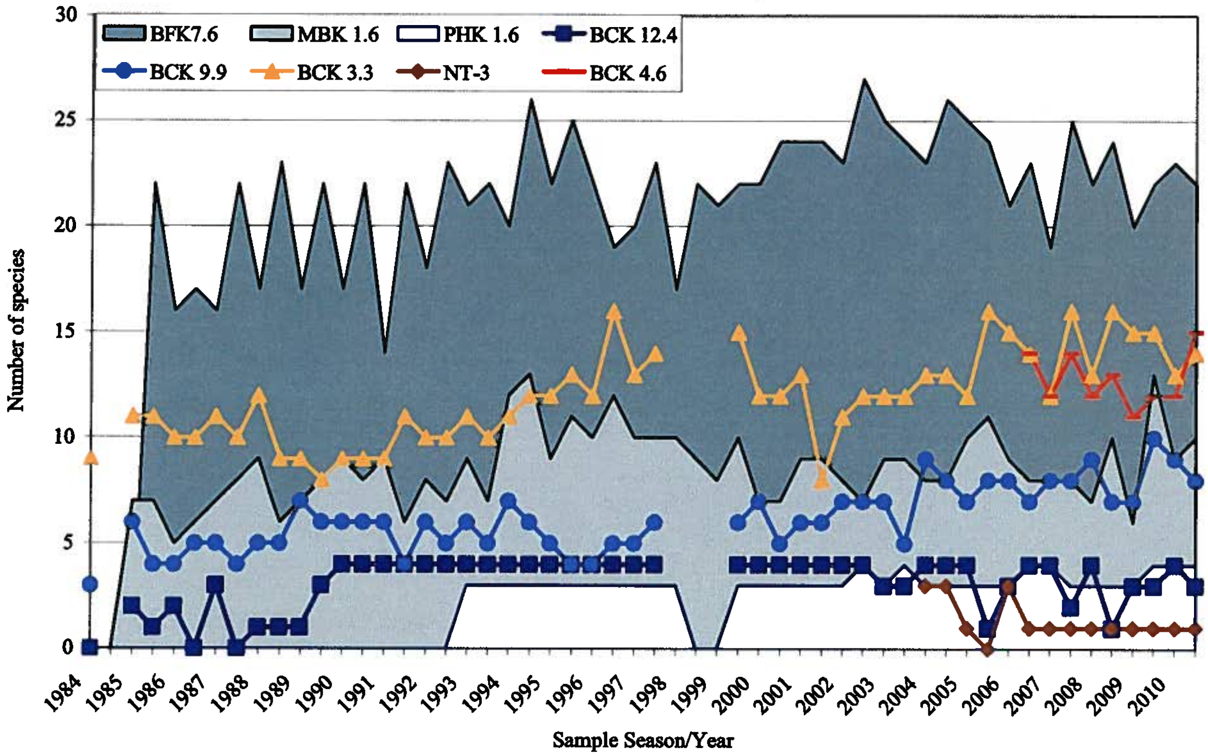
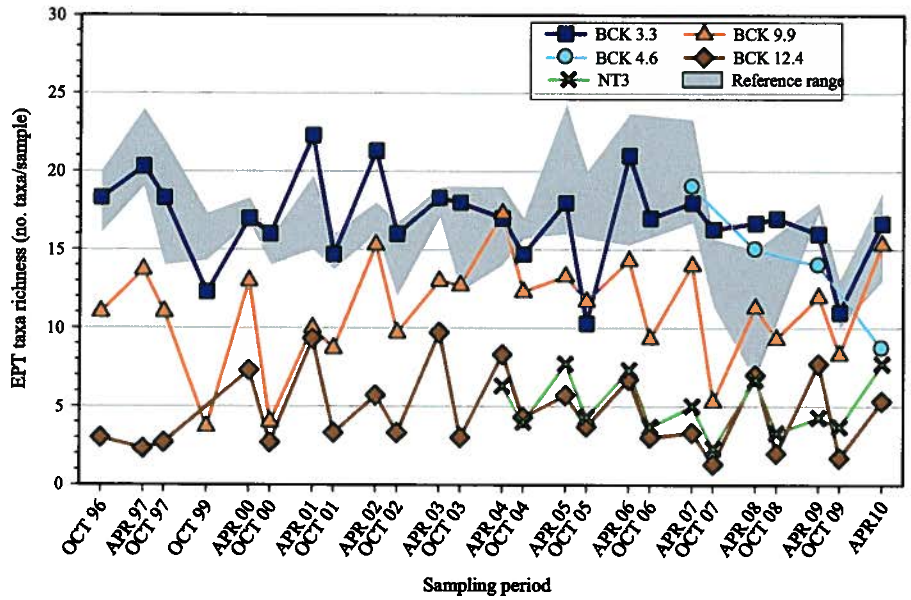


Figure 4.18. Species richness (number of species) in samples of the fish community in Bear Creek (BCK), NT-3, and reference streams, BFK, MBK, and Pinhook Branch (PHK), 1984–2010.[a]

[a]Interruptions in data lines for BCK and PHK sites indicate no results available for those periods.

Upper Bear Creek (BCK 12.4) and NT-3 continue to support considerably fewer pollution-intolerant benthic macroinvertebrate taxa than nearby reference streams, and as in past years, this difference is most pronounced in October (Figure 4.19). Long-term trends in the number of pollution-intolerant invertebrate taxa at BCK 9.9 continue to indicate the presence of mild to moderate impacts, and as for BCK 12.4 and NT-3, evidence of degradation is most pronounced in October. Relative to the previous three years, a sharp drop was observed in the number of pollution-intolerant taxa at BCK 4.6 in April 2010. While it is not possible to definitively identify the cause for the reduction, it was most likely the result of a major change in habitat caused by the presence of a large beaver dam near Highway 95. Only limited patches of slowly flowing water remained between Highway 95 and the northwest exit spur from Bear Creek Road. Macroinvertebrate samples have historically been collected from shallow, rapid reaches (i.e., riffles) where species composition is normally higher and very different from deep pool and standing-water habitats. Finally, results continue to suggest that the invertebrate community at BCK 3.3 is comparable to the communities at the reference sites.



BCK = Bear Creek kilometer; NT3 = North Tributary #3 to Bear Creek. EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, caddisflies, and stoneflies.

Figure 4.19. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in Bear Creek, NT-3, and range of mean values among reference streams (two sites in Gum Hollow Branch and one site in Mill Branch), October 1996–April 2010.

4.2.2.3.2 BYBY Stream Performance Monitoring

NT-3 Riparian Monitoring

NT-3 stream habitat and riparian surveys were conducted in August 2010. Surveys continued for the seventh year, two years beyond the 5-year monitoring requirement (DOE 2003d). The additional monitoring was conducted because habitat and stream communities were still in poor condition at the end of the initial five-year period (Peterson *et al.* 2009). Surveys included measures of in-stream habitat within established stream transects (Figure 4.7). Riparian habitat included primarily vegetation cover (percent cover and species diversity) within 10m X 5m plots corresponding to the surveyed stream habitat transects.

Transect and plot results from the stream and riparian surveys are presented in tables 4.13 and 4.14. In general, NT-3 is a small first order stream that is around a half a meter wide in most places in summer. The stream widens during high flows to as much as 1-2 meters, with overland sheet flow in some bends that allows for some riparian wetland development. In 2010 there was clear water evident in many pools, and some included fish.

The 2010 sediment characterization showed a diversity of particle sizes. Stream sediments are primarily of a gravel substrate, with occasional cobbles, sand, fine sediments, and clays in some stream sections. Unlike most previous years, there was no silt. In general, fine sediments appeared to be less than previous years, with no transect dominated by only silts or clays. Percent embeddedness also decreased approximately 10%. Surrounding banks were well vegetated and erosion-related issues did not appear to be a problem. There was a much higher percentage of plant detritus and root wads in the stream, reflecting the greater density of riparian vegetation.

Table 4.13. Summary of transect physical habitat metrics for NT-3, August 23, 2010

Transect[b]	Stream width (m)	Percentage substrate[a]							Percent embeddedness[c]
		Plant detritus	Root Wads	Cobble	Gravel	Sand/ fines	Silt	Clay	
0	0.8	50			50				44.4
1	0.4	25			50	25			44.4
2	0.4	20		20	40	20			36.5
3	0.6				71			29	37.1
4	0.6	17			67			17	46.7
5	0.6	100							73.2
6	0.4	20			40			40	51.0
7	0.3			25	75				17.5
8	0.3				50			50	51.3
9	0.4			17	83				30.8
10	1.3	10		10	80				65.3
25	0.5	60		20	20				19.5
26	0.8	22	11	11	56				81.9
27	0.3		25	25	50				17.5

[a]Particle size ranges in mm: clay = <0.004, silt = 0.004 – 0.062, sand/fine sediment = 0.062 – 2.0, gravel = 2.0 – 64.0, cobble = 64.0 – 250.0, small boulder = 250.0 – 610.0.

[b]Transects 0 through 10 and 25 through 27 are 10 m apart. Transects 10 and 25 are 150 m apart.

[c]Percent embeddedness = percent of surface of predominant particles covered by fine sediment. Measurements were taken every 10 cm across transect.

Table 4.14. Vegetation metrics. The percent ground and canopy cover, plant species diversity, the amount of riparian overhang, and planted tree/shrub survival and condition for each monitored transect at the NT-3 restoration site, August 25, 2010

Transect/ Plot #	% Canopy	% Ground Cover	No. of plant species	L Bank Overhang (cm)	R Bank Overhang (cm)
0	18	100	17	3	41
1	0	100	10	8	8
2	4	100	7	6	16
3	2	100	11	15	15
4	3	100	12	35	4
5	7	95	11	9	11
6	4	80	9	6	0
7	1	100	8	3	1
8	1	100	9	11	0
9	0	95	8	2	16
10	0	90	6	0	0
25	56	100	13	15	8
26	0	100	16	21	23
27	94	100	15	16	27
2010 Ave	14	97	11	11	12

The results of the 2010 vegetation survey showed high percentage plant cover (average 97%) (Table 4.14). This is the highest measurement of vegetation cover to-date. In general, ground cover was greatest near the stream and open-ground clay areas were primarily found on the sloped ground near the top of the stream banks. Not surprisingly, the riparian area is primarily open habitat; however, there is increased canopy in 2010 relative to previous years.

The average number of plants species observed per plot in 2010 (11) was slightly higher than last year. Although species diversity is down relative to the early years of the restoration, this is due to the most aggressive and well established plant species taking over the survey plots. As in recent past years, the top of banks with poorest soils contained the greatest percentage of nonnative *Lespedeza*. *Lespedeza cuneata* is a well known invasive plant that commonly out competes with other species. Planted big bluestem (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*) were still present within many of the survey plots. Other native herbaceous species less commonly encountered in 2010 included a variety of sedges, rushes, and grasses.

BYBY Performance Summary

Instream and riparian habitat metrics, including percentage of fine sediments, percent plant cover, percent canopy, and number of plant species have all improved in FY 2010. Fish are present throughout, reflecting higher base flows than were evident during the drought years when the required five years of monitoring were completed. Continued successional changes in vegetation to more shrub and tree species is expected within the restoration area over time. Given the improved habitat and the lack of need for further actions, DOE recommends the instream and riparian habitat monitoring be discontinued.

4.2.2.3.3 EMWMF Haul Road Mitigation Site

In 2005, DOE ORO constructed an extension to the existing EMWMF haul road ("Haul Road") built as a component of the CERCLA remedy. DOE documented this decision in a CERCLA ESD document (DOE 2004a), issued with the concurrence of EPA and the TDEC.

To the extent possible, environmental impacts as a result of Haul Road construction were avoided or minimized during the design phases of the project. However, the project could not avoid impacting 1.35 acres of wetland habitat within the road corridor. Environmental surveys of the affected environment were described in *Environmental Survey Report for the ETTP: Environmental Management Waste Management Facility (EMWMF) Haul Road Corridor* (Peterson *et al.* 2005).

As a result of the wetland losses from the Haul Road project, compensatory wetland mitigation was required. The wetland mitigation for the Haul Road project included both in-kind (e.g., wetland creation) and out-of-kind (e.g., stream restoration) mitigation, and was defined based on numerous interactions and advice from regulatory agencies, especially TDEC's DOE Oversight Office. The primary restoration action was associated with the bypass of the existing Bear Creek weir and the old U.S. Geological Survey gauging station to restore natural stream flow in this section of creek. As part of that effort, a new wetland was created within the old stream channel.

Monitoring of restored or created mitigation sites for five years is a conventional requirement of TDEC's wetland-mitigation Aquatic Resources Alteration Permit (as required by Sect. 401 of the Clean Water Act). The monitoring strategy adopted, beginning shortly after construction was completed in the summer of 2006, the substantive monitoring requirements of typical wetland and stream restorations and is similar in strategy to the NT-3 restoration monitoring (also conducted in the Bear Creek watershed). The following summarizes the 5th year of survey results obtained in the summer of 2010.

Previous surveys have focused on three areas and types of assessments: 1) in-stream habitat, 2) stream riparian habitat, and 3) wetland condition in the old stream channel. No physical stream habitat survey was possible in 2010 because of substantial flooding throughout the survey reach (Figure 4.20). A beaver dam downstream of the old and new Bear Creek channels, which affected half the reach by flooding in 2009, was even larger and higher in 2010. The flooding was such in 2010 that the entire restoration reach located at BCK 4.55 was inaccessible by wading.

The riparian plot survey, which is done by surveying the vegetation within the same plot every year, was similarly challenged with estimates of 60-90% inundation by flooded water. The 10-40% of the plot out of the water was completely covered with vegetation (100% coverage). The annual riparian vegetation cover in surveyed plots was 60, 68, 83, and 94 % from 2006-2009. Within plots that had some ground not flooded, species diversity ranged from 5-10 species, typical of past years. The reference site in comparison averaged 25 species. Willow shrubs and small trees were dominant near the water, and did well in the flooded conditions.

Figure 4.20. Photograph showing the Bear Creek restoration site on August 25, 2010. The boulders that can be seen submerged in the photograph were at the edge of the stream bank prior to flooding.

Many of the riparian areas were atypically upland species, because near water areas that were historically more wetland in character were now under water. The planted and upland growing Partridge Pea was particularly dominant in many upland plots on the left bank (facing upstream). The upland areas on the west bank were planted with approximately 5 ft tall trees, and a relatively large number of sprigs (~ 1 ft to 18"). The sprigs are now up to 15 ft tall and appear to be thriving, as were volunteer shrub and tree species.

At the wetland plots, 100% of the plots were covered with vegetation. Water was present in many of the wetland plots, with substantial flow through the wetland and out through the old weir dam. The greater amount of flow through the wetland is undoubtedly due to earthen bank repairs conducted in 2010 near the old spring bypass, allowing a greater amount of spring water to flow through the wetland before entering Bear Creek. The beaver dam has resulted in such a back-up of water that there is no waterfall drop from the wetland weir elevation and the stream's surface water elevation. Fish have direct access to the wetland through the old weir and were found throughout the wetland and spring/seep areas. The beaver dam was breached in January 2011 causing the pond to drain (Figure 4.21). The dam was repaired and the area reflooded within several weeks returning the area to end of FY 2010 conditions.

Figure 4.21. Photograph showing the Bear Creek restoration site on January 27, 2011. Photograph shows drained beaver pond and stream back within its banks.

Summary

After five years the constructed stream channel and wetland remediation is well on its way to recovery and appears to be at or near the reference conditions for many key metrics. Although the restored stream and riparian areas are different in habitat than was designed, in general, the restoration site is in excellent condition. Since the five year monitoring requirement is completed and the site is in excellent condition, DOE recommends that no further monitoring be conducted. This triangle area between TN 95 and Bear Creek Road includes two large springs/seeps, a created and successful wetland restoration site, and extensive flooded swamp/forest from beaver dam activity. The wetland complex in this area is among the most interesting and valuable habitats on all of the ORR.

4.2.3 Compliance with BCV LTS Requirements

4.2.3.1 Requirements

Watershed-wide Requirements

Stewardship requirements outlined in the ROD (DOE 2000c) include LUCs to restrict groundwater and surface water use consistent with designated land use for each zone (Table 4.2, Figure 4.2). Objectives of these controls include preventing unauthorized contact, removal, or excavation of buried waste in the BCV; preclude residential or recreational use of Zone 3; and prevent unauthorized access to contaminated groundwater in the BCV. The ROD also states that DOE will maintain the BCV Phase I sites as controlled industrial areas, and limit public access by posting signs and conducting security patrols.

PCCR-Specific Requirements

The individual RAs under the BCV Phase I ROD have the following additional stewardship activities.

- BYBY—The site will be inspected by the Y-12 S&M Program quarterly until the site is stabilized, then on a semiannual basis. Surveillance activities include inspection of capped areas for unwanted vegetation and erosion, and inspection of access controls to the site. Routine maintenance includes mowing of the capped areas. Non-routine maintenance will be performed as necessary. There are no stewardship requirements specified for the OLFSCP.

- S-3 Ponds Pathway 3—Control and restrict access; once action is complete, inspect and maintain the passive *in situ* treatment system.

- DARA Solids Storage Facility—Control and restrict access.

4.2.3.2 Status of Requirements for FY 2010

Watershed-wide Requirements

Institutional controls in place in the BCV were maintained throughout FY 2010 as part of the BJC Y-12 S&M Program and in conjunction with B&W Y-12. Current land use restrictions in BCV (i.e., government-controlled, heavy-industrial land use in Zone 3 and access restrictions in Zone 2) were maintained.

PCCR-Specific Requirements

Individual RAs under the BCV Phase I ROD underwent routine site inspections conducted by the BJC Y-12 S&M Program as follows:

- BYBY—All components of the site were inspected semiannually in FY 2010, including assessing the vegetative covers for erosion or subsidence; checking for blockage or erosion of the drainage control system; ensuring there are no construction activities and unauthorized materials within the area; evaluating that signs are not missing or damaged and contain correct contact information; ensuring access controls are in place and gates are locked; and ensuring the stability of the channel and banks of NT-3 from the Haul Road to the confluence with Bear Creek. No maintenance was required in FY 2010; however, this site received routine mowing.

- S-3 Ponds Pathway 3 and DARA Solids Storage Facility—These RAs have not yet been implemented. Access control requirements were maintained in FY 2010 and will be maintained until the actions are complete. These sites are not accessible to the public. Signs restricting access are in place and the areas are routinely patrolled by Y-12 security personnel.

4.2.4 BCV ROD Performance Summary

During FY 2010, surface water monitoring at the IP (BCK 9.2) showed that the ROD goal of ≤34 kg/yr of uranium was not attained. The measured uranium flux at the IP was about 119 kg. About 29% of the FY 2010 uranium flux is attributed to surface water discharged from the S-3 Ponds plume as measured at BCK 12.34 and about 51% of the FY 2010 uranium flux originated in the BCBGs and discharged to Bear Creek via NT-8. Other contributors to the total uranium flux include deeper groundwater flows in the S-3 plume that discharge to Bear Creek via springs SS-4 and SS-5 and diffuse bed seepage, as well as smaller contributions from NT-3, NT-5, and NT-7. During FY 2010, the risk level associated with uranium at the IP remained about twice the ROD goal. Nitrate concentrations measured at the IP during FY 2010 were less than the 58 mg/L RBC. Both nitrate and cadmium concentrations meet AWQC requirements at the IP. During FY 2010, the risk level associated with uranium at the IP remained about twice the ROD goal.

DOE has recommended a re-instatement of flow-paced monitoring at NT-3 and NT-5 and the creation of an additional flux monitoring station (BCK 10.15) downstream of SS-4 but upstream of NT-7 to attempt to determine inputs directly to the stream channel from karst discharges. DOE will send an Appendix I-12 letter to the regulators recommending these changes.

During FY 2010, the average nitrate concentration measured at BCK 12.34 near the S-3 Pond source area was less than the industrial RBC. The RBC for nitrate in an industrial land use scenario is 160 mg/L. During FY 2010, the average nitrate concentration was 35 mg/L based on 52 weekly grab sample results. None of the samples exceeded the 160 mg/L RBC.

Groundwater monitoring during FY 2010 showed that groundwater contaminant trends in monitored areas are relatively stable and changes from FY 2009 levels are minor. Increases in some VOC constituents were observed in groundwater at the BCBGs.

A new technical issue identified in Bear Creek Valley from an evaluation of FY 2010 data is the high uranium flux discharging from NT-8. DOE will be collecting surface water samples along a transect from the NT-8 flume upstream to the BCBGs fence to identify contaminant inputs. Additionally, records for the non-CERCLA groundwater seepage collection system in the NT-8 headwaters will be retrieved and system performance evaluated.

Because of improved stream riparian vegetation at the NT-3 site, DOE recommends that no further stream habitat or riparian vegetation monitoring will be conducted at that site. Similarly, improved habitat at the Bear Creek Weir restoration site suggests that stream habitat, riparian vegetation, and wetland monitoring are no longer needed and a recommendation to that affect is made.

4.3 COMPLETED SINGLE ACTIONS IN BEAR CREEK VALLEY WITH MONITORING AND/OR LTS REQUIREMENTS

4.3.1 BCV OU2 Remedial Action

Location of the Spoil Area 1 and SY-200 Yard (BCV OU 2) RA is shown on Figure 4.1. The primary objective of this action was to mitigate exposure to contaminated soil and waste left in place. The scope of the remedy was to address the principle threats at the sites by maintaining the existing waste covers and implementing specific access and use restrictions. Background information on this remedy and performance standards are provided in Chap. 4 of Vol. 1 of the 2007 RER (DOE 2007a). These sites have only stewardship requirements, which are provided in Table 4.2. A review of compliance with these stewardship requirements is included in Sect. 4.3.1.1.

No surface water or groundwater monitoring is required to verify the effectiveness of the RA.

4.3.1.1 Compliance with LTS Requirements

4.3.1.1.1 Requirements

Stewardship requirements specified in the BCV OU2 ROD (DOE 1996a) include physical barriers (fences, gates, and signs) to limit access to the site, deed restrictions to restrict construction at the sites and prohibit waste intrusion to mitigate direct exposure, and periodic physical surveillance of the soil cover and other features of the site and maintenance or repair, as required. Restrictions also require incorporation of indoor radon mitigative measures in accordance with EPA guidelines for any future structure built on-site. These sites are designated as restricted industrial use areas in the BCV Phase I ROD (DOE 2000c).

4.3.1.1.2 Status of Requirements for FY 2010

Spoil Area 1 and the SY-200 Yard sites were inspected quarterly by the Y-12 S&M Program in FY 2010 for items including erosion of the cover, integrity of surface drainage control systems, evidence of rodent damage, proper signage, unlocked gates, and the presence of unauthorized materials within the area. Minor maintenance was required at the SY-200 Yard including removal of saplings and vegetation from the rip-rap perimeter. Minor maintenance at Spoil Area 1 included replacing a stop sign that had fallen from the bar gate, and fixing a broken "Authorized Personnel Only" post sign. Both sites received routine mowing. In addition, the deed restrictions for both Spoil Area 1 and the SY-200 Yard were verified at the Anderson County Register's of Deeds office.

4.4 BEAR CREEK VALLEY MONITORING CHANGES AND RECOMMENDATIONS

Table 4.15 summarizes technical issues and recommendations for monitoring changes in the BCV Watershed.

Lack of well control in Zone 2 points to a need for pathways investigation and possible installation of new wells. Significant uranium discharge from NT-8 suggests a source and a need to determine upgradient pathways, as well as discharge points.

Stream channel stability monitoring of NT-3 has been completed at the BYBY. DOE now recommends that riparian monitoring and fish/macroinvertebrate monitoring also be discontinued.

Issues that have been completed or resolved are identified as such at the end of the table and will not be included in subsequent RERs.

Table 4.15. Summary of BCV Watershed technical issues and recommendations

Issue[a]	Action/Recommendation
2011 Current Issue	
1. Documented discharge of contaminants from upstream sources in NT-8. (2011 RER)[a]	1a. Surface water samples will be collected along a transect from the NT-8 flume upstream to the BCBG fence to identify inputs of uranium, VOCs, and PCBs to NT-8. 1b. Engineering design and operational records for the non-CERCLA groundwater seepage collection system in the NT-8 headwaters associated with BCBG D-West will be reviewed and the system performance will be evaluated.
Issue Carried Forward	
1. Monitoring results for Zone 1 of BCV exhibit trace-to-low contaminant concentrations in groundwater, thereby compromising the Phase I ROD goal to maintain clean groundwater acceptable for unrestricted use. (2010 RER)[b]	1. The contaminant concentrations have remained low and are observed intermittently at various monitoring locations. In FY 2010, concentrations continued to trend downward or were not observed at all. The intermittent plume in the Maynardville Limestone will continue to be monitored during FY 2011.
2. Results for BCK 9.2 show an increase in the proportion of ungauged uranium flux beginning in FY 2002. Increasing uranium trends are not observed at gauged monitoring stations, or in principal groundwater exit points contributing to Bear Creek surface flow. (2006 FYR)[b]	2. Uranium flux mass balance in the Bear Creek watershed is complicated by the karst groundwater system. However, during FY 2010 the mass balance between source area contribution and the BCK 9.2 total matched within an 1% (<1 kg). DOE is sending an Appendix I-12 letter to the regulators recommending re-instatement of flow paced monitoring at NT-3 and NT-5 and the creation of an additional flux monitoring station at BCK 10.15 (downstream of SS-4 but upstream of NT-7) to attempt to determine inputs to the stream channel from karst discharge. Flow calibration at BCK 10.15 is on-going in FY 2011.
3. In addition to surface water monitoring at the BYBY, the PCCR (DOE 2003d) specifies stream-stability monitoring, riparian vegetation monitoring, and in-stream biological monitoring of the restored NT-3 channel. (2008 RER)[b]	3. DOE completed the fifth and final year of stream-stability monitoring at BYBY during FY 2008. DOE recommends that in-stream and riparian vegetation monitoring be discontinued because of improved habitat and lack of a need for further actions.

Table 4.15. Summary of Bear Creek Valley Watershed technical issues and recommendations (cont.)

Issue[a]	Action/Recommendation
4. Five years of riparian monitoring has been completed at Bear Creek restoration site (BCK 4.55). (2011 RER)[a]	4. Monitoring has shown that the site is well on its way to recovery. Since a five year commitment to monitor recovery has been completed and the restoration site is in excellent condition it is recommended that no further monitoring be conducted.
Completed/Resolved Issues	
None.	

[a]An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

[b]The year in which the issue originated is provided in parentheses, e.g., (2006 FYR).

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5. CERCLA ACTIONS ON CHESTNUT RIDGE

5.1 CHESTNUT RIDGE OVERVIEW

This chapter provides an update to CERCLA actions completed on ChR, all of which have performance monitoring and LTS requirements. ChR is not physically situated within one of the five established watersheds, but is located south of Y-12 on the ORR (Figure 5.1). Because ChR is dissected by a number of small tributaries rather than forming a single defining hydrologic watershed, all completed remedies have been single-action decisions to address known or potential sources of releases. This chapter presents performance goals and objectives, monitoring results, and a technical assessment of the results for each completed action. A review of compliance with LTS requirements is included (Sect. 5.2.4, Sect. 5.3.4, and Sect. 5.4.4), as well as any proposed monitoring changes and recommendations.

For background information of each remedy and performance standards, a compendium of all CERCLA decisions in ChR is provided in Chap. 5 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated in the annual RER and republished every fifth year at the time of the CERCLA FYR. The status of ChR long-term CERCLA decision making is provided in Figure 1.5 of Vol. 1 of the 2007 RER (DOE 2007a).

Table 5.1 summarizes the CERCLA actions completed in ChR and Table 5.2 provides a summary of LTS requirements.

All of the actions to date along ChR have post-remediation monitoring and site inspection requirements.

5.1.1 Status and Updates

During FY 2010, no additional CERCLA actions were implemented or completed on ChR, nor were any associated FFA documents submitted or approved for CERCLA actions located on ChR. Monitoring in support of performance assessments and evaluations continued.

Three monitoring wells at the United Nuclear Corporation (UNC) Disposal Site (GW-203, GW-205, and GW-221) were redeveloped in September 2010 following FY 2010 groundwater sampling.

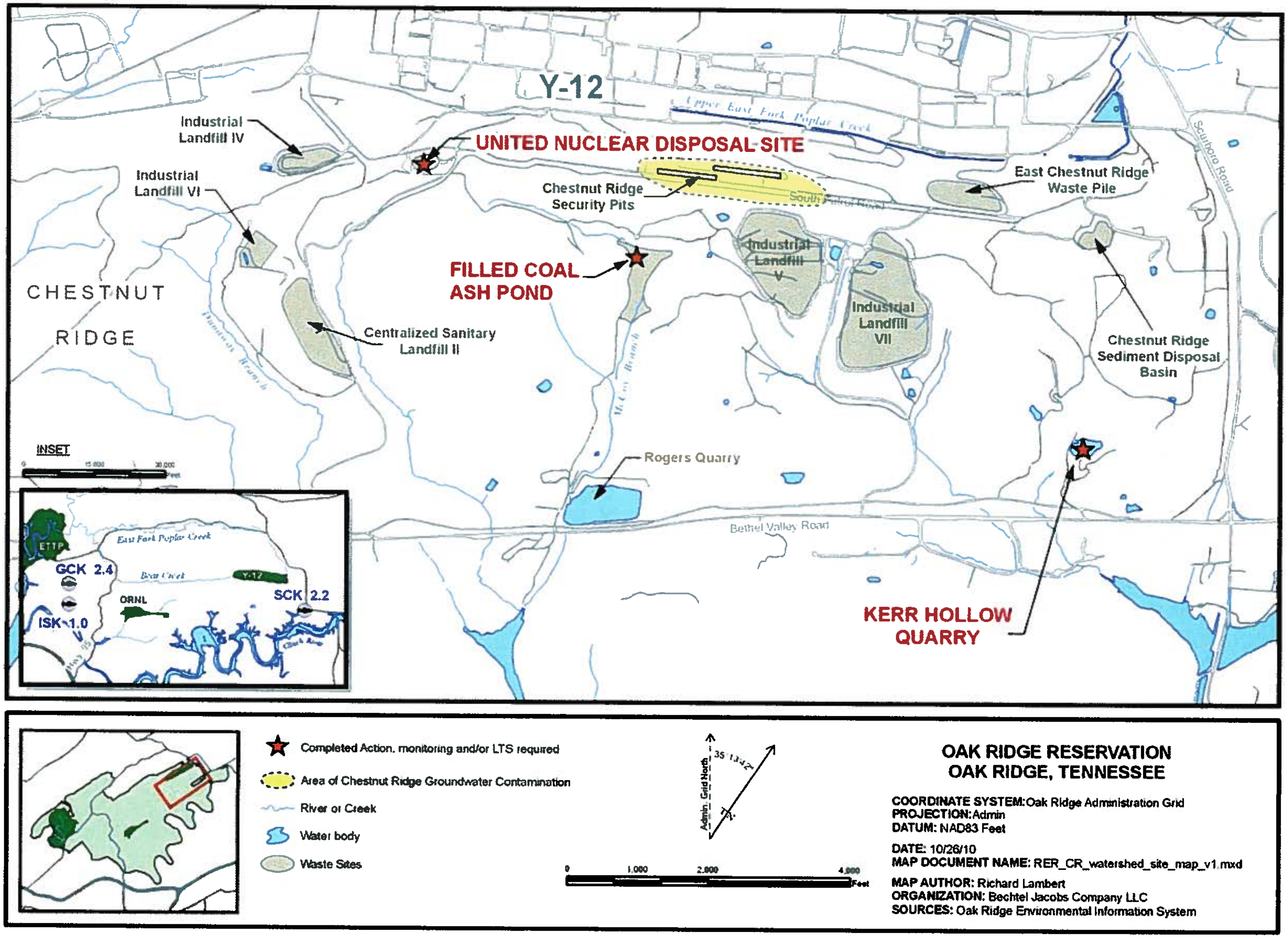

Figure 5.1. CERCLA actions in the Chestnut Ridge administrative watershed.

Table 5.1. CERCLA actions on ChR

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
UNC Disposal Site RA	ROD: 06/28/91	RA complete. PCR (DOE/OR/01-1128&D1) approved 09/06/94.	Yes/Yes	5.2
KHQ RA	NFA ROD[b] (DOE/OR/02-1398&D2): 09/29/95	RA completed under approved RCRA closure plan.	Yes/Yes	5.3
FCAP/Upper McCoy Branch RA	ROD (DOE/OR/02-1410&D3): 02/21/96	RA complete. RAR (DOE/OR/01-1596&D1) approved 06/3/97.	Yes/Yes	5.4

[a] Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <http://www.bechteljacobs.com/ettp_ffa_appendices.shtml>.
[b] CERCLA NFA ROD defers all monitoring and LTS/LUC requirements to the RCRA post-closure permits.

FCAP = Filled Coal Ash Pond
KHQ = Kerr Hollow Quarry
NFA = No Further Action
UNC = United Nuclear Corporation

Table 5.2. LTS requirements for CERCLA actions on ChR

Site/Project	LTS Requirements		Status	RER section
	LUCs	Engineering controls		
UNC Disposal Site RA	• Installation of access controls	• Maintain cap	• Engineering controls remain protective.	5.2.4
KHQ RA[a]	• Access controls (fences and locked gates) • Deed restrictions	• Inspections	• LUCs in place. • Engineering controls remain protective.	5.3.4
FCAP/Upper McCoy Branch RA	• Controls to limit access	• Inspect and maintain dam, slope, and spillway	• Engineering controls remain protective.	5.4.4

[a] All requirements deferred to RCRA post-closure permit.

FCAP = Filled Coal Ash Pond
KHQ = Kerr Hollow Quarry
UNC = United Nuclear Corporation

5.2 UNITED NUCLEAR CORPORATION DISPOSAL SITE REMEDIAL ACTION

The UNC Disposal Site is a 1.3-acre landfill located near the crest of ChR south of Y-12 (Figure 5.1 and Figure 5.2). The ROD for the UNC Site (DOE 1991a) was approved in June 1991. Field activities began in May 1992 and were completed in August 1992. Remedial activities included construction of a multilayer cover system, installation of access controls, and implementation of a groundwater monitoring program using existing wells.

A more complete discussion of the UNC closure and a summary of performance goals and requirements are provided in Chap. 5 of Vol. 1 of the 2007 RER (DOE 2007a). This waste disposal facility utilized an unlined excavation in the thick soils near the crest of ChR for retention of approximately 11,000 55-gal drums of cement-fixed sludge, 18,000 drums of contaminated soil and 288 wooden boxes of contaminated building and process equipment demolition debris from the UNC uranium recovery facility in Wood River Junction, Rhode Island. In addition, Formerly Utilized Sites Remedial Action Program (FUSRAP) waste from the Elza Gate site in Oak Ridge was placed in the site before the final multilayer cap was constructed to limit percolation of rainwater into the waste.

5.2.1 Performance Goals and Monitoring Objectives

The major goal of the UNC RA, per the ROD, is to "ensure that mobile contaminants in the UNC waste, principally nitrate and ^{90}Sr, are not leached to groundwater at a rate that would result in concentrations of these contaminants above safe drinking water standards." The FS for the UNC Site (DOE 1991b) included results of contaminant transport modeling that indicated possible impacts to groundwater including potential nitrate concentrations of as much as 193 mg/L and ^{90}Sr concentrations as great as about 50 pCi/L. The ROD stated that the expected performance of the remedy is to control contaminant migration so that nitrate is less than the SDWA limit of 10 mg/L and no more than 2 pCi/L of ^{90}Sr would occur in groundwater, which is within the CERCLA risk range of 10^{-4} to 10^{-6}. The ROD also states that groundwater concentration "is not expected to exceed 8 mg/L for nitrate." The PCR (DOE 1993a) specifies implementation of a groundwater monitoring program. Although specific frequencies, locations, and analytes are not mandated by the PCR, groundwater is monitored for COCs on which performance assessment is based (nitrate and ^{90}Sr).

5.2.2 Evaluation of Performance Monitoring Data – FY 2010

Groundwater monitoring was performed in FY 2010 at upgradient well 1090 and downgradient wells GW-203, GW-205, GW-221 and at a downgradient spring designated UNC SW-1 (Figure 5.2). Samples were analyzed for metals, nitrate, gross alpha and beta activity, and ^{90}Sr. Additional isotopic analyses were conducted on samples collected from well GW-205 as noted below. Data for nitrate, gross alpha and beta activity, and ^{90}Sr analyses for all wells are provided in Table 5.3. Potassium-40 was analyzed in well GW-205 and the UNC SW-1 (Table 5.3).

In FY 2010, nitrate concentrations downgradient of the site have remained well below the 10 mg/L SDWA MCL and the "not expected to exceed range" of 8 mg/L. Also, the downgradient concentrations, with the exception of Q4 sample from well GW-203, were below the concentrations in the upgradient well. In FY 2010, ^{90}Sr was not detected in any monitoring locations.

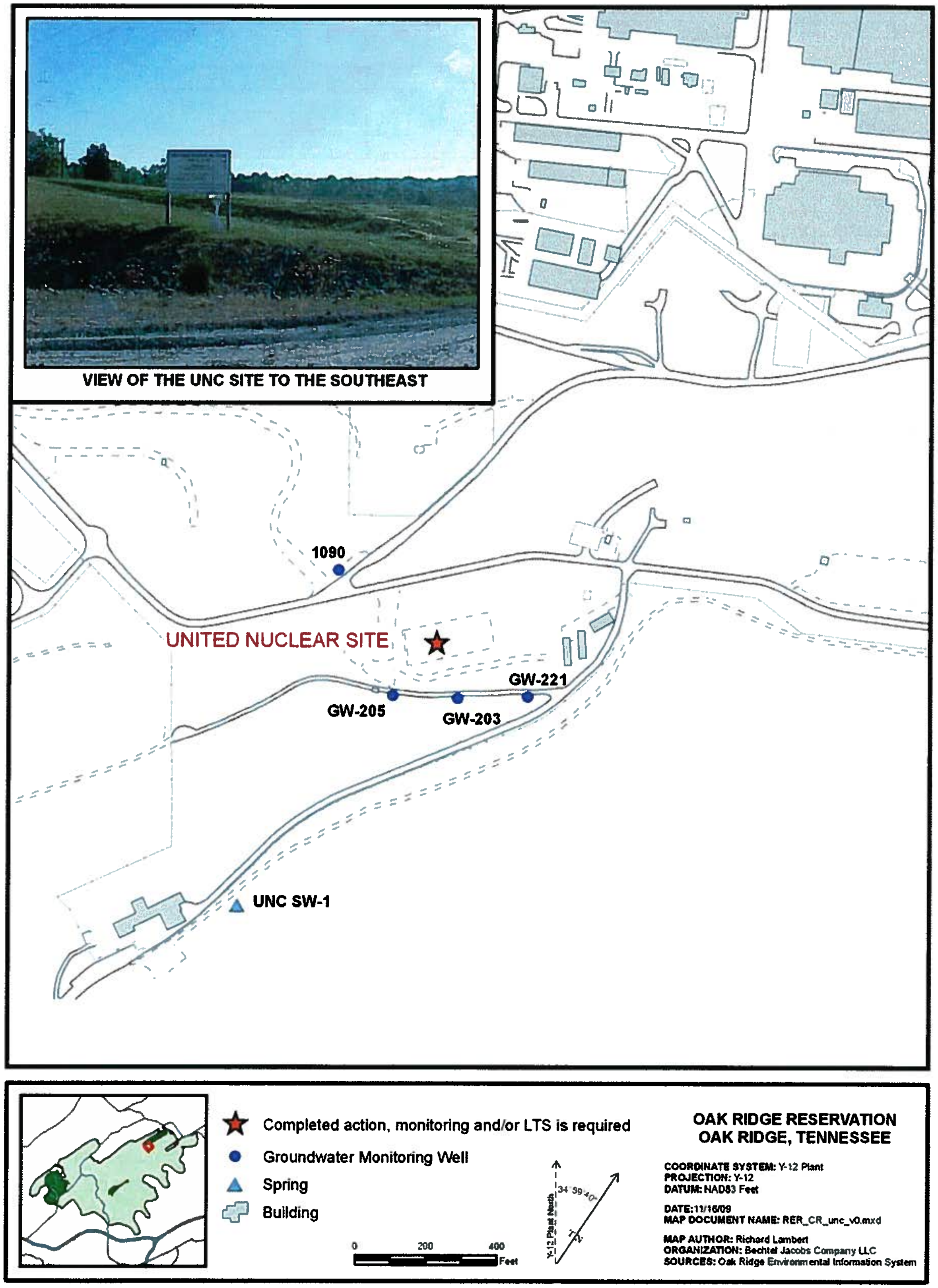

Figure 5.2. United Nuclear Corporation site map.

Table 5.3. Analytical results for performance indicator constituents at the UNC Site, FY 2010

	Upgradient well	Downgradient wells			Downgradient spring
Date	**1090**	**GW-203**	**GW-205**	**GW-221**	**UNC SW-1**
Nitrate (mg/L)					
Q2-10	0.77	0.55	0.058	0.54	0.12
Q4-10	0.75	1.1	0.19	0.41	0.056
Gross alpha (pCi/L)					
Q2-10	<2.57 U	<3.23 U	<3.45 U	<3.53 U	<2.62 U
Q4-10	<1.77 U	<2.57 U	<2.01 U	<2.0 U	2.33
Gross beta (pCi/L)					
Q2-10	<3.53 U	<4.47 U	15.7±3.08	<4.46 U	<3.77 U
Q4-10	<2.69 U	<3.38 U	**50.6±3.69**	<3.59 U	<3.71 U
^{90}Strontium (pCi/L)					
Q2-10	<2.45 U	<1.75 U	<2.48 U	<1.97 U	
Q4-10	<1.84 U	<1.93 U	<1.93 U	<2.36 U	
^{40}Potassium (pCi/L)					
Q2-10	-	-	124 J	-	<136 U
Q4-10	-	-	<161 U		260 J

Bolded value indicates gross alpha above the drinking water MCL level [15 picoCuries per liter (pCi/L)] or gross beta above the effective dose equivalent (50 pCi/L) to the drinking water MCL (4 mrem/yr).

GW = groundwater well
U = Not detected or result less than minimum detectable activity

Gross alpha activities have remained well below the 15 pCi/L MCL in FY 2010. With the exception of well GW-205, gross beta activity in groundwater at the site was below the 50-pCi/L screening value for compliance with a 4-mrem/yr dose limit for man-made radionuclides. Gross beta results in FY 2010 for well GW-205 were 15.7 and 50.6 pCi/L, which is consistent with results in previous years.

The history of monitoring at well GW-205 started in 1987. In 1998 the well purge method was changed from a standard 3-well-volume method to low-flow purging. Contemporaneous with that change, pH, conductivity, beta activity and potassium concentrations increased, possibly an indication of grout or other alkaline material influence on local groundwater. Prior to the sampling method change the pH ranged between 7.5 and 8.5 and, following the method change, the pH has ranged between 9.5 and 10.5. During FY 2010, the pH at well GW-205 was 9.26 in March and 9.61 in August, which is consistent with past data.

During FY 2010, ^{40}K was reported in the radiological analyses conducted on site groundwater (well(GW-205) and surface water (UNC SW-1). One sample from well GW-205 contained an estimated 124 pCi/L, while one sample from the surface water location contained an estimated 260 pCi/L of ^{40}K. However, as discussed in the 2009 RER, natural potassium in the environment (in bedrock, soils, and groundwater) contains a known natural abundance of ^{40}K. The concentration of radioactive ^{40}K based on its natural abundance in total elemental potassium has been calculated for all samples from GW-205. The calculated ^{40}K activities closely track (within ~20 pCi/L except for a single outlier) the beta activity values indicating that increased potassium concentrations that are detected under lower stress sampling are responsible for the increase in beta activity. Analyses for other beta-emitting radionuclides (^{99}Tc, ^{90}Sr) have not detected site-related contaminants other than low concentrations of ^{90}Sr, which was not detected in FY 2010.

Figure 5.3 shows the measured beta activity, the computed beta activity attributable to the total potassium in groundwater samples, and the residual beta activity that would not be attributable to the natural potassium. Several of the samples had measured beta activities less than the computed potassium beta and, therefore, negative residual results are not plotted. As shown, the typical residual beta activity is near or less than 20 pCi/L, with the exception of the single elevated beta value measured in July 2006. Numeric drinking water criteria do not exist for the gross beta screening measurement in water supplies. This is because beta activity is a general measure of radioactivity and risk factors for different beta-emitting radionuclides vary. However, various agencies have selected target levels ranging from about 25 to 50 pCi/L, above which further identification of radionuclides and evaluation of risk is indicated.

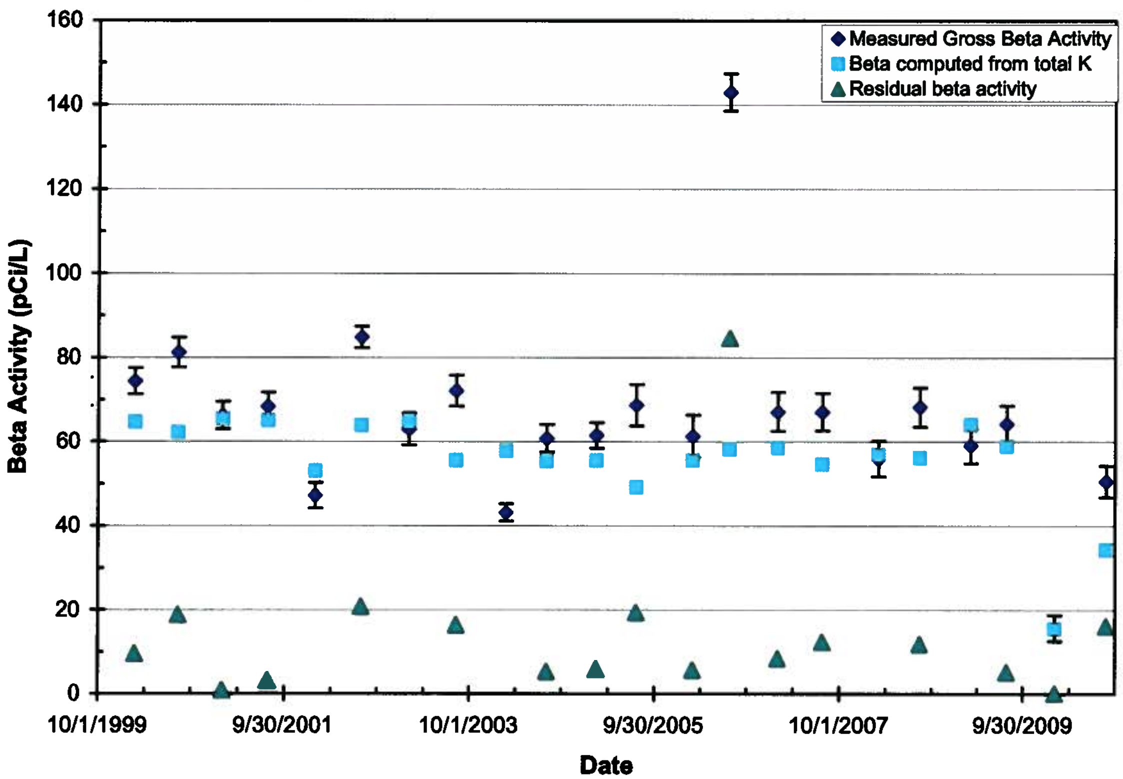

Figure 5.3. Well GW-205 measured and computed beta activity.

Table 5.4 presents the ^{90}Sr analytical results for the four monitoring wells at the UNC site for FY 2000 through FY 2010. Strontium-90 has been detected sporadically at low concentrations in groundwater adjacent to the UNC site but was not detected at any of the monitoring locations during FY 2010. The FY 2006 17.8 pCi/L result from well GW-205 exceeded the MCL EDE but was below the UNC site FS estimate of a maximum groundwater ^{90}Sr concentration of 50 pCi/L. During the spring of FY 2008, ^{90}Sr was detected at about 2.5 pCi/L in well GW-221. This result is similar to the level detected in this well during FY 2006.

During FY 2010, surface water was sampled at the nearest downgradient spring location (UNC SW-1) to determine if site related contaminants affect surface water. Analytical results indicate that nitrate and beta activity levels are below drinking water criteria and are similar to results from site monitoring wells.

Table 5.4. UNC Site groundwater ^{90}Sr results,[a] FY 2000 through FY 2010

Sample date	1090	GW-203	GW-205	GW-221
Feb-99	<1.4 U	0.82 J	<1.54 U	1.16 J
Aug-99	<1.48 U	<1.67 U	<1.47 U	<1.68 U
Feb-00	<3.15 U	<3.14 U	<3.34 U	<3.25 U
Aug-00	2.22 J	<1.73 U	<4.33 U	<2.08 U
Jan-01	<1.7 U	<1.8 U	0.53 J	0.15 J
Jul-01	0.5 J	<2.39 U	<1.47 U	0.23 J
Jan-02	0.16 J	<1.56 U	0.51 J	0.6 J
Jul-02	<1.92 U	1.28 J	<1.91 U	<1.46 U
Feb-03	<1.57 U	<1.39 U	<1.64 U	<1.59 U
Aug-03	1.39 J	<1.37 U	<1.44 U	1.3 J
Feb-04	0.73 J	<0.99 U	<0.97 U	<1.04 U
Aug-04	<1.06 U	0.65 J	<0.96 U	0.73 J
Feb-05	0.61 J	<1.05 U	<1.18 U	<1.04 U
Jul-05	<1 U	<0.96 U	<1.76 U	<1 U
Mar-06	<1.03 U	<1.36 U	<1.41 U	<1.13 U
Jul-06	1.21 J	1.34 J	**17.8**	2.83
Jan-07	<0.407 U	<0.437 U	<0.433 U	<0.443 U
Jul-07	<0.617 U	<0.613 U	<0.184 U	<0.518 U
Mar-08	< 1.72 U	< 2.11 U	< 1.84 U	2.49 ± 1.11
Aug-08	<- 1.89 U	< 2.04 U	< 2.12 U	< 2.08 U
Mar-09	< 1.54 U	< 1.92 U	< 1.61 U	< 1.61 U
Jul/Aug-09	< -1.84 U	< 1.93 U	< 2.3 U	< 2.16 U
Jan/Feb 10	< 1.19 U	< 1.75 U	< 1.93 U	< 1.97 U
Aug 10	< 1.84 U	< 2.45 U	< 2.42 U	< 2.36 U

[a]All values pCi/L.

Bolded value exceeds 8 pCi/L EDE to the beta particle and photon activity MCL of 4 mrem/yr.
J = estimated value
U = reported concentration was below the minimum detectable activity

5.2.3 Performance Summary

As discussed in previous RERs, elevated gross beta activity continues to be observed in downgradient well GW-205 at the UNC site, suggesting a potential contaminant release from the site. The gross beta activity does not appear to be caused by ^{90}Sr, but does track closely to ^{40}K. A downgradient spring, added to the monitoring network in FY 2008 to assess the potential impacts of the UNC groundwater seepage on surface water quality, exhibits data consistent with results from other downgradient monitoring wells at the site that do not detect any COCs above an action limit.

5.2.4 Compliance with LTS Requirements

5.2.4.1 Requirements

The PCR (DOE 1993a) requires that surveillance activities continue for 30 years from RA completion to ensure that the cap is adequately containing the waste in the site (see Table 5.2). UNC RA construction was completed in August 1992. Specific requirements include a visual inspection of the cap be conducted quarterly for the first two years after construction, and semiannually thereafter. If necessary, restorative measures will be implemented. Minor deficiencies such as damaged drains or signs will be noted on the inspection forms and corrected. However, major deficiencies such as the collapse of the cap or major erosion problems will be reported. Required routine maintenance of the site includes mowing and replacement of any topsoil and vegetation, as required.

5.2.4.2 Status of Requirements for FY 2010

All components of the UNC site were inspected semiannually in FY 2010 by the Y-12 S&M Program, including erosion or settlement of the cover, integrity of surface drainage, evidence of rodent damage, proper signage, and integrity of benchmarks and monitoring wells. Minor maintenance included repair of a damaged sign stating "No Unauthorized Vehicles" and routine mowing. Additionally, the UNC site is located within Y-12 property protection area and, as such, is not accessible to the public. The area is routinely patrolled by Y-12 security personnel.

5.2.5 Monitoring Changes and Recommendations for the UNC

No changes to monitoring at the UNC site are recommended at this time.

5.3 KERR HOLLOW QUARRY REMEDIAL ACTION

The ROD (DOE 1995a) for Kerr Hollow Quarry (KHQ) (Figure 5.1 and Figure 5.4) presents the decision for NFA at the site, deferring all monitoring, reporting, and maintenance requirements to the RCRA post-closure permit (TDEC 1996) and amendments. Because the RCRA closure left contaminated material in place, the permit requires monitoring of groundwater. The RCRA post-closure permit for the ChR Hydrogeologic Regime was reissued in September 2006 (TDEC 2006), changing monitoring requirements from semiannual to annual beginning in January 2007.

A more complete discussion of the closure of KHQ and a summary of the regulatory history of the site are provided in Chap. 5 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated in the annual RER and republished every fifth year in the CERCLA FYR.

5.3.1 Performance Goals and Monitoring Objectives

The objective of the site closure was to prevent physical exposure to contaminants within the quarry and mitigate migration of contaminants to groundwater or surface water runoff. The RCRA closure was deemed protective of human health and the environment under CERCLA, resulting in the NFA ROD. The RCRA post-closure permit for the ChR Regime specifies annual detection monitoring, alternating between seasonally high and low flow conditions, to identify any potential future releases to groundwater from the unit. Statistical analysis for groundwater target list compounds is conducted for each annual sampling event. The statistical procedure included in the RCRA permit involves three steps: (1) comparison to a background value (e.g., a calculated upper tolerance limit), (2) trend analysis (Kendall-Tau method or equivalent) if the background value is exceeded, and (3) if the results fail the trend analysis, verification sampling is conducted. If statistically significant contamination is detected in groundwater at the site while conducting monitoring in accordance with the permit, notification is provided in accordance with the terms of the permit and any necessary remediation will be addressed under CERCLA.

The ROD states that monitoring of the surface water discharge point (Outfall 301) from the quarry will be performed as a best management practice (BMP). Because the outfall was typically dry, DOE obtained approval to discontinue monitoring of Outfall 301 at the quarry in 2002.

5.3.2 Evaluation of Performance Monitoring Data – FY 2010

During FY 2010, annual groundwater monitoring was conducted in upgradient/background well GW-231 and in downgradient/point-of-compliance wells GW-143, GW-144, and GW-145 (Figure 5.4) for metals, VOCs, and gross alpha and gross beta. Statistical analyses of target constituents were conducted in accordance with the post-closure permit requirements. Monitoring results and statistical analyses are reported to TDEC in post-closure permit monitoring reports. Site-specific background values were determined for each inorganic target list constituent using historical data for upgradient wells along ChR and including current monitoring results for upgradient well GW-231. Groundwater samples from all of the downgradient wells at the site had target list constituent concentrations below the applicable background values during FY 2010. Therefore, a release of target list constituents to groundwater is not indicated at KHQ and NFA was necessary per requirements of the post-closure permit.

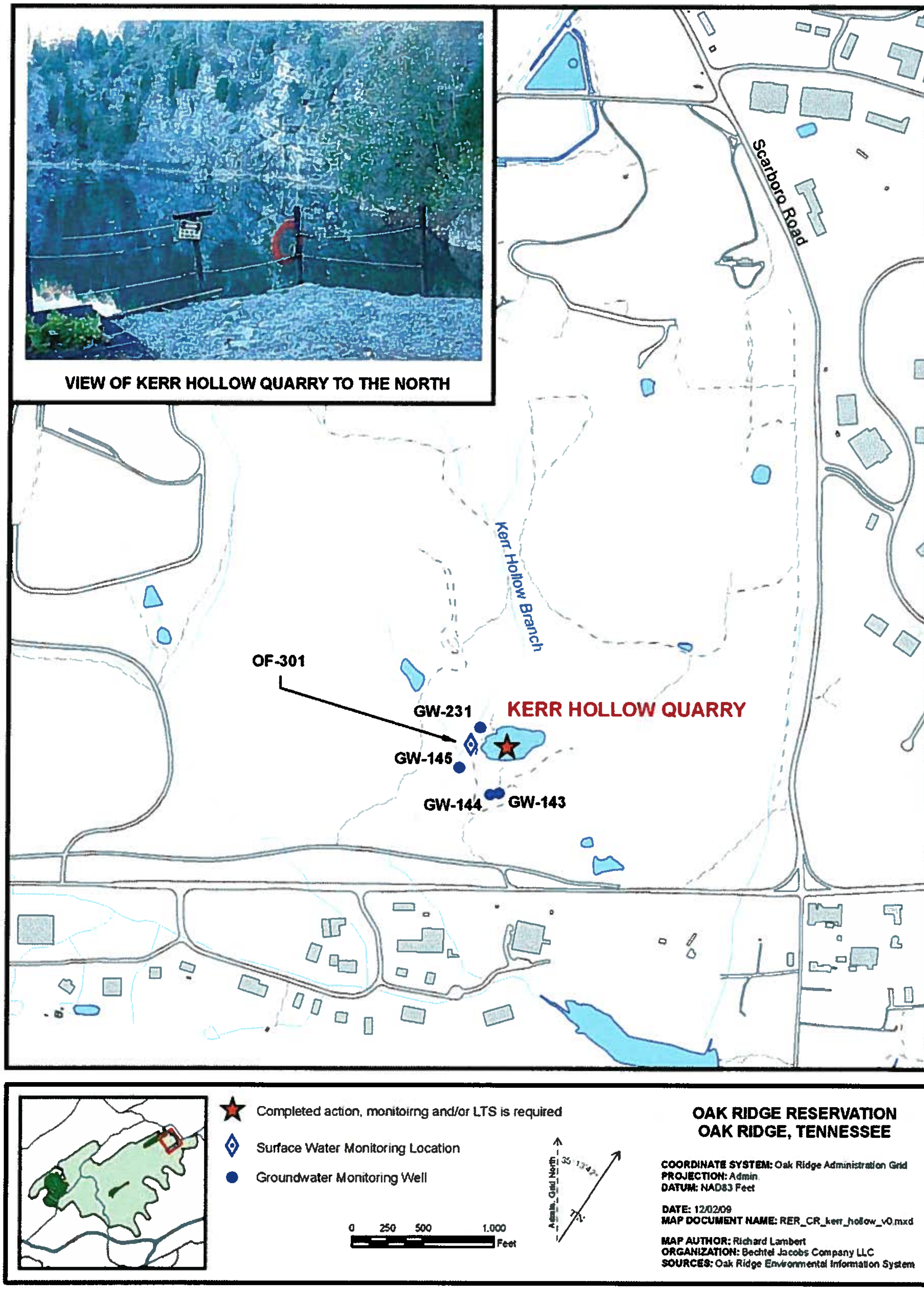

Figure 5.4. Kerr Hollow Quarry site map.

5.3.3 Performance Summary

Results of statistical evaluations of FY 2010 groundwater analytical data for KHQ do not indicate a contaminant release for the uppermost aquifer and do not warrant any response action specified in the post-closure permit that governs the site.

5.3.4 Compliance with LTS Requirements

5.3.4.1 Requirements

The KHQ ROD (DOE 1995a) does not specify any LTS requirements; however, the RCRA post-closure permit requires that all security components, signage, survey benchmarks, and monitoring systems at KHQ be inspected quarterly throughout the post-closure care period of 30 years (see Table 5.2). Final closure certification for the site was February 22, 1995. As a RCRA closure, deed restrictions were required to be filed at the County Court House Register's of Deeds office.

5.3.4.2 Status of Requirements for FY 2010

KHQ was inspected quarterly in FY 2010 by the Y-12 S&M Program for items including proper signage; integrity of benchmarks and monitoring wells including downhole condition; condition of the fences, gates, and locks; and condition of the access road. Minor maintenance included mowing and removing fallen trees from across the upper access road. In FY 2010, the Y-12 S&M Program removed miscellaneous debris from the site remaining from the remediation. B-25 boxes, flex floats and vegetation were removed from the characterization area (CA) (spillway and decon pad), which allowed the area to be down-posted to a fixed contamination area.

Additionally, the KHQ is located outside Y-12 property protection area; therefore, separate security fencing and signs exist at the site. The KHQ deed restrictions were filed on April 28, 1994 at the Anderson County Register's of Deeds Office and remain in place.

5.3.5 Monitoring Changes and Recommendations for KHQ

If statistically significant contamination is detected in groundwater at the site while conducting monitoring in accordance with the RCRA post-closure permit, any necessary remediation will be addressed under CERCLA.

No changes to monitoring at KHQ are recommended at this time.

5.4 FILLED COAL ASH POND/UPPER MCCOY BRANCH REMEDIAL ACTION

The Filled Coal Ash Pond (FCAP) is situated south of Y-12 along the southern slope of ChR (see Figure 5.1 and Figure 5.5). The ChR OU2 ROD was approved on February 21, 1996 (DOE 1996b) to remediate FCAP and vicinity. The RAR was approved on June 3, 1997 (DOE 1997a) documenting the following actions: the crest of the dam was raised, the face of the dam was reinforced, a subsurface drain was installed, large trees were removed from the face of the dam, the emergency spillway was repaired (including removal of the steep slope to the east of the spillway), a settling basin and oxygenation weir were constructed at the foot of the dam, and a small wetland was replaced downstream of the settling basin. The RA also includes long-term monitoring of the dam and controls to limit access.

A more complete discussion of the FCAP remedy and a summary of performance goals and requirements are provided in Chap. 5 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated in the annual RER and republished every fifth year at the time of the CERCLA FYR.

5.4.1 Performance Goals and Monitoring Objectives

The goal of the response action is to reduce risk posed by the site to "plants, animals and humans by: (1) upgrading containment of the coal ash with dam improvements and stabilization, (2) reducing contaminant migration into Upper McCoy Branch with a passive treatment system (existing wetland), and (3) restricting human access to the contamination by implementing institutional controls." The functional goals per the ROD are to do the following:

- minimize the migration of contaminants into surface water,
- minimize direct contact of humans and animals with the ash,
- reduce the potential for future failure of the dam, and
- preserve the local habitat in the long term.

The ROD requires that surface water be periodically sampled "and analyzed to verify that the passive treatment system reduces contaminant levels in water entering Upper McCoy Branch at least as well as the existing wetland and to evaluate whether the passive treatment system requires maintenance." The RAR (DOE 1997a) specifies that surface water samples "be collected and analyzed for the primary COCs (aluminum, arsenic, iron, manganese, and zinc) and other constituents of relevance to evaluating wetland performance at the site." Two locations, one at the influent to the wetland [McCoy Branch kilometer (MCK) 2.05] and one below the wetland (MCK 2.0), are monitored for metals, anions, radionuclides, and water quality parameters on a semiannual basis. Both monitoring locations are downstream of the contaminant source.

Monitoring of biological communities is conducted to evaluate protection of the ecosystem in the FCAP vicinity in accordance with applicable or relevant and appropriate requirements (ARARs) for protection of aquatic resources specified in the ROD. Biological communities are monitored near the wetland (MCK 1.9) and also below the Rogers Quarry dam (MCK 1.4 and MCK 1.6). Fish are also collected from Rogers Quarry for contaminant analysis on an annual basis.

5.4.2 Evaluation of Performance Monitoring Data – FY 2010

Results for surface water monitoring at FCAP in FY 2010 did not exceed the upper range of baseline values from pre-remediation monitoring conducted in 1996. Results for pre-remediation baseline monitoring and FY 2010 monitoring are presented in Table 5.5 and Table 5.6, respectively. The results are for unfiltered samples taken at locations above and below the wetland.

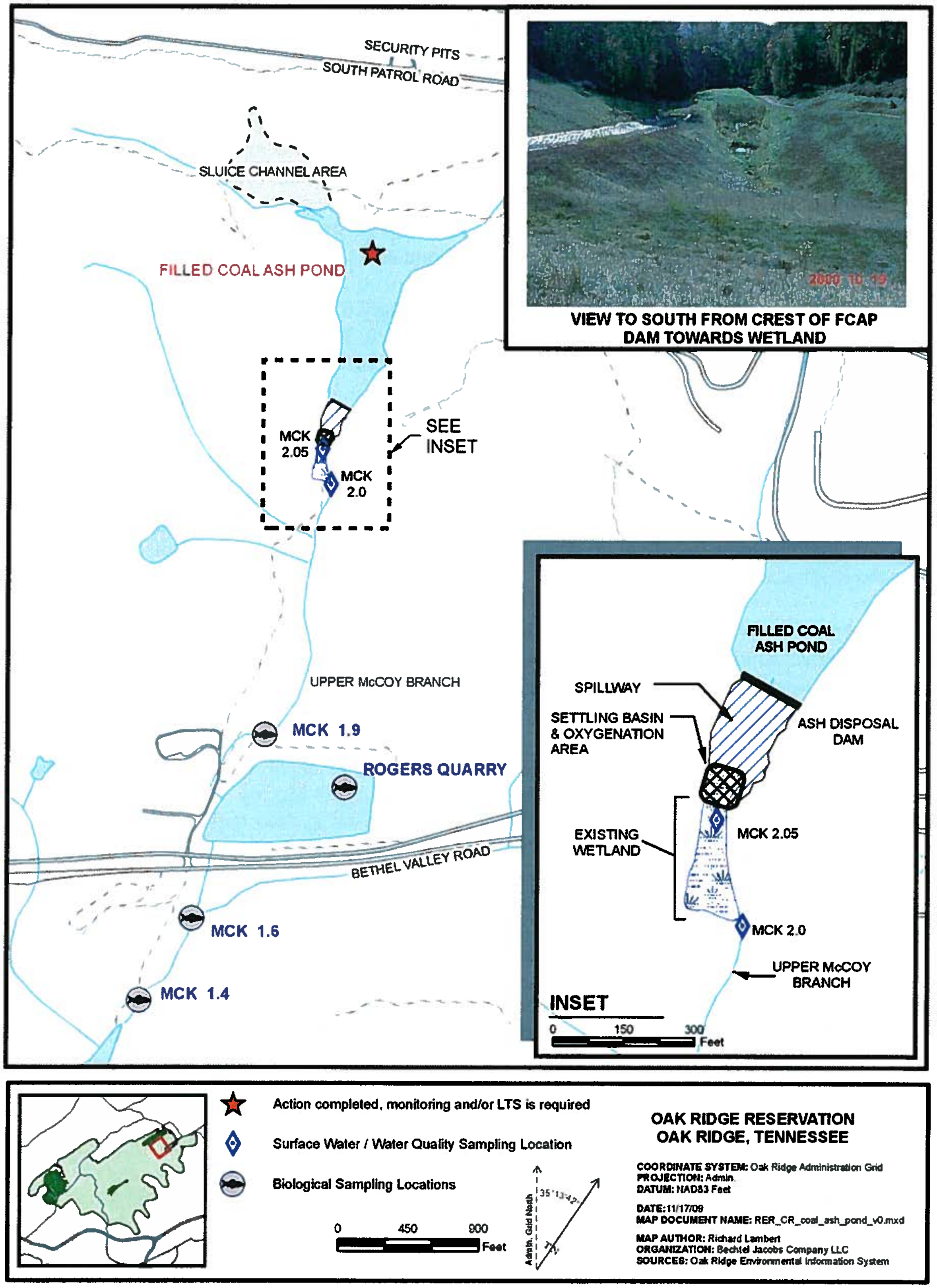

Figure 5.5. Filled Coal Ash Pond site map.

Table 5.5. Summary of FCAP pre-remediation monitoring results, 1996

Analyte	Units	MCK 2.05[a]	MCK 2.0[b]
Arsenic	mg/L	0.007–1.4	0.029–1.2
Iron	mg/L	5.6–43	0.6–48
Manganese	mg/L	0.47–3.8	0.6–39.0
Zinc	mg/L	0.0094–0.056	ND-0.2

[a]Dam effluent/wetland influent.
[b]Wetland effluent.

ND = not detected

Table 5.6. Summary of FY 2010 post-remediation data from MCK 2.05 and MCK 2.0

		Wet-season sample		Dry-season sample		
Analyte	Units	MCK 2.05[a] Mar-10	MCK 2.0[b] Mar-10	MCK 2.05[a] Sep-10	MCK 2.0[b] Sep-10	AWQC
Aluminum	mg/L	<0.1 U	0.1	<0.1U	0.1	N/A
Arsenic	mg/L	**0.029**	**0.012**	**0.16**	**0.019**	0.01[c]
Iron	mg/L	0.8	0.16	8	0.32	N/A
Manganese	mg/L	0.66	0.12	1.7	0.23	N/A
Zinc	mg/L	<0.01 U	<0.01U	<0.01 U	<0.01 U	0.12[d]

[a]Dam effluent/wetland influent.
[b]Wetland effluent.
[c]Source: TDEC 1200-4-3-.03(4) recreation criteria for organisms only.
[d]Source: TDEC 1200-4-3-.03(3) criterion continuous concentration for protection of fish and aquatic life. AWQC for zinc are hardness dependent. *The 0.12 mg/L AWQC for zinc is based on the most conservative criterion for hardness.*

Bold value indicates sample concentration exceeds AWQC.
N/A = not applicable
U = not detected

The FY 2010 concentrations of COCs (Al, As, Fe, Mn, and Zn) above (MCK 2.05) and below (MCK 2.0) the wetland showed that, although the wetland does attenuate arsenic levels in the site discharge, arsenic exceeded the AWQC in both the upstream and downstream locations. The March 2010 results, representing the wet-season results, are typically lower than the dry-season results although the iron and manganese levels were high in the September samples. Results for COCs presented in Table 5.6 show a consistent pattern of the COC concentration in the wetland influent (MCK 2.05) greater than the concentration in the wetland effluent (MCK 2.0). In FY 2010, only arsenic exceeded the AWQC at FCAP although concentrations have decreased since the RA.

The historic data presented in Figure 5.6 shows that elevated measurements in the upstream location (MCK 2.05) are almost ten times higher for iron than observed downstream of the wetland. The elevated measurements appear to occur when oxyhydroxide precipitate conditions are observed in the FCAP leachate, consistent with low rainfall conditions. The reduction factors for arsenic between the upstream and downstream monitoring locations range from a low of 25% to a high of >99% with an average of about 74% between FY 1998 and FY 2010.

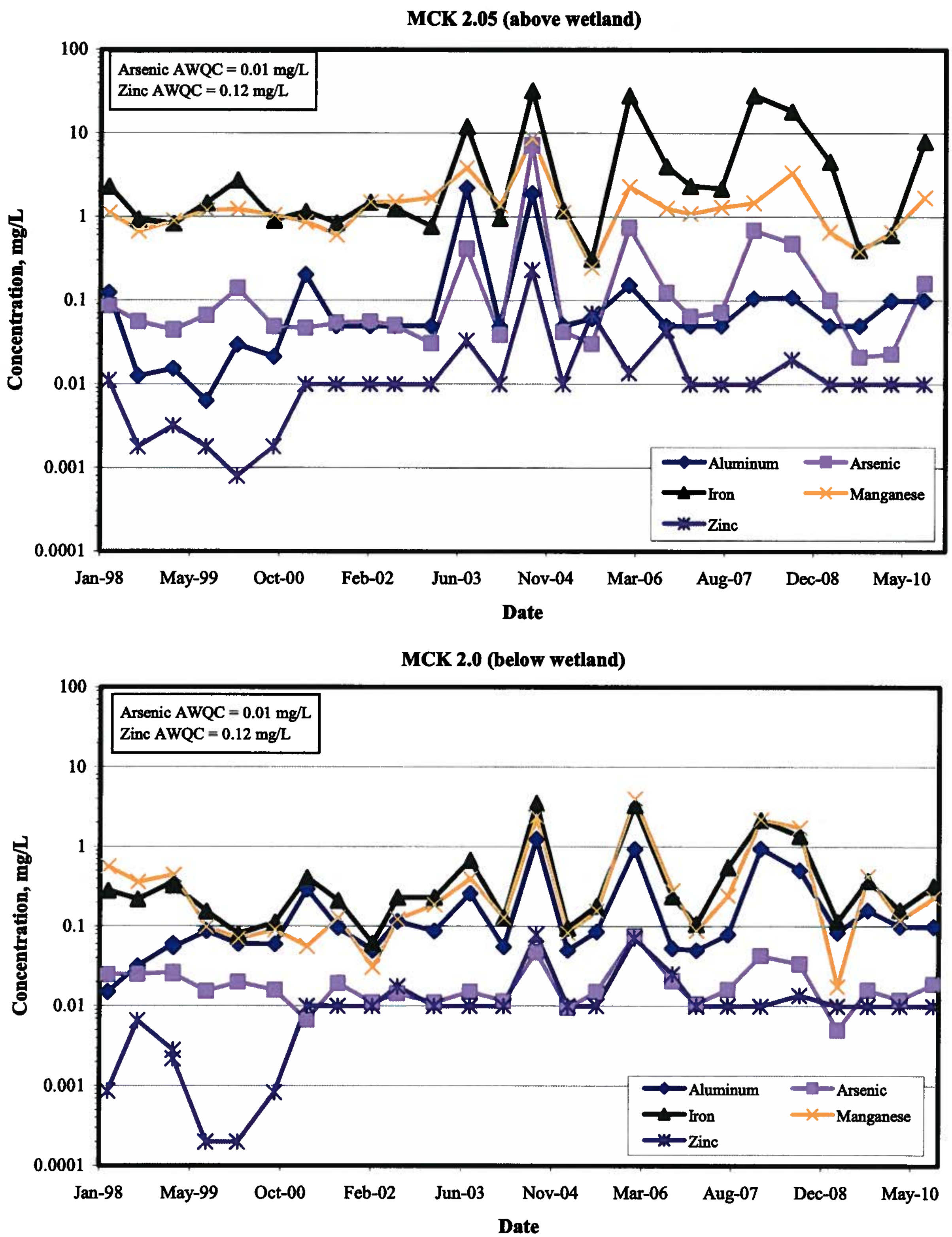

Figure 5.6. Historic data at MCK 2.0 and MCK 2.05 between FY 1998 and FY 2010.

5.4.2.1 Other Surface Water Monitoring

5.4.2.2 Biota Monitoring Results

Fly-ash disposal from Y-12 into the FCAP, as well as direct disposals of ash into Rogers Quarry, affected water quality in the lower reaches of McCoy Branch and the quarry. Biological monitoring studies have documented contaminants in fish and impacts to biota in the lower reaches of the McCoy Branch watershed and Rogers Quarry. To evaluate in-stream exposure and potential human health risks in the McCoy Branch watershed, adult largemouth bass are collected from Rogers Quarry and analyzed for bioaccumulation of key COCs. An evaluation of overall ecological health in the stream is conducted by monitoring the fish and benthic macroinvertebrate communities.

Average selenium concentrations in largemouth bass in Rogers Quarry decreased from 2.2 µg/g in 2009 to 1.3 µg/g in 2010, but remained above typical background concentrations (0.5 µg/g), suggesting possible continuing low level inputs from the FCAP site (Figure 5.7). A 2001 selenium result near 6 µg/g was considered spurious given the much lower concentrations prior to and after 2001, and removed from the temporal trend line. Arsenic concentrations continued to be near background levels. Average mercury concentrations in bass from Rogers Quarry increased to 0.76 µg/g, but remained within the range of values observed in the last decade. The concurrent increase in Hg levels with a reduction in Se levels in muscle tissue in bass is consistent with the long-term trend of negative relationships between Hg and Se in these fish. Se has been shown to have an antagonistic effect on mercury bioaccumulation (Figure 5.7).

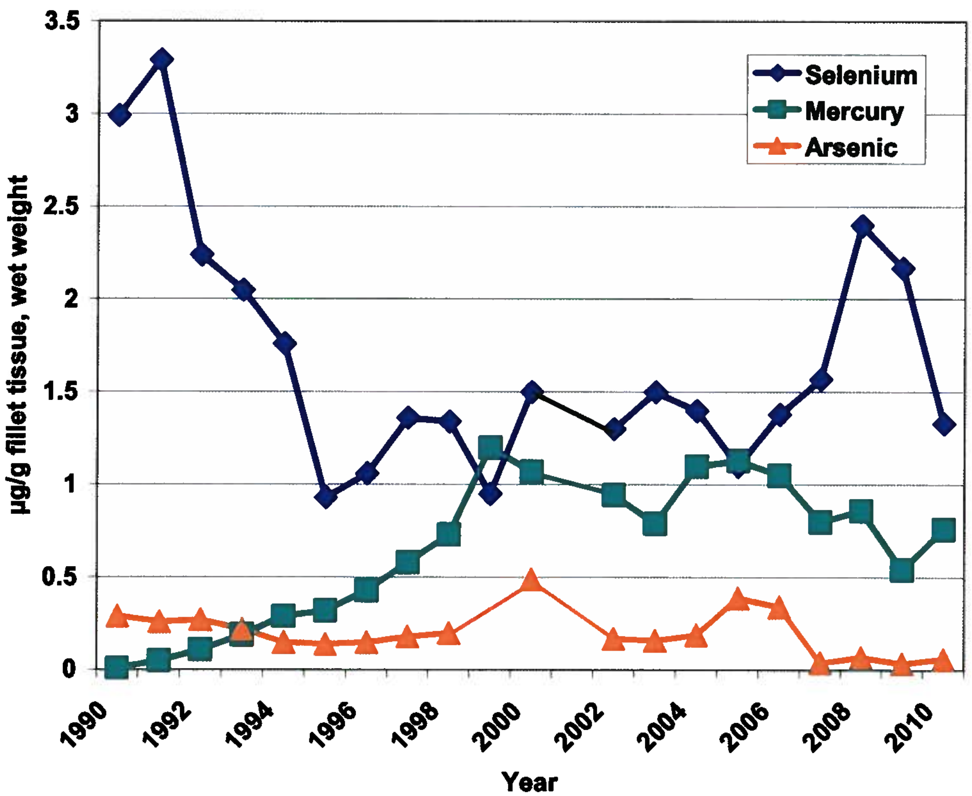

Figure 5.7. Mean concentrations of selenium, mercury, and arsenic in fillets of largemouth bass from Rogers Quarry.

The species richness (number of species) of the fish community at MCK 1.6 in McCoy Branch had been increasing in the last two years, but sampling in 2010 showed a marked decrease in values (Figure 5.8). This decrease may be related to limited flow, especially for the fall 2010 sample. The species richness at MCK 1.9 remained stable, where introduction of the western blacknose dace appears to be successful. Additional introductions of appropriate fish species, such as the creek chub, may be initiated in the coming year.

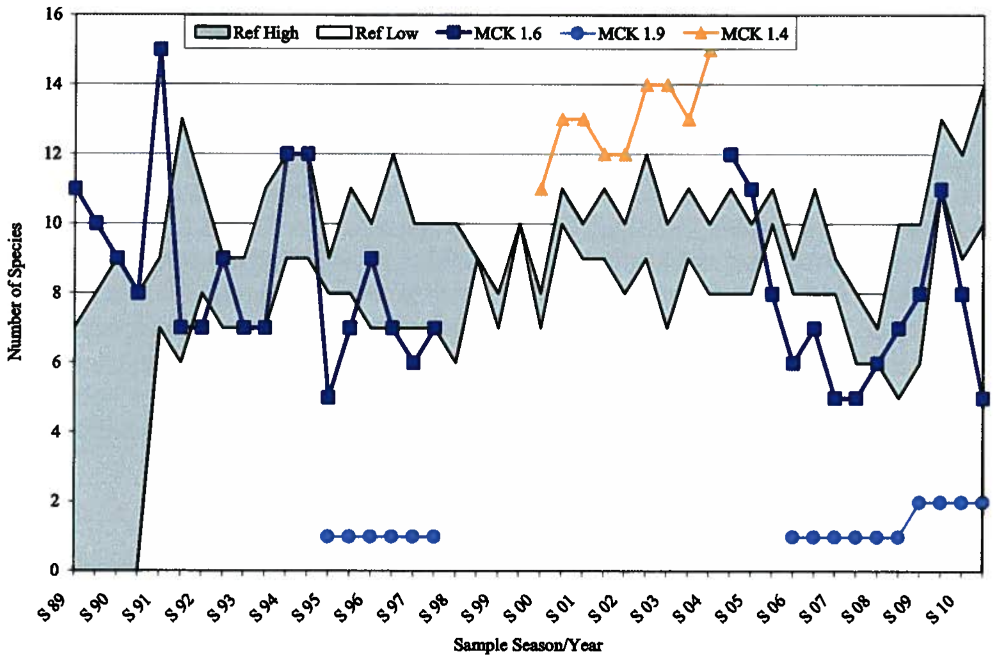

Figure 5.8. Species richness (number of species) in samples of the fish community in McCoy Branch (MCK) and three reference streams, Scarboro Creek (SCK), Grassy Creek (GCK), and Ish Creek (ISK) 1989–2010 (See Figure 5.1 for locations of reference sampling sites).

The number of pollution-intolerant benthic macroinvertebrate taxa at the most downstream site in McCoy Branch (MCK 1.4) continues to show strong seasonal differences, but in contrast to previous years, there is little difference between this site and the reference sites in either season (Figure 5.9). The most upstream site (MCK 1.9) continues to exhibit much less change between seasons, but after 2006 there appears to have been a reduction in the number of pollution-intolerant taxa present in April. The cause of reduced numbers of taxa at this site is not known.

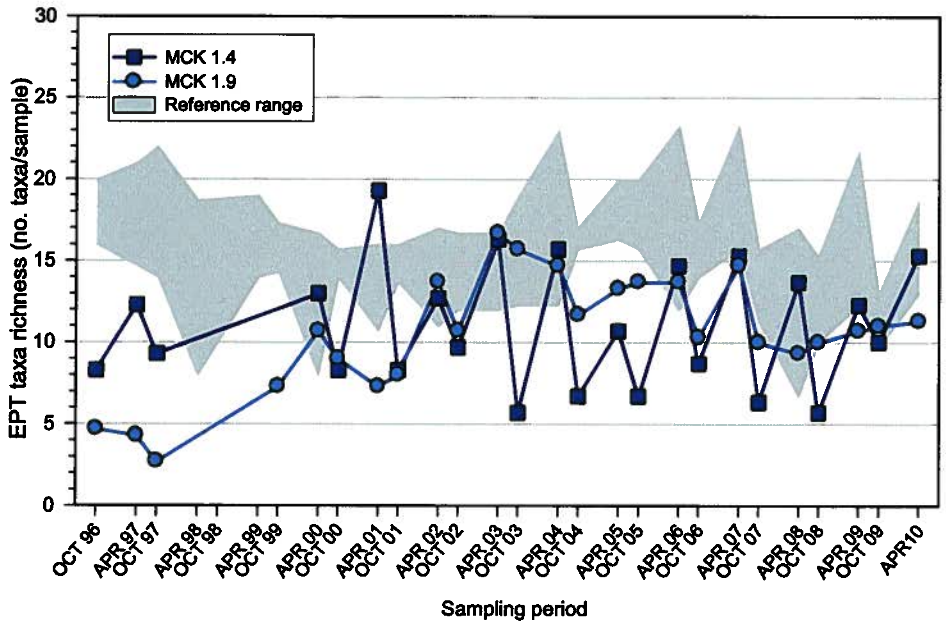

Figure 5.9. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in McCoy Branch, and range of mean values among reference streams (First Creek, Fifth Creek, Gum Hollow Branch, Mill Branch, Walker Branch, and WOC), 1996–2010.

5.4.3 Performance Summary

The monitoring results since the RA indicate that the remedy is successfully lowering the concentration of COCs in surface water as it exits the wetland. Arsenic concentrations, however, generally exceeded the AWQC in both the upgradient and downgradient locations at the FCAP wetland although concentrations have decreased since implementation of the RA. Biological indicators show that McCoy Branch is improving but remain below the values observed in reference streams.

5.4.4 Compliance with LTS Requirements

5.4.4.1 Requirements

LTS requirements for FCAP are summarized in Table 5.2. The RAR (DOE 1997a) requires that inspections of the site be conducted quarterly throughout the post-remediation care period, and any required maintenance be conducted based on inspection findings. Post-remediation performance of FCAP is strongly dependent on adequate inspection and maintenance of the dam, spillway channel, adjacent slopes, settling basin, and wetlands. Because erosional damage is of great concern, the dam and spillway will also be inspected following any rainfall event equivalent to a 25-year, 24-hour intensity.

5.4.4.2 Status of Requirements for FY 2010

All components of the FCAP were inspected quarterly in FY 2010 by the Y-12 S&M Program including dam and slope stability, vegetative cover of dam and adjacent slopes, settling basin, spillway, underdrain discharge pipe, wetland area, benchmarks, and site security and access controls. Minor maintenance included removing downed trees from the road blocking access, and removing kudzu and saplings from spillway. There were no 25-year, 24-hour intensity rainfall events in FY 2010.

5.4.5 Monitoring Changes and Recommendations for FCAP

No changes to the monitoring network at FCAP are recommended at this time.

5.5 CHESTNUT RIDGE MONITORING CHANGES AND RECOMMENDATIONS

Table 5.7 summarizes issues and recommendations for ChR. No additional issues were identified from evaluation of the FY 2010 monitoring data and, therefore, no changes to the existing monitoring network are recommended at this time.

Table 5.7. Summary of technical issues and recommendations

Issue[a]	Action/ Recommendation
2011 Current Issue	
None.	
Issue Carried Forward	
None.	
Completed/Resolved Issues	
None.	

[a] An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

6. CERCLA ACTIONS IN UPPER EAST FORK POPLAR CREEK WATERSHED

6.1 INTRODUCTION AND OVERVIEW

This chapter provides an update to completed CERCLA actions in the UEFPC Watershed during FY 2010. Figure 6.1 shows the locations of the actions within the watershed. Only sites that have performance monitoring and/or LTS requirements, as noted in Table 6.1, are included in the performance evaluations provided in this chapter. In this chapter, performance goals and objectives, monitoring results, and an assessment of the effectiveness of each completed action are presented. A summary of LTS requirements is provided in Table 6.2, and a review of compliance with these requirements is included in Sects. 6.2.4 and 6.3.2.3. UEFPC Phase I and II ROD-designated land uses and interim controls are shown on Figure 6.2.

For background information on each remedy and performance standards, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chap. 6 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated in the annual RER and republished every fifth year at the time of the CERCLA FYR.

Because many CERCLA actions are either in-progress or have not yet been implemented within the UEFPC Watershed (Figure 6.1), monitoring data collected to date are not sufficient to assess the watershed-wide impact of the remedial strategy. Thus, this chapter provides only a preliminary evaluation of the early indicators of effectiveness at the watershed scale, such as contaminant trends at the surface water IP.

6.1.1 Status and Updates

Remediation of the UEFPC Watershed is being conducted in stages using a phased approach. Phase I addresses remediation of mercury-contaminated soil, sediment, and groundwater discharges that are considered to be principal threat source material that contribute contamination to surface water. Clean up and repair of storm sewers in the West End Mercury Area (WEMA) was initiated in FY 2009. The initial phase included the videotaping of more than 20,000 linear ft of storm sewer to provide important data on the condition of the sewer lines. Future phases of this action will include the removal of contaminated sediments from the storm sewers and relining or replacement of leaking sewer sections. The Storm Drain Engineering Study Report (DOE 2009h) that documents the results of this initial phase was approved on December 1, 2009. Results of this study were used to prepare the RAWP for remediation of the storm sewers. This action is part of three actions identified in the Phase I ROD to limit mercury migration by hydraulically isolating the WEMA. The RAWP for storm sewer remediation (DOE 2010h) received regulatory approval on August 26, 2010. As agreed with the UEFPC Core Team, reinstatement of flow-proportional composite sampling of the four WEMA outfalls (150, 160, 163, and 169) was implemented in early FY 2010.

A Characterization Plan for the 81-10 Area (DOE 2009i), the site of a historic mercury recovery process, was approved on April 12, 2010. It established procedures for the characterization of mercury contamination in soils in the 81-10 area. The characterization activity was conducted in FY 2010 to determine the nature and extent of mercury contamination in site soils and to determine if this contamination is a source to the UEFPC. Thirty-one borehole locations were investigated and determined

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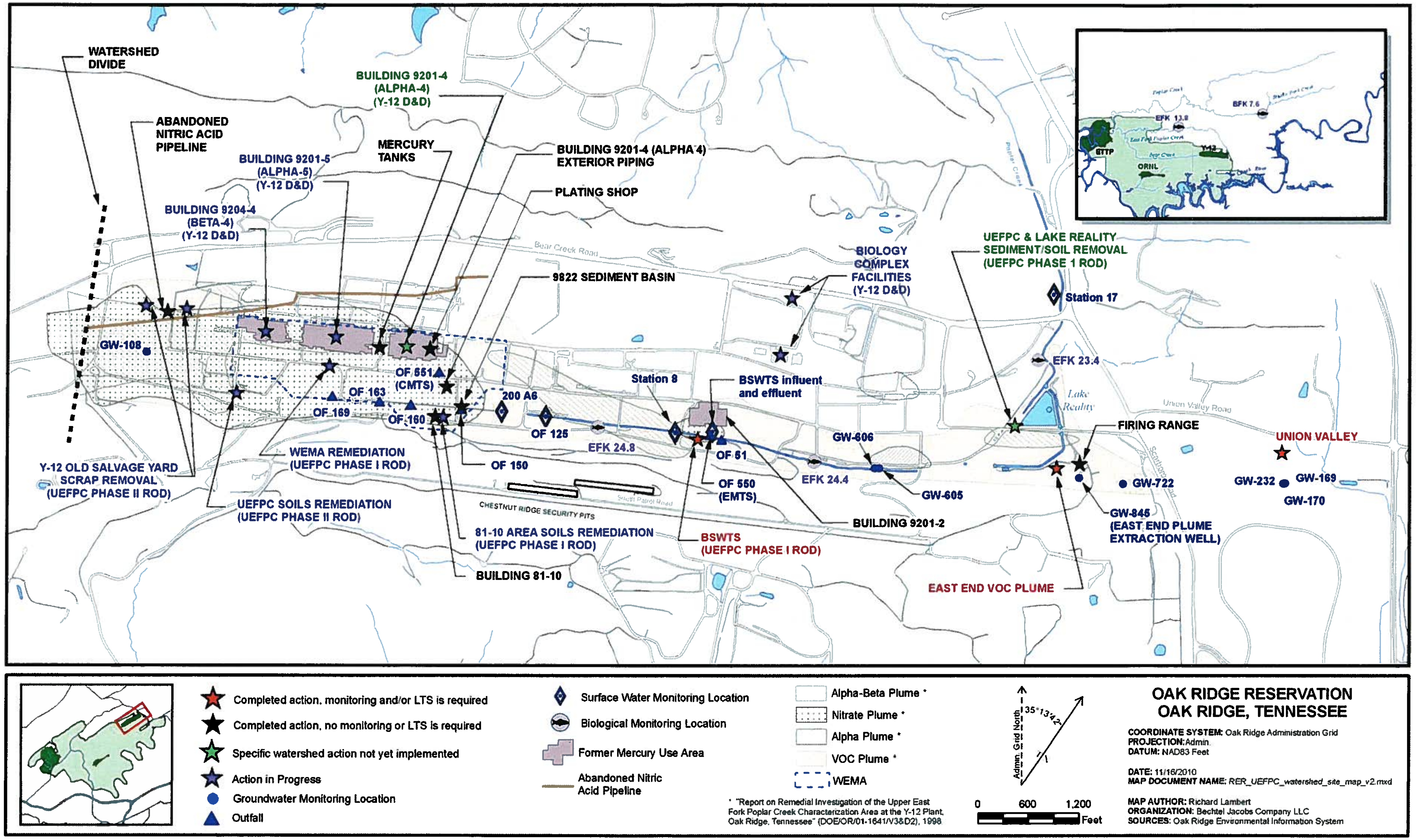

Figure 6.1. CERCLA actions in the Upper East Fork Poplar Creek Watershed.

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Table 6.1. CERCLA actions in UEFPC Watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
		Watershed-scale actions		
Phase I Interim Source Control Actions	ROD (DOE/OR/01-1951&D3): 05/02/02 NSC: 10/05/06 NSC: 05/17/07 Erratum to the 10/05/06 NSC: 06/09/08 NSC: submitted 09/30/09; pending approval	Actions complete • PCCR for BSWTS for Building 9201-2 (DOE/OR/01-2218&D1) approved 07/01/05. Actions in progress • RAWP WEMA remediation (DOE/OR/01-2447&D2) approved 8/26/10. • UEFPC sediments (81-10 Area) Actions not yet implemented • UEFPC & Lake Reality sediment/soil removal.	Yes/Yes TBD TBD	6.2.2 – –
Phase II Interim RA for Contaminated Soils and Scrapyard	ROD (DOE/OR/01-2229&D3): 04/21/06	Actions in progress • RDR/RAWP for Y-12 Salvage Yard – Scrap Removal (DOE/OR/01-2376&D2) approved 01/21/09. • RAWP UEFPC soils remediation (DOE/OR/01-2423&D1 Attachment A.1) submitted 8/10/10.	TBD	–
		Single-project actions		
Y-12 EEVOC Plume Removal Action	AM (DOE/OR/01-1819&D2): 06/25/99	RmAR (DOE/OR/01-2297&D1): 06/07/06	Yes/No	6.3.1
Union Valley	IROD (DOE/OR/02-1545&D2): 07/10/97	– [b]	No/Yes	6.3.2
Mercury Tanks Interim RA (Tanks 2100-U, 2101-U, 2104-U)	IROD (DOE/OR/02-1164): 09/26/91	RAR (DOE/OR/01-1169&D1): 12/20/93	No/No	–
Plating Shop Container Areas NFA	ROD (DOE/OR-1049&D3): 09/30/92	NFA	No/No	–
ANAP (UEFPC OU 2)	ROD (DOE/OR/02-1265&D2): 09/12/94	NFA	No/No	–
Bldg. 9201-4 Exterior Process Piping	AM (DOE/OR/02-1571&D2): 04/22/97	RmAR (DOE/OR/02-1650&D1): 09/30/99	No/No	–
Lead Source Removal of Former YS860, Firing Range Removal Action	AM (DOE/OR/02-1622&D1): 03/10/98	RmAR (DOE/OR/01-1774&D2): 02/24/99	No/No	–

Table 6.1 CERCLA actions in UEFPC Watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
9822 Sediment Basin and 81-10 Sump Removal Action	AM (DOE/OR/01-1716&D2): 06/19/98	RmAR (DOE/OR/01-1763&D2): 02/24/99	No/No	--
		Y-12 decontamination and demolition projects		
Y-12 Building D&D	TC AM (DOE/OR/01-2404&D1): 05/04/09	Start of removal action (Bldgs 9201-5 and 9204-4).	TBD[c]	--
	TC AM (DOE/OR/01-2405&D1): 05/04/09	Start of removal action (Bldgs 9735 and 9206).	TBD[c]	--
	TC AM (DOE/OR/01-2406&D1): 05/04/09	Start of removal action (Bldgs 9211, 9220, 9224, and 9769).	TBD[c]	--

[a]Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <**http://www.bechteljacobs.com/ettp_ffa_appendices.shtml**>.
[b]This action was completed prior to uniform adherence to the RAR process; hence, no RAR exists for this decision.
[c]Action is not yet started or is in progress and, therefore, monitoring/LTS requirements are not identified.

ANAP = Abandoned Nitric Acid Pipeline
BSWTS = Big Spring Water Treatment System
EEVOC = East End Volatile Organic Compound
NSC = Non-Significant Change
IROD = Interim Record of Decision
WTS = Water Treatment System

Table 6.2. LTS requirements for CERCLA actions in UEFPC Watershed

Site/Project	LTS Requirements		Status	RER section
	LUCs	Engineering controls		
		Watershed-scale actions		
ROD for Phase I Interim Source Control Actions in the UEFPC Watershed[a] ▪ BSWTS PCCR	Watershed LUCs Administrative: ▪ land use and groundwater deed restrictions ▪ property record notices ▪ zoning notices ▪ permits program Physical: ▪ access controls ▪ signs ▪ security patrols	▪ Maintenance of treatment facilities	▪ Physical LUCs in place. ▪ Administrative LUCs required at completion of actions. ▪ Engineering controls remain protective.	6.2.4
UEFPC Union Valley Interim Action	Institutional controls related to groundwater use. ▪ License agreements ▪ Annual property owner notification ▪ Annual title searches ▪ Annual water use surveys ▪ Annual notification to well drillers		▪ LUCs in place.	6.3.2.3

[a]Remaining actions have not been implemented (e.g., West End Mercury Area).
BSWTS = Big Spring Water Treatment System

that mercury contamination is relatively shallow. Exceptions were noted in two boreholes, but results from this and prior studies indicate that this contamination is not impacting UEFPC.

Uranium concentration and fluxes in UEFPC originate from groundwater seepage and storm water transport of surface contamination at the Y-12 plant. Groundwater contamination in the WEMA is a source of uranium flux at Outfall 200A6. Another source of the increased uranium flux observed at Station 17 may be the former Oil Skimmer Basin. Uranium flux at Station 17 in FY 2010 remains elevated, near FY 2009 levels, relative to that observed in drought years.

The initial project of the Phase II Interim Remedial Action for Contaminated Soils and Scrapyard (i.e., the Phase II ROD) is removal of scrap from the Y-12 Old Salvage Yard. Cleanup of the 7-acre Y-12 Old Salvage Yard was initiated in May 2009. The salvage yard is located both within and outside the high security area of Y-12 bisected by the construction of the Perimeter Intrusion Detection and Assessment System (PIDAS). In January 2009 the RDR/RAWP (DOE 2008d) was approved by the regulators. The Waste Handling Plan (DOE 2009j) was approved in April. As of September 30, 2010, a total of 15.7 million pounds of scrap have been removed from the Old Salvage Yard – 8.7 million pounds shipped to EMWMF and 7 million pounds to the Nevada National Security Site. Complete disposition of all materials is expected by June 2011. In addition, ARRA funding was received in August 2010 to characterize soil contamination in the area to determine remediation requirements.

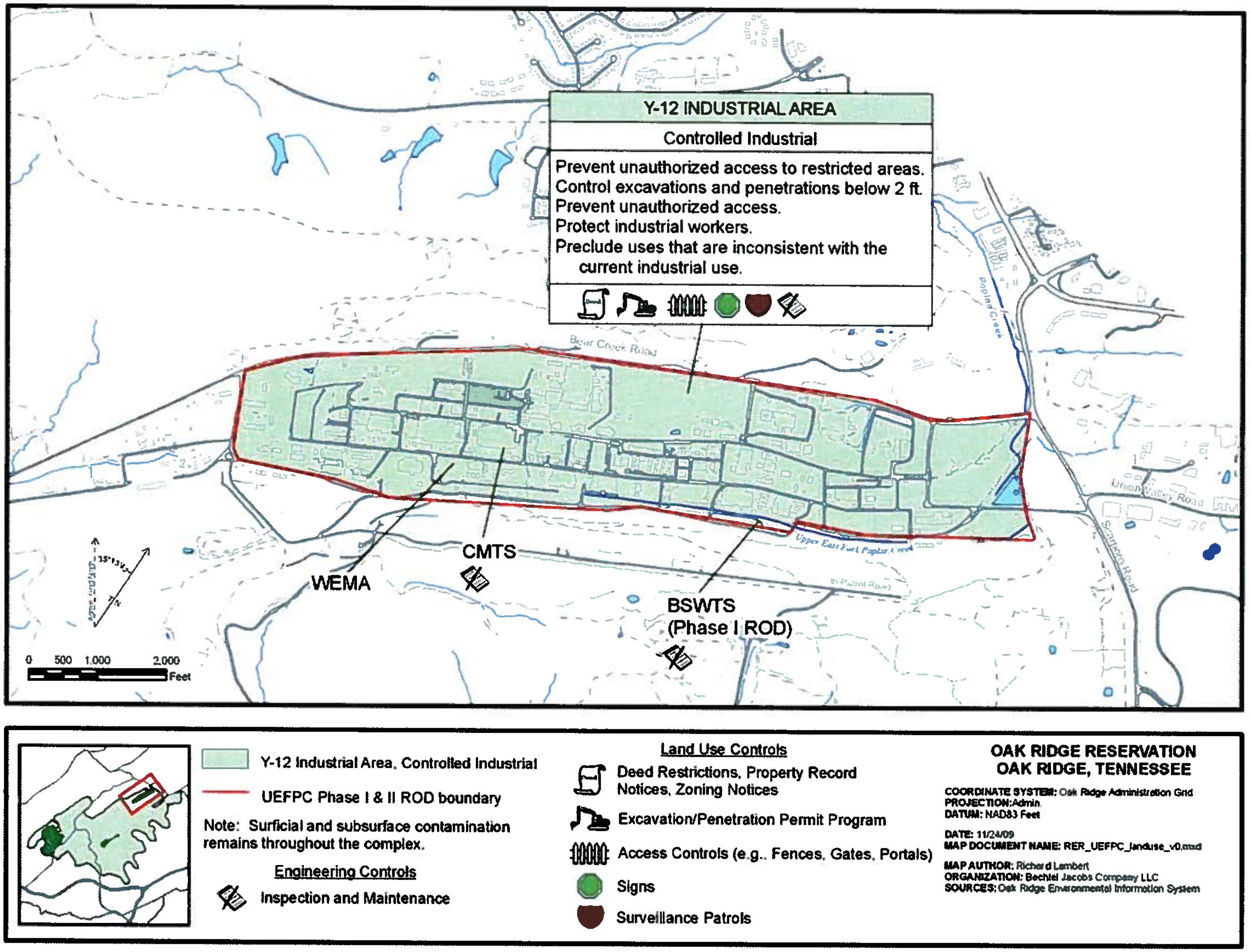


Figure 6.2. UEFPC Phase I and II ROD-designated land use and interim controls.

The UEFPC Soils RAWP (DOE 2009k) was awaiting regulatory approval with a Dynamic Work Plan Addendum (DOE 2010i) on September 30, 2010. This RAWP includes all remediation projects identified in the UEFPC Phase I and II RODs and sets forth a strategy for sequencing and performing these remediation activities. In addition, it integrates priorities for current planned soils remediation with the proposed Integrated Facilities Disposition Program (IFDP) remediation activities.

Activities under three Time-Critical Removal Actions (TC RmAs) initiated in FY 2009 to remove legacy materials from the Alpha 5 and Beta 4 buildings, to demolish the Biology Complex Buildings and to demolish Building 9735 and a portion of Building 9206 were in progress in FY 2010. The second and fourth floors of Alpha 5 were cleared of legacy materials. The clearing of the second floor of Beta-4, the scope of the Beta-4 Legacy Material Disposition Project, was ~96% complete on September 30, 2010. Completion of legacy material disposition from these facilities is anticipated by September 2011. The Biology Complex Facilities (Buildings 9769, 9211, 9220, and 9224 have been demolished and approximately 28,000 cubic meters of waste has been disposed. The Building 9206 D&D project is demolishing a portion of the building and deactivating the recovery furnace exhaust system to reduce exposure from potential release. As of September 30, 2010, 41.0 cubic meters of waste has been disposed. Demolition of these facilities is also expected by September 2011. The demolition of Building 9735 and disposal of 2,964 cubic meters of waste at Y-12 landfills and 8 cubic meters at the Nevada National Security Site were completed in FY 2010.

In FY 2010 a Removal Action Work Plan for the Y-12 Facilities Deactivation/Demolition Project (DOE 2010j) was submitted to the regulators on June 30, 2010 in an attempt to streamline the deactivation process. This plan addresses all non-time critical removal action IFDP facilities at Y-12, totaling more than 100 buildings and facilities. Additional CERCLA documentation will be required for individual subproject activities.

6.2 PHASE 1 INTERIM SOURCE CONTROL ACTIONS IN THE UEFPC CHARACTERIZATION AREA

The ROD for Phase I Interim Source Control Actions (DOE 2002c) addresses principal threat source material source control remedies designed to reduce mercury loading within UEFPC. The RAO for the selected remedy presented in the ROD is to restore surface water to human health recreational risk-based values at Station 17 (DOE 2002c). Principal components of the decision include:

- hydraulic isolation (e.g., capping contaminated soils) of the WEMA;
- removal of contaminated sediments in storm sewers, UEFPC, and Lake Reality;
- treatment of discharge from Outfall 51 (including a large-volume spring) and Bldg. 9201-2 sumps;
- temporary water treatment using existing facilities East End Mercury Treatment System (EEMTS) and the Central Mercury Treatment System (CMTS);
- LUCs to prevent consumption of fish from UEFPC and to control/monitor access by workers and the public; and
- monitoring of surface water (Station 17).

The Big Spring Water Treatment System (BSWTS) was constructed to treat discharge from Outfall 51 (including the large-volume spring) and to treat water from the Bldg. 9201-2 sumps. Mercury contaminated water was rerouted from Bldg. 9201-2 sumps and EEMTS to the BSWTS during December 2006. The EEMTS and Outfall 550 are no longer in operation.

6.2.1 Performance Goals and Monitoring Objectives

Performance goals and monitoring objectives of all the components of the Phase I Interim Source Control ROD are provided in Chap. 6 of Vol. 1 of the 2007 RER (DOE 2007a). Only monitoring performance goals of the actions that have been completed or are on-going are discussed in this section. These goals and objectives are summarized in Table 6.3, and monitoring locations are shown in Figure 6.1. Land use for Y-12, as identified in the Phase I ROD (DOE 2002c), is controlled industrial throughout the entire facility.

6.2.2 Evaluation of Performance Monitoring Data – FY 2010

6.2.2.1 Surface Water Monitoring Data

6.2.2.1.1 Surface Water Quality Metrics and Monitoring Requirements

Surface water quality metrics utilized to evaluate progress toward attainment of ROD goals are summarized in Table 6.3, and monitoring locations are shown in Figure 6.1.

Table 6.3. Performance measures for Phase I Interim Source Control Actions in the UEFPC Watershed

Site	UEFPC ROD goal	Performance standard	Monitoring location	Schedule and parameters
Station 17	Reduce mercury levels to a level protective of a recreational receptor based on fish consumption	0.2 μg/L (200 ppt) total mercury Specific numeric standards not defined for U or Zn monitoring; Performance determined from trend evaluation.	Station 17	Continuous flow-paced monitoring for mercury and uranium (weekly collection); weekly grab sample for zinc.
Building 9201-2 WTS (BSWTS)	Reduce mercury levels to a level protective of a recreational receptor based on fish consumption	200 ppt mercury	WTS effluent discharge point	Quarterly grab samples for VOCs and semiannual monitoring for mercury and uranium.
CMTS	Ongoing treatment of effluents from WEMA pending demonstration of effectiveness of remedy (hydraulic controls, capping)	200 ppt mercury	Outfall 551	Continuous flow-paced monitoring for mercury (minimum weekly collection frequency); continue current system performance monitoring as required by operations and maintenance specifications.
EEMTS no longer operational	Treatment of effluents from Bldg. 9201-2 sumps was tied-in to BSWTS December 2006	200 ppt mercury	Outfall 550 flow piped to the BSWTS in December 2006	Discontinued.
WEMA	Protect recreational surface water users	Reduction by ~50% of mercury flux in WEMA outfalls. Reduction will be monitored in outfalls and is anticipated within one year of remediation.[a]	Outfalls 150, 160, 163, and 169	Continuous flow-paced monitoring for mercury (minimum weekly collection frequency) prior to remediation.
UEFPC and Lake Reality	Protect recreational surface water users	Reduction of 70% of Station 8 area ungauged mercury flux and up to 100% of ungauged mercury flux between Stations 8 and 17. Reduction will be monitored at Station 8 and Station 17 and is anticipated within one year of remediation.	Station 8 and Station 17	Grab samples at Station 8 weekly. Weekly monitoring at Station 17 for mercury.

[a]Baseline monitoring re-instated FY 2010.

WTS = Water Treatment System

The UEFPC Phase I ROD (DOE 2002c) includes a 200 ppt performance metric for mercury in surface water at the UEFPC IP (Station 17) based on an adult recreator consuming fish. Surface water monitoring at Station 17, including analysis for uranium and zinc, is conducted to gauge the cumulative effects of the various actions as they are completed. In addition, biological monitoring is performed to assess reductions of mercury in fish tissue at EFK 23.4. To achieve the watershed-wide mercury reduction objectives, individual components of the Phase I remedy have action-specific performance standards. The BSWTS and CMTS effluent must meet the 0.2 μg/L (200 ppt) interim performance goal for mercury.

6.2.2.1.2 Surface Water Monitoring Results

Continued monitoring of effluent from the CMTS (Outfall 551), which treats building sump discharges from the WEMA, is specified in the UEFPC Phase I ROD pending demonstration of the effectiveness of actions (e.g., hydraulic controls, storm sewer relining/replacement).

The UEFPC Phase I ROD states that the mercury limit for CMTS is 200 ppt. The CMTS effluent discharges through Outfall 551. Effluent samples were collected from weekly composites at Outfall 551 and analyzed for mercury. The total volume of water treated in FY 2010 was 2,513,619 gal. In FY 2009, the treated volume was 2,306,335 gal. Due to introduction of methanol, a contaminant that interfered with mercury treatment, from a leaking Alpha 2 brine system, a Non Significant Change (NSC) to the UEFPC Phase I ROD was approved in May 2007 so that the CMTS no longer receives water from sump pumps located in the basement of Bldg. 9201-5. The CMTS continues treatment of Bldg. 9201-4 sump water (a much larger source of mercury). The CMTS experienced no downtime during FY 2010. Once the brine system has been rerouted, the collection of 9205-1 sump pump water will be re-evaluated.

Extensive mercury contamination exists in the WEMA as a result of historic process leaks and spills. Some of the mercury remains in the soil as elemental mercury metal. Movement of elemental mercury in the soil can occur as a result of pore pressure changes related to groundwater level fluctuations and rainfall percolation processes. As the mercury moves downward and laterally, it can seep into the subsurface storm drains through cracks and open joints. Once in the storm drains, the mercury accumulates in low points moved by the current of stormwater. Seven (7.0) pounds of metallic mercury were recovered from Manhole D3-330, west of 9805-1, in two events in 2010 through October 21, 2010.

The main source of flow at Outfall 51 was Big Spring, located near the southeast corner of Bldg. 9201-2. Mercury contamination within shallow groundwater beneath and adjacent to Bldg. 9201-2 discharges at this spring. The spring discharge was captured within a brick enclosure (spring box) during Bldg. 9201-2 construction in 1943 and directed to UEFPC via a drainpipe. Big Spring flow was routed to the new BSWTS in the latter part of FY 2005 during test and start-up operations. As a result, the flow at Outfall 51 decreased significantly and consists now only of minor contributions from groundwater infiltration. While it was anticipated that construction and operation of BSWTS would cut off flow to Outfall 51, during BSWTS construction it was discovered that, in addition to flow from the spring box, Outfall 51 also provides a conduit for drainage of the BSWTS area shallow subsurface flow.

The BSWTS has been fully operational since September 26, 2005. During FY 2010 the Oak Ridge area experienced slightly above average rainfall which was responsible for increased flow into the BSWTS groundwater collection system. The amount of inflow exceeded the system design treatment capacity which necessitated allowing bypass flows to occur during significant time periods during the wetter than average months. These bypass flows are discharged via Outfall 51 and the affects of the increased bypass flows are discussed below.

The UEFPC Phase I ROD specifies a 0.2 μg/L (200 ppt) goal for mercury in BSWTS effluent. Outfall 51 and BSWTS effluent are separate monitoring locations. Figure 6.3 provides a comparison of mercury concentrations at Outfall 51 and the BSWTS effluent. The average mercury concentration from Outfall 51 was 2.51 μg/L during FY 2010, which is approximately 1 μg/L greater than the values measured during FY 2007 and FY 2008. The daily flux of mercury discharged from Outfall 51 ranged from about 0.2 to 2 grams per day and averaged about 0.9 grams per day based on monthly grab samples. The estimated yearly mercury flux discharged into UEFPC was approximately 0.3 to 0.5 kg based on the monthly grab sample results. The mercury flux discharged via Outfall 51 was higher during FY 2010 than in 2008 and 2009, and this increase is attributed to the slightly above average rainfall during the year. An issue is identified to better identify the mass of Hg flux from Outfall 51 when the BSWTS is bypassed. DOE will continuously monitor Outfall 51 flow and also monitor the Hg concentrations during high flows at Outfall 51.

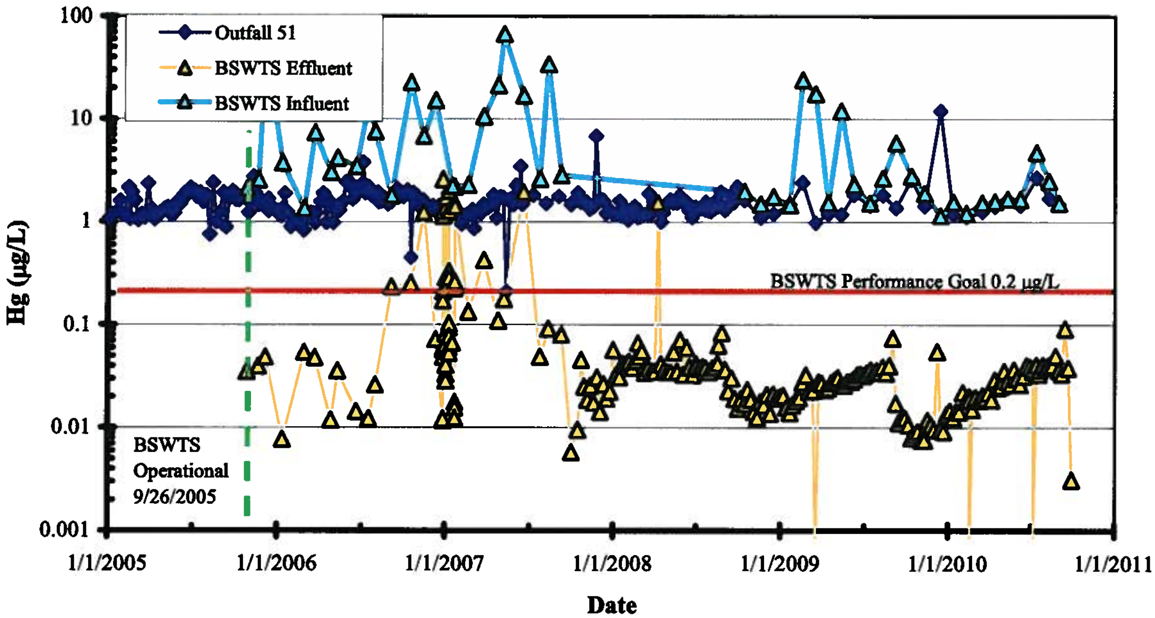


Figure 6.3. Mercury concentrations at Outfall 51 and BSWTS.

The average BSWTS influent concentration was about 2 µg/L. In FY 2020, the BSWTS treated approximately 105 million gal of contaminated water, which was about 9 million gal less than was treated during FY 2009. Since July 2008, the BSWTS effluent is sampled continuously and weekly composite samples are analyzed for total mercury. The average mercury concentration in BSWTS effluent during FY 2010 was 0.025 µg/L, which is the same as in FY 2009 and is nearly an order of magnitude less than the 0.2 µg/L goal specified in the UEFPC Phase I ROD. None of the weekly composite samples exceeded the 0.2 µg/L effluent goal during FY 2010. The FY 2010 total mercury flux discharged in the treated BSWTS effluent was approximately 9.8 grams which is approximately 10% less than the FY 2009 discharge. Based on comparison of the average influent and effluent mercury concentrations for FY 2010, the treatment effectiveness was approximately 99%.

WEMA Mercury Discharges (Outfalls 200A6, OF150, OF160, OF163, OF169)

The approach to monitoring of WEMA storm drain mercury discharges has varied through time and during FY 2010 flow-paced continuous sampling was initiated at five locations related to the WEMA. In early January 2010 flow-paced continuous sampling devices became operational at Outfalls OF150, OF160, OF163, and OF169. These outfalls carry the principal WEMA drainages into the main storm drain pipes that discharge at Outfall 200 and make up the headwater baseflow of UEFPC. Continuous flow-paced monitoring at Outfall 200A6 has been implemented since the beginning of FY 2007. Outfall 200A6 is located in the main storm drain that carries discharge from the WEMA to the headwater of the UEFPC and the other outfalls are located to the west and upstream in the storm drain network (Figure 6.1). Outfall 200A6 serves as an IP for contamination leaving the WEMA. The flux of mercury measured at Outfall 200A6 for FY 2010 is shown on Figure 6.4. The FY 2010 total measured flux was estimated to be about 9,340 grams, inclusive of two high mercury concentration spikes that

Outfall 200A6 Mercury Data FY 2010

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Hg Flux (grams)	2,118	178	332	440	293	297	184	191	181	403	4,536	190	9,342

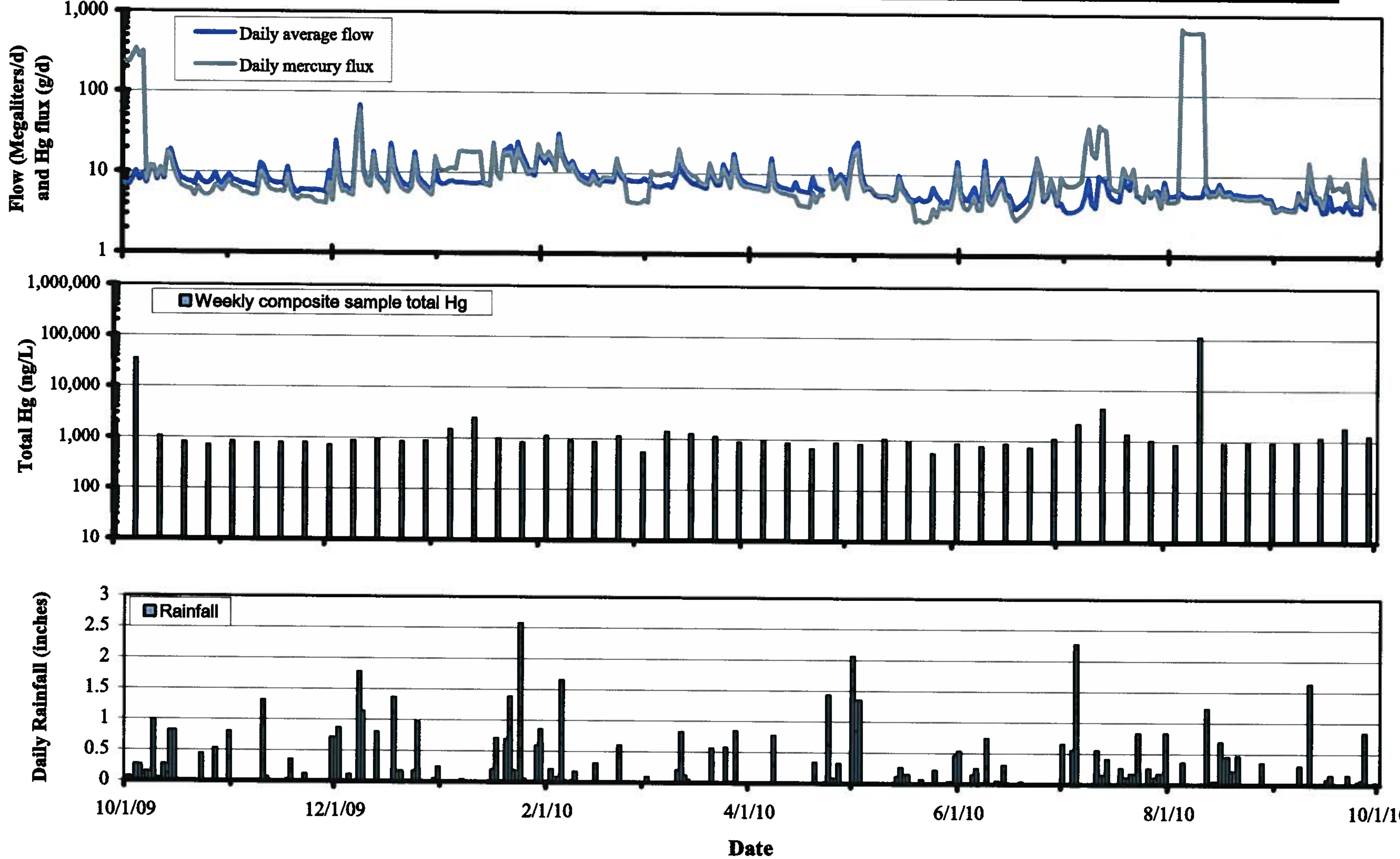


Figure 6.4. FY 2010 mercury concentrations and flux measured at Outfall 200A6.

occurred in early October and mid-August. The origin of the spikes is not known, although it is thought to have been caused by uptake of solids in the sampler sometime during the respective sampling week. The reason these concentration and flux spikes are thought to be attributable to sediment uptake in the sampler is because in neither instance was a similar magnitude of concentration or flux elevation measured downstream. Table 6.4 provides summary statistical parameters for the measured mercury discharges from the WEMA storm drains and Outfall 200A6. Within Table 6.4 the Outfall 200A6 mercury flux is estimated for the same time period as the WEMA outfalls and for the full year, both including the affect of the August concentration spike and dampening the affect by calculating fluxes for the affected week assuming the daily fluxes were similar to those in the preceding and following weeks. Figure 6.5 shows graphically the percentage contribution of OF150, OF160, OF163, and OF169 to the total mercury flux measured at 200A6 during the period January through September 2010. The monitoring data show that OF163, which drains the area between Buildings 9201-4 and 9201-5, is the major contributor of mercury to Outfall 200A6, followed by OF169 and OF150 which are comparable to one another. OF160 contributed the least to the Outfall 200A6 discharge during the monitoring period.

Table 6.4. Summary statistics for daily mercury discharge from WEMA storm drains and Outfall 200A6

Outfall	Time Period	Median[1]	Mean[1]	Max[1]	Hg flux[2]
OF150	Jan 6 - Sep 29	1.2	1.4	10.2	370
OF160		0.4	0.6	4.2	147
OF163		4.8	5.5	40.3	1,460
OF169		1.2	1.4	8.5	384
WEMA Outfall total		7.6	8.9		2,361
200A6	Jan 6 - Sep 29 with Aug spike reduced	6.8	8.6	42.5	2,294
	Jan 6 - Sep 29 with Aug spike included	7.0	24.6	688	6,715
	Full year (52 weeks) with Aug spike reduced	6.8	13.7	345	4,978
	Full year (52 weeks) with Aug spike included	7.0	25.6	688	9,342
Station 8	Jan 6 – Sep 29	8.8	9.5	18.9	2,606
	Full year	8.7	9.9	24.5	3,599
Station 17	Jan 6 – Sep 29	10.3	23.7	532	6,482
	Full year	7.96	19.4	532	7,081

[1] all values are grams/day
[2] Total grams for stated time period

All of the UEFPC continuous surface water monitoring stations are prone to showing periodic spikes in mercury concentration that translate into short time periods with apparently very high mercury discharge. These events are sometimes related to periods of high flow associated with major rain events, but sometimes occur during low flow periods, as was observed in August 2010. The high mercury spike events skew the annual population of calculated daily mercury loading and consequently affect central tendency statistics such as the mean. In such cases the median value determined from the cumulative distribution function can provide a more stable central tendency indicator. Table 6.4 includes the median, mean, maximum daily mercury flux and total mercury flux for individual monitoring locations over selected time periods. Measurements from the WEMA storm drain outfalls (OF150 through 169) exhibit relatively stable central tendency metrics during their active monitoring period in FY 2010. Outfall 200A6 showed a rather unstable condition with respect to the mean daily mercury flux depending upon how the August high mercury concentration week is evaluated. Inclusion of the calculated

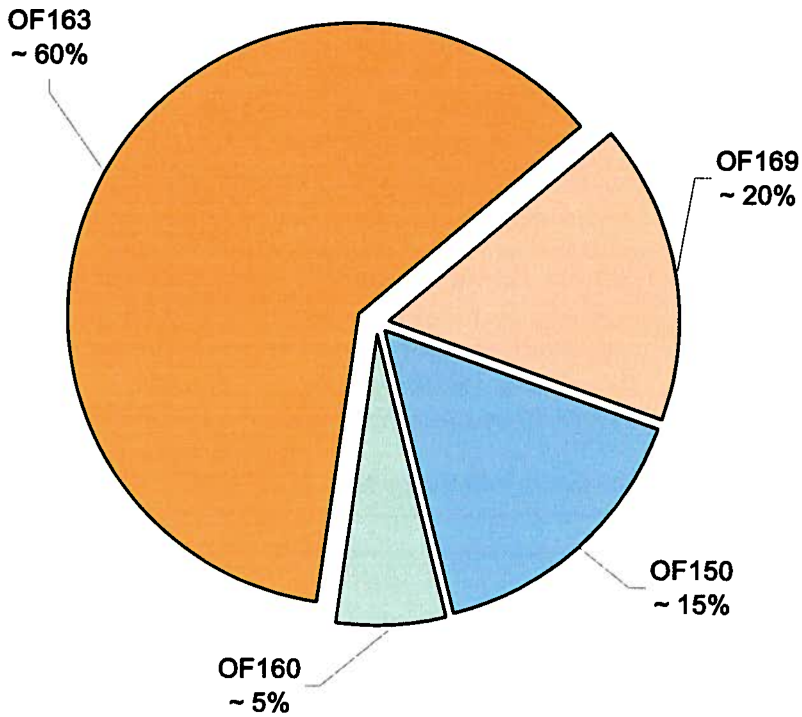


Figure 6.5. WEMA storm drain percentage contributions to the Outfall 200A6 mercury discharge – January through September, 2010.

daily mercury flux for the August week containing the high concentration spike (Table 6.4 row for the full year) in the mean daily flux resulted in an increase in the mean from 13.7 g/d to 25.6 g/d. The median and mean daily flux for the full year with August spike influence dampened and for the January through September period when coincident with the operation of the WEMA outfall monitoring were relatively stable at about 6.8 and 7.0 grams/day.

Station 8

Surface water monitoring at Station 8 is conducted to measure mercury concentrations and estimate mercury flux in the reach upstream to Outfall 200A6, and downstream to Station 17. Sampling consists of weekly grab sampling for mercury with a simultaneous instantaneous flow measurement. During FY 2010, the measured mercury concentrations at Station 8 ranged from 217 to 771 ng/L and averaged 371 ng/L. The daily mercury flux in UEFPC at Station 8 based on the grab samples and instantaneous flow measurements ranged from about 6 g/d to about 25 g/d and averaged about 9.9 g/d. Based on the weekly grab samples and average daily flux, the annual flux estimate for mercury at Station 8 is approximately 3,599 grams. This estimate is lower than the spike-dampened flux of 4,978 grams at Outfall 200A6 shown in Table 6.4. The reason for this difference is that the once per week grab sampling provides relatively infrequent sampling coverage compared to the continuous flow-paced sampling that is conducted at Outfall 200 A6. The daily flux calculated from the Station 8 sampling was compared with the calculated flux for the same dates at Outfall 200A6. That comparison showed that the general fluctuations observed at both stations were similar however many short-term peaks observed at Outfall 200A6 were not captured by the lower frequency sampling at Station 8.

Station 17 (IP)

Surface water monitoring in the UEFPC is conducted at Station 17, the IP where the stream leaves the Y-12 site and DOE Property. The UEFPC Watershed remediation goals focus on reduction of mercury in surface water in and downstream of Y-12. Uranium and zinc are also COCs in UEFPC surface water.

Annual fluxes and average concentrations of uranium and mercury at Station 17 are provided in Table 6.5, Figure 6.6, and Figure 6.7. Locations of mercury source areas are shown on Figure 6.1. As shown in Table 6.5, the FY 2010 mercury discharge measured at Station 17 based on flow-paced continuous sampling data was about 7 kg. About 30% of this flux is attributed to ungauged contributors from groundwater and storm drain discharges downstream of Outfall 200A6. Based on the flow-paced data, the other ~70% originated from sources in the WEMA, as measured at Outfall 200A6. As noted in the BSWTS section, approximately 0.3 to 0.5 kg may have been discharged via Outfall 51 associated with uncaptured groundwater and treatment system bypass flows.

Table 6.5. Annual uranium and mercury fluxes[a] and average concentrations at Station 17

Date	Hg flux (kg)	Avg Hg (µg/L)[b, c]	U flux (kg)	Avg U (mg/L)	Annual rainfall (in)[d]
2000	12.0	**0.746**	143	0.012	52
2001	9.4	**0.638**	85	0.007	45.98
2002	7.3	**0.536**	172	0.014	52.67
2003	8.8	**0.597**	148	0.011	73.73
2004	8.2	**0.524**	119	0.010	56.38
2005	14.6	**0.742**	157	0.012	58.96
2006	4.0	**0.328**	89	0.008	46.42
2007	4.0	0.198	86	0.007	36.26
2008	2.7	**0.221**	98	0.009	46.02
2009	3.9	**0.273**	177	0.014	62.5
2010	7.0	**0.476**	198	0.016	55.8

[a]ROD flux goals for U and Hg at Station 17 do not exist.
[b]**Bold** values exceed UEFPC Phase I ROD Hg concentration goal of 200 ppt (0.2 µg/L) for Station 17.
[c]Reported average is for 7-day continuous flow-paced samples.
[d]Average annual rainfall = 54 in.

Avg = average

Station 17 Mercury Discharge Data FY 2010

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Hg Flux (grams)	222	109	269	1266	468	588	874	1,323	211	831	437	483	7,081

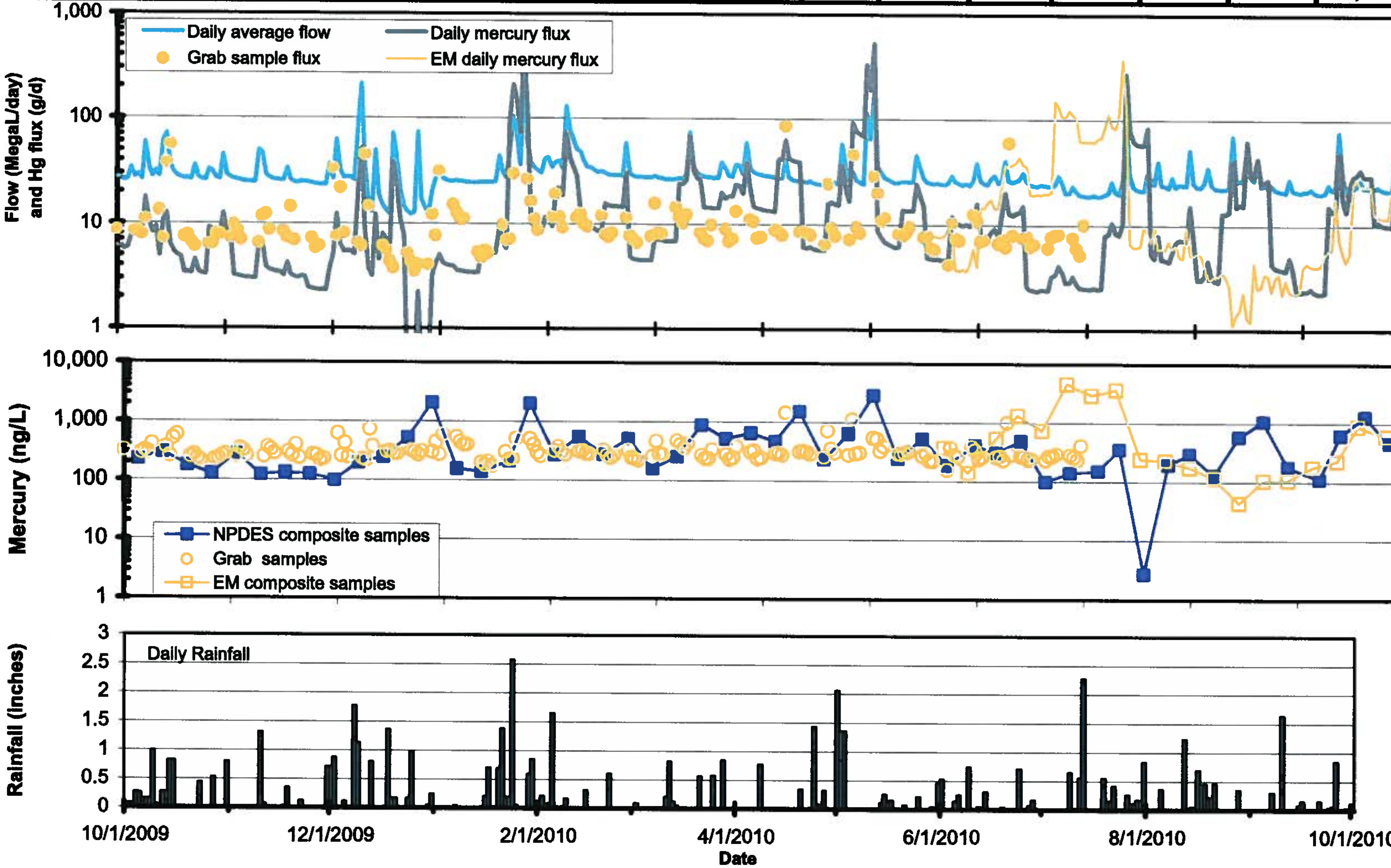


Figure 6.6. Summary of FY 2010 mercury discharge data from Station 17.

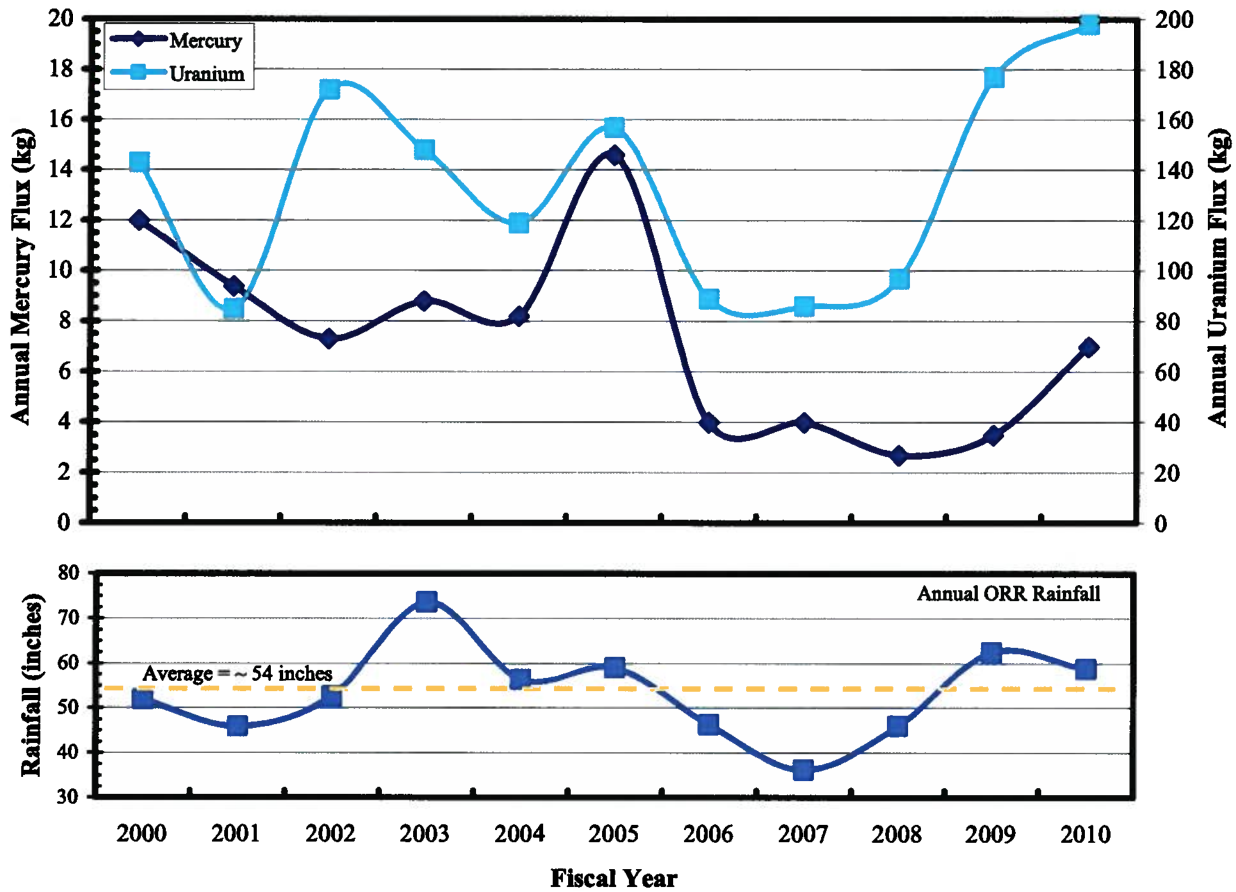


Figure 6.7. Annual mercury and uranium fluxes at Station 17 and annual ORR rainfall.

During prior years, mercury fluxes ranged from over 14 kg in FY 2005 to 4.0 kg measured in FY 2006 and FY 2007 and the lowest of 2.7 kg in FY 2008. The average flow-paced composite mercury concentration measured during FY 2010 was 476 ng/L and the average concentration obtained from grab samples was 392 ng/L. Both concentrations exceeded the ROD goal of 200 ng/L. Flow-paced composite sampling is conducted to determine the average concentrations and loadings (fluxes) of contaminants in surface water, while grab sampling allows determination of instantaneous concentrations. Both sampling approaches have been utilized at Station 17. During most previous years, the flow-paced composite average mercury concentrations are lower than those obtained from grab samples collected at Station 17. Reasons for this difference include differences in laboratory procedures for analysis and differences in the sampling processes used. The FY 2010 mercury flux result shows a significant increase in discharge compared to FY 2009.

Mercury daily flux monitoring at Station 17 is affected by large changes in water flow volumes and similarly large changes in the total mercury concentration that comprises both dissolved and particle-associated mercury. Station 17 experiences occasional very high mercury concentration sample results, similar to the observations at Outfall 200A6. These results are suspected to be associated with collection of suspended sediment particles that have extremely high mercury concentrations. Such particles represent a very small fraction of the total particulate load in suspension but when they are included in the composite sample aliquot in the laboratory analysis the result is a very high weekly sample concentration. As described in the Outfall 200A6 section, the calculated weekly flux for samples of this nature suggests kg quantities of total mercury discharged. These results provide overestimates of the mercury flux as suggested by the observation that, during sampling weeks where such events occur at Outfall 200A6, there is not usually a high concentration or flux observed at Station 17 and vice-versa.

The daily mercury flux measured at Station 17 from FY 2000 through FY 2010 has been examined to determine the differences between the years pre- and post- startup of the BSWTS. All the calculated daily mercury flux results were ranked and cumulative distribution functions were created. Figure 6.8 shows the results of this data evaluation. The average and standard deviation of ranked daily flux for the pre- and post- BSWTS time periods are shown. The median daily mercury flux at Station 17 from FY 2000 through FY 2005 was 11.5 g/d and the median for FY 2006 through FY 2010 was 7.0 g/d. The data from the two time periods show a separation from the lowest fluxes to about the 80th percentile, above which the separation diminishes. At daily flux values above the 95th percentile overlap occurs because of high daily fluxes observed during FY 2010. Factors to consider, in addition to the operation of BSWTS, include the observed flux reduction, the generally low fluxes measured during the drought years of FY 2006 through 2008, and the above normal rainfall during FY 2009 and 2010.

A summary of the spatial flux distribution in UEFPC is shown on Figure 6.9.

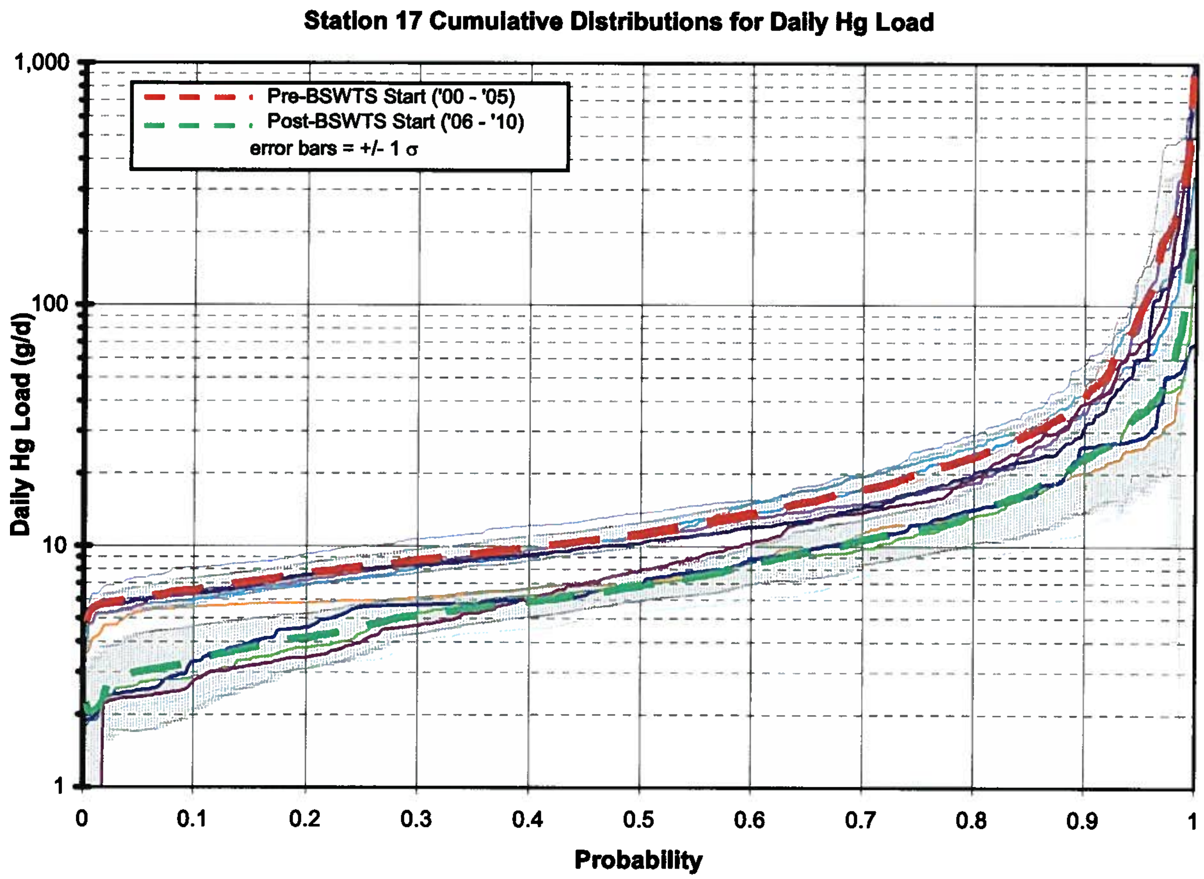


Figure 6.8. Pre- and post-BSWTS startup mercury daily flux at Station 17.

COCs in UEFPC watershed also include zinc and uranium. Areas of radiologically contaminated groundwater in the UEFPC Watershed are shown on Figure 6.1. Areas of uranium contamination in groundwater (alpha activity plumes) and combined uranium/technetium (alpha/beta activity plumes) are shown. Uranium contamination in the UEFPC originates from groundwater seepage and storm water transport of surface contamination in Y-12. Groundwater contamination in the WEMA is a source of

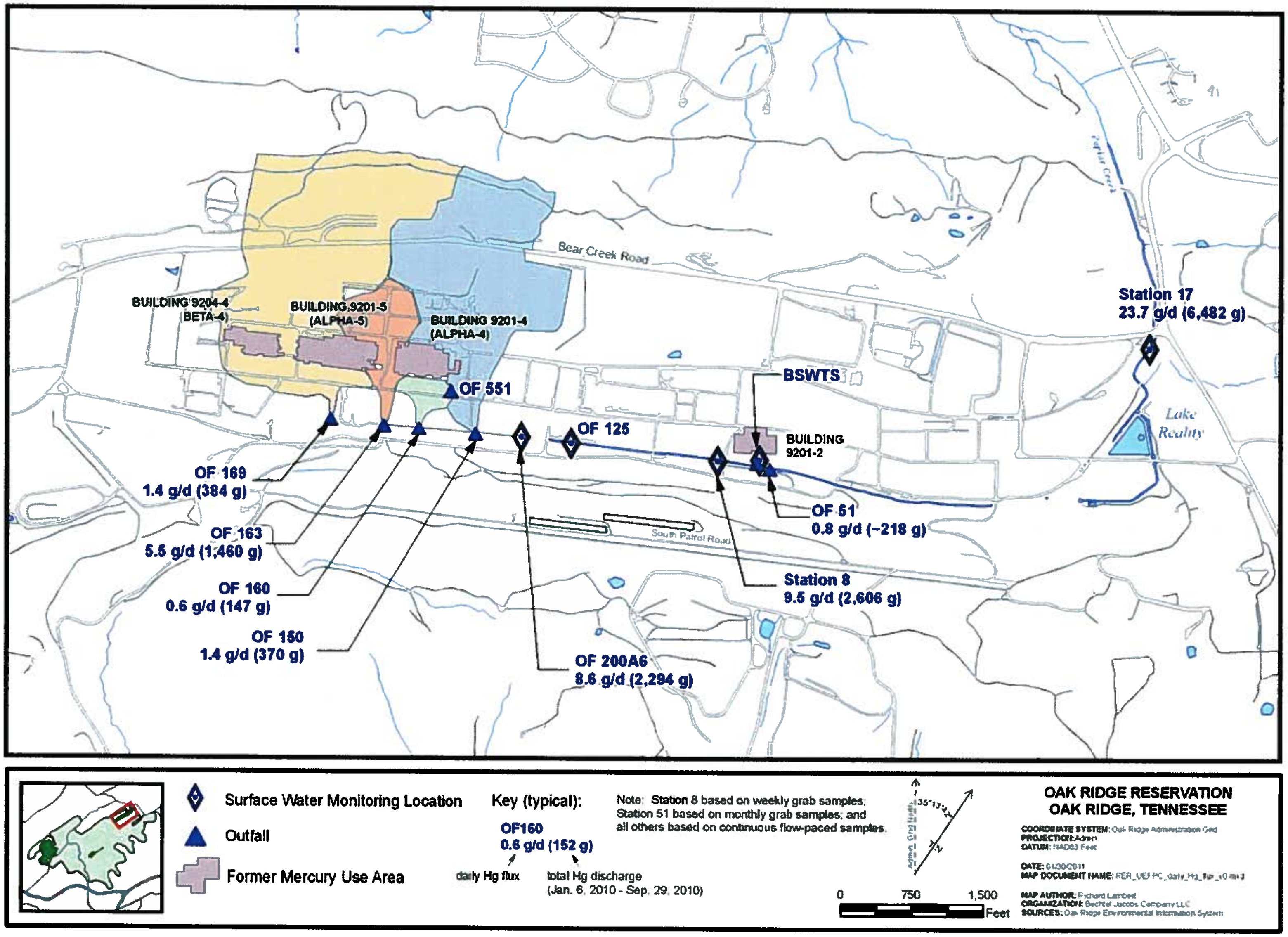


Figure 6.9. Summary flux distribution in UEFPC.

uranium flux at Outfall 200A6. Another significant source of uranium that may enter UEFPC is the former Oil Skimmer Basin located adjacent to the original UEFPC channel in the eastern end of the plant area. As shown in Table 6.5 and Figure 6.7, the uranium flux and average concentrations measured at Station 17 during FY 2010 remained elevated compared to the drought years. The annual uranium flux is generally proportional to annual rainfall with higher uranium fluxes occurring during years of higher rainfall. The average uranium concentration measured at Station 17 was about 16 μg/L, although five samples (three in December and one each in February and May) were greater than the 30 μg/L MCL. The maximum detected uranium concentration was 120 μg/L.

Zinc was analyzed in weekly grab samples collected at Station 17 during FY 2010 for comparison to the AWQC (120 μg/L). Thirty-one of the results were below the detection limit (10 μg/L) and twenty-three samples yielded detectable concentrations that ranged from <10 to 54 μg/L. During FY 2010, none of the zinc samples exceeded the AWQC.

6.2.2.2 Other Watershed Monitoring

6.2.2.2.1 Aquatic Biological Monitoring

The ecological health of East Fork Poplar Creek (EFPC) has been monitored since 1985. Data collected on contaminant bioaccumulation and the composition and abundance of communities of aquatic organisms provide direct evaluation of the effectiveness of abatement and remedial measures in improving ecological conditions in the stream. Since 1986, these studies have been augmented by twice yearly monitoring of aqueous mercury concentrations and speciation at sites throughout the length of EFPC.

Mercury in sunfish at EFK 23.4 in spring of 2010 decreased from levels seen in 2009 despite the significant increase in aqueous mercury at Station 17 over this same time period (Figure 6.10). For the 2011 RER period, the mean mercury concentrations in rockbass in December 2009 was 0.99 + 0.08 (SE); range was 0.72 – 1.21. In spring 2010, the mean +/- SE was 0.73 +/- 0.13 with a range of 0.44 - 1.30. The average mercury concentration measured at Station 17 during 2010 (Jan-Jun) was 566 ng/L (the average mercury concentration for the entire FY 2010 was 476 ng/L), which is significantly higher than in 2009 and which exceeds the 200 ng/L goal. Sunfish mercury levels, however, remained within the range of values that have been observed for the past 20 years. Future biological monitoring efforts will determine whether the very recent increased aqueous mercury concentrations at Station 17 result in higher mercury levels in fish. See Chap. 7 (CERCLA Offsite Actions) for additional information about mean mercury concentrations in sunfish in UEFPC and hydrologically-connected locations downstream in LEFPC and CR/PC. Stoneroller minnows at EFK 24.5 decreased by 50% between 2009 and 2010, averaging 1.20 ± 0.05 μg/g in 2010.

A first glance at Figure 6.10 suggests that mercury levels in fish have increased in recent years, but this apparent trend is driven by a shift in fish species sampled rather than by an actual increase in mercury exposure or bioaccumulation at this site. Note that when redbreast sunfish (shown in red on Figure 6.10) could not be found at EFK 23.4, rockbass were collected instead (shown in green on Figure 6.10). Previous studies have shown that rockbass have at least 15-20% higher Hg levels than redbreast sampled concurrently from the same site, most likely because their diet includes higher trophic level organisms with greater mercury content. Overall, the lack of response in fish to decreased mercury concentrations in water is a complex issue that is being investigated by scientists and environmental managers throughout the DOE complex. Two recent reports focused on mercury sources, transport, and fate have been drafted or published that may be helpful in future remedial decision-making (Southworth *et al.* 2010, Peterson *et al.* pending publication).

Mean PCB concentrations of 5.53 +/- 0.44 µg/g in whole body composites of stoneroller minnows at EFK 24.5 were 5.53 ± 0.44 µg/g, increased slightly from levels seen in 2009. Total PCB concentrations in sunfish fillets at EFK 23.4 also increased in 2010 (0.64 µg/g), but still remained much lower than the peak levels observed in the mid-1990s (Figure 6.11).

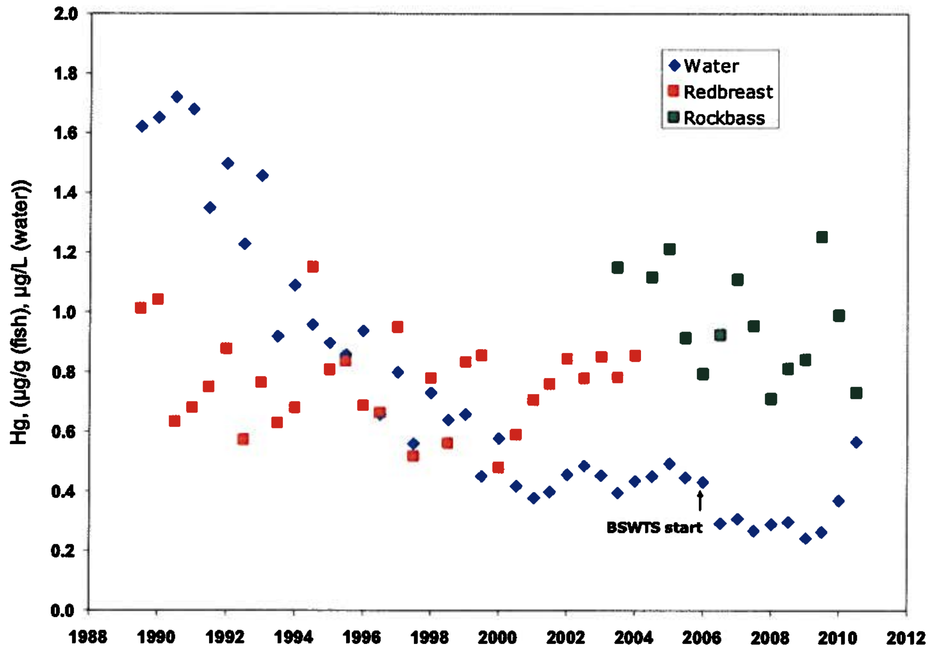


Figure 6.10. Mean concentration of mercury in redbreast sunfish and rockbass at EFK 23.4 versus trailing 6-month mean concentration of mercury in water.

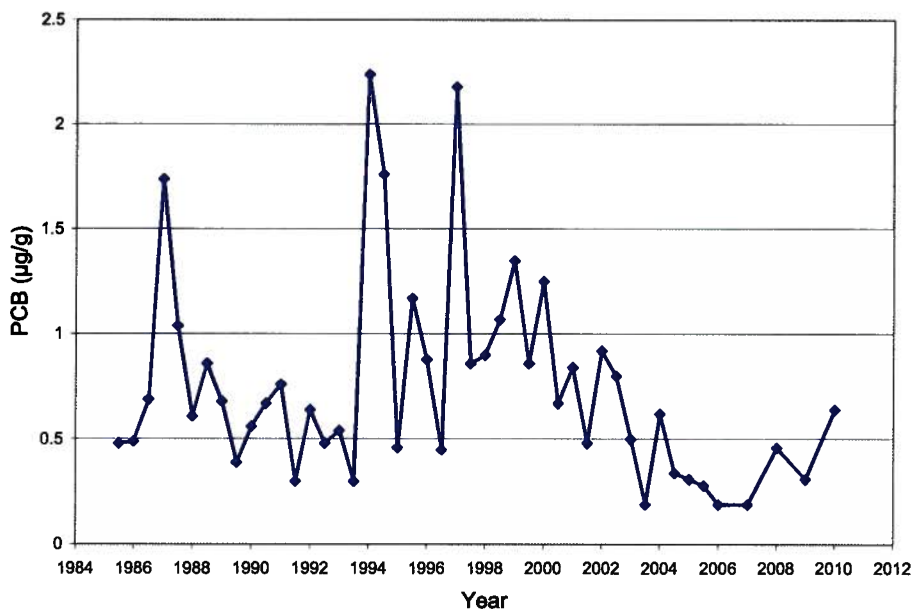


Figure 6.11. Mean concentrations of PCBs in redbreast sunfish and rockbass at EFK 23.4, 1985–2010.

After substantial increases in the number of species at EFK 23.4 in the late 1980s and early to mid-1990s, the number of fish species has leveled out in recent years (Figure 6.12) and remains below comparable reference fish communities like BFK 7.6 (inset, Figure 6.1). In contrast, the species richness (number of species) of the fish community further downstream at EFK 13.8 has continued to improve, and now routinely meets or exceeds richness at the reference site. The improvement includes more sensitive species, but the density of these sensitive species at EFK 13.8 is still below reference values.

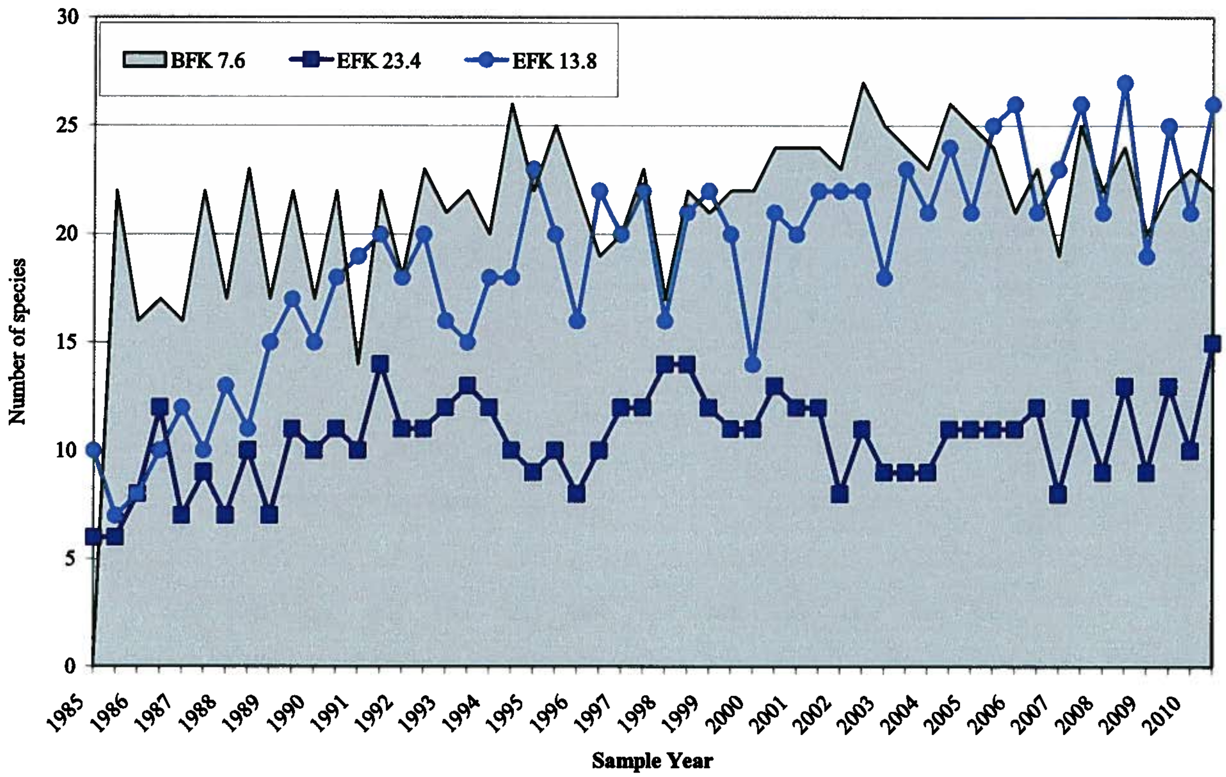


Figure 6.12. Species richness (number of species) in samples of the fish community in East Fork Poplar Creek (EFK) and a reference stream, Brushy Fork (BFK), 1985–2010.

No unusual change was observed in long-term trends in taxonomic richness of pollution-intolerant benthic macroinvertebrates at EFK 24.4 in 2010 (Figure 6.13), suggesting that the extent of recovery has stabilized to existing environmental conditions at that site. At EFK 23.4, in contrast, a trend now appears to exist suggesting that after a notable reduction in the number of pollution-intolerant taxa in 2005, the number of taxa has increased from around three to four taxa per sampling period to approximately four to five taxa per sampling period. The number of pollution-intolerant taxa at the Brushy Fork reference site continues to show wide fluctuation between years, but except for 2009, there continues to be two and usually more taxa per sample than at either site in EFPC.

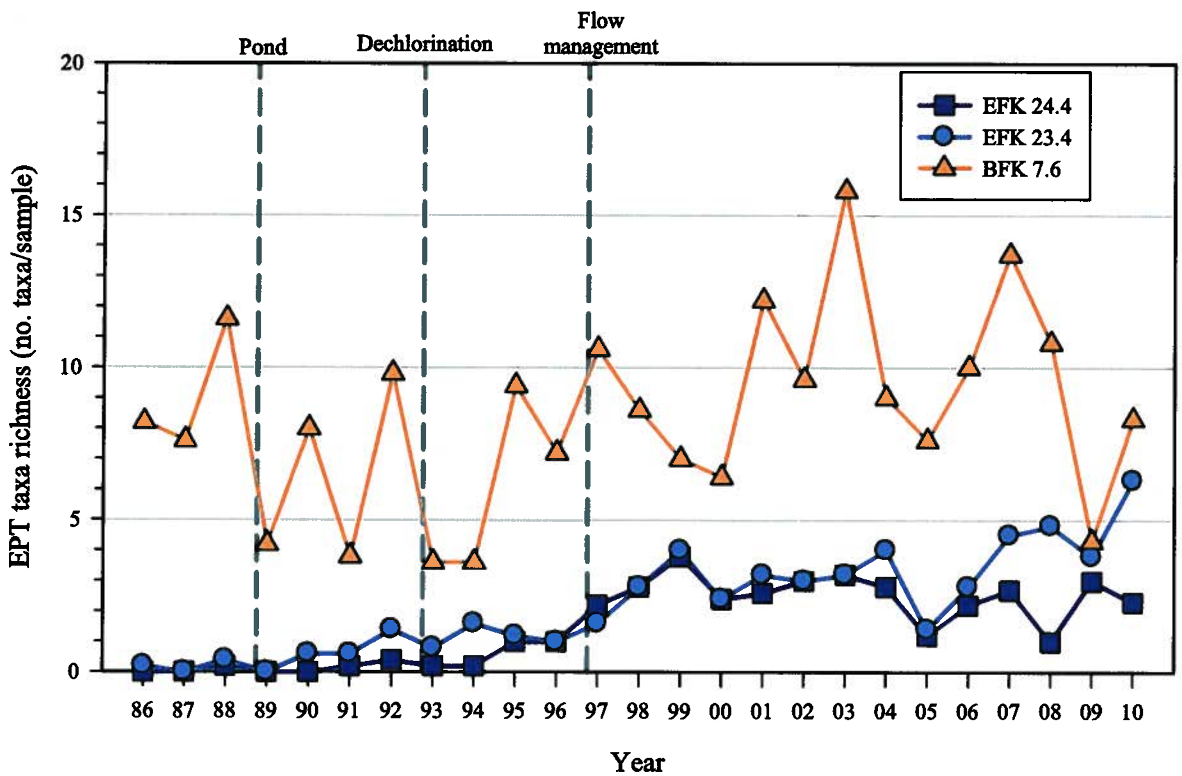


Figure 6.13. Mean (n = 5; n = 4 after 2006) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in EFPC and Brushy Fork, April sampling periods, 1986–2010.[a,b]

[a]Major events in the 1980s and 1990s include New Hope Pond replacement with Lake Reality, dechlorination of discharges, and the start-up of flow management.
[b]EFK = East Fork Poplar Creek kilometer; BFK = Brushy Fork kilometer. EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, caddisflies, and stoneflies.

6.2.2.2.2 Groundwater Quality Monitoring

The UEFPC Remedial Investigation/Feasibility Study (RI/FS) estimated that groundwater contamination underlies about half of the industrial portion of the UEFPC Watershed and VOCs, radionuclides, nitrate, and metals are the prevalent groundwater contaminants. Figure 6.1 incorporates the UEFPC RI/FS groundwater contaminant plume map that shows several areas of VOC and radiological contamination, as well as monitoring locations. Well GW-108 is a 58 ft deep well located in the eastern portion of the S-3 Ponds Plume. Figure 6.14 shows analytical results for ^{99}Tc and nitrate in well GW-108. These contaminants, which far exceed their drinking water standards (900 pCi/L EDE based on 4 mrem/yr MCL for beta activity and photon particles for ^{99}Tc, and 10 mg/L for nitrate), originate from the S-3 Ponds in a low pH plume finger that seeps eastward into the UEFPC watershed. The data histories for both contaminants during FY 2010 show continued high levels of these contaminants.

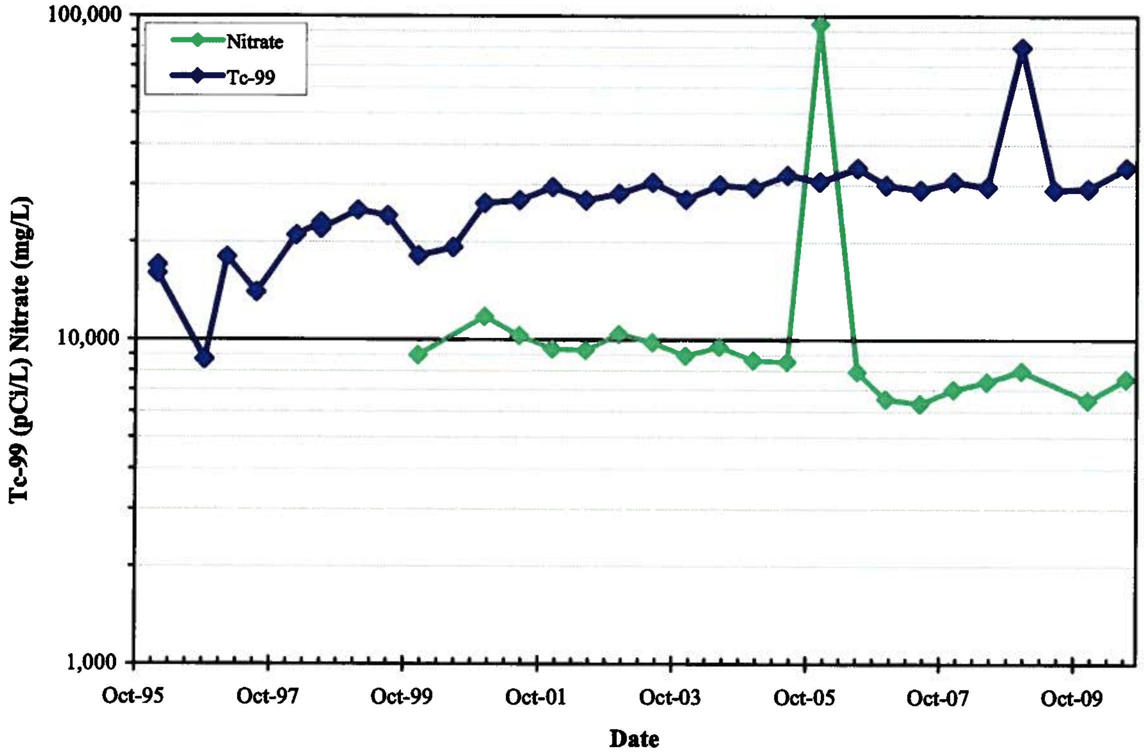
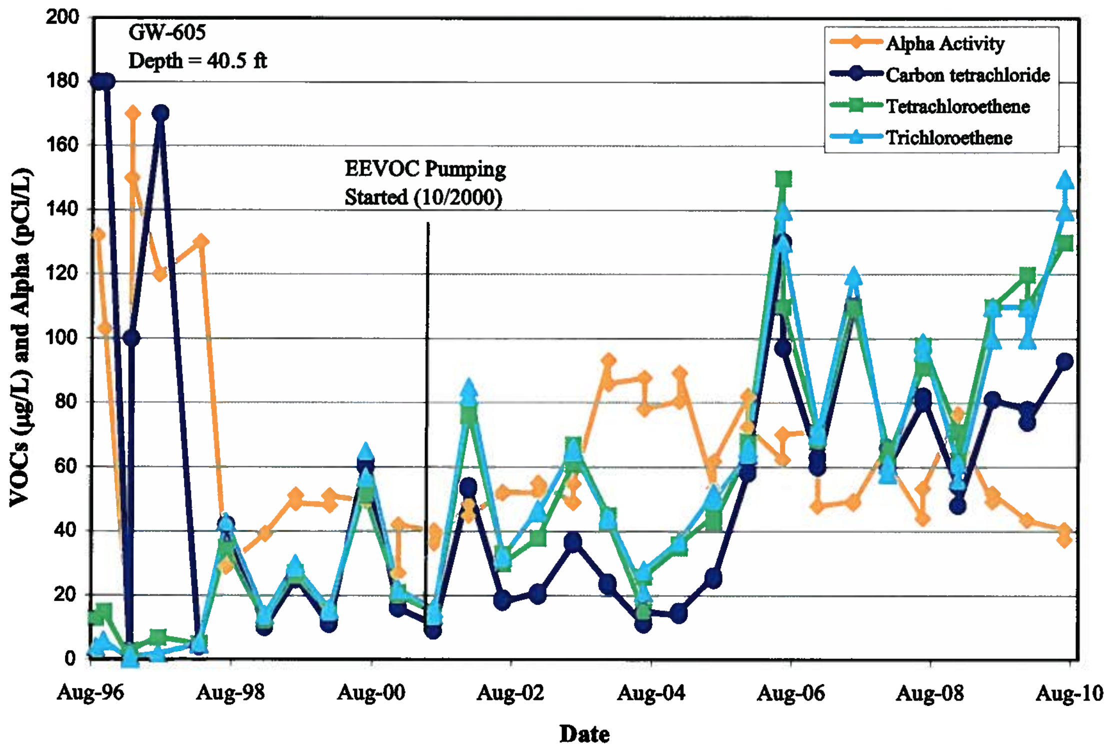


Figure 6.14. Well GW-108 nitrate concentration and ^{99}Tc activity.

Wells GW-605 and GW-606 are located in the Maynardville Limestone exit pathway upgradient of the East End Volatile Organic Compound (EEVOC) plume interception and treatment system (see Figure 6.1). Well GW-605 is a relatively shallow well (40.5 ft deep), while GW-606 is deeper (175 ft deep). Figure 6.15 shows concentrations of signature contaminants in wells GW-605 and GW-606. GW-605 exhibits a long-term decreasing trend for alpha activity. The alpha activity is associated with uranium which was present at 0.11 mg/L (greater than the 0.03 mg/L MCL) in both semiannual samples during FY 2010. The source of uranium contamination in groundwater in the area is not known. The VOC concentrations are seasonally variable but increased to levels comparable to those measured during the previous observed maxima during 2006. Groundwater in the vicinity of GW-605 tends to follow the hydraulic gradient eastward into the edge of the EEVOC plume extraction well drawdown feature where it enters the plume treatment system.

At well GW-606 concentrations of carbon tetrachloride and its degradation product chloroform have decreased since the FY 2000 time period, apparently as a consequence of EEVOC plume extraction. Nitrate was present in well GW-606 prior to initiation of groundwater withdrawal and treatment. As shown in Figure 6.15, the nitrate concentration increased after groundwater withdrawal started and has fluctuated in the concentration range between 8 and 16 mg/L. During FY 2010, nitrate in GW-606 decreased from its previous high of 16 mg/L to 10 and 11 mg/L. Well GW-606 contains about 5 µg/L of uranium and PCE is present at 4 – 5.5 µg/L. TCE was not detected during FY 2010 although it has been present historically. Like the VOCs detected in well GW-605, the nitrate contamination is thought to be captured in the zone of influence of the EEVOC treatment system. Section 6.3.1 presents performance monitoring data relevant to the Y-12 EEVOC Plume removal action.



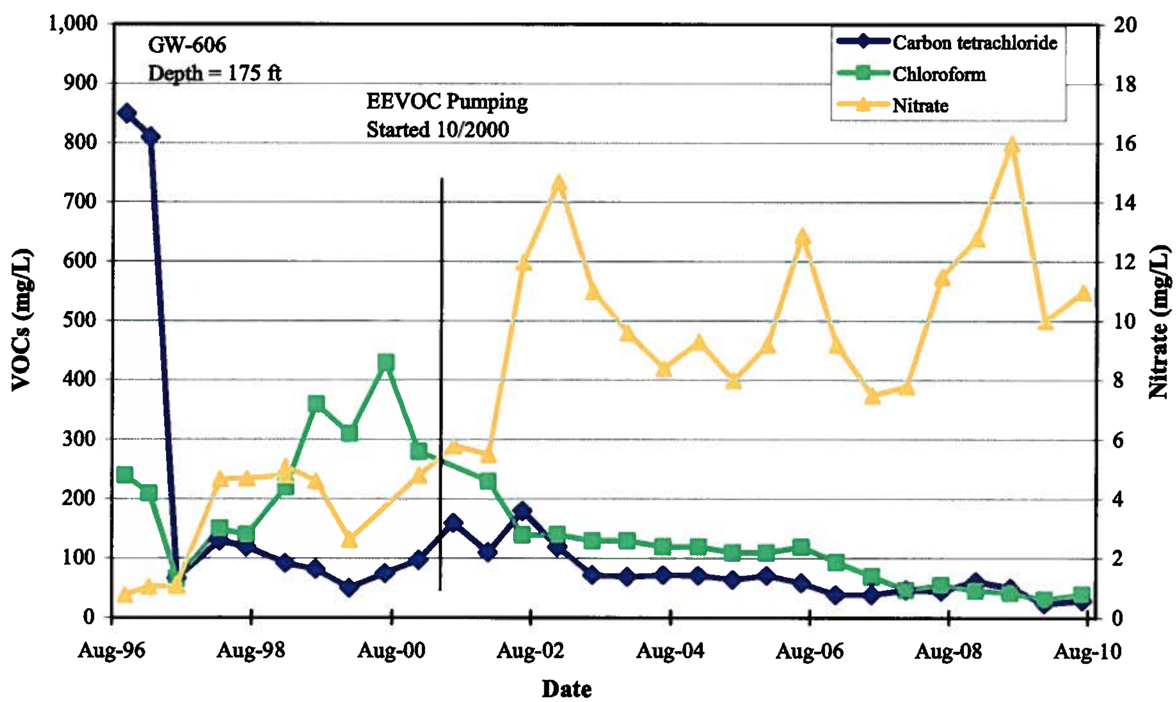


Figure 6.15. Wells GW-605 and GW-606 signature contaminant concentrations.

6.2.3 Performance Summary

Surface water contaminant discharge conditions in UEFPC reflected the continued above-average rainfall during FY 2010. Mercury discharges measured at the WEMA IP (Outfall 200A6) and at the watershed IP (Station 17) using flow-paced sampling were about 5 and 7 kg, respectively. The BSWTS was fully operational during FY 2010 and although no significant downtime or operational problems occurred, inflow volumes exceeded treatment capacity which caused bypass of untreated water to discharge via Outfall 51. Based on available data it is estimated that 0.3 to 0.5 kg of mercury may have been discharged as a result of the bypass. The average effluent concentration for BSWTS was 0.025 µg/L, which is the same as FY 2009 and is less than the performance standard of 0.2 µg/L. An issue is identified to better identify the mass of Hg flux from Outfall 51 when the BSWTS is bypassed. DOE will monitor the Hg concentrations during high flows at Outfall 51.

The mercury ROD goal at Station 17 is 200 ng/L. The average flow-paced composite mercury concentration during FY 2010 was 476 ng/L and the average concentration obtained from grab samples was 392 ng/L.

The performance standard for uranium at Station 17 is to monitor the trend. The uranium flux at Station 17 in FY 2010 remains elevated, near FY 2009 levels, relative to that observed in drought years. Uranium concentration and fluxes in UEFPC originate from groundwater seepage and storm water transport of surface contamination at the Y-12 plant. Groundwater contamination in the WEMA is a source of uranium flux at Outfall 200A6. Another source of the increased uranium flux observed at Station 17 may be the former Oil Skimmer Basin.

Aquatic biological monitoring shows that mercury concentrations remain stable in fish tissue at EFK 23.4 near the watershed IP. PCB concentrations in fish increased to 0.64 µg/g in 2010 but remained much lower than peak levels. The lack of a response in fish to decreased mercury concentrations in water is an ongoing issue. Recently, two reports have been drafted or published which focused on mercury sources, transport, and fate (Southworth *et al.* 2010, Peterson, *et al.* pending publication). Although fish and benthic communities in UEFPC are relatively stable, they continue to show impairment compared to the reference streams.

6.2.4 Compliance with LTS Requirements

6.2.4.1 Requirements

The UEFPC Phase I ROD (DOE 2002c) specifies LTS activities, such as maintenance and LUCs, to reduce the risk of human exposure to contaminants (see Table 6.2). Required maintenance activities include periodic inspections and repair of the WEMA asphalt caps upon completion. The LUCs include an EPP program, property record restrictions, property record notices, zoning notices, signs, and surveillance patrols for the former mercury use areas in Y-12.

6.2.4.2 Status of Requirements for FY 2010

Because not all of the UEFPC Phase I ROD actions have been completed, no maintenance activities and LUCs were verified as part of this action in FY 2010. However, Y-12 is an active federal installation and many of the LUCs in the UEFPC are already in place to prevent consumption of fish from UEFPC and to control/monitor access by workers and the public, including an ongoing EPP program. Signs are in place and the security patrols continue to provide protection. Operation and maintenance of water treatment systems (CMTS and BSWTS) are discussed in Sect. 6.2.2.

6.3 COMPLETED SINGLE ACTIONS IN UEFPC WATERSHED WITH MONITORING AND/OR LTS REQUIREMENTS

6.3.1 Y-12 East End VOC Plume Removal Action

The EEVOC Plume Removal Action was initiated in October 2000 as a non-TC RmA documented in an AM (DOE 1999c). Construction of the extraction/treatment system began in May 2000 and operation of the system started in October to prevent further migration of the VOC-contaminated groundwater plume off the ORR. At the request of the regulators, the system operated for five years so that performance could be evaluated before preparation and approval of the RmAR in FY 2006 (DOE 2006b). The RmAR recommended continuation of the current plume interception system and specified evaluation of the system performance in the annual RER.

6.3.1.1 Performance Goals and Monitoring Objectives

The goals of the action are to "reduce health and environmental risks associated with the migration of VOC-contaminated groundwater from the east end of Y-12. In addition, the action will reduce the potential risk from exposure to this contamination in off-site areas." The AM also includes a goal to mitigate off-site migration of contaminants. No specific numeric performance standards were established for the selected alternative. Existing human health or ecological risks specific to groundwater were evaluated during the UEFPC RI (DOE 1998a) and a Union Valley Interim Study was incorporated into the removal action. The risk assessments presented in the Union Valley Interim Study addressed hypothetical risks related to groundwater use, as well as potential risk related to exposure to spring discharges in Union Valley. These risk estimates form a comparative baseline for future performance evaluations in CERCLA FYRs.

As stated in the AM (DOE 1999c), system performance is measured by evaluating reductions in VOC concentrations downgradient of the extraction well (GW-845). The RmAR identified changes to monitoring frequencies and analysis, which were implemented in the FY 2007 monitoring. Quarterly sampling is performed on extracted groundwater from GW-845 with analysis including VOCs, metals, nitrate, and uranium. Additional analysis is performed on the effluent from the treatment system discharging to UEFPC. The performance goal of the treated effluent is to meet the AWQC recreational (for organism only) criteria (16 μg/L carbon tetrachloride). Semiannual sampling is performed at the downgradient multiport well (GW-722) and downgradient well cluster (GW-169 and GW-170) for VOCs analysis.

6.3.1.2 Evaluation of Performance Monitoring Data

6.3.1.2.1 Groundwater Monitoring Data

Figure 6.16 and Figure 6.17 show the EEVOC chlorinated hydrocarbon concentrations before pumping at well GW-845 was started in FY 2000, and in FY 2010 showing the region of maximum contaminant removal, respectively. Concentrations represent the sum of chlorinated volatile organic compounds (CVOCs). Two distinct contaminant sources are evident – a carbon tetrachloride source near the southwestern portion of the plume and a source of PCE and TCE near the northwestern portion of the plume. Comparison of the two figures shows that the groundwater pump and treat system has decreased CVOC concentrations along the extent of the southern half of the plume while concentrations along the northern edge have remained essentially constant. This contrast is attributed to the occurrence of less permeable bedrock at the base of the Maynardville Limestone near the Nolichucky Shale contact area.

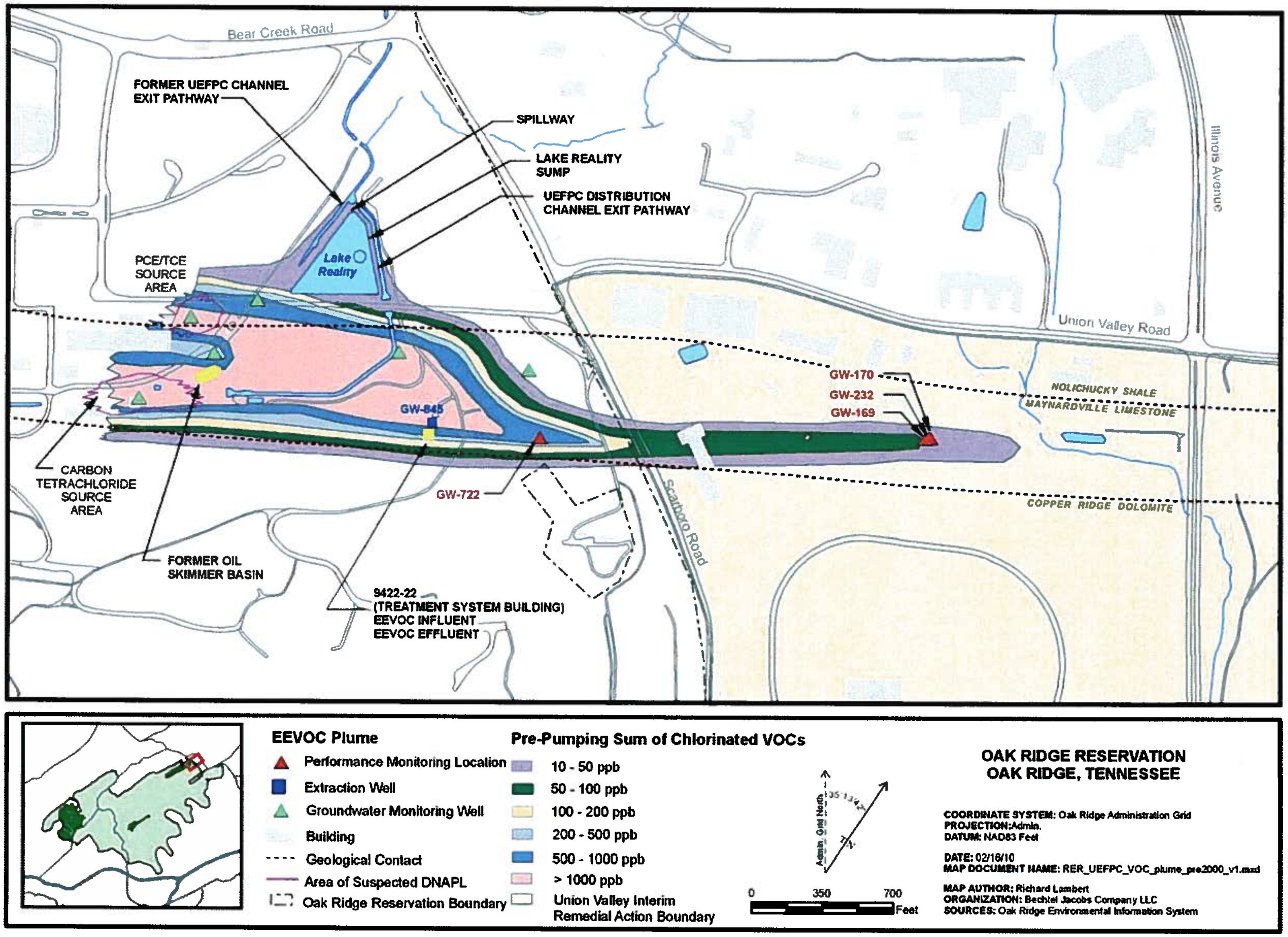


Figure 6.16. EEVOC Plume before pump and treatment system startup (1998-2000).

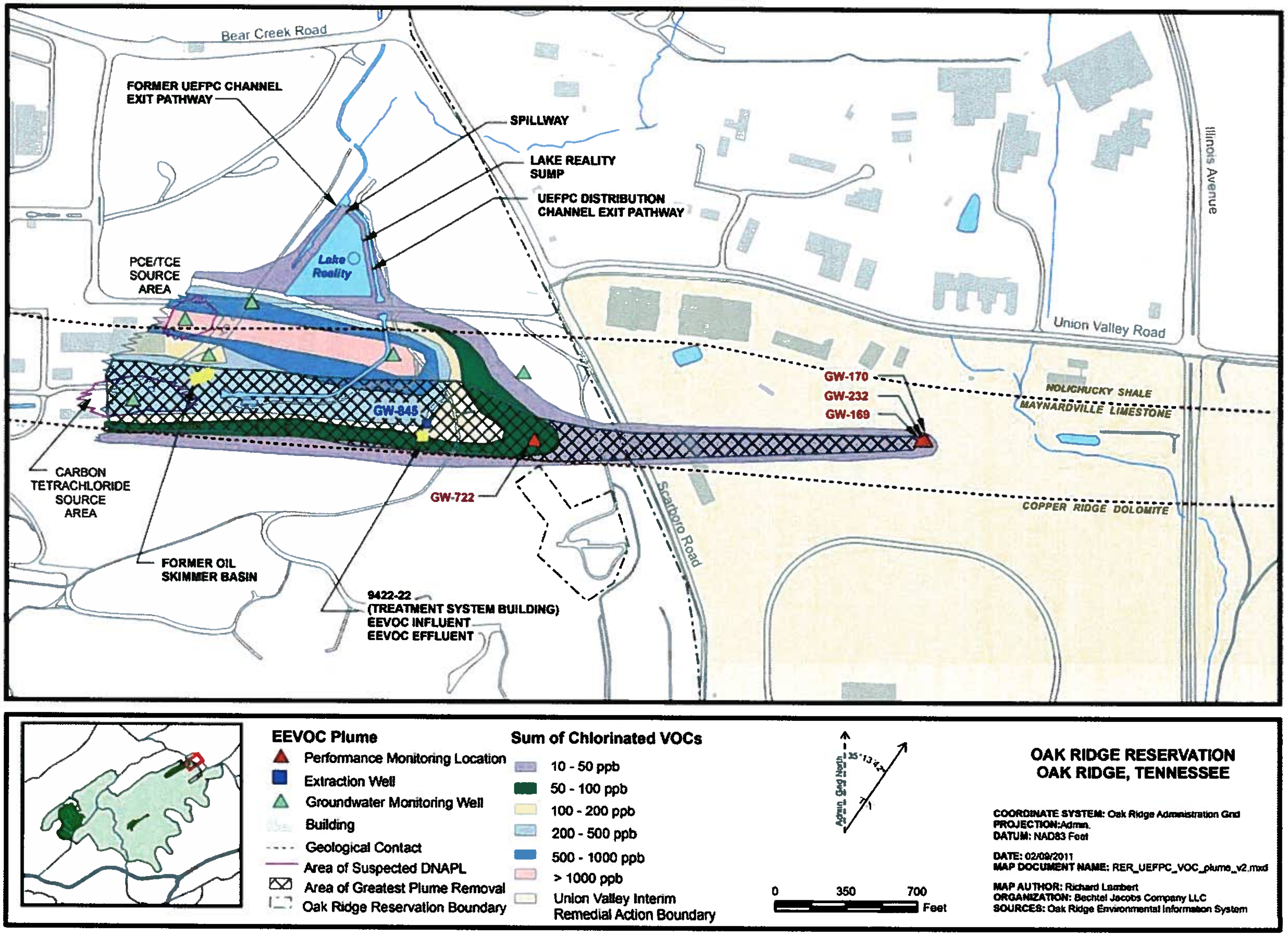


Figure 6.17. EEVOC Plume in FY 2010 showing region of maximum CVOC removal.

The groundwater extraction system has effectively withdrawn contaminant mass from the more permeable limestone area, but the contaminated groundwater is not as effectively withdrawn from the shaley bedrock. PCE and TCE are detected at low concentrations in the extracted groundwater that is sent to the treatment system, suggesting that there is capture of that portion of the plume, although the mass removal is small.

Figure 6.18 shows the drawdown feature created by pumping of well GW-845 in plan view and in cross-sectional views. The asymmetrical drawdown feature is created because of the dipping attitude of bedrock and spatial variability of permeability. The screened interval of well GW-845 is 280 ft long, as shown in Figure 6.18, which allows the well to capture contaminants from a large vertical region in bedrock. This extensive vertical capture capability increases the likelihood that this system will intercept contaminants seeping eastward in the Maynardville Limestone from source areas to the west in the Y-12 industrial area.

As stated in the AM (DOE 1999c), system performance is measured by evaluating reductions in VOC concentrations downgradient of the extraction well (GW-845). The RmAR specified quarterly sampling and analysis at the extraction well; well GW-722 located approximately 180 m (600 ft) downgradient of the extraction well; and wells GW-169, -170, and -232 located about 730 m (2400 ft) east along geologic strike in Union Valley (Figure 6.16). Additional analyses for uranium, mercury, and nitrate were specified to evaluate whether long-term pumping mobilizes metals, radiological contaminants, or nitrate from upgradient sources within Y-12, such as the former Oil Skimmer Basin located approximately 300 m (1000 ft) west of well GW-845 (Figure 6.16). Consistent with recommendations in the approved 2006 RER FYR and RmAR (DOE 2006b), sampling of well GW-232 in Union Valley has been discontinued and sampling frequency and target analytes at other AM-specified wells have been modified.

Treated groundwater is continuously discharged into the UEFPC. The RmAR requires at least quarterly sampling and analysis of influent and effluent for VOCs, metal, nitrate, and uranium. The TDEC AWQC for carbon tetrachloride (currently 16 μg/L) is the ARAR applicable to this treated discharge.

6.3.1.2.2 Maynardville Limestone Exit Pathway

The EEVOC influent station has a valved sample port that allows collection of water before treatment to represent groundwater concentrations from well GW-845 completed in the Maynardville Limestone Exit Pathway. Data obtained to date indicate that carbon tetrachloride concentrations in the pumping well have stabilized at about 200 μg/L or less (Figure 6.19). Likewise, chloroform concentrations have stabilized at about 10 to 15 μg/L.

Signature VOCs within the intermediate and deep intervals of the Maynardville Limestone directly downgradient of the pumping well (Figure 6.16) also decreased significantly relative to baseline data. This pathway is monitored via well GW-722 (Port 14 at 425 ft bgs, Port 17 at 385 ft bgs, Port 20 at 333 ft bgs, and Port 22 at 313 ft bgs). The ports discussed here contain the highest concentrations of contaminants. Other ports in well GW-722 are sampled by the Y-12 Groundwater Protection Program. That monitoring confirms that carbon tetrachloride, PCE, and TCE are generally not detected or occur at concentrations below MCLs in other ports since the pump and treatment operation started. The FY 2010 analytical results for several signature VOCs in well GW-722, Port 17, are provided in Table 6.6. Sample Port 17 has historically shown some of the highest and most consistent VOC results; therefore, data from this sampling point are used to best illustrate carbon tetrachloride trends over time (Figure 6.19). Since operation of the extraction system, carbon tetrachloride concentrations has decreased from the 200 – 1,000 μg/L range to less than 50 μg/L. Overall, since system operations began, concentrations of PCE have decreased by a factor of about ten and similar trends have also been noted for TCE and DCE. The other sampling zones in well GW-722 show similar decreases in VOC concentrations.

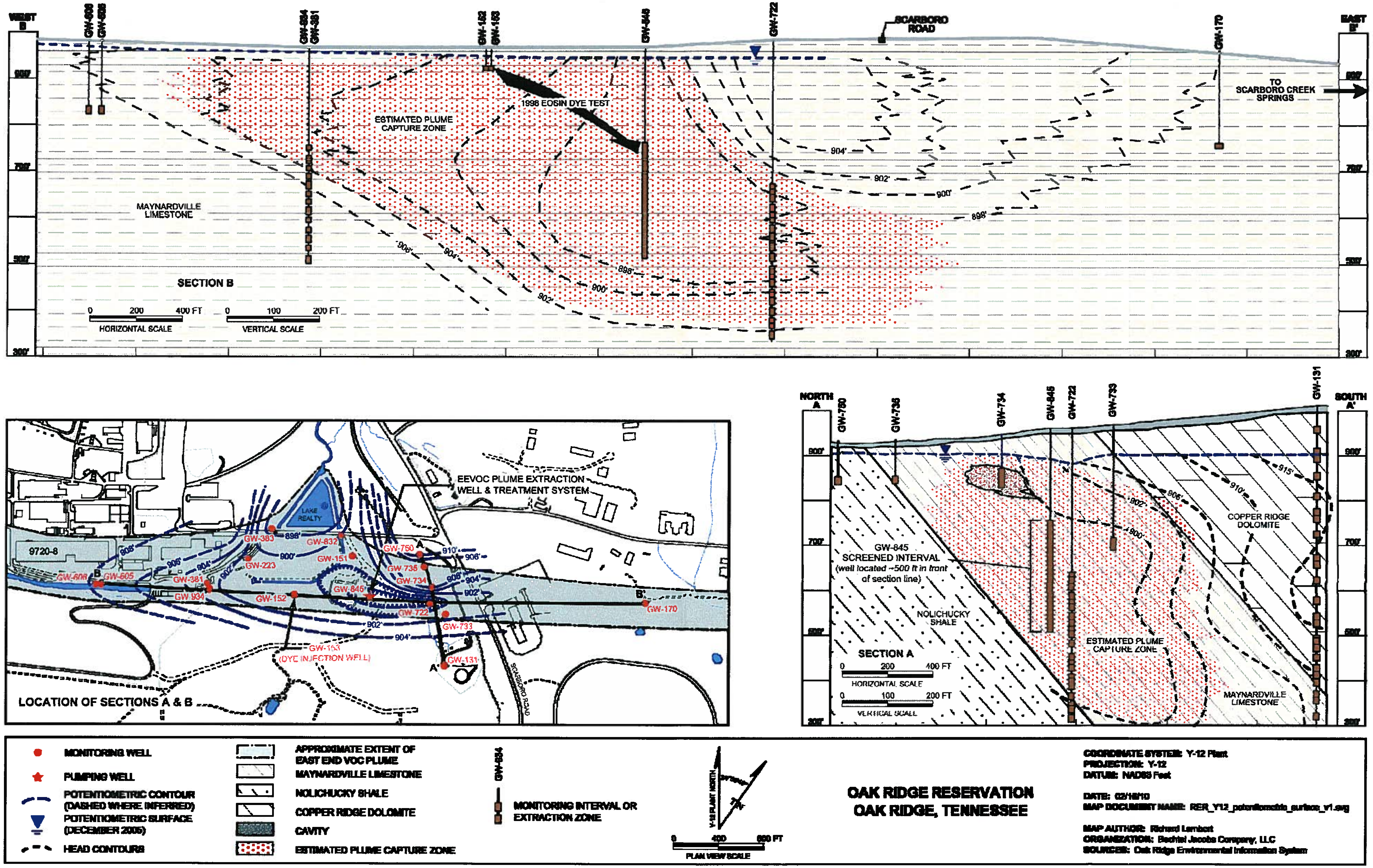


Figure 6.18. Potentiometric surface at the eastern Y-12 area.

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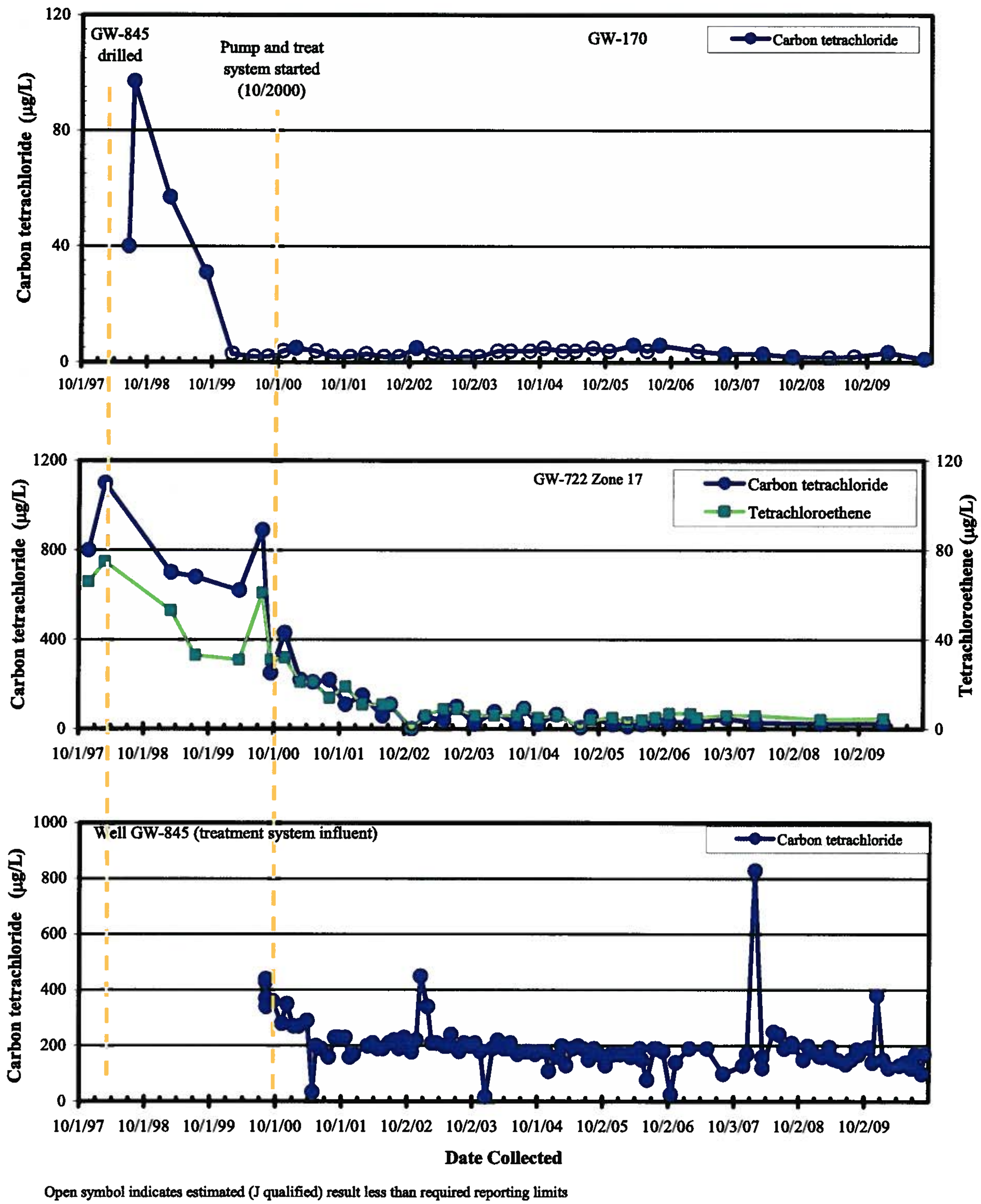

Figure 6.19. Selected VOC trends in the Maynardville Limestone exit pathway.

Table 6.6. Selected FY 2010 data for Y-12 EEVOC Plume performance

Chemical	Station Name Sample Date Units	GW-169 1/272010	GW-169 8/19/2010	GW-170 1/272010	GW-170 8/19/2010
Alpha activity	pCi/L	<3.15 (U)	< 2.18 (U)	< 2.63 (U)	< 1.53 (U)
Beta activity	pCi/L	< 3.59 (U)	< 3.27 (U)	11.6 ±3.76	14.5 ±2.59
Carbon tetrachloride	µg/L	1 U	1 U	3.6	1
Chloroform	µg/L	1 U	1 U	1.3	1 U
Tetrachloroethene	µg/L	1.5	1.7	1.2	1 U
Trichloroethene	µg/L	1 U	1 U	1.5	1.3
Nitrate	mg/L	0.96	0.83	0.34	0.22

Chemical	Station Name Sample Date Units	GW-722-17 2/18/2010	GW-722-17 7/24/2010	GW-722-14 2/18/2010	GW-722-14 7/29/2010?
Carbon tetrachloride	µg/L	24	19	15	8
Chloroform	µg/L	5.4	5 J	1.5	1 J
Tetrachloroethene	µg/L	4.7	2 J	2.2	5 U
Trichloroethene	µg/L	1.2	5 U	1.1	5 U

GW = groundwater well
J = estimated value

U = Not detected or result less than minimum detectable activity and/or counting errors (radiological results)

In Union Valley east of Scarboro Road (Figures 6.16 and 6.17), signature VOCs (carbon tetrachloride, chloroform, PCE, and TCE) have historically been detected in wells GW-169 (water table interval) and GW-170 (intermediate interval; 120 ft bgs), which are directly along strike to the east of Y-12 (Table 6.6). Well GW-170 has historically had the highest levels of carbon tetrachloride and chloroform with highly variable concentrations, but with an overall decline since 1994. Historical VOC concentrations in well GW-170 suggest that contaminant migration is episodic and may be driven primarily by rainfall events, which produce short-term concentration peaks. Since 2000, carbon tetrachloride concentrations have stabilized at about 5 µg/L or less. A sharp, persistent decrease of carbon tetrachloride concentrations occurred in well GW-170 prior to the EEVOC Plume treatment system start-up in October 2000, which correlated to an increase in pH. The available data suggest that water quality in the Union Valley area west of Illinois Avenue may have been affected by large-scale construction activities near Scarboro Road, resulting in elevated pH conditions and increased surface water dilution in the shallow and intermediate zones of the Maynardville Limestone in this area. Signature VOCs observed in well GW-169 have remained consistently low over time at between 1 and 4 µg/L.

Low levels of benzene (1 to 4 µg/L) have been detected intermittently in well GW-170 since first appearing in FY 2001. Wells that sample groundwater on DOE property in the exit pathway of the plume (GW-733, GW-722, and GW-734 shown on Figure 6.18) show less frequent and lower (estimated 1 to 2 µg/L) benzene concentrations, which suggests that the benzene detected in off-site well GW-170 may not originate from the EEVOC plume. The off-site area is an industrial park. A source for benzene in the well has not been identified to date. All detected results are below the MCL for benzene which is 5 µg/L.

6.3.1.2.3 Treatment System Performance

Treatment system performance monitoring began in November 2000, following system startup. During FY 2010, the treatment system operated fairly reliably with minor, short-term outages (Figure 6.20).

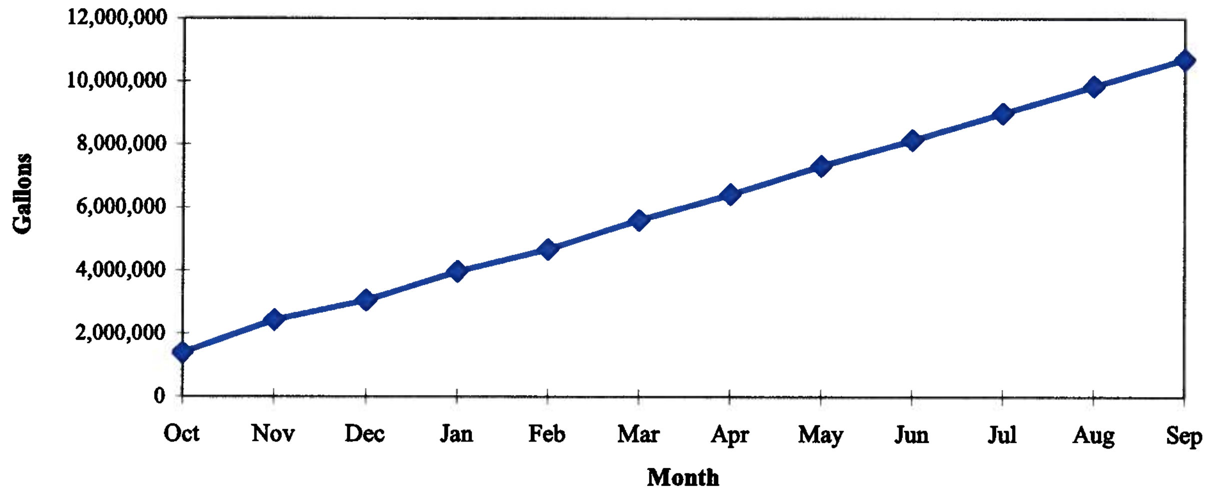

Figure 6.20. EEVOC treatment system cumulative water treated during FY 2010.

To evaluate the effectiveness of the treatment system, influent and corresponding effluent samples have been collected since operations began. In FY 2010, concentrations of carbon tetrachloride in treatment system influent (from well GW-845) ranged from 100 µg/L to 380 µg/L and averaged 165 µg/L for the year (Table 6.7). The concentration range for carbon tetrachloride in the effluent stream was 8.3 µg/L to 52 µg/L and averaged 31.6 µg/L. Removal efficiency for carbon tetrachloride averaged about 81% in FY 2010. Table 6.8 summarizes total mass removals for the principal VOCs since operations began in 2000.

An effluent concentration limit was not stipulated for the treatment system. However, to maintain protectiveness of the environment and to monitor the effectiveness of the treatment system, the EEVOC treatment system effluent is sampled and analyzed monthly for VOCs. The air stripper system performance is affected by ambient air temperature and relative humidity. During the warm, damp summer months, the effluent VOC concentrations typically increase relative to those measured during autumn and winter when relative humidity is lower. Maximum FY 2010 results of selected organic and radiological constituents in both influent and effluent samples are listed in Table 6.9. Reductions were observed for other signature VOCs detected in the influent stream, although removal efficiencies were lower than those observed for the carbon tetrachloride (Table 6.7 and Table 6.9).

Table 6.7. Selected Y-12 EEVOC Plume treatment system performance data, FY 2010

Chemical	Date	Influent result (µg/L)	Effluent result (µg/L)	Percent reduction	Estimated net mass removal (kg)[a]
Carbon tetrachloride	10/27/2009	194	11.8	94%	0.97
	11/19/2009	140	8.3	94%	0.52
	12/14/2009	380	23	94%	0.84
	1/18/2010	150	17	89%	0.46
	2/18/2010	120	13	89%	0.28
	4/20/2010	130	26	80%	0.32
	5/24/2010	140	49	65%	0.31
	6/24/2010	120	47	61%	0.23
	7/22/2010	170	49	71%	0.39
	8/23/2010	100	52	48%	0.16
	9/7/2010	170	51	70%	0.39
FY 2010 annual average:		**165**	**31.6**	81%	
FY 2010 annual mass removal:					**4.8[b] kg**
Chloroform	10/27/2009	11.4	2.8	75%	0.05
	11/19/2009	8.6	2.6	70%	0.02
	12/14/2009	26	7.4	72%	0.04
	1/18/2010	9.6	3.9	59%	0.02
	2/18/2010	8.9	3.2	64%	0.02
	4/20/2010	8.2	4.1	50%	0.01
	5/24/2010	10	7	30%	0.01
	6/24/2010	9.3	6.8	27%	0.01
	7/22/2010	10	7	30%	0.01
	8/23/2010	9.2	7	24%	0.01
	9/7/2010	9.9	6.9	30%	0.01
FY 2010 annual average:		11.0	5.3	52%	
FY 2010 annual mass removal:					**0.21[b] kg**
PCE	10/27/2009	22.7	2.88	87%	0.11
	11/19/2009	24	2.2	91%	0.09
	12/14/2009	47	4.1	91%	0.10
	1/18/2010	24	3.9	84%	0.07
	2/18/2010	24	3.1	87%	0.06
	4/20/2010	21	5	76%	0.05
	5/24/2010	21	8.8	58%	0.04
	6/24/2010	23	10	57%	0.04
	7/22/2010	22	8.9	60%	0.04
	8/23/2010	22	9.4	57%	0.04
	9/7/2010	24	10	58%	0.05
FY 2010 annual average:		25	6.2	75%	
FY 2010 annual mass removal:					**0.68[b] kg**

[a]Estimated net mass removal is based on treated volume for the sample month. Influent and effluent concentrations are assumed to be applicable to total treated volume.

[b] Estimate is low because VOC data are not available for March 2010. Facility operated normally during March.

U = Result less than method reporting limits or minimum detectable activity

Table 6.8. Estimated mass removals for key EEVOC Plume constituents since inception of treatment operations

FY	Carbon tetrachloride (kg)	Chloroform (kg)	Tetrachloroethene (kg)
FY 2001	9.18	0.805	0.741
FY 2002	7.69	0.396	0.81
FY 2003	9.96	0.437	1.03
FY 2004	7.39	0.269	0.832
FY 2005	6.33	0.296	0.860
FY 2006	6.66	0.338	0.856
FY 2007	5.67	0.216	0.625
FY 2008	7.21	0.368	1.07
FY 2009	6.8	0.20	0.88
FY 2010	4.9	0.21	0.68
Totals	**71.8**	**3.54**	**8.41**

Table 6.9. Summary of Y-12 EEVOC Plume groundwater treatment system performance results, FY 2010

Analyte[a]	Units	Maximum influent detect (GW-845)	Maximum effluent detect
2-Butanone	μg/L	10 U	10 U
Carbon tetrachloride	μg/L	380	52
Chloroform	μg/L	26	7.4
1,1-DCA	μg/L	1	0.21 J
1,1,1-TCA	μg/L	0.68 J	< 1 U
1,2-DCE (total)	μg/L	5.8	2.2
Cis-1,2-DCE	μg/L	5.8	2.2
Trans-1,2-DCE	μg/L	< 1 U	< 1 U
PCE	μg/L	47	10
TCE	μg/L	6.9	3
Nitrate[b]	mg/L	0.96	0.96
Total uranium[b]	mg/L	0.005	0.005
^{234}U[b]	pCi/L	3.82 ± 1.04	3.69 ± 0.95
^{235}U[b]	pCi/L	0.376 ± 0.317	0.338 ± 0.314
^{238}U[b]	pCi/L	2.27 ± 0.837	1.53 ± 0.639

[a] All VOCs detected are listed.
[b] Note system design and remedy is targeted for VOCs.
GW = groundwater well
U = Result less than method reporting limits or minimum detectable activity
J = estimated value

During FY 2010, monitoring data for treatment system influent do not show any indication of substantially increased levels of total uranium or nitrate. An apparent trend of increasing ^{234}U and ^{238}U identified in the 2010 RER showed a decline during FY 2010. Figure 6.21 is a graph of the measured activities of ^{234}U and ^{238}U throughout the EEVOC treatment system operations through FY 2010. Table 6.9 includes the average EEVOC treatment system influent and effluent uranium isotopic activities. The effluent levels are slightly lower than the influent levels. The average isotopic activities in effluent equate to about 2.8 μg/L, which is less than the 30 μg/L MCL reference concentration. Based on the average groundwater withdrawal rate throughout FY 2010, the uranium mass discharged from the EEVOC system was approximately 0.1 kg for the year. This mass is a minor contribution to the yearly uranium mass measured at Station 17, (i.e., 140 kg/yr) (Sect. 6.2.2.1.2).

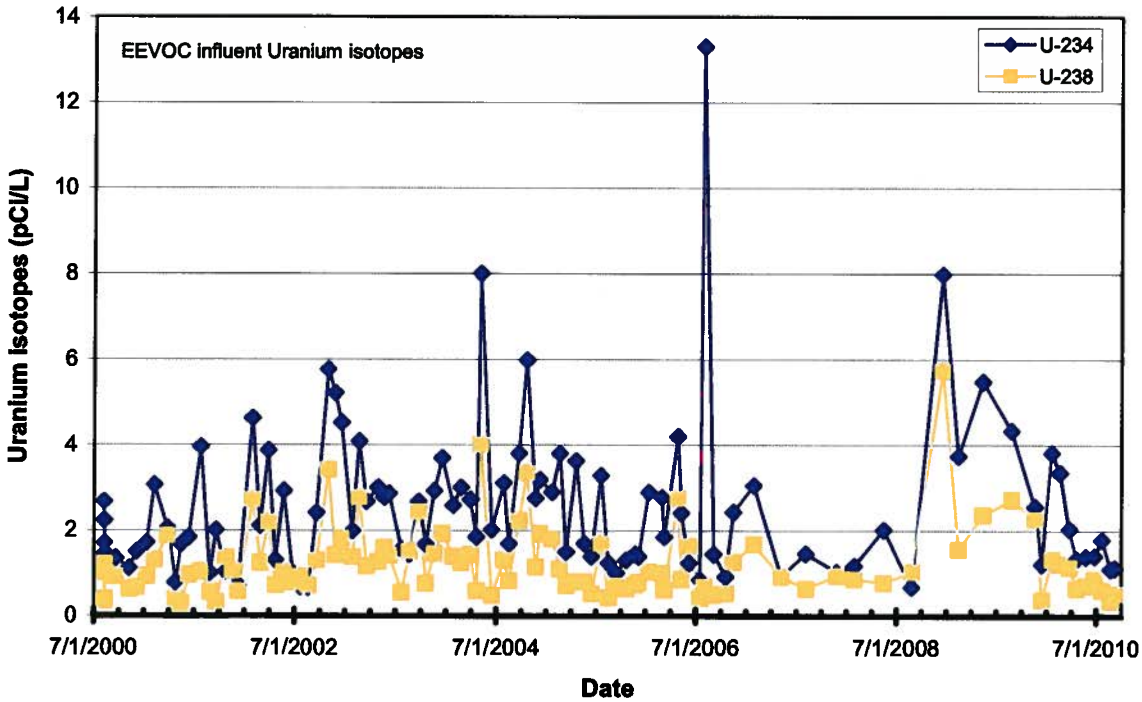

Figure 6.21. Measured activities of ^{234}U and ^{238}U in EEVOC treatment system influent.

The AM for the EEVOC remedy acknowledged the potential for other contaminants to increase in the EEVOC collected groundwater over time as a result of the groundwater withdrawals. The AM recognized the possibility that the treatment process could be modified to accommodate treatment of other contaminants, as warranted.

6.3.1.3 Performance Summary

The EEVOC Plume treatment system performance is measured by evaluating reductions in VOC concentrations downgradient of the extraction well, GW-845. FY 2010 data indicate that the groundwater pump and treatment system has effectively withdrawn contaminant mass from the permeable limestone downgradient in Union Valley, thereby meeting the performance criteria of the AM. Increasing uranium isotopic levels evident in FY 2009 in the influent and effluent streams did not continue in FY 2010.

6.3.1.4 Compliance with LTS Requirements

6.3.1.4.1 Requirements

No LTS requirements were specified in the decision documents for this site.

6.3.1.4.2 Status of Requirements for FY 2010

Although no requirements are specified, the site remained protected by the DOE 229 Boundary access controls and was regularly patrolled by security personnel. In addition, groundwater use remained restricted within Y-12 and Union Valley (See Sect. 6.3.2.3).

6.3.2 Union Valley Interim Action

Location of the Union Valley Interim Action is shown on Figure 6.1. The primary objective of this interim action was to protect human health from a contaminated plume originating from beneath Y-12 and detected in the groundwater below privately owned land in Union Valley. Institutional controls were selected as the interim remedy to accomplish the following goals: ensure that public health is protected while final actions are being developed and implemented, and identify and prohibit, if necessary, future activities with a potential to accelerate the rate of contaminant migration from the CA or increase the extent of the contaminant plume.

Background information on this remedy and performance standards are provided in Chap. 7 of Vol. 1 of the 2007 RER (DOE 2007a).

This site has only LTS requirements. A review of compliance with these LTS requirements is included in Sect. 6.3.2.3.

6.3.2.1 Performance Goals and Monitoring Objectives

No surface water or groundwater monitoring is required as part of this interim action to verify the effectiveness of the RA. An associated action, the EEVOC Plume Removal Action, included construction of a groundwater treatment facility to prevent further migration of the VOC-contaminated groundwater plume off of the ORR into Union Valley. The EEVOC Plume performance monitoring objectives are discussed in Sect. 6.3.1 of this report.

6.3.2.2 Evaluation of Performance Monitoring Data

No surface water or groundwater monitoring is required as part of the Union Valley Interim Action. However, evaluation of performance monitoring data for the associated EEVOC Plume Removal Action is included in Sect. 6.3.1.2 of this report.

6.3.2.3 Compliance with LTS Requirements

6.3.2.3.1 Requirements

The ROD (DOE 1997b) requires that the DOE Program Office ensure that the required property title searches and appropriate notifications are made during the term of the ROD (i.e., until a final ROD is issued for the UEFPC CA). The DOE Real Estate Office is responsible for the following institutional controls:

- Complete an annual title search by the anniversary date of the ROD to determine whether any affected property has changed hands;
- Notify property owners, the Oak Ridge city manager, and the TDEC/DOE Oversight Division of their obligations under the agreements and update them on the status of the environmental investigations;
- Survey owners by telephone to determine whether any new groundwater wells have been constructed or planned or there are any new uses for surface water; and
- Notify licensed well drillers in Tennessee of the license agreements and their terms.

6.3.2.3.2 Status of Requirements for FY 2010

Compliance with all requirements was verified in FY 2010. The DOE-ORO Realty Officer provided documentation that property owners, the Oak Ridge City Manager, and TDEC-DOE/ORO had been notified of their respective obligations and that Tennessee licensed well drillers were notified of the license agreements and terms. Documentation that all required title searches were conducted by the anniversary date of the ROD (July 10th) and that property owners were surveyed by telephone, as required, was provided by the BJC Property Management Office. LUC verification information used to document these results is compiled by the BJC Property Management Office in conjunction with the DOE Realty Office. A copy of the documentation is submitted to the WRRP for use in summarizing annually in the RER the status of compliance with the LTS requirements. Original documents are maintained by the BJC PDCC for the Property Management Office.

6.3.2.4 Issues and Recommendations

No changes to the Union Valley Interim Action are recommended at this time.

6.4 UPPER EAST FORK POPLAR CREEK MONITORING CHANGES AND RECOMMENDATIONS

Table 6.10 summarizes issues and recommendations for the UEFPC Watershed. A current issue was identified from evaluation of the FY 2010 monitoring data and a recommendation for evaluation of Hg flux bypassing BSWTS is put forward at this time. Several issues remain unresolved from previous RERs and are carried forward for tracking purposes.

Table 6.10. Summary of UEFPC Watershed technical issues and recommendations

Issue[a]	Action/ Recommendation
2011 Current Issue	
1. During FY 2010 inflow to BSWTS exceeded system design treatment capacity necessitating bypass flow to occur during significant periods of time.	1. Recommend the evaluation of Hg flux bypassing the system relative to rainfall intensity. It is not believed that a significant mass bypassed the system but this should be confirmed.
Issues Carried Forward	
1. Mercury concentrations in fish within the EFPC system remain elevated, despite decreasing concentrations in aqueous mercury levels. (2007 RER)[b]	1. A team consisting of DOE EM, NNSA, and Office of Science continue working together to develop a conceptual model(s) for mercury fate and transport relevant to methyl mercury concentrations in the EFPC ecosystem. Two recent reports focused on mercury sources, transport, and fate have been drafted or published (Southworth *et al.* 2010, Peterson *et al.* pending publication).
2. FY 2005 pre-action Hg concentrations at Station 17 are above the 200-ppt performance goal. Hg concentrations in fish in UEFPC have yet to respond to commensurate reductions of Hg from historical RMPE actions. Biota monitoring in UEFPC shows impaired diversity and density of pollution-intolerant species. (2006 FYR)[b]	2 Remedial measures required by the UEFPC Phase I ROD are expected to reduce Hg concentrations at Station 17. Issue Carried Forward #1 above will support Hg reductions in fish.. FY 2010 Hg levels in LEFPC fish remain above federal AWQC, but are less than peak levels observed in 2001-2002.
Completed/Resolved Issues	
None.	

[a] Issues are identified in the table as "ISSUES CARRIED FORWARD" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through 4resolution.

[b] The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2007 RER).

NNSA = National Nuclear Security Administration

RMPE = Reduction of Mercury in Plant Effluents

7. CERCLA OFF-SITE ACTIONS

7.1 INTRODUCTION AND OVERVIEW

This chapter provides an update to completed CERCLA actions outside the DOE ORR, all of which have performance monitoring and/or LTS requirements (Table 7.1). In this section, performance goals and objectives, monitoring results, and an assessment of the effectiveness of each completed action are presented. Table 7.2 provides a summary of LTS requirements for each action and a review of compliance with those requirements is also included within the chapter.

For background information on each remedy and performance standards, a compendium of all CERCLA decisions for off-site actions is provided in Chap. 7 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated in the annual RER and republished every fifth year at the time of the CERCLA FYR. The status of off-site long-term CERCLA decision making is provided in Figure 1.5 of Vol. 1 of the 2007 RER (DOE 2007a).

Poplar Creek, the Clinch River, and Watts Bar Reservoir comprise a single, hydrologically connected system through which contaminants originating from the ORR are transported. In September 1999, DOE recommended combining the monitoring plans for the CR/PC and LWBR OUs. This combined monitoring plan was revised in FY 2004 (DOE 2004b) to better identify and evaluate changes in COC concentrations in fish. However, the CERCLA decisions and evaluations of effectiveness are discussed separately within this report (Sects. 7.3 and 7.4).

7.1.1 Status and Update

DOE proposed a NSC (clarifying that the ROD decision included ecological protectiveness) to the LWBR ROD (DOE 1995b) to EPA and TDEC in December 2009. Per the 2008 RER, a Core Team will discuss changes to assure ecological protectiveness sampling in LWBR and CR/PC. Any additional or ambiguous sampling will be codified and changes, as appropriate, will be made to decision documents or provided in the applicable SAP/Quality Assurance Program Plan (QAPP).

Early morning on December 22, 2008, a retaining wall failed at the Tennessee Valley Authority (TVA) Kingston Fossil Plant in Roane County, Tennessee. More than 5.4 million cubic yards of coal ash spilled from an on-site holding pond to cover more than 300 acres of surrounding land and waters of the Clinch River arm of Watts Bar Lake. TVA, local, state and federal agencies continue to work on recovery and clean-up of the release of ash at the plant.

Table 7.1. CERCLA actions at off-site locations

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
		Completed actions		
LEFPC	ROD (DOE/OR/02-1370&D2): 08/17/95 ESD (DOE/OR/02-1443&D2): 11/15/96	RAR (DOE/OR/01-1680&D5) approved 08/15/00	Yes/Yes	7.2
CR/PC	ROD (DOE/OR/02-1547&D3): 09/23/97	RAR (DOE/OR/02-1627&D3) approved 06/14/99	Yes/Yes	7.3
LWBR	ROD (DOE/OR/02-1373&D3): 09/29/95	RAWP[b] (DOE/OR/02-1376&D3) approved 05/25/96	Yes/Yes	7.4

[a] Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <http://www.bechteljacobs.com/ettp_ffa_appendices.shtml>.
[b] This action was completed prior to uniform adherence to the RAR process; hence, no RAR exists for this decision.

Table 7.2. LTS requirements for CERCLA actions at off-site locations

Site/Project	LTS Requirements		Status	RER section
	LUCs	Engineering controls		
LEFPC RA	▪ Annual land use survey at Dean Stallings Ford ▪ Periodic survey to detect residential use of shallow groundwater		▪ LUCs in place.	7.2.4
CR/PC RA	▪ Fish consumption advisories ▪ Permits for sediment disturbing activities ▪ Survey to confirm effectiveness of fish consumption advisories (one time only) ▪ Survey of local irrigation practices (one time only prior to issuing surface water ROD)		▪ LUCs in place.	7.3.4
LWBR RA	▪ Fish consumption advisories ▪ Permits for sediment disturbing activities		▪ LUCs in place.	7.4.4

7.2 LOWER EAST FORK POPLAR CREEK REMEDIAL ACTION

The ROD for LEFPC (DOE 1995c) addressed the mercury contamination in the floodplain sediments of the creek that runs from Y-12 (in the UEFPC Watershed) through the city of Oak Ridge (Figure 7.1). A complete discussion of the LEFPC ROD is provided in Chap. 7 of Vol. 1 of the 2007 RER (DOE 2007a).

7.2.1 Performance Goals and Monitoring Objectives

A major component of the selected remedy for LEFPC was for DOE to perform appropriate monitoring to ensure effectiveness of the remediation. The RAR for LEFPC (DOE 2000d) provides a description of all measures taken during the remedial activities to comply with ARARs and supplemental monitoring activities needed to support the subsequent FYR (through 2005). The following monitoring was performed during FY 2010.

- Monitored mercury inputs from UEFPC to LEFPC at Station 17. This requirement is covered by the mercury monitoring at Station 17 required by the UEFPC Phase I ROD.

- Performed an annual survey of the former Dean Stallings Ford automobile dealership parking lot to ensure land use has not changed that would bring into question the protectiveness of leaving soils with > 400 ppm mercury.

7.2.2 Evaluation of Performance Monitoring Data – FY 2010

As a requirement of the RAR, mercury releases from Y-12 have been, and continue to be, measured at Station 17, the point at which the government land transitions to city property along EFPC (Figure 7.1). Data are reported annually in the RERs. A full discussion of the historical and current trends in mercury releases at Station 17 is presented in Chap. 6, Sect. 6.2.2.1.2 of this RER.

The effect of the upstream mercury source in EFPC and downstream dilution on mercury bioaccumulation in sunfish is depicted in Figure 7.2. Although the mix of sunfish species obfuscates the comparison within EFPC somewhat, mercury levels in all fish species collected in spring 2010 remain elevated from EFK 23.4 to EFK 13.8, and there was a clear response to downstream dilution of EFPC in Poplar Creek, and of Poplar Creek in the Clinch River (Figure 7.2). Fish species collected from the same site can vary greatly in their mercury content. At other EFPC sites, rockbass on average have been found to be approximately 20% higher in mercury than redbreast sunfish. However, at EFK 6.3 the difference appears to be much greater, with rockbass concentrations in all years exceeding 1 mg/kg total mercury (Figure 7.3).

With the exception of some higher concentrations in redbreast sunfish in the 2000 time-frame, the long trend suggests there has been little change in EFK 6.3 fish since the late 1980s. The increasing trend over the 1988-2000 time period did not continue.

Mercury concentrations in sunfish, largemouth bass, and channel catfish in Poplar Creek all exceeded EPA's 0.3 µg/g fish-based federal AWQC, while the same species in the Clinch River fell below this AWQC in 2010 (Sect. 7.3). TDEC adopted EPA's 0.3 µg/g criterion for use in issuing the State of Tennessee's fish advisories in April 2007.

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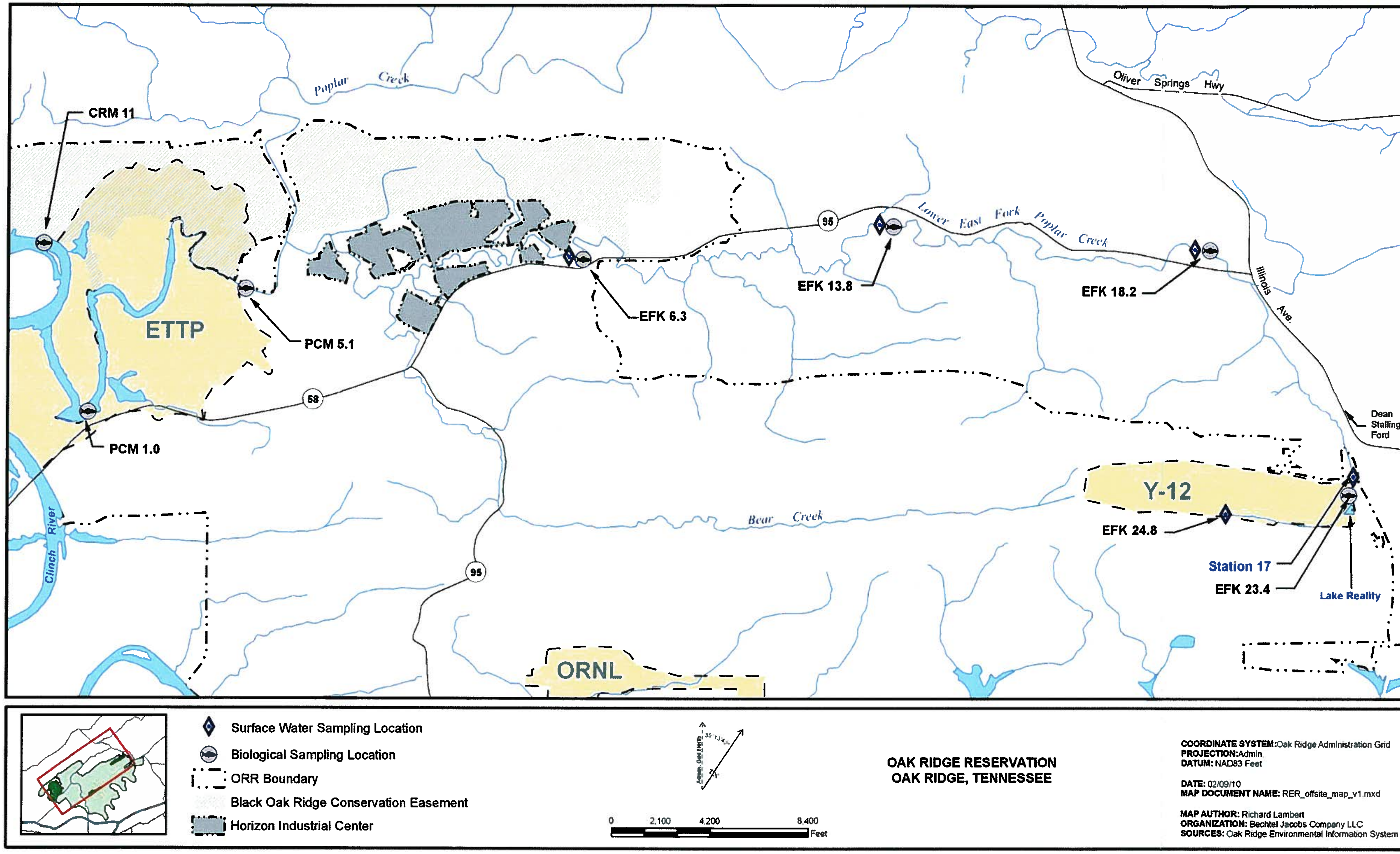

Figure 7.1. Site map of LEFPC.

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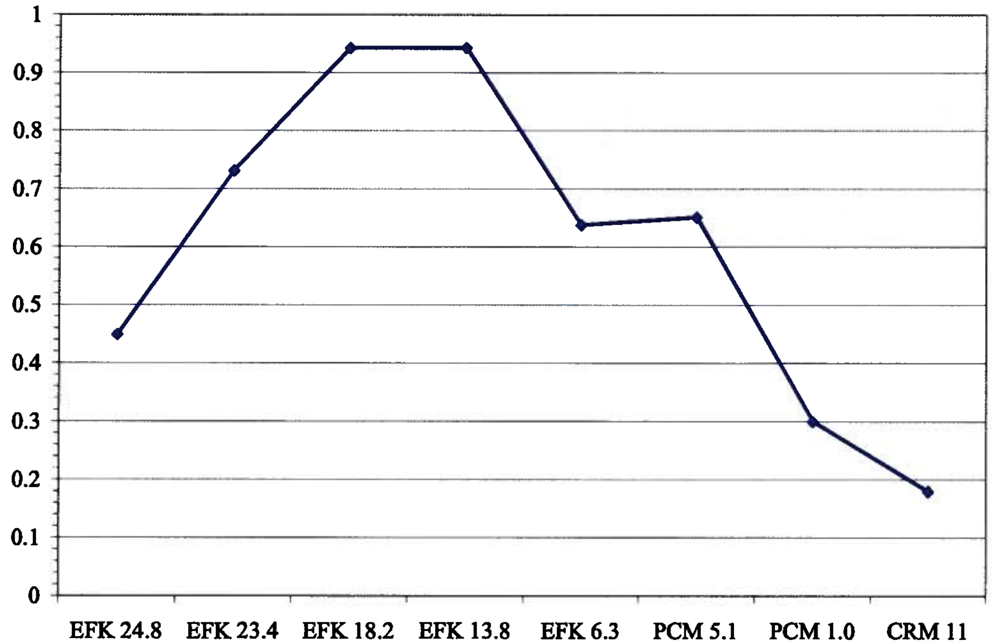

Figure 7.2. Spatial pattern of mercury bioaccumulation in bluegill (PCM 1 and CRM 11) redbreast sunfish (EFK 24.8, PCM 5.1, EFK 6.3) and rock bass (EFK 23.4-13.8) collected in spring 2010.

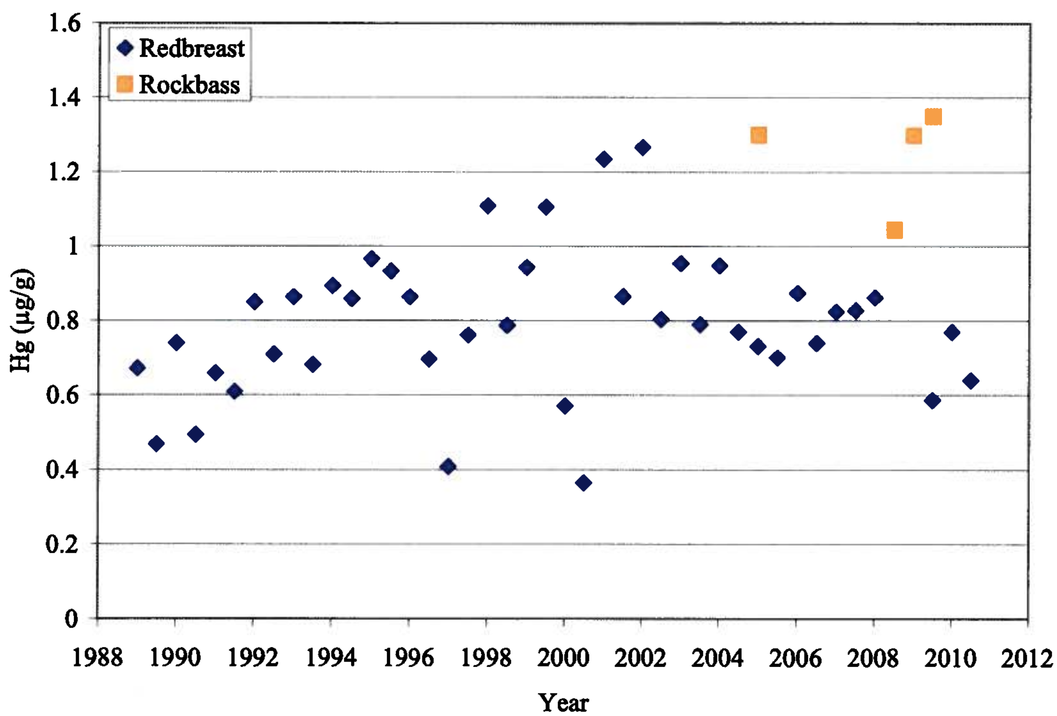

Figure 7.3. Mean mercury concentration in muscle tissue of redbreast sunfish at EFK 6.3.[a]

[a]When redbreast sunfish could not be found, rockbass (orange boxes) were collected instead.

Ecological Monitoring in LEFPC

The FYR in 2011 will include ecological contaminant exposure on the ORR. In 2010, whole body composites of stoneroller minnows, damselfly and dragonfly nymphs, and fishing spiders were collected from EFK 6.3 for analysis of total and methyl mercury, metals, and PCBs. Results will be reported in an ORNL-TM report and used as appropriate in the FYR.

Experimental simulation of mercury methylation dynamics in LEFPC

The relative role of in-stream sediments in LEFPC versus continued releases of mercury from the Y-12 facility is not well understood. The LEFPC ROD (DOE 1995c) addressed soil, floodplain sediment, and groundwater, and deferred surface water and creek bed sediments to a future ROD. Various environmental factors including water chemistry characteristics can impact sediment microbes that methylate mercury. Controlled experimental studies were conducted by ORNL scientists in FY 2010, using indoor stream mesocosms (Figure 7.4) to examine the factors controlling mercury methylation in LEFPC. Four indoor stream mesocosms (23 x 0.32 m) containing 200 L of stream water re-circulating at 10 L/m were set up to simulate conditions in LEFPC. Hg-contaminated fine grained sediments from EFK 6.3 were placed in two of the streams, and experiments were designed to investigate whether "legacy" sediment-bound Hg or "fresh" inputs of dissolved Hg were more readily available for methylation. Baseline monitoring in these systems has shown the presence of low concentrations of MeHg (~ 0.05 ng/L) and inorganic Hg (< 5 ng/L) in those mesocosms with no Hg in sediments, and ~ 50 ng/L total waterborne Hg and 0.1 - 0.2 ng/L MeHg in those mesocosms containing contaminated sediments. Nutrient (sulfate and nitrate) depletion in the streams indicates the likely presence of a microbial flora capable of generating MeHg. Further experiments will examine the role of dissolved organic matter on Hg methylation.

7.2.3 Evaluation of Performance Data – FY 2010

Monitoring at Station 17 is conducted to measure the concentration and mass flux of mercury that is discharged from the UEFPC watershed. During FY 2010, the flow-paced continuous monitoring detected an average concentration of 476 ng/L and a mass flux of about 7.0 kg mercury. The levels of mercury in fish tissue in the LEFPC have remained elevated.

7.2.4 Compliance with LTS Requirements

7.2.4.1 Requirements

The LEFPC ROD (DOE 1995c) states that although residential use of soil horizon (shallow) groundwater is not realistic, as a safeguard, DOE will periodically monitor to detect any future residential use of the shallow groundwater.

The RAR (DOE 2000d) requires an annual survey to verify land use in the area of the former Dean Stallings Ford automobile dealership parking lot has not changed since the issuance of the LEFPC ROD (DOE 1995c) and exposure pathways remain protected (Table 7.2).

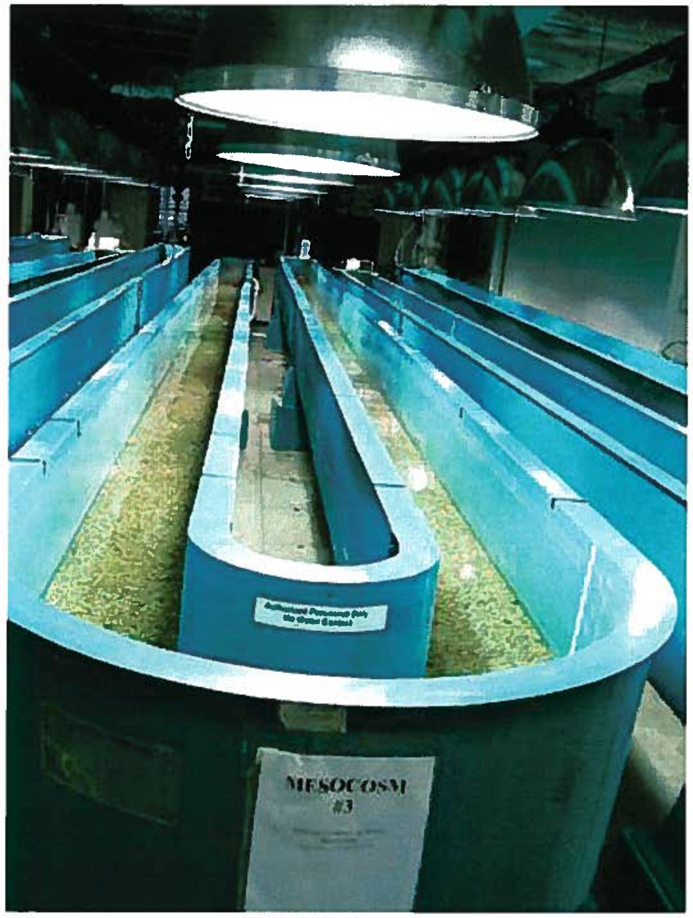

Figure 7.4. Experimental stream mesocosms used to investigate the relative roles of sediment-associated and waterborne Hg as precursors for methylmercury formation.

7.2.4.2 Status of Requirements for FY 2010

Periodic surveys to detect residential use of shallow groundwater were performed in FY 2009 and FY 2007; no additional survey was conducted in FY 2010. A list of residential wells recorded in the Elverton, BV, and Windrock quadrangles were obtained from the TDEC, Division of Water Supply. There were no records of water wells in the area along LEFPC.

In FY 2010, DOE verified that the noted property is still paved for use as a parking lot. Dean Stallings Ford is now closed and the property is listed for sale.

7.2.5 Monitoring Changes and Recommendations for LEFPC

Changes to the monitoring strategy for LEFPC are not recommended at this time.

7.3 CLINCH RIVER/POPLAR CREEK

The CR/PC OU extends 34 river miles from the mouth of the Clinch River at Tennessee River mile (TRM) 567.5 [Clinch River mile (CRM) 0.0] at Kingston, upstream past the Melton Hill Reservoir dam at CRM 23.1, to the upstream boundary of the ORR at CRM 43.7 (Figure 7.5). The CR/PC OU also includes the lower portion of Poplar Creek from the mouth of Poplar Creek on the Clinch River at CRM 12.0, upstream to its confluence with EFPC at Poplar Creek mile (PCM) 5.5 (Figure 7.1). A complete discussion of the CR/PC ROD is provided in Chap. 7 of Vol. 1 of the 2007 RER (DOE 2007a).

7.3.1 Performance Goals and Monitoring Objectives

A major component of the selected remedy for CR/PC is for DOE to perform appropriate monitoring to ensure the institutional controls remain protective against the risk of potential exposure to COCs in sediments and fish tissue.

The original post-ROD monitoring plans for the action are in the RAR for the CR/PC OU (DOE 1999d). However, in September 1999, DOE recommended two broad changes to the monitoring plans for the LWBR and CR/PC OUs. The first was to combine the two OUs into a single entity for monitoring purposes. The second was to change the number and locations of monitoring stations and sampling techniques in both OUs. Based on these recommendations, which were based on the hydrological connection of Poplar Creek, Clinch River, and Watts Bar Reservoir. DOE implemented a combined monitoring plan for the LWBR and CR/PC OUs (DOE 1999e) in FY 2000.

Based on sampling results from 1999–2004, the combined monitoring plan was revised in FY 2004. This revised plan is presented in *Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River/Poplar Creek Operable Units* (DOE 2004b). The current plan consists of two components for the CR/PC: (1) annual monitoring of major COCs in fish, and (2) additional monitoring for CR/PC (sediment, surface water, turtles) once every five years to support the CERCLA FYR (Table 7.3).

The combined monitoring program uses a scientifically rigorous sampling design supporting the identification and evaluation of changes in COC concentrations in fish. This evaluation is directly applicable to the ROD-specified requirements to detect changes in fish contaminant concentrations and to evaluate whether institutional controls (i.e., the fish consumption advisory) are effective (DOE 2004b). If concentrations of contaminants in tissues of these species increase substantially, a study to determine the cause of the change may be warranted. Conversely, decreases in COC concentrations would support the evaluation of the need for continuing the fish advisory.

DOE addresses the ROD requirements for the CR/PC hydrologic unit by conducting annual sampling of contaminant concentrations in CR/PC fish. Sites sampled in FY 2010 include four sites in the Clinch River, a site in Poplar Creek, a site in LWBR and two reference sites in Melton Hill Reservoir upstream of the OUs that are sampled for comparison purposes (Figure 7.5). The sites sampled are based on their position below key DOE inputs and stream/river exit points, as well as their importance as long-term measures of change. Most of the designated sites have been monitored annually since the mid-1980s and are important sites for evaluating long-term change (DOE 2003e). Target species are channel catfish, largemouth bass, and striped bass. Depending on the site and species, PCBs, mercury, and ^{137}Cs concentrations are determined in fish fillets. Snapping turtle tissue, including muscle, liver, and fats, are also checked for contaminants on a five-year cycle, and this sampling was conducted in the summer of 2005 and was completed again in 2010.

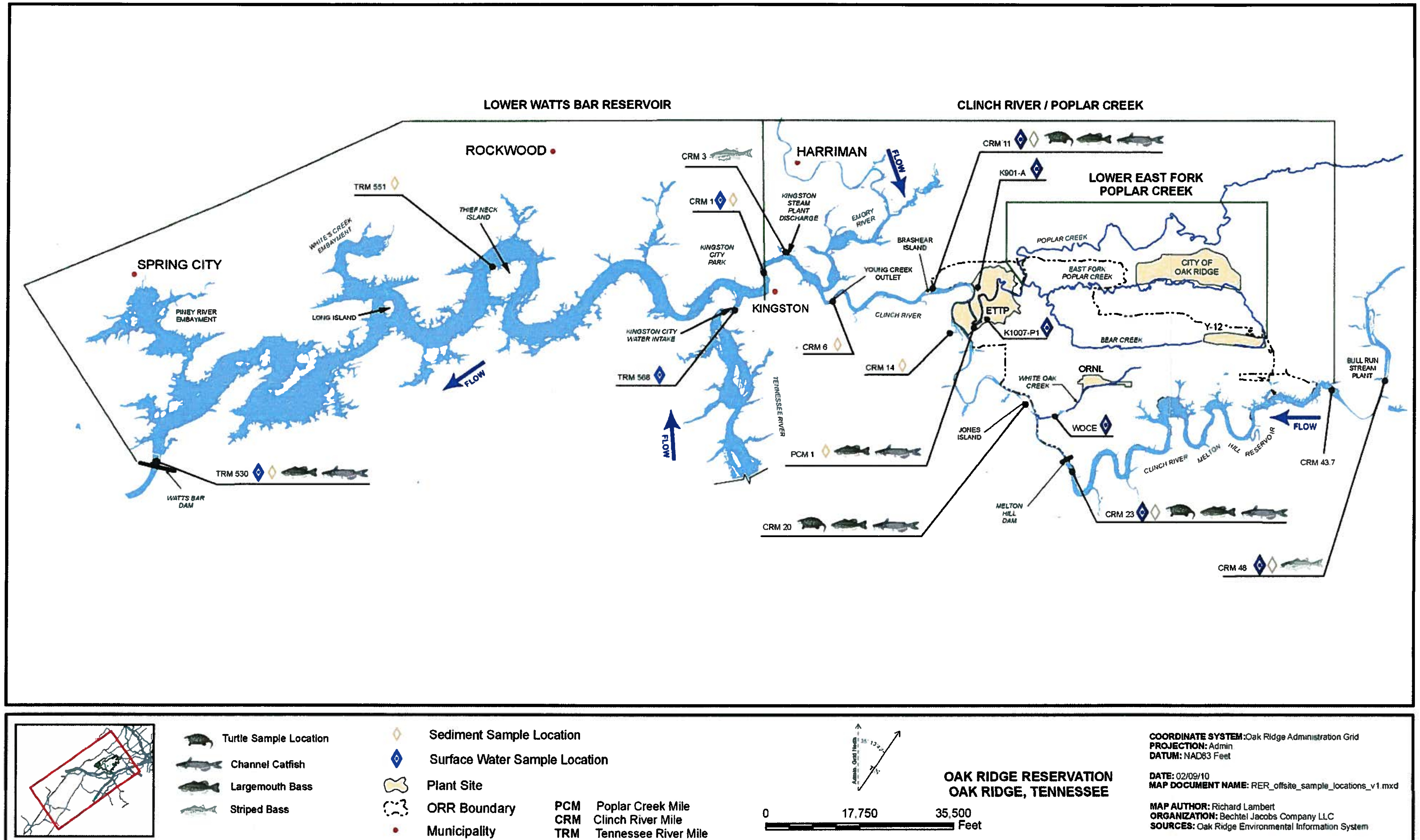

Figure 7.5. Monitoring locations in the CR/PC and LWBR OUs.

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Table 7.3. Monitoring locations in CR/PC

Monitoring stations	Analyses[a]
Surface water: CRM 48, CRM 23.4–24.7, WOCE, K-1007-P1 Pond, K-901-A Pond, CRM 10.5–12, and CRM 1, once every five years	Surface water—isotopic uranium, total mercury, TAL metals, and hydrolab profile
Sediment: CRM 48, CRM 23.4–24.7, CRM 14–15, PCM 1, CRM 10.5–12, CRM 6–7, and CRM 1, once every five years	Total metals, total mercury, and ^{137}Cs. Samples from Poplar Creek will also be analyzed for ^{99}Tc, ^{234,235,238}U, ^{60}Co, and PCBs
Fish: CRM 23.4–24.7, PCM 1, CRM 10.5–12, and CRM 19.7-20.7 (catfish and largemouth bass), annually, summer only	PCBs (catfish only), total mercury, ^{137}Cs (CRM 19.7–20.7 only), and total lipid
Bull Run Steam Plant effluent (CRM 48), Kingston Steam Plant effluent (CRM 3) (striped bass), winter only	PCBs and total lipid
Turtles: CRM 23.4–24.7, CRM 19.7–20.7, and CRM 10.5–12, once every five years in summer	PCBs, total mercury, ^{137}Cs, and total lipid

[a]Analyses listed are those required to monitor action effectiveness.

TAL = target analyte list

Fish consumption advisories are issued by the TDEC http://www.state.tn.us/environment/wpc/publications/. The basis of the advisories can be FDA limits or EPA or state risk calculations. TDEC has issued the following:

- East Fork of Poplar Creek including Poplar Creek embayment, from the mouth to New Hope Pond (replaced by Lake Reality) (in Y-12) for mercury and PCBs for no fish consumption and also to avoid contact with water.
- Clinch River arm of Watts Bar Reservoir for PCBs for no consumption of striped bass and a precautionary advisory for catfish and sauger.[1]
- Watts Bar Reservoir (Roane, Meigs, Rhea and Loudon) for PCBs for no consumption of catfish, striped bass, and hybrid (striped bass-white bass). Precautionary advisory for white bass, sauger, carp, smallmouth buffalo and largemouth bass.[1]

Signs are placed at main public access points and a press release is submitted to local newspapers. The list of advisories is also published in TWRA's annual fishing regulations.

7.3.2 Evaluation of Performance Data – FY 2010

The selected remedy identified in the CR/PC ROD (DOE 1997c) is still in place and effective in CR/PC: institutional controls prevent exposure to contaminated sediment [via the Watts Bar Interagency Working Group (WBIWG) activities], fish consumption advisories are issued by TDEC and annual monitoring is conducted to evaluate changes in contaminant levels. Performance monitoring for the CR/PC has primarily

[1]A precautionary advisory is for children, pregnant women and nursing mothers that they should not consume the named fish species, and all other persons should limit consumption of the named species to one meal per month.

focused on contaminant trending in fish to address the ROD requirement of "annual monitoring to detect changes in CR/PC contaminant levels or mobility."

Results of FY 2010 monitoring for Poplar Creek and the Clinch River arm of Watts Bar Reservoir are presented in Table 7.4. PCB concentrations in channel catfish were lower at all sites than those observed in 2009, and remain substantially lower than concentrations observed during the 1980s and 1990s (Figure 7.6). PCB concentrations in Clinch River channel catfish have been trending downward for more than a decade, although there is substantial year-to-year variability. PCBs in channel catfish from Poplar Creek are similarly variable, but may be slightly increasing (Figure 7.6). The influence of PCB flux in the PC/EFPC drainage, which has historically been evident in higher PCB concentrations in catfish at PCM 1, was again evident in 2010. Striped bass were collected from three sites in 2010 because of facility operations at the Kingston Fossil Plant (CRM 3). The plant was shut down in winter 2010 for maintenance and repair and was therefore not generating warm water. Only four fish were collected from this site. An additional four fish were taken from CRM 22, just below Melton Hill Dam, with the hypothesis that these fish would be from the same population as fish caught at Kingston because this species is known to migrate over large distances, and the dam is a barrier to fish movement. PCB levels in striped bass at CRM 3 and CRM 48 were comparable to values seen in 2009, and within the range of normal inter-annual variation observed at these sites. The striped bass collected from CRM 22 had significantly lower levels of PCBs than at either of the normal sampling sites, but this is likely because of significant size differences between fish caught at the different sites (Figure 7.7). Within the same species, PCBs are found at higher concentrations in larger, fattier, and older fish. The fish caught at CRM 22 were significantly smaller (mean mass 3926 g) than those collected at CRM 3 (mean mass 6070) and CRM 48 (mean mass 7612). TDEC typically issues fish consumption advisories in water where fish exceed 0.8-1.0 ppm PCBs. Despite the apparently lower level of PCBs in smaller fish collected at CRM 22, PCB concentrations in striped bass from Melton Hill Reservoir and the Clinch River portion of Watts Bar Reservoir continue to be high enough to be of concern relative to human consumption. Similarly, some catfish from Poplar Creek were also in the range of human health concern.

Mean mercury concentrations exceeded the federal EPA fish tissue-based recommended water quality criterion (0.3 µg/g) in catfish and largemouth bass from PCM 1 (Table 7.4). Levels of ^{137}Cs were below analytical detection limits in all fish collected from the sample site downstream of ORNL.

Contaminant levels in turtles

Three common snapping turtles (*Chelydra serpentina*) were collected from each of two off-site locations (CRM 20 & CRM 24) for contaminant analyses. Only one snapping turtle of suitable size was collected from CRM 11, although 67 turtles of various species were captured at this location. A same-sized aliquot of muscle, liver, and fat was taken from each individual turtle, and these samples from individual turtles were composited by site and by tissue type. The analytical samples for CRM 11 were based on the one suitable specimen that was collected. These collections address both human health and ecological risk concerns associated with common snapping turtles, the only legal reptilian game species in Tennessee. Analytical results from 2010 are presented in Table 7.5.

Table 7.4. Mean concentrations (N = 6 fish, ± standard error) of total PCBs (Aroclor- 1248+1254+1260), total mercury, and ^{137}Cs in fish muscle fillet from off-site locations in FY 2010[a]

Monitoring location		Total PCBs (mg/kg)		Mercury (mg/kg)		Cs-137 (pCi/g)
Site[a]	**Description**	**Channel catfish**	**Striped bass**	**Largemouth bass**	**Channel catfish**	**Channel catfish**
Clinch River						
CRM 20	Jones Island downstream of WOC	0.16 ± 0.03		0.18 ± 0.03	0.07 ± 0.01	< 0.07
CRM 11	Brashear Island downstream of Poplar Creek	0.17 ± 0.04		0.28 ± 0.03	0.12 ± 0.02	
CRM 3	Kingston Steam Plant discharge		1.02 ± 0.23			
CRM 22	Below Melton Hill Dam		0.55 ± 0.16			
Poplar Creek						
PCM 1	Near K-1007-P1 outlet	0.70 ± 0.16		0.42 ± 0.07	0.30 ± 0.07	
LWBR						
TRM 530	Watts Bar Reservoir forebay	0.25 ± 0.06		0.21 ± 0.05	0.14 ± 0.02	
Reference sites (upstream of CR/PC-LWBR)						
CRM 48	Bull Run Steam Plant (Melton Hill Reservoir)		1.19 ± 0.23			
CRM 23	Melton Hill Reservoir forebay	0.13 ± 0.04		0.11 ± 0.02	0.09 ± 0.03	

[a]CRM = Clinch River mile, PCM = Poplar Creek mile, and TRM = Tennessee River mile.

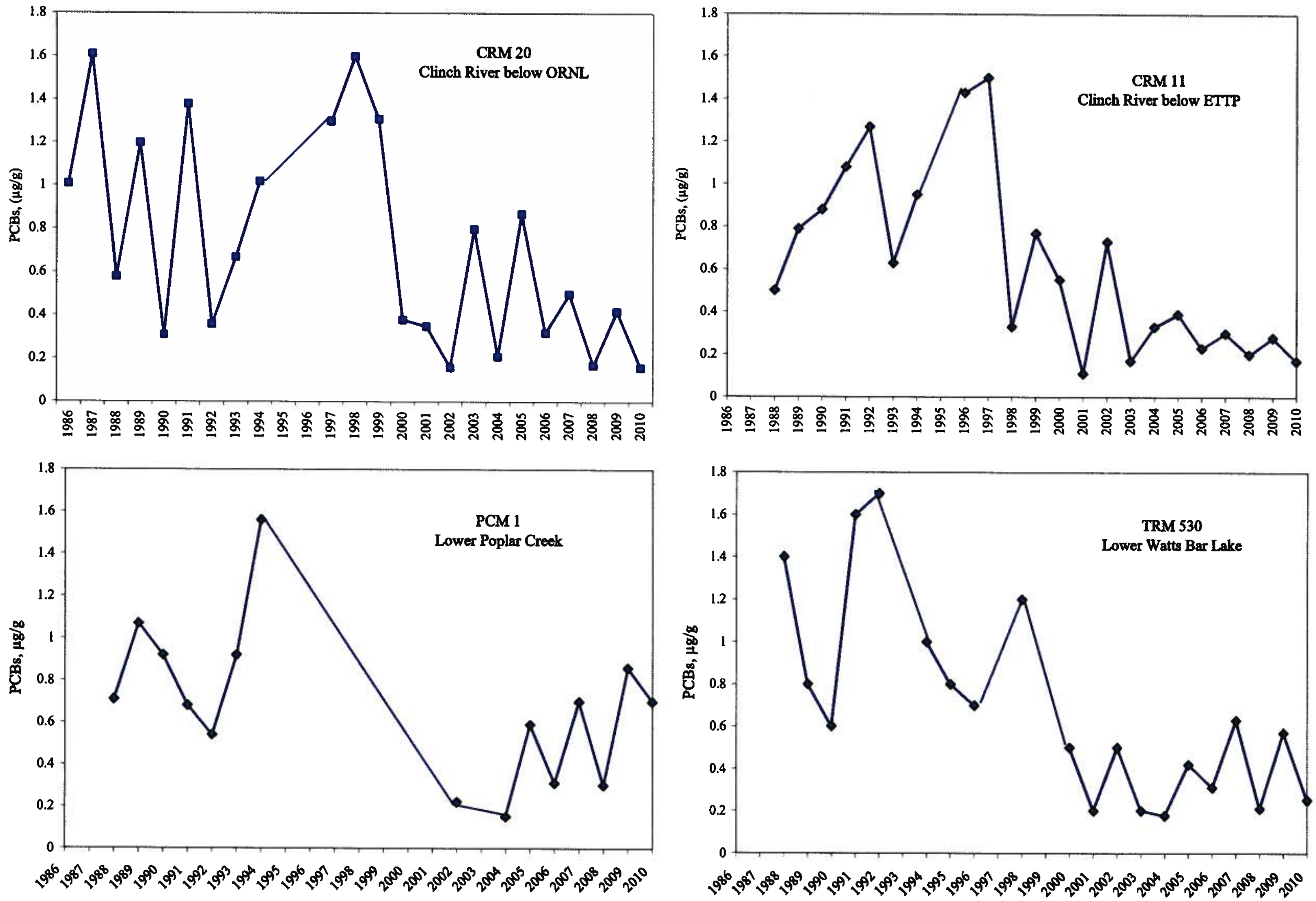

Figure 7.6. Average PCB concentrations in channel catfish from CR/PC and LWBR sites, 1986–2010.
Courtesy of multiple programs, including BMAP, ASER, and Tennessee Valley Authority, 1986–2003. WRRP, 2004-2006.

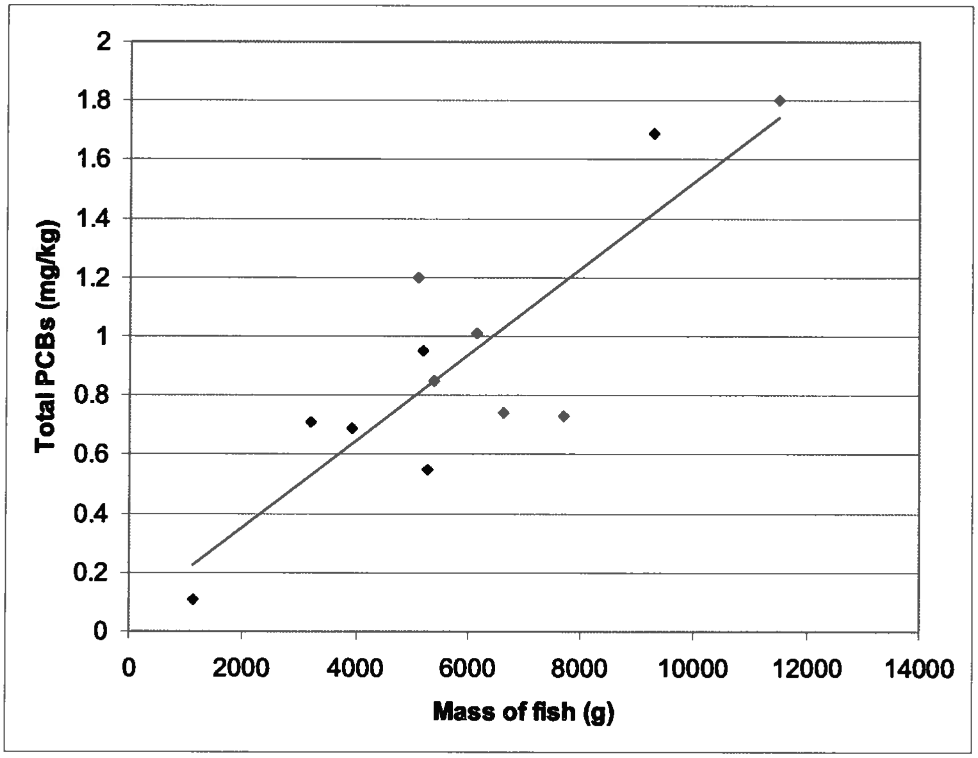

Figure 7.7. Relationship between total PCB concentrations in striped bass fillets collected in the Clinch River (CRM 3, 22, and 48) in 2010.

Table 7.5. Contaminant concentrations and percent lipids in muscle, liver, and fat of common snapping turtles (*Chelydra serpentina*) collected in 2010 from off-site locations

(Values for CRM 11 are for one turtle; values for CRM 20 and CRM 24 represent equal aliquots of tissue composited from three turtles from each site)

Tissue	Location	Hg (mg/kg)	MeHg (mg/kg)	PCB (Aroclor-1260) (mg/kg)	Lipids %	Cs-137 (pCi/g)
Muscle	CRM 11	0.1969	0.0989	0.043	0.72	0
	CRM 20	0.1029	0.0451	0.051	0.52	0
	CRM 24	0.1286	0.0497	0.04	4.7	0.152*
Liver	CRM 11	3.407	0.0839	4.4	11	0.11*
	CRM 20	2.4805	0.1085	1.9	5.3	0.119*
	CRM 24	0.9162	0.0671	4.7	23	0
Fat	CRM 11	0.0255	.0008	47	81	0.336*
	CRM 20	0.0188	0.0049	28	73	0
	CRM 24	0.0152	0.007	17	75	0

* = concentration estimated at a level below detection limit
CRM = Clinch River Mile
MeHg = methylmercury
PCB = polychlorinated biphenyls (only Aroclor 1260 was detected in all samples)
Cs = Cesium
pCi = picocurie

The turtle contaminant results were consistent with the spatial trends observed in fish. Like fish, the highest mercury concentrations were found in turtles from the Clinch River downstream of Poplar Creek (CRM 11). Levels were substantially lower in the Clinch River upstream (at CRM 20) and in Melton Hill Reservoir (CRM 24). Mercury concentrations were relatively high in both muscle and liver, with much lower levels in fat. Methylmercury accounted for between 40-50% of total mercury in muscle across all sites, and 30-50% of total mercury in fat. Almost all of the mercury in liver tissue was inorganic mercury. PCB concentrations (all detectable PCBs were identified as Aroclor-1260) were more similar across sites. As expected, fat and liver contained high levels of PCBs, which are lipophylic. Turtle muscle was relatively low in percent lipids and contained two to three orders of magnitude lower PCB concentrations than in fat. Cesium-137 was below detection limits at all sites and in all tissues.

Although total mercury concentrations in turtle muscle were highest at CRM 11, they have been steadily decreasing since 2000 (Figure 7.8). There was no apparent temporal trend for mercury in liver or fat tissue. Polychlorinated biphenyls in turtle fat, on the other hand, decreased at all three locations (CRM 11, CRM 20, and CRM 24) in 2010 (Figure 7.9). The decrease is consistent with trends observed in fish over time.

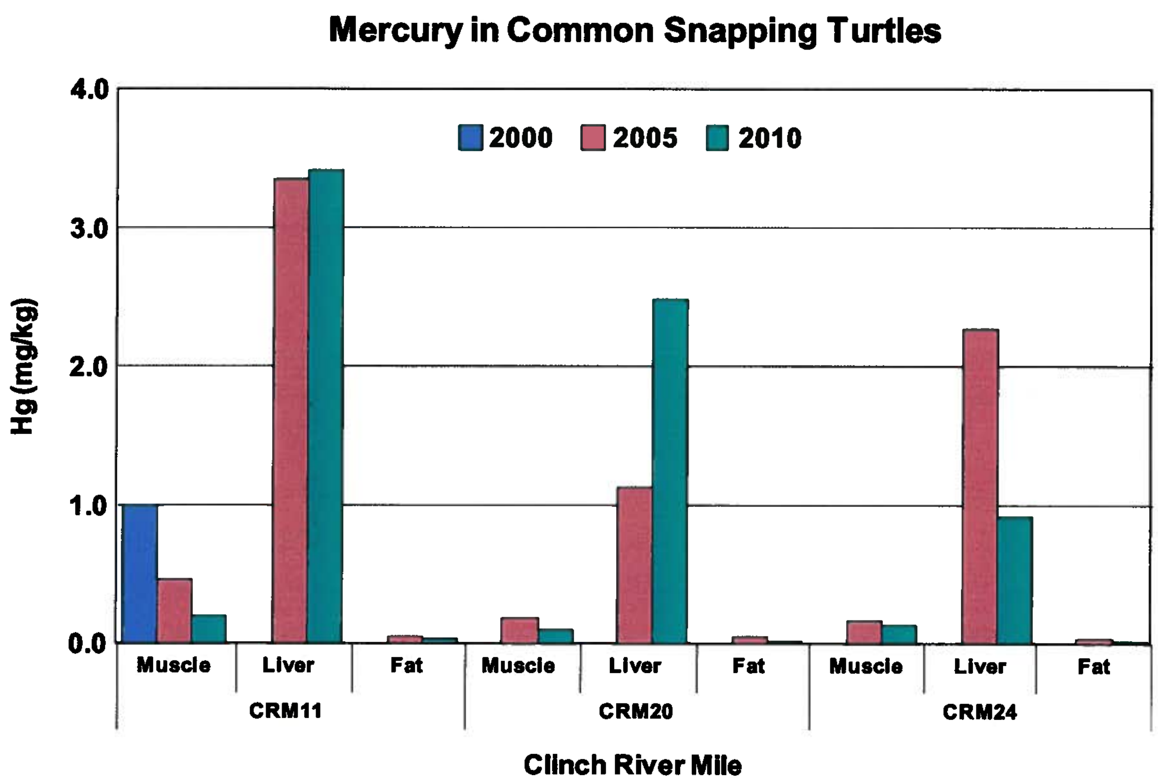

Figure 7.8. Total mercury concentrations in tissue of common snapping turtles (each value is a composite of three turtles/site, except at CRM 11 in 2010 where only one turtle was collected).

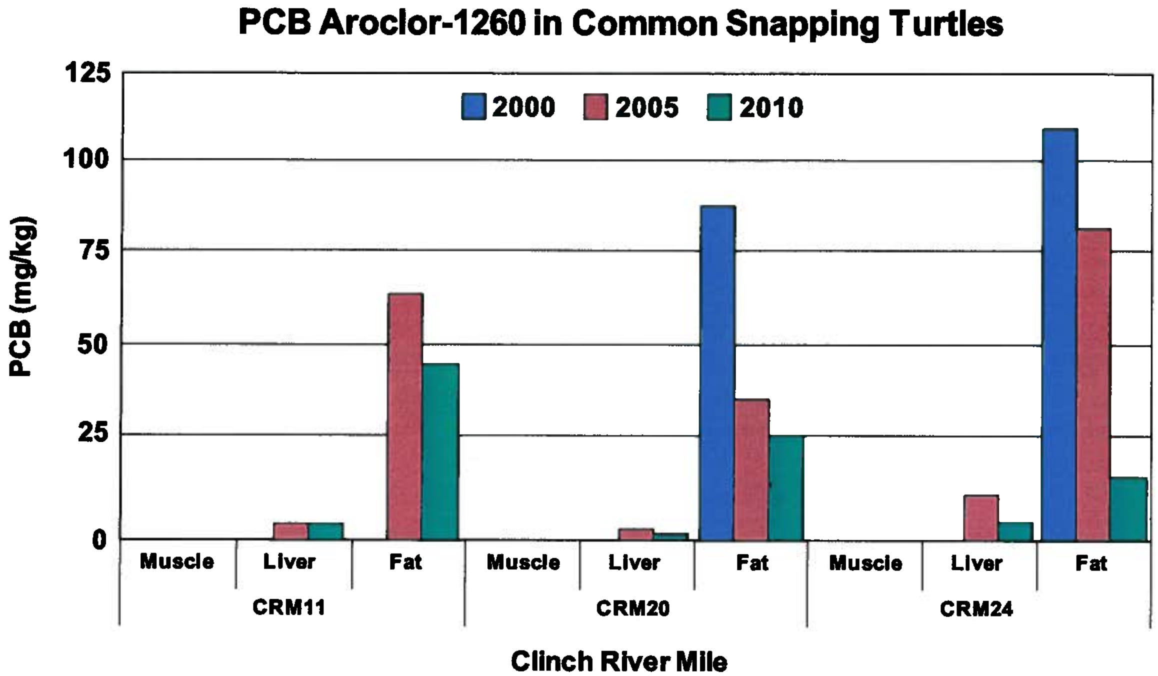

Figure 7.9. PCB concentrations (Aroclor-1260) in tissue of common snapping turtles (each value is a composite of three turtles/site, except at CRM 11 in 2010 where only one turtle was collected).

7.3.3 Performance Summary

Performance monitoring of the Clinch River and Poplar Creek continues to indicate a downward trend in fish PCB concentrations since the late 1980s. Channel catfish are in most years below the fish advisory levels for PCBs in the Clinch River, but at or near the advisory limits the last couple years in Poplar Creek. Striped bass are routinely above advisory limits, especially larger fish. Mercury concentrations in fish at monitored sites continue to indicate the influence of mercury sources from EFPC, with the highest levels in fish in Poplar Creek and lower levels with distance downstream. Turtle sampling showed similar spatial trends relative to mercury, with the highest concentrations downstream of Poplar Creek. PCBs in turtles downstream of Poplar Creek have also decreased, similar to trends observed in fish. Overall, the performance monitoring has been successful in addressing the ROD goal of evaluating changes in fish contaminant levels and how those levels compare to fish advisory limits.

7.3.4 Compliance with LTS Requirements

7.3.4.1 Requirements

LTS requirements specified in the RAR (DOE 1999d) include institutional controls (Table 7.2) for the CR/PC and LWBR, including: (1) continued use of TDEC's fish consumption advisories to limit exposure to contaminated fish, (2) continued scrutiny of sediment-disturbing activities in LWBR by WBIWG, comprised of TDEC, TVA, ACOE, and DOE, to prevent exposure to potentially contaminated dredged soil, (3) the conduct of a survey of irrigation practices and (4) the determination of the effectiveness (i.e., awareness) of fish consumption advisories.

7.3.4.2 Status of Requirements for FY 2010

TDEC, Division of Water Pollution Control, maintains fish consumption advisories for the local area. The TWRA posts these advisories on their web site and it was last updated in August 2008. These same advisories are included in the TWRA's 2010 Tennessee Fishing Guide that is available on-line and where fishing licenses are sold.

A review of the efficacy of institutional controls preventing sediment exposure and the effectiveness of the fish consumption advisory was provided in the 2006 CERCLA FYR (DOE 2007b). The results of that review suggest that institutional controls in place are effective in limiting human exposure, although some areas of the reservoir are not well posted and there are some groups of fisherman who do not follow advisories. The State of Tennessee is responsible for issuing fish consumption advisories and communicating relevant health information to the public.

After the TVA ash spill, the TWRA advised until further notice that fishing should be avoided in the lower section of the Emory River (Figure 7.5), and along with TDEC, urged the public to follow the fishing advisory for the lower Clinch River that existed prior to the ash spill. In the Clinch River arm of Watts Bar, there is a fish consumption advisory against eating striped bass and a precautionary advisory for catfish and sauger. A precautionary advisory means that children, pregnant women and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month. Given the data generated to date, TDEC feels the existing fishing advisory is protective of public health. The state will continue to monitor the levels of contaminants in fish tissue and will inform the public if current conditions change.

7.3.5 Monitoring Changes and Recommendation for CR/PC

No monitoring changes are recommended for CR/PC.

7.4 LOWER WATTS BAR RESERVOIR

The LWBR OU extends 38 river miles from TRM 567.5, at the mouth of the Clinch River, downstream to the Watts Bar Reservoir dam at TRM 529.9 (Figure 7.5). A complete discussion of the LWBR ROD is provided in Chap. 7 of Vol. 1 of the 2007 RER (DOE 2007a).

7.4.1 Performance Goals and Monitoring Objectives

The original post-ROD monitoring plans for the action are in the RAWP for the LWBR OU (DOE 1996c). As discussed in Sect. 7.3.1, monitoring requirements for the LWBR are included with requirements for CR/PC in a combined monitoring plan (DOE 2004b).

The overall goal of the remedy for LWBR is to protect human health and the environment by reducing exposure to: (1) contaminated sediment in the main river channel, and (2) contaminants in fish. The monitoring strategy for LWBR is provided in the combined monitoring plan and summarized in Table 7.6.

Table 7.6. Monitoring locations in LWBR

Monitoring stations	Analyses[a]
Surface water: TRM 568.4 and TRM 530–532, once every five years	Surface water—isotopic uranium, total mercury, TAL metals, and hydrolab profile
Sediment: TRM 551–556 and TRM 530–532, once every five years	Total metals, total mercury, and ^{137}Cs
Fish: TRM 530–532 (catfish and large mouth bass), annually, summer only	PCBs, total mercury, and total lipid

[a]Analyses listed are those required to monitor effectiveness.

TAL = target analyte list

Fish consumption advisories are issued by the TDEC at the web site http://www.state.tn.us/environment/wpc/publications/. The basis of the advisories can be FDA limits or EPA or State risk calculations. TDEC has issued the following:

- East Fork of Poplar Creek including Poplar Creek embayment, from the mouth to New Hope Pond (replaced by Lake Reality) (in Y-12) for mercury and PCBs for no fish consumption and also to avoid contact with water.

- Clinch River arm of Watts Bar Reservoir for PCBs for no consumption of striped bass and a precautionary advisory for catfish and sauger.

- Watts Bar Reservoir (Roane, Meigs, Rhea and Loudon) for PCBs for no consumption of catfish, striped bass, and hybrid (striped bass-white bass). Precautionary advisory for white bass, sauger, carp, smallmouth buffalo and largemouth bass.

- Signs are placed at main public access points and a press release is submitted to local newspapers. The list of advisories is also published in TWRA's annual fishing regulations.

7.4.2 Evaluation of Performance Monitoring Data – FY 2010

Performance monitoring in LWBR has primarily focused on the Combined Monitoring Plan (DOE 2004b) requirements to evaluate changes in fish contaminant levels. These trending results are directly related to the ROD requirement that monitoring of water, sediment, and biota "be continued to determine if there is a change in the currently calculated risk that would pose a threat to human health and/or the environment." The ROD indicated that the response action (namely, monitoring of contaminant levels or mobility) was considered applicable to reducing ecological risk.

Monitoring results indicate that PCB concentrations in 2010 averaged 0.25 mg/kg in channel catfish (Table 7.4). In general, TDEC has issued fish consumption advisories when PCB levels in fish are approximately 0.8 to 1 mg/kg (or higher). PCB concentrations in channel catfish have remained below the advisory level since 1998. The current levels are substantially lower than the concentrations observed in the 1980s and 1990s when the advisories were first issued (Figure 7.6).

Mercury concentrations in fish from LWBR are also low, averaging equal to or less than 0.21 mg/kg depending on species (Table 7.4). This level is less that the federal EPA fish tissue-based recommended water quality criterion of 0.3 mg/kg. Mercury concentrations in the 0.2 mg/kg range are typical of largemouth bass and channel catfish in Tennessee reservoirs.

7.4.3 Performance Summary

Performance monitoring results from LWBR obtained during FY 2010 continue to indicate that mercury and PCB levels in fish are below commonly-used fish advisory levels.

7.4.4 Compliance with LTS Requirements

7.4.4.1 Requirements

The RAWP (DOE 1996c) requires institutional controls (Table 7.2) for the LWBR, including: (1) continued use of TDEC's fish consumption advisories to limit exposure to contaminated fish, and (2) continued scrutiny of sediment-disturbing activities in LWBR by TDEC, TVA, ACOE, and DOE to prevent exposure to potentially contaminated dredged soil.

7.4.4.2 Status of Requirements for FY 2010

TDEC, Division of Water Pollution Control, maintains fish consumption advisories for the local area. The TWRA posts these advisories on their web site and it was last updated in August 2008. These same advisories are also published in the TWRA's 2010 Tennessee Fishing Guide that are available on-line and where fishing licenses are sold.

The WBIWG, formed in 1991 and comprised of TDEC, TVA, COE, EPA, and DOE, provided continued controls on sediment-disturbing activity in the deep-water channel of the LWBR. In FY 2010, ten dredging permit applications were received and reviewed by the WBIWG. All requests were approved.

A review of the efficacy of institutional controls preventing sediment exposure and the effectiveness of the fish consumption advisory was provided in the 2006 CERCLA FYR (DOE 2007b). The results of that review suggest that institutional controls in place are effective in limiting human exposure, although some areas of the reservoir are not well posted and there are some groups of fisherman who do not follow advisories. The State of Tennessee is responsible for issuing fish consumption advisories and communicating relevant health information to the public.

After the TVA ash spill, the TWRA and TDEC urged the public to follow the fishing advisory for Watts Bar that existed prior to the ash spill. In the Tennessee River portion of Watts Bar there is a fish consumption advisory against eating striped bass, catfish, and hybrid (striped bass-white bass), and a precautionary advisory for white bass, sauger, carp, smallmouth buffalo, and largemouth bass. A precautionary advisory means that children, pregnant women and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to one meal per month. Given the data generated to date, TDEC feels the existing fishing advisory is protective of public health. The state will continue to monitor the levels of contaminants in fish tissue and will inform the public if current conditions change.

7.4.5 Monitoring Changes and Recommendations for LWBR

No monitoring changes are recommended for LWBR.

7.5 OFF-SITE MONITORING CHANGES AND RECOMMENDATIONS

No issues were identified for off-site areas in FY 2010. No changes to the off-site monitoring activities are recommended.

Table 7.7. Summary of technical issues and recommendations

Issue[a]	Action/ Recommendation
2011 Current Issue	
None.	
Issue Carried Forward	
None.	
Completed/Resolved Issues	
None.	

[a] An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

8. CERCLA ACTIONS AT EAST TENNESSEE TECHNOLOGY PARK

8.1 INTRODUCTION AND OVERVIEW

This chapter provides an update to CERCLA activities completed during FY 2010 at ETTP (Sect. 8.1.1). Only sites that have performance monitoring and/or LTS requirements are included in the performance evaluations; those sites are noted in Table 8.1. Performance goals and objectives, monitoring results, an assessment of the effectiveness of each completed action are presented, and a review of compliance with any LTS requirements (Table 8.2) is also provided, as appropriate (Sect. 8.2.1, Sect. 8.3.3, Sect. 8.4.1.4, Sect. 8.4.2.5, Sect. 8.4.3.1, Sect. 8.4.4.1, and Sect. 8.5.1). Figure 8.1 shows the locations of completed actions at ETTP.

Background information about each remedy and performance standards, and a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chap. 8 of Vol. 1 of the 2007 RER (DOE 2007a). This information will be updated with information provided in the annual RER and republished every fifth year at the time of the CERCLA FYR.

ETTP does not have a sole surface water IP at which all upstream contaminant releases converge to exit the watershed; ETTP has several subwatersheds and, therefore, has several surface water IPs (Figure 8.1). Because many CERCLA decisions are in the process of being implemented (or have not been implemented yet) at ETTP, baseline monitoring data continue to be collected. This chapter includes preliminary evaluations of early indicators of effectiveness for each subwatershed, such as contaminant trends at the surface water IPs for the various subwatersheds.

For planning and administrative purposes, ETTP is divided into zones. Zone 1 comprises approximately 1400 acres outside the fenced main plant area, but within the area where most disposal activities took place, and Zone 2 comprises approximately 800 acres containing the main plant area. The remainder of the site, which encompasses approximately 2800 acres surrounding Zones 1 and 2, is primarily uncontaminated and part of DOE's planned footprint reduction. Figure 8.2 illustrates the land uses and interim controls identified in Zone 1 and Zone 2 RODs.

To date, most of the completed remedies at the ETTP have been single-action project decisions to address primary sources of contamination or primary release mechanisms. Concurrent with these actions, D&D of most buildings at ETTP is occurring under CERCLA removal authority. While these actions ultimately help to reduce contaminant loading or minimize the potential for future releases to exit pathways from ETTP, the goals of many of these actions have not included specific, measurable performance criteria for reductions in flux or risk in surface water and groundwater at the watershed scale. More recent watershed-scale decisions relate to soil, buried waste, and subsurface structures for the protection of human health and to limit further contamination of groundwater through source reduction or removal. The remaining media (e.g., groundwater, surface water, and sediments) and ecological receptors will be evaluated and addressed by final decision(s).

Table 8.1 CERCLA actions at ETTP

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
Watershed-scale actions				
Zone 1 Selected Contaminated Areas Interim Remedial Actions	ROD (DOE/OR/01-1997&D2): 11/08/02	PCCRs complete or in progress		
		• Duct Island/K-901 Area PCCR (DOE/OR/01-2261&D2) approved 04/03/06. o Duct Island/K-901 Area PCCR (DOE/OR/01-2261 &D2/A1/R1) submitted 09/10/10.	No/Yes	8.2
		• K-1007 Ponds/Powerhouse PCCR (DOE/OR/01-2294&D2) approved 10/04/06. o K-1007 Ponds/Powerhouse PCCR (DOE/OR/01-2294&D2/A1) submitted 06/29/10.	No/Yes	
		• K-770 Scrap Removal PCCR (DOE/OR/01-2348&D1) approved 5/30/07. o K-770 Scrap Removal PCCR Addendum (DOE/OR/01-2348&D1/A1) submitted 08/20/10.	No/Yes	
		• FY 2008 PCCR for Units Z1-01, Z1-03, Z1-38, Z1-49 (DOE/OR/01-2367&D2) approved 04/23/08.	No/Yes	
Zone 2 Soil, Buried Waste, and Subsurface Structure Remedial Actions	ROD (DOE/OR/01-2161&D2): 04/19/05	PCCRs complete or in progress.		
		• FY 2006 PCCR for Zone 2 (DOE/OR/01-2317&D2) approved 02/08/07.	Yes/Yes	8.3
		• FY 2007 PCCR for Zone 2 (DOE/OR/01-2723&D2) approved 06/09/08.	No/Yes	
		• FY 2008 PCCR for EU Z2-33 in Zone 2 (DOE/OR/01-2368&D2/R1) approved 09/28/09. o FY 2008 PCCR for EU Z2-33 in Zone 2 - Erratum (DOE/OR/01-2368&D2/R2 approved 12/16/09.	No/Yes	
		• FY 2009 PCCR for EU Z2-36 in Zone 2 (DOE/OR/01-2399&D1) approved 06/03/09.	No/Yes	
		• FY 2009 PCCR for Zone 2 EUs 11, 12, 17, 18, 29, 38 (DOE/OR/01-2415& D2) approved 04/02/10.	No/Yes	
		• FY 2010 PCCR for EU Z2-31 in Zone 2 (DOE/OR/01-2443&D2) submitted 08/19/10.		
		• FY 2010 PCCR for EU Z2-32 in Zone 2(DOE/OR/01-2452&D1) approved 04/08/10.	No/Yes	

Table 8.1. CERCLA actions at ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
ETTP Ponds	AM (DOE/OR/01-2314&D2): 03/12/07 (K-1007-P and K-901-A holding ponds, K-720 Slough, and 770 Embayment)	• RmAWP (DOE/OR/01-2359&D2/A1) approved 08/16/10. o Addendum to the RmAWP (DOE/OR/01-2359&D2/A1) approved 08/16/10. • RmAR (DOE/OR/01-2456&D1) submitted 04/20/10.	Yes/Yes	8.4.2
Mitchell Branch Chrome Reduction	AM (DOE/OR/01-2369&D1): 12/20/07 (Reduction of Hexavalent Chromium Releases to Mitchell Branch Time-Critical RA)[d] AM (DOE/OR/01-2448&D1) (Long Term Reduction of Hexavalent Chromium Releases to Mitchell Branch) approved 03/26/10 (supersedes DOE/OR/01-2369&D1).	Removal action ongoing (water collection and treatment). • RmAR (DOE/OR/01-2384&D1) submitted 07/30/08; review and approval suspended 10/09/08.[c]	Yes/No	8.4.5
Single-project actions				
K-1417-A/B Drum Storage Yards RA[c]	ROD (DOE/OR-991&D1): 09/19/91	RA complete. • RAR (Letter) approved 03/02/95.	No/No	–
K-1070-C/D SW-31 Spring RA[d]	IROD (DOE/OR-1050&D2): 09/30/92 ESD (DOE/OR/02-1132&D2): 07/08/93	RA complete. • Remedial Action Effectiveness Report (RAER) (DOE/OR/01-1520&D1) approved 12/11/96. o Addendum (DOE/OR/01-1520&D1/R1/A1) to RAER to terminate action approved 02/28/07.	Yes/No[e]	–
K-1407-B/C Ponds RA[d]	ROD (DOE/OR/02-1125&D3): 09/30/93	RA complete. • Also, closed under RCRA. • RAR (DOE/OR/01-1371&D1) approved 08/16/95.	Yes/Yes	8.4.1
K-1401 and K-1420 Sumps Removal Action[c]	AM (DOE/OR/02-1610&D1): 08/18/97 NSC (DOE/OR/02-1610/R1): 10/23/07 (reroute K-1401 sump discharge to sanitary wastewater treatment)	Removal action complete. • RmAR (DOE/OR/01-1754&D2) approved 02/01/99. o Addendum to RmAR (DOE/OR/01-1754&D2/A1) to terminate operation approved 04/21/06.	No/No	–

Table 8.1. CERCLA actions at ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
K-1070-C/D and Mitchell Branch Removal Action[d]	AM (DOE/OR/02-1611&D2): 08/25/97	Removal action complete. • RmAR (DOE/OR/01-1728&D3) approved 03/02/99. • Approval to terminate operation of non-cost effective system 12/17/04.	Terminated[f]	–
K-901-A and K-1007-P Pond Removal Action	AM (DOE/OR/02-1550&D2): 9/15/97	Removal action complete. • RmAR (DOE/OR/01-1767&D2) approved 11/12/99.	Superseded	8.4.2
K-1070-C/D G-Pit and Concrete Pad RA[d]	ROD (DOE/OR/02-1486&D4): 01/23/98	RA complete • RAR (DOE/OR/01-1964&D2) approved 02/18/03.	No/Yes	8.4.3
K-1070-A Burial Ground RA[d]	ROD (DOE/OR/01-1734&D3): 01/13/00	RA complete. • RAR (DOE/OR/01-2090&D1) approved 11/28/03.	No/Yes	8.4.4
K-1085 Old Firehouse Burn Area Drum Burial Site Removal Action[d]	AM (DOE/OR/01-1938&D1): 03/27/01	Removal action complete. • RmAR (DOE/OR/01-2050&D1) conditionally approved 02/18/03. • Completion Letter approved 01/19/07.	No/No	–
Outdoor LLW Removal Action	AM (DOE/OR/01-2109&D1): 11/14/03	Removal action complete. • RmAR (DOE/OR/01-2225&D2) approved 08/24/05.	No/No	–
		ETTP decontamination and demolition projects		
K-25 Auxiliary Facilities Group I Building Demolition (KAFaD)[d]	AM (DOE/OR/02-1507&D2): 01/17/97	Removal action complete. • RmAR (DOE/OR/01-1829&D1) issued August 1999. ○ Addendum I (DOE/OR/01-1829&D1/A1) approved 06/02/05. ○ Addendum II (DOE/OR/01-1829&D1/A2) approved 06/05/06.	No/No	–
K-29, K-31, and K-33 Equipment Removal and Building	AM (DOE/OR/02-1646&D1): 09/30/97	Removal action complete. • RmAR (DOE/OR/01-2290&D3) approved 06/08/07.	No/No	–

Table 8.1. CERCLA actions at ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
Decontamination[d]		○ Addendum (DOE/OR/01-2290&D3/A1) submitted 09/26/07; EPA approved 01/25/08; TDEC conditionally approved 11/01/07. ○ Addendum (DOE/OR/01-2290&D3/A2) approved 03/16/09.		
K-25 Auxiliary Facilities Group II, Phase I Building Demolition, Main Plant[d]	AM (DOE/OR/01-1868&D2): 08/03/00	Removal action complete. • RmAR (DOE/OR/01-2116&D2) approved 09/24/04.	No/Yes	–
K-25 and K-27 Buildings D&D[d]	AM (DOE/OR/01-1988&D2): 02/13/02 NSC (DOE/OR/01-2259&D1): 12/16/05	Removal action in progress. • PCCR (DOE/OR/01-2275&D1) for Hazardous Materials Abatement conditionally approved 12/19/05. • Completion of Hg ampoules disposal in accordance with the PCCR (DOE/OR/01-2275&D1) approved 03/17/06. • Completion Letter, Disposition of Centrifuge and Y-12 Materials, Excess Materials Removal, K-25/K-27 D&D 06/30/08. • PCCR for FY 2008 Earned Value (DOE/OR/2396&D2) approved 10/19/09. ○ PCCR for FY 2008 Earned Value – Erratum (DOE/OR/2396&D2) submitted 10/30/09. • PCCR for FY 2009 Earned Value (DOE/OR/01-2436&D2) approved 06/29/10.	No/No	–
K-25 Auxiliary Facilities Group II, Phase II Building Demolition, K-1064 Peninsula Area[d]	AM (DOE/OR/01-1947&D2): 07/31/02	Removal action complete. • RmAR (DOE/OR/2339&D1) approved 06/27/07.	No/Yes	8.5
K-25 Group II, Phase 3 Building Demolition, Remaining Facilities[d]	AM (DOE/OR/01-2049&D2): 09/30/03	Removal action in progress. • FY 2004 PCCR PUF (DOE/OR/01-2193&D2) approved 03/28/05. • FY 2005 PCCR PUF (DOE/OR/01-2269&D2) approved 02/15/06.	 No/No No/No	8.5

Table 8.1. CERCLA actions at ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
		• FY 2005 PCCR LR/LC Facilities (DOE/OR/01-2270&D2) approved 02/15/06.	No/No	
		• FY 2006 PCCR PUF (DOE/OR/01-2326&D2) approved 11/05/09.	No/No	
		• FY 2006 PCCR LR/LC Facilities (DOE/OR/01-2327&D2) approved 12/02/09.	No/Yes	
		• BOS D&D-Labs D&D PCCR (DOE/OR/01-2309&D2) approved 08/30/07.	No/No[g]	
		• FY 2007 PCCR PUF (DOE/OR/01-2363&D2) approved 06/25/08.	No/No	
		• FY 2007 PCCR LR/LC Facilities (DOE/OR/01-2362& D3) approved 09/27/10.	No/Yes	
		• K-29 Process Building PCCR (DOE/OR/01-2336&D2) approved 10/18/07.	No/No	
		• K-1420 Decon & Recovery Facility PCCR (DOE/OR/01-2341&D2) approved 10/26/07.	No/Yes	
		• Building K-1401 PCCR (DOE/OR/01-2365&D2/A1) approved 04/08/09.	No/Yes	
		• FY 2008 PCCR LR/LC Facilities (DOE/OR/01-2394&D1) approved 03/13/09.	No/Yes	
		• FY 2008 PCCR PUF (DOE/OR/01-2395&D1) approved 02/09/09.	No/No	
		• FY 2009 PCCR for LR/LC Facilities (DOE/OR/01-2434&D2) submitted 09/24/10.		
		• FY 2009 PCCR for PUF (DOE/OR/01-2435&D2) approved 04/12/10.	No/No	
		• PCCR for Poplar Creek - 3HR (DOE/OR/01-2444&D2) approved 07/28/10.	No/Yes	

[a]Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <http://www.bechteljacobs.com/ettp-ffa-appendices.html>.

[b]Once completed, monitoring activities associated with this AM (DOE 2007i) will supersede monitoring associated with the previous removal action (DOE 1997d) and will then be incorporated into the format of the annual RER. Until that time, the reader is referred to Sect. 8.4.2 for a summary of performance monitoring results for K-1007-P1 and K-901-A holding ponds.

[c]EPA suspended review of the TC RmAR on 10/09/08. This document will be superseded by a non-time critical action RmAR.

[d]Action completed as defined/required in CERCLA decision document listed. However, site requires subsequent CERCLA decision/action, e.g., the *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2005b).

[e]Collection and treatment of SW-31 Spring discharge is no longer required per addendum to the RAER. However, per the RAER, interim spring monitoring is required.

[f]See discussion of terminated action in FY 2007 RER Vol. 1, Chap. 8.

[g]The PCCR for the Group II, Phase 3 BOS-LABS D&D required surveys and monitoring of the slabs from K-1004 and K-1015. These slabs were removed in FY 2007 and monitoring is no longer required. The long term stewardship of these sites is no longer reported in the RER.

Table 8.1. CERCLA actions at ETTP (cont.)

[h]Although the Bldg. K-1401 PCCR documents the building demolition and prescribes LTS for the remaining slab, the K-1401 slab was removed in 2009 and LTS requirements are no longer implemented at the site. The removal of the slab is documented in the FY 2010 PCCR for EU Z2-31 in Zone 2 (DOE 2010m), which was submitted to the regulators in August 2010 and is pending approval.

BOS = Balance of Site
IROD = Interim Record of Decision
LR/LC = low risk/low complexity
PUF = predominantly uncontaminated facilities
RAER = Remedial Action/Effectiveness Report

Table 8.2. LTS requirements for CERCLA actions at ETTP

<table>
<tr><th rowspan="2">Site/Project</th><th colspan="2">LTS requirements</th><th rowspan="2">Status</th><th rowspan="2">RER section</th></tr>
<tr><th>LUCs</th><th>Engineering controls</th></tr>
<tr><td colspan="5">Watershed-scale actions</td></tr>
<tr><td>ROD for Interim Actions for Selected Contaminated Areas Within Zone 1, ETTP
▪ Duct Island/K-901 Area PCCR
▪ K-1007 Ponds/Powerhouse PCCR
▪ K-770 Scrap Removal PCCR
▪ FY 2008 PCCR for EUs Z1-01, Z1-03, Z1-38, and Z1-49</td><td>Watershed LUCs
Administrative:
▪ property record restrictions
▪ property record notices
▪ zoning notices
▪ permits program

Physical:
▪ access controls
▪ signs
▪ security patrols

K-770 PCCR specific:
▪ fencing
▪ CA postings</td><td>K-770 PCCR specific:
▪ radiological surveys</td><td>Watershed LUCs
▪ Physical LUCs in place.
▪ Administrative LUCs required at completion of actions.

K-770 PCCR specific:
▪ LUCs in place.
▪ Engineering controls remain protective.</td><td>8.2.1</td></tr>
<tr><td>ROD for Soil, Buried Waste and Subsurface Structure actions in Zone 2, ETTP
▪ FY 2006 PCCR
▪ FY 2007 PCCR
▪ FY 2008 PCCR
▪ FY 2009 PCCR
▪ FY 2010 PCCR</td><td>Watershed LUCs
Administrative:
▪ property record restrictions
▪ property record notices
▪ zoning notices
▪ permits program

Physical:
▪ access controls
▪ signs
▪ security patrols

K-1070-C/D Burial Ground specific:
▪ access controls</td><td></td><td>Watershed LUCs
▪ Physical LUCs in place.
▪ Administrative LUCs required at completion of actions.
▪ Property record restrictions filed upon transfer of buildings in Zone 2.

K-1070-C/D Burial Ground specific:
▪ LUCs in place.</td><td>8.3.3</td></tr>
<tr><td colspan="5">Completed single-project actions</td></tr>
<tr><td>K-1407-B/C Ponds RA</td><td>▪ Access and activity controls</td><td>S&M, including
▪ Periodic inspections
▪ Radiological and industrial hygiene surveillance</td><td>▪ LUCs in place.
▪ Engineering controls remain protective.</td><td>8.4.1.4</td></tr>
<tr><td>K-901-A Pond and K-1007-P Ponds Removal Action</td><td>▪ Signs</td><td>▪ Maintain weir</td><td>▪ LUCs in place. Engineering controls remain protective.</td><td>8.4.2.5</td></tr>
<tr><td>K-1070-C/D G-Pit and Concrete Pad RA</td><td>▪ Fences
▪ EPP program</td><td>▪ Maintain vegetated soil cover on concrete pad
▪ Periodic radiological surveys</td><td>▪ LUCs in place.
▪ Engineering controls remain protective.</td><td>8.4.3.1</td></tr>
</table>

Table 8.2. LTS requirements for CERCLA actions at ETTP (cont.)

Site/Project	LTS Requirements: LUCs	LTS Requirements: Engineering controls	Status	RER section
K-1070-A Burial Ground	▪ Access controls ▪ EPP program ▪ Surveillance patrols	▪ Maintain soil cover	▪ LUCs in place. ▪ Engineering controls remain protective.	8.4.4.1
		ETTP D&D Projects		
K-25 Auxiliary Facilities Group II, Phase 1 Building Demolition, Main Plant	▪ EPP program		▪ LUCs in place.	–
K-25 Auxiliary Facilities Group II, Phase 2 Building Demolition, K-1064 Peninsula Area	▪ CA postings	▪ radiological surveys	▪ LUCs in place. ▪ Engineering controls remain protective.	8.5.1
K-25 Group II, Phase 3 Building Demolition, Remaining Facilities ▪ FY2006 PCCR-LR/LC Facilities ▪ BOS D&D-Labs D&D PCCR[a] ▪ K-29 Process Building PCCR ▪ K-1420 Decon & Recovery Facility PCCR ▪ Bldg K-1401 PCCR ▪ FY2008 PCCR-LR/LC Facilities ▪ FY2007 PCCR-LR/LC Facilities ▪ FY2009 PCCR-LR/LC Facilities ▪ Poplar Creek High Risk Facilities PCCR	▪ CA postings	▪ radiological surveys	▪ LUCs in place. ▪ Engineering controls remain protective.	8.5.1

[a]All the slabs under this action were removed in FY 2007 and no longer require CA postings or radiological surveys.

BOS = balance of sites
EUs = Exposure Units

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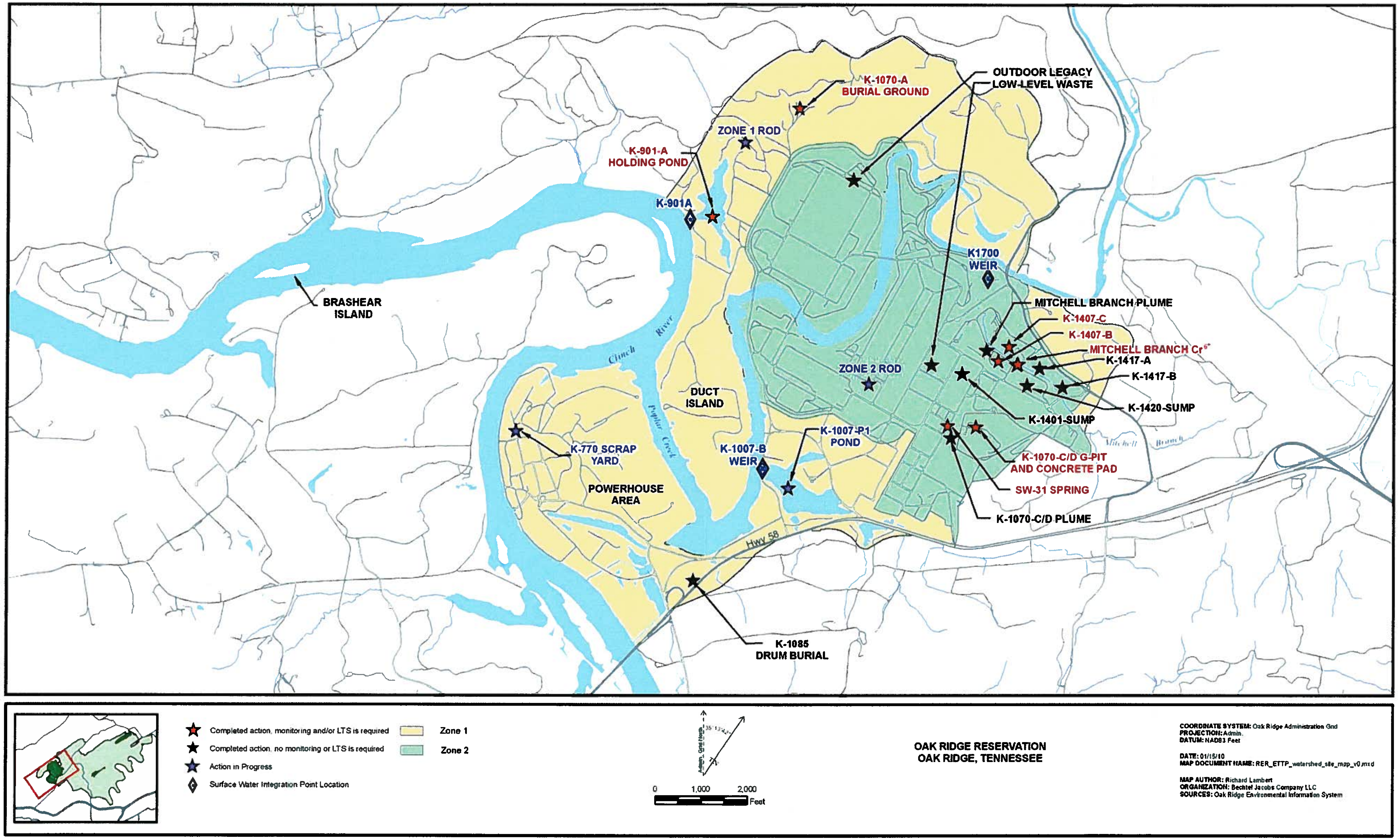

Figure 8.1. ETTP RA site map.

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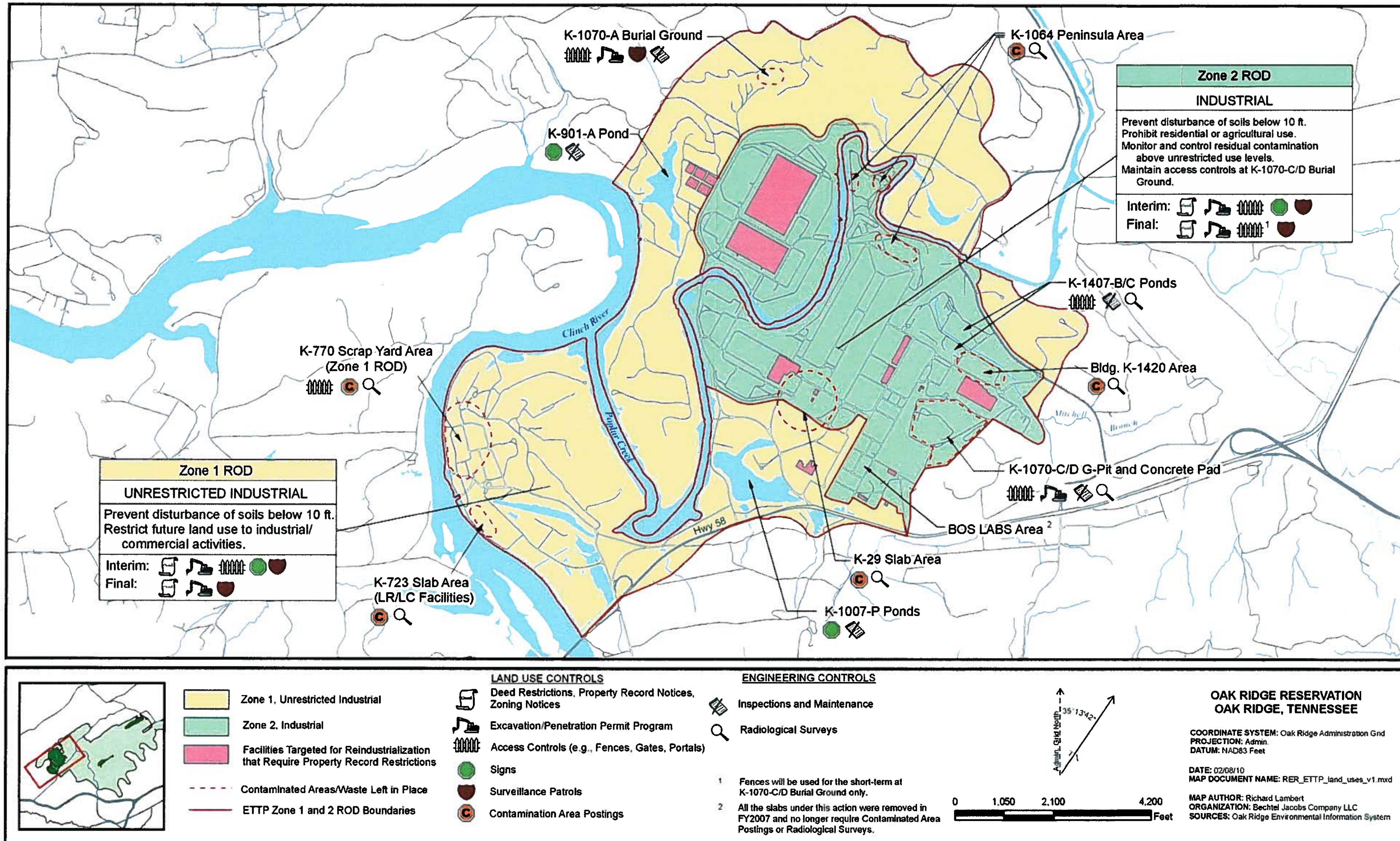

Figure 8.2. ETTP Zone 1 and 2 ROD-designated land uses and interim controls.

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8.1.1 Status and Updates

This section provides the status and updates of RAs and D&D projects at ETTP for FY 2010. Historically, D&D projects did not include any monitoring and/or LUCs and, therefore, were not included in the annual CERCLA document that evaluated monitoring data to assess the effectiveness of the RA, i.e., the RER. But now, however, because some D&D projects do have LUC requirements, D&D projects are included in Table 8.1, although only those with LUCs will be discussed in the text.

ETTP Watershed-scale Actions

The PCCR (DOE 2006c) for the Duct Island Area and K-901 Area of Zone 1 documents completion of the RAs at Blair Quarry, describes the risk assessment evaluations performed and determinations made using DVS, and identifies additional sites requiring RAs. An addendum to this PCCR (DOE 2009l) addressing EUs Z1-50 through Z1-52, Z1-66 and Z1-70 was submitted to the regulators on September 10, 2010. A second PCCR (DOE 2006d) documents the characterization results of the DVS for the accessible EUs within the K-1007 Ponds Area and Powerhouse Area, and identifies additional areas that require remediation. An addendum to this PCCR (DOE 2010k) was submitted to the regulators on June 29, 2010 recommending unrestricted industrial use to 10 ft bgs for EUs Z1-11, Z1-17 through Z1-22 and Z1-26. Work was initiated in FY 2010 to prepare the Zone 1 Final ROD that will address groundwater and ecological protection. Field work on this project will be initiated in FY 2011.

The D2/R1 version of the FY 2008 PCCR for Exposure Units (EUs) EU Z2-33 in Zone 2 (DOE 2008e) was approved on September 28, 2009 (with erratum D2/R2 approved on December 16, 2009). In addition, the FY 2009 PCCR for Zone 2 EUs 11, 12, 17, 18, 29, and 38 (DOE 2009m) received regulatory approval on April 2, 2010. Soil remediation work was completed in Exposure Units 31 and 32 in Zone 2. The PCCR for EU Z2-32 in Zone 2 ((DOE 2010l) was approved on April 8, 2010. The PCCR for EU Z2-31 in Zone 2 (DOE 2010m) was submitted to the regulators on August 19, 2010. None of these post-decision documents include any requirements for monitoring, although controls are required to restrict land use to 10 ft bgs. Details of these post-decision documents are discussed in Sect. 8.3.

The two-phase groundwater treatability study at ETTP began in FY 2009 to support selection of a site-wide groundwater remediation process. Phase I will perform characterization activities necessary to design the Phase II pilot-scale demonstration. The Treatability Study Work Plan for Phase I (DOE 2008f) was approved December 15, 2008. The Construction Start for Phase I of the Treatability Study was submitted in April 2009. Field activities included the installation of seven 120-160 ft boreholes, borehole geophysics, Flexible Liner Underground Technologies, LLC (FLUTe) testing for DNAPL detection, and transmissivity testing. During FY 2010, DNAPL was detected in bedrock in one of the seven FY 2009 boreholes. An additional seven boreholes were installed in FY 2010 to further delineate the lateral extent of DNAPL contamination. A workshop was held in September 2010 to review data and select a technology for a Phase II Field Study. The workshop concluded that *in situ* thermal treatment was appropriate for DNAPL in the weathered bedrock zone, that *in situ* thermal or biological treatment may be appropriate in the unconsolidated zone, and that a waiver may be appropriate for the deep bedrock zone. The workshop also identified the need for design characterization to further define the boundaries for the Phase II field studies.

Additionally, excavation of contaminated soil continued at the K-770 Scrapyard under the Zone 1 ROD at ETTP during FY 2010. Approximately 97,000 yd^3 of soil has been shipped to the EMWMF for disposal. Remediation of the K-770 Scrapyard was 99% complete at the end of FY 2010. An addendum to the PCCR for the K-770 Scrap Removal (DOE 2010n) documenting removal of cesium containing casks was submitted on August 20, 2010.

Remediation of the K-1070-B Burial Ground under the Zone 2 ROD continued in FY 2010. Trench excavation was initiated and a groundwater management system was installed to support trench excavation. Approximately 86,000 yd^3 of soil and debris from the Burial Ground was shipped to the EMWMF for disposal.

ETTP Single-action Projects

During FY 2007, hexavalent chromium was detected in surface water in Mitchell Branch in exceedance of the AWQC and was found to be discharging from Outfall 170. In response to this condition, DOE conducted a TC RmA to install and operate groundwater seepage collection pumps to capture chromium-contaminated groundwater associated with the Outfall 170 discharge (See Section 8.4.1.2). The notice of intent to conduct the removal action was issued on November 5, 2007, and the AM (DOE 2007e) was issued on December 20, 2007. The RmAR (DOE 2008g) was submitted July 30, 2008. A non-TC RmA for a long-term solution to the release of hexavalent chromium to Mitchell Branch (DOE 2010o) was approved on March 26, 2010, superseding the Time-Critical Action Memorandum of December 2007 (DOE 2007e). An Engineering Evaluation/Cost Analysis (EE/CA) (DOE 2009n) recommending *ex-situ* treatment by chromium reduction was approved on December 3, 2009.

Additional remediation activities to reduce ETTP groundwater and surface water contamination were continued in FY 2010. Ecological enhancement removal action, including fish removal, recontouring and revegetation, for the K-1007-P1 Holding Pond. The pond was restocked with fish species less likely to agitate the sediment. Barriers were installed to prevent fish from migrating into the pond from Poplar Creek. The Removal Action Report was submitted April 20, 2010. The fish barrier was damaged by a storm event and subsequently repaired in FY 2010. Details are provided in Sect. 8.4.2.

ETTP Decontamination and Demolition Projects

During FY 2010, most of the CERCLA actions at ETTP focused on completion of D&D activities. Most buildings, except for property transfer candidates, are scheduled for demolition. The facilities that will remain are targeted for potential title transfer to private sector organizations under a reindustrialization program. Building demolition is performed as part of CERCLA removal actions, organized into several projects as follows:

K-25/K-27 Buildings. An AM for the demolition of the K-25 and K-27 buildings was signed in 2002, stipulating that the buildings be demolished to slab and the associated waste disposed. Hazardous materials removal, Phase 1 of the demolition, was completed in June 2005. A new plan for demolishing the buildings was developed in 2006 that would better protect workers from the deteriorated conditions in the buildings by removing high-risk components and demolishing the buildings from the outside using heavy equipment. The approved Earned Value PCCRs for FY 2008 (DOE 2009o) and FY 2009 (DOE 2010p) document the project status at the end of those respective fiscal years.

Full-scale demolition of the K-25 building began in December 2008 as workers began demolishing the west wing. At the end of FY 2010 the K-25 was undergoing demolition. During FY 2010, demolition of the West Wing was completed and pre-demolition work continued in the East and North Wings, including the removal of high risk materials, removal of asbestos and the draining of lubrication oils and coolant. Pre-demolition work was initiated in the K-27 building. Work completed in the K-27 building included the removal of asbestos, hazardous and loose materials, and the draining of lubricant oils and coolant. Predemolition work has also been completed on K-27.

K-29/K-31/K-33 Buildings Decontamination. The AM was approved in 1997 to decontaminate and remove equipment from the K-29, K-31, and K-33 gaseous diffusion buildings. The work was completed in FY 2005 and the RmAR was approved in FY 2007. Building K-29 was later demolished as part of the Group II, Phase 3 Remaining Facilities Demolition, after DOE determined that the facility was not suitable for reindustrialization. A contract for the demolition of the K-33 Building was awarded in FY 2010 and isolation of the tie line to the K-31 Building was completed so demolition could progress.

Group I Auxiliary Facilities. In FY 1997, the AM to demolish five ETTP auxiliary facilities was signed. This project was completed in FY 2006 with the final addendum to the RmAR approved.

Group II, Phase 1 Main Plant Facilities. In FY 2000, DOE signed an AM to demolish the ETTP main plant facilities. This project began in August 2000 and was completed in December 2003. In FY 2004, the RmAR was approved.

Group II, Phase 2 Building Demolition (K-1064 Peninsula). DOE signed an AM in July 2002 for the demolition of 18 facilities and the removal of scrap material located in the K-1064 peninsula area. In FY 2007, the work was completed, and the RmAR was approved June 27, 2007.

Group II, Phase 3 Remaining Facilities Demolition. In September 2003, an AM was approved to demolish approximately 500 remaining facilities at ETTP. The FY 2008 PCCR for the Low Risk/Low Complexity Facilities (DOE 2008h) and the FY 2008 PCCR for the PUFs (DOE 2008i) were both approved in FY 2009. In the FY 2008 Low Risk/Low Complexity Facilities PCCR, storm drain and surface water monitoring are required at the Building K-1024 slab along with radiological surveys of the slab. Interim access controls are also required at the K-1066-G yard and the hydrofluoric acid (HF) Tank Farm due to elevated radiological readings. In FY 2010, six low risk/low complexity facilities were demolished.

In FY 2009, four predominantly uncontaminated facilities (PUFs) and 11 low-risk/low-complexity facilities were demolished. In the Poplar Creek area, three high risk buildings were demolished: K-1231, K-1233, and K-413. These actions are documented in the FY 2009 PCCR for the Predominantly Uncontaminated Facilities (DOE 2009p) which was approved on April 12, 2010, and the FY 2009 PCCR for the Low Risk/Low Complexity Facilities (DOE 2010q) that was submitted on September 24, 2010. Once approved, the FY 2009 Low Risk/Low Complexity Facilities PCCR will require storm drain and surface water monitoring along with radiological surveys at the Building K-1231-B slab. The Poplar Creek – 3HR PCCR (DOE 2010r) was submitted in December 2009 and received regulatory approval on July 28, 2010. Interim access controls are required at the former Building K-1035 slab site and the Building K-1204-3 slab.

Over the past few years, completion of D&D activities (mostly Group II, Phase 2 and Group II, Phase 3 actions) has been documented by various PCCRs (see Table 8.1), many of which included requirements for radiological surveys and access controls because slabs or portions of foundations were left in place. If radiological surveys indicated a slab or the remaining soil had residual contamination that exceeded the release criteria of DOE Order 5400.5, then interim access controls were implemented and the slab was posted and became part of the radiological surveillance and monitoring program. In general, storm water runoff from concrete pads is not sampled directly. The ETTP Environmental Compliance Program determines the effectiveness of the radiological control program through ongoing storm drain outfall sampling and instream water sampling, i.e., monitoring in compliance with the ETTP NPDES permit and storm water runoff plans.

Section 8.5 provides a summary of monitoring and reporting requirements for each of the D&D closure projects that left slabs/foundations or contaminated soils in place. Because all D&D activities have been completed as removal actions, the CERCLA Zone 1 and the Zone 2 RODs will determine the final remedy for the contaminated slabs, soils, and below-grade structures that remain.

8.2 ZONE 1 INTERIM RECORD OF DECISION

The ROD for Interim RAs for Selected Contaminated Areas within Zone 1 (Figure 8.2) of ETTP (Zone 1 ROD) includes RAs for unrestricted industrial use to a depth of ten ft and for sources of groundwater contamination (DOE 2002d). Major components of the remedy include:

- excavation of contaminated soil in the K-895 Cylinder Destruct Facility Area (EU-49) and in the Powerhouse Area (including K-725 Beryllium Building Slab) (EU-30);
- excavation of the Blair Quarry burial area (EU-27);
- removal of scrap metal and debris from the K-770 area (EU-27 through -33);
- removal of sludge and demolition of the K-710 sludge beds and Imhoff tanks (EU-26);
- characterization of areas with insufficient data to determine if a release occurred or if the potential for a release is present; and
- interim LUCs to prevent access to remaining contamination.

Zone 1 was divided into four geographic areas for evaluation for unrestricted industrial use to 10 ft bgs– the Duct Island Area, K-901 Area, K-1007 Ponds Area, and the Powerhouse Area. The final status assessments and associated data gap sampling efforts for the remaining areas of soil in these four geographic areas is being conducted using the DVS (DOE 2007f). These four areas are further divided into EUs (see Figure 8.3). EUs in these areas are being addressed in PCCRs as outlined below and summarized in Table 8.3.

K-1007 Ponds/Powerhouse Area

The PCCR (DOE 2006d) for the K-1007 Ponds Area and Powerhouse Area documents the characterization results of the DVS for the 21 accessible EUs, and identifies additional areas that require remediation (EUs 1, 3, and 9). Fifteen EUs in the K-1007 Ponds Area and Powerhouse Area were not addressed in this PCCR because RAs in these areas and ongoing operations precluded final characterization. Eight of these EUs originally omitted were addressed in an addendum to this PCCR (DOE 2010k) which was submitted to the regulators on June 29, 2010. It documents completion of DVS characterization in EUs 11, 17 through 22, and 26, and includes RAs performed in EU 26 (several small soil RAs) and EU 9 (USTs and K-1085 soils) as recommended in the original PCCR. No monitoring requirements are specified for the remediated sites; general LUCs for Zone 1 are reiterated.

Water bodies within the EUs of the K-1007 Ponds/Powerhouse Areas comprise 9.2 acres and are addressed in Sect. 8.4.2.

K-770 Group (EUs Z1-27 through Z1-33)

Seven EUs omitted from the original K-1007 Ponds Area/Powerhouse Area PCCR (DOE 2006d) are in the K-770 group and are being addressed under two separate PCCRs to address 1) the scrap and debris and 2) the soils. The K-770 Scrap Removal Project began shipping contaminated scrap from the K-770 Scrap Yard (Figure 8.1) to the EMWMF in July 2004. The PCCR (DOE 2007g) was approved in

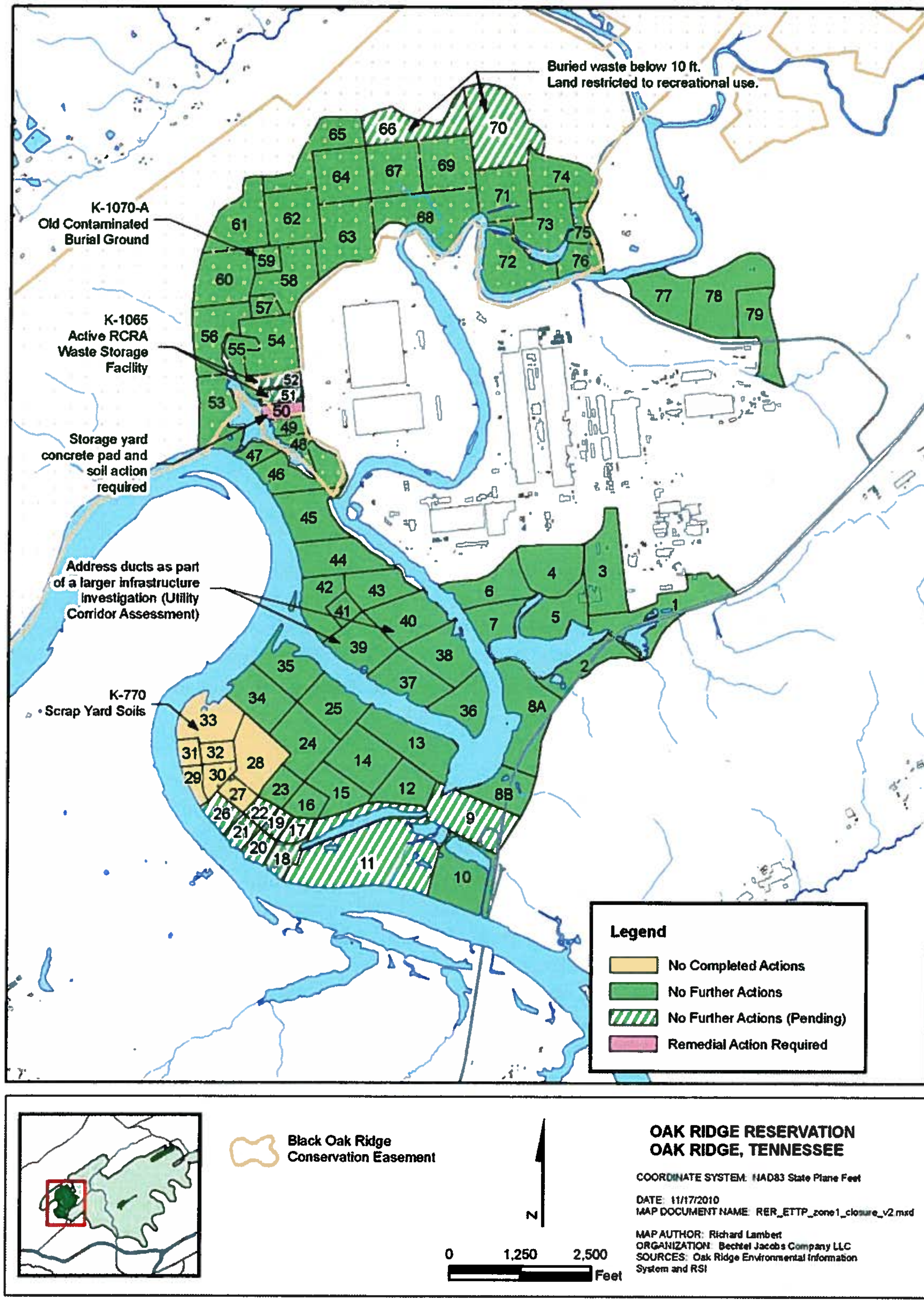

Figure 8.3. ETTP Zone 1 closure document and action status.

Table 8.3. ETTP Zone 1 completion documents and EU status

Fiscal Year of Completion Document	Evaluated		NFA		RA Required		RA Completed	RA Remaining
	# of EUs	# of Acres	# of EUs	# of Acres	# of EUs	# of Acres[a]	# of EUs	# of EUs
Zone 1 Totals (80 EUs, 1,341.5 acres)								
K-1007 Ponds and Powerhouse Areas (36 EUs, 579.2 acres)								
Duct Island and K-901 Areas (44 EUs, 762.3 acres[b])								
K-1007 Ponds and Powerhouse Area PCCR (FY2006)	21	396.5	18	318.5	3	78	0	3 (EU-1, 3, 9)
Duct Island and K-901 Area PCCR (FY2006)	39	686.8	37	662.2	2	24.6	0	2 (EU-38, 49)
FY2006 Totals	**60**	**1,083.3**	**55**	**980.7**	**5**	**102.6**	**0**	**5**
K-770 Scrap Removal Project PCCR (FY2007)[c]	-	-	-	-	-	-	-	-
FY2007 Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
PCCR for EU 1, 3, 38, 49 (FY2008)	-	-	4	77.3	-	-	4 (EU-1, 3, 38, 49)	1 (EU-9)
FY2008 Totals	**0**	**0**	**4**	**77.3**	**0**	**0**	**4**	**1**
FY2009 Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
K-1007 Ponds and Powerhouse Area PCCR Addendum (FY2010-Pending)	8[d]	117.2	9	142.6	1[d]	7.4	2 (EU-9, 26)	0
Duct Island and K-901 Area PCCR Addendum (FY2010-Pending)	5	71	4	66.2	1	4.8	0[e]	1 (EU-50)
K-770 Scrap Removal Project PCCR Addendum (FY2010-Pending)[f]	-	-	-	-	-	-	-	-
FY2010 Totals	**13**	**188.2**	**13**	**208.8**	**2**	**12.2**	**2**	**1**
As of 9/30/10	**73**	**1,271.5**	**72**	**1,266.8**	**-**	**-**	**-**	**1**
Remaining for Evaluation	**7**	**65.5[g]**	**EU-27 through 33 (K-770 Group)**					

[a]Represents the sum of the acreages of all EUs in which a RA is required.
[b]4.5 acres of this total are pond and stream sediments and will be addressed in the Site-Wide ROD.
[c]Documents the removal and disposition of scrap metal and debris from EU-27 through 33. Soil removal remains.
[d]EU-9 was evaluated in FY2006 and is not included in this total. EU-9 (25.4 acres) is however included in the NFA total (post-RA).
[e]K-1066-J and -K Yard wooden cylinder saddles RA in EU-50 completed under this PCCR. K-1066-K Yard PCB-contaminated debris and adjacent soil removal in EU-50 is still required.
[f]Documents the transfer of cesium casks to complete the K-770 Scrap Removal Project.
[g]4.5 acres not included in this total are pond and stream sediments and will be addressed in the site-wide ROD.

May 2007. Over 48,100 tons of waste material were shipped for disposal. During scrap removal activities at the K-770 Scrap Yard, three unexpected cesium casks were discovered. The containerized casks were transported to ORNL in April 2006 for storage until final disposition planned for the Nevada Test Site. An addendum to the K-770 Scrap Removal PCCR (DOE 2010n) was submitted to the regulators on August 20, 2010, and documents the transfer of responsibility of disposal of the three casks. Once approved, this transfer of responsibility will complete the Scrap Removal Project. The K-770 Scrap Removal PCCR (DOE 2007g) required interim LUCs to verify contamination was not migrating from the site. As discussed in Sect. 8.2.1 these interim controls have been discontinued as contaminated slabs have been removed. The ETTP Zone 1 RAR will determine the final LUCs and monitoring for these areas.

Remediation of the K-770 Scrapyard Soil in EUs 27 through 33 was initiated in FY 2009 and continued in FY 2010 with the shipment of approximately 97,000 yd^3 of soil to the EMWMF for disposal. Remediation of the K-770 Scrapyard was 99% complete at the end of FY 2010.

Duct Island/ K-901 Areas (EUs Z1-36 through Z1-79)

The PCCR (DOE 2006c) for the Duct Island/K-901 Areas of Zone 1 documents completion of the remedial activities at Blair Quarry, describes the risk assessment evaluations performed and determinations made using DVS, and identifies additional sites requiring RAs (EUs 38 and 49). An Addendum to this PCCR (DOE 2009l) was submitted on September 10, 2010 to address five EUs that were originally excluded from the PCCR because either waste removal was needed before DVS could be performed (EUs 50, 51, and 52), or they awaited risk evaluation to determine action/NFA decision (EUs 66 and 70). The addendum documents DVS results for these 5 EUs, the evaluation of a recreational end use for Contractor's Soil Area (CSA) in EU-66 and 70, and includes the K-1066-J and –K Yard cylinder saddle RA performed in EU-50. K-1066-K Yard PCB-contaminated debris and adjacent soil removal in EU-50 is still required. No monitoring requirements are specified; general LUCs for Zone 1 are reiterated.

FY 2008 PCCR

The FY 2008 PCCR for EUs 1, 3, 38, and 49 in Zone 1 (DOE 2008j) was approved on April 23, 2008. This PCCR documents the RAs completed within each of the specified EUs as recommended in both the Duct Island/901 Areas PCCR (the Duct Island South soil mounds in EU 38 and the K-895 Cylinder Destruct Facility FFA site in EU 49) and the K-1007 Ponds/Powerhouse Area PCCR (The Happy Valley Service Station FFA site in EU 1 and the K-1055 Gasoline/Diesel Station Tanks FFA site in EU 3). The FY 2008 PCCR does not specify any monitoring requirements for the remediated sites; general LUCs for Zone 1 are reiterated.

As shown in Table 8.3, there currently are 72 EUs in Zone 1 that have been determined as NFA, with 1 EU still requiring remedial action (EU-50), and 7 EUs remaining for evaluation in the K-770 Group.

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

A complete discussion of the ETTP Zone 1 ROD and a summary of actions are provided in Chap. 8 of Vol. 1 of the FY 2007 RER (DOE 2007a).

8.2.1 Compliance with LTS Requirements

8.2.1.1 Requirements

Zone 1–wide ROD Requirements

LTS requirements for CERCLA actions at ETTP are summarized in Table 8.2. The Zone 1 ROD (DOE 2002d) establishes "unrestricted industrial" as the land use for Zone 1, and requires LUCs to prevent disturbance of soils below 10 ft in depth and to restrict future land use to industrial/commercial activities. To implement restrictions that prohibit more aggressive use of this area and to restrict access to this area until that land use has been achieved, seven LUCs will be implemented. Until the land use is achieved, reliance will be primarily on property record and zoning notices, the EPP program, access controls, and surveillance patrols. Once it has been established that Zone 1 is safe for unrestricted industrial use, property record restrictions, property record notices, zoning notices, excavation permits, and less significant surveillance patrols will be used. The objectives of these controls are as follows:

- Property record restrictions to restrict uses of the property by imposing limitations on its use and to prohibit uses of groundwater;
- Property record notices to provide notice to anyone searching records about the existence and location of contaminated areas and limitations on their use;
- Zoning notices to provide notice to the city about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes;
- An EPP program to provide notice to permit requestors of the extent of contamination and prohibiting or limiting excavation/penetration activity;
- Access controls to control and restrict access to workers and the public in order to prevent unauthorized uses;
- Signs that provide notice or warning to prevent unauthorized access; and
- Surveillance patrols to control and monitor access by workers and the public.

Duct Island Area/K-901 Areas (EUs Z1-36 through Z1-79) PCCR-Specific Requirements

The PCCRs completed under the Zone 1 ROD for the Duct Island/K-901 Areas state that, consistent with the Zone 1 ROD, the NFA decision means that an EU is available for unrestricted industrial use to a depth of 10 ft. bgs. All EUs that have been cleared for industrial use to a depth of 10 ft bgs have a high probability of being cleared for industrial use to all depths, with the exception of EU 59 in the Duct Island Area. EU 59 contains the K-1070-A Old Contaminated Burial Ground where a previous RA was conducted (See Sect. 8.4.4). EU 59 does not pose a threat to groundwater and is considered NFA; however, subsurface data indicate unacceptable concentrations of radionuclides and organic chemicals for lifting of LUCs at depths below 10 ft. bgs. Because formerly buried wastes are present at depths in this EU, LUCs are in place.

The FY 2010 Addendum to the Duct Island/K-901 Areas PCCR (DOE 2010s) is pending approval and recommends recreational end-use for the Contactors Soil Areas (CSA) in EU-66 and EU-70. These two EUs are included in the Black Oak Ridge Conservation Easement (BORCE) and managed by the State of Tennessee as a Wildlife Management Area and State Natural Area. A large portion of these two EUs

(15.6 acres) comprises the CSA construction debris and fly-ash landfill. It has been recommended that EU 66 and EU 70 be changed to a recreational end use, which implicitly assumes activities only on the surface.

K-1007 Ponds/Powerhouse Areas (EUs Z1-1 through Z1-35) PCCR-Specific Requirements

All EUs within the K-1007Ponds/Powerhouse Areas that have been cleared for industrial use to a depth of 10 ft bgs have a high probability of being cleared for industrial use to all depths, with the exception of EU 9 at the K-1085 Burn Area and EU 11 at the K-720 Fly Ash Pile Site. EU 9 required a RA at the K-1085 Old Firehouse Burn Area to remove contaminated soils to 12 ft bgs. This action was documented under the K-1007 Ponds and Powerhouse Area PCCR Addendum (pending as of September 30, 2010) (DOE 2010k). EU 9 is considered NFA post-RA; however, due to groundwater contaminated with VOCs, it is recommended that soils below 10 ft. bgs in EU 9 at this site be available for restricted use only. EU 11 does not require an RA and is considered, NFA; however, groundwater beneath the K-720 Fly Ash Pile is contaminated with SVOCs, metals, and radionuclides. Because formerly contaminated groundwater is present at depths in these EUs, LUCs are in place.

K-770 Group (EUs Z1-27 through Z1-33) PCCR-Specific Requirements

The K-770 Scrap Removal PCCR under the Zone 1 ROD required additional LTS activities including controlling access to the K-770 Scrap Metal Yard and ensuring the fence surrounding the area remains intact. Additional interim controls such as maintaining CA postings and conducting radiological surveys were required at areas with residual radiological contamination above the release criteria of DOE Order 5400.5. While the K-770 Scrap Removal Project was officially completed in FY 2010, these interim controls were required as needed during the K-770 soil removal action. However, by the end of FY 2010, all contaminated areas and slabs that required monitoring had been removed. These interim controls are summarized below, but will not be included in next year's RER. Final LTS requirements for this area will be documented in the PCCR planned for submission in FY 2011.

Requirements provided in the PCCR (DOE 2007g) listed in Table 8.4 for the K-770 Scrap Removal Project include the following: (1) radiological surveillance, (2) storm drain characterization performed at least once within each NPDES permitting period ($\leq$5 years) for representative outfalls in each drain grouping, and (3) surface water monitoring. Figure 8.4 shows the locations of the storm drains and surface water locations relative to the K-770 Scrap Yard. Storm drain characterization and surface water monitoring results are used to verify the effectiveness of the Radiological Control Program.

Table 8.4. LTS requirements for K-770 Scrap Removal Project facilities associated with remaining contaminated media

Area/action	Slab/Foundation (annual survey)	Storm drain (characterize at least once every NPDES permit cycle)	Surface water
ROD for Interim Actions in Zone 1 at ETTP/PCCR for the K-770 Scrap Removal Project	K-770 Scrap Metal Yard soil K-725 slab K-736 slab K-1300 area – contaminated soil and concrete pad[a] K-1066-G yard – contaminated material	SD-724 SD-730 SD-740 SD-750[b] SD-770 SD-780 SD-800 SD-820 SD-830 SD-860 SD-870 SD-880 SD-890 SD-892	CRM 9.5[c] (Brashear Island)

[a]This area refers to the contaminated K-1302 pad and the soils area where the K-1300 stack used to be. This is not referring to the K-1300 clean spoils area.

[b]SD-750 is not a required monitoring location per the PCCR, however, it drains an area of the rad contaminated K-770 scrap metal yard directly between SD-740 and SD-760. The omission of SD-750 in the PCCR is considered an oversight.

[c]The PCCR requires monitoring at Clinch River kilometer 16 Brashear Island, however, the actual sampling point is identified as CRM 9.5.

SD = storm drain

Radiological gross alpha and gross beta surveys, at a minimum, are conducted annually. If radiological contamination is found to be migrating out of the contamination area, then additional controls are implemented. The frequency and level of surveillance and monitoring is established at each site by the radiological engineers responsible for the program, in accordance with requirements and criteria set forth in 10 CFR §835, Occupational Radiation Protection. Contamination monitoring programs are reviewed and changed annually by the Project Health Physicist to ensure that appropriate surveys are performed at a frequency that is consistent with existing and potential hazards and activities planned in the area.

In general, storm water runoff from concrete or asphalt pads is not sampled directly. Instead, the ETTP Environmental Compliance Program determines the effectiveness of the radiological control program through ongoing storm drain characterization sampling program and instream water sampling, i.e., monitoring in compliance with the ETTP NPDES Permit characterization requirements. Representative outfalls from storm drain discharges groupings are characterized at least once during each NPDES permitting period, a maximum of five years, for a minimum of gross alpha, gross beta, isotopic uranium, and ^{99}Tc. Instream water monitoring is conducted at least annually downstream of ETTP at Clinch River kilometer CRK 16 Brashear Island [Clinch River mile (CRM) 9.5] for a minimum of gross alpha, gross beta, isotopic uranium, and ^{99}Tc. Data are compared to screening levels established at 4% of DOE Order 5400.5 Derived Concentration Guidelines (DCGs) to maintain discharges as low as reasonably achievable (ALARA). When a screening level is exceeded, a field investigation is conducted to determine the source

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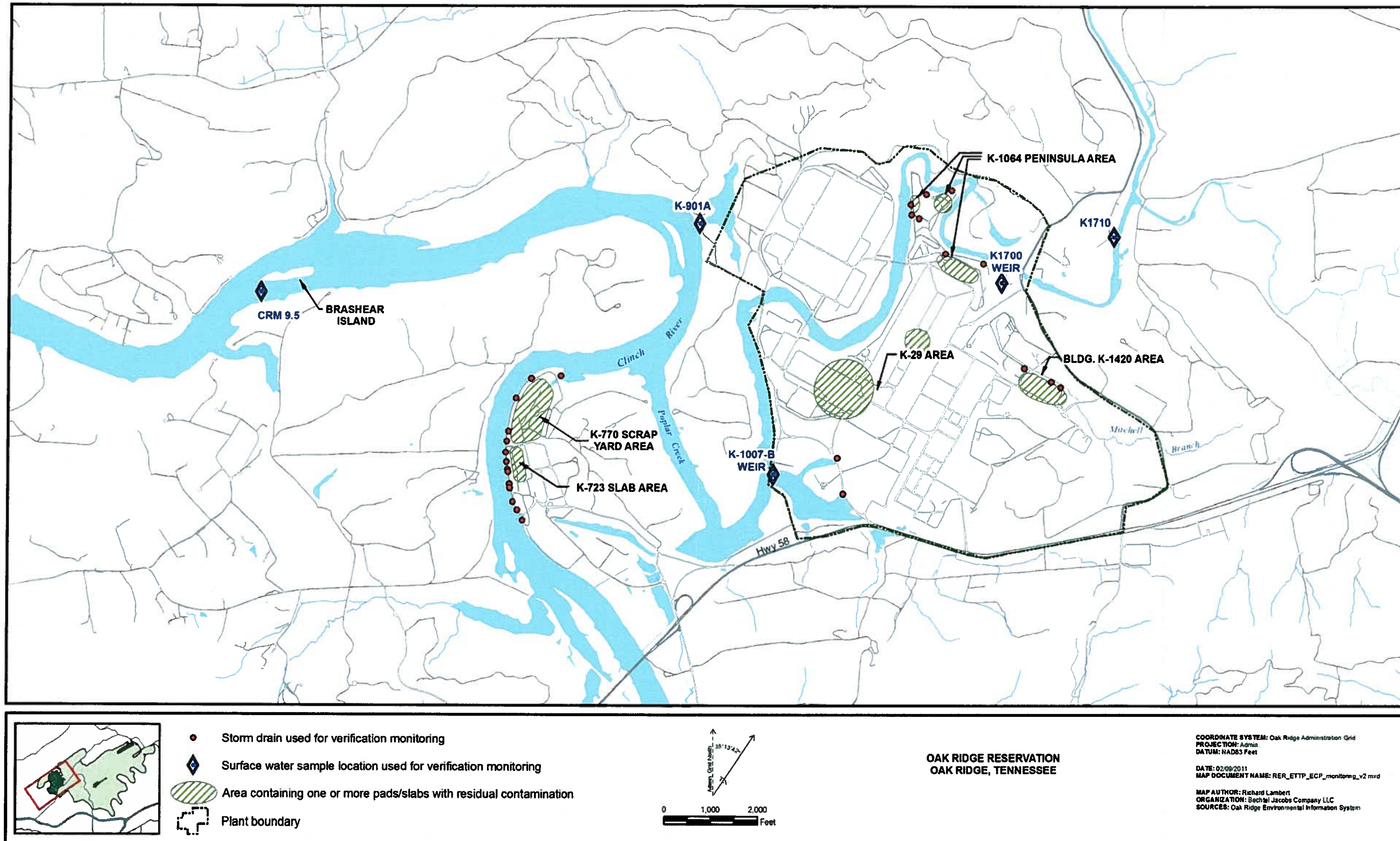

Figure 8.4. ETTP Compliance Program monitoring locations to verify radiological controls of remaining contaminated slabs.

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of the radiological release. Corrective measures are implemented, as needed. The ETTP Environmental Compliance Program provides an annual summary of analytical data and provides investigation details on any exceedance of screening levels in the Annual Site Environmental Report.

8.2.1.2 Status of Requirements for FY 2010

Zone 1-wide ROD Requirements

Restrictions were maintained for government-controlled industrial land use. The EPP functioned according to established procedures and plans for the site. Signs were maintained to control access, and surveillance patrols conducted as part of routine S&M inspections were effective in monitoring access by unauthorized personnel.

PCCR-Specific Requirements

General LUCs for Zone 1 remained in place (see above).

K-770 Group (EUs Z1-27 through Z1-33) PCCR-Specific Requirements

Although the K-770 Scrap Removal project was officially completed in FY 2010, interim controls were in place for remaining slabs or areas with contamination during the K-770 Soils Removal Action. A summary of the interim radiological monitoring conducted per the K-770 Scrap Removal PCCR in FY 2010 is included in Table 8.5. Radiological monitoring of the facilities listed in the table is performed as part of the Radiological Compliance Monitoring as required by 10 CFR §835 and adopted in the BJC Radiation Protection Plan (RPP). All surveys are performed and documented in compliance with applicable BJC procedures. Limits that apply to the surveys performed are found in Attachment D to 10 CFR §835 and provided in Table 8.6. There were no exceedances noted for FY 2010. As stated above, the frequency of surveillance and monitoring is established at each site by the radiological engineers responsible for the program. In FY 2010, the K-725 slab was removed and monitoring is no longer required. The K-770 Scrap Metal Yard soil is now the only survey requirement left in the K-770 group area. Changes to the K-1066-G yard monitoring requirements are documented in the FY 2010 Zone 2 PCCR for EU Z2-32 (DOE 2010l). The K-1066-G Yard remains a fenced and graveled area that requires periodic mowing.

Table 8.5. Summary of radiological monitoring for K-770 Scrap Removal Project

ROD for Interim Actions in Zone 1 at ETTP/PCCR for the K-770 Scrap Removal Project				
Facility/Location	**Status**	**Survey frequency**[a]	**Survey date(s)**	**Survey summary**
K-770 Scrap Metal Yard soil	Contamination Area	Frequency changed from annually to survey performed only when worker entries required.	N/A	N/A
K-725 slab	Pad Removed 4/23/10, Survey Discontinued	N/A	N/A	N/A
K-736 slab	Located within K-770 CA and is not routinely surveyed.	N/A	N/A	N/A
K-1300 area – contaminated soil and concrete pad[b]	Contamination Area	Frequency changed from annually to none after fresh concrete poured over area.[c]	N/A	N/A
K-1066-G yard – contaminated material	Remediation activities completed. Radioactive Material Area down-posted.	Frequency changed from annually to none after radiological areas and items removed.	N/A	N/A

[a]The K-770 PCCR states that contamination monitoring programs should be reviewed annually by the Project Health Physicist to ensure that appropriate surveys are performed at a frequency that is consistent with existing and potential hazards and activities planned in the area.

[b]This area refers to the contaminated K-1302 pad and the soils area where the K-1300 stack used to be. This is not referring to the K-1300 clean spoils area.

[c]The K-1300 area-contaminated soil and concrete pad was covered with fresh concrete in FY 2008 and no longer requires an annual survey. This site will remain in the Radiation Protection Organization's database and surveys will still be required before any excavation/penetration activities.

N/A = not applicable
CFR = Code of Federal Regulation

Table 8.6. 10 CFR §835 limits

Radionuclide	Removable dpm/100cm	Total (Fixed + Removable) dpm/100cm
U-Nat, U-235, U-238, and associated decay products	1,000	5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-Nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1000
Beta-Gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1,000	5,000
Tritium and tritiated compounds	10,000	N/A

CFR = Code of Federal Regulations
dpm = disintegrations per minute
Nat = natural occurring

Storm drain sampling and surface water monitoring of these areas were performed as part of the ETTP NPDES permit compliance monitoring and storm water runoff plans. A summary of the storm drain sampling and surface water monitoring conducted for the K-770 Scrap Removal PCCR in 2010 is included in Table 8.7. Storm drains 724, 730, 740, 750, 760, 770, and 780 are the outfalls that drain the specific storm water runoff from the K-770 Scrap Metal Yard. Storm water outfalls 800, 820, 830, 860, 870, 880, 890, and 892 drain the larger areas of the K-770 Powerhouse area and are also reviewed as a conservative look at adjacent acreage.

Table 8.7. Summary of storm drain and surface water monitoring for K-770 Scrap Removal Project

ROD for Interim Actions in Zone 1 at ETTP/PCCR for the K-770 Scrap Removal Project				
Slab/Foundation	**Storm drain locations (characterize at least once every NPDES permit cycle, ≤ 5 yrs)**	**2010 Storm drain monitoring summary[a]**	**Surface water locations (annually)**	**2010 Surface water monitoring summary**
K-770 Scrap Metal Yard soil K-736 slab	SD-724	2010 results above screening criteria but similar to historical trends	CRM 9.5	Less than 1% of the allowable DCG
	SD-730	Not sampled in 2010		
	SD-740	Not sampled in 2010		
	SD-750[b]	Not sampled in 2010		
	SD-760	Not sampled in 2010		
	SD-770	Not sampled in 2010		
	SD-780	Not sampled in 2010		
	SD-800	Not sampled in 2010		
	SD-820	Not sampled in 2010		
	SD-830	Not sampled in 2010		
	SD-860	Not sampled in 2010		
	SD-870	Not sampled in 2010		
	SD-880	Not sampled in 2010		
	SD-890	Not sampled in 2010		
	SD-892	Not sampled in 2010		

[a]Storm drain monitoring performed at least once within each NPDES permitting period (≤ 5 years).

[b]SD-750 is not a required monitoring location per the PCCR, however, it drains an area of the rad contaminated K-770 scrap metal yard directly between SD-740 and SD-760.The omission of SD-750 in the PCCR is considered an oversight.

As part of the FY 2010 ETTP Storm Water Pollution Prevention Program (SWPPP) sampling effort, NPDES permit renewal samples were collected for total uranium, isotopic uranium, gross alpha/gross beta, ^{99}Tc, ^{238}Pu, $^{239/240}$Pu, and ^{237}Np at outfall 724. No additional storm water samples were collected from the K-770 Scrap Metal Yard drainage area as part of the FY 2010 SWPPP sampling effort. As part of the FY 2011 SWPPP, additional storm water sampling will be performed at outfall 724 in order to monitor radiological discharges that may be occurring as a result of ongoing remedial activities at the K-770 Scrap Yard.

Samples will be collected from outfall 890 as part of the NPDES permit renewal sampling effort that is included in the FY 2011 SWPPP monitoring program. Samples will be collected for total uranium, isotopic uranium, gross alpha/gross beta, ^{99}Tc, ^{238}Pu, $^{239/240}$Pu, and ^{237}Np.

Surface water sampling results for two events at CRM 9.5 during FY 2010 provided values that calculated to less than 1% of the allowable DCG.

The northern section (see Figure 8.3) of ETTP Zone 1 was identified as a conservation easement, the Black Oak Ridge Conservation Easement (BORCE) on March 14, 2005. The BORCE is utilized for recreational use, e.g., hiking, bicycling, and select controlled deer hunts. The BORCE trailhead is posted with a sign which designates the trails that are available for use in the BORCE for recreational use. Additionally, trail maps are located within the BORCE at key intersections. The trailhead sign also states that there is no motorized use (except for select hunts) and users are to stay on the trails. However, the end use identified in the ETTP Zone 1 ROD is unrestricted industrial, i.e., recreational use was not designated. DOE acknowledges the land use differences that exist between the BORCE use and that which is in the Zone 1 ROD. This is included as an issue in Sect. 8.7. Addendum to the Duct Island/ K-901 Area PCCR (DOE 2010s) was submitted for regulatory review on September 10, 2010, recommending this change in land use designation.

8.3 ZONE 2 SOIL, BURIED WASTE, AND SUBSURFACE STRUCTURE REMOVAL ACTIONS RECORD OF DECISION

The Zone 2 ROD (DOE 2005b) addresses contaminated soil, buried waste, and other subsurface structures within Zone 2 of ETTP (see Figure 8.2). The selected remedy consists primarily of removal of existing contamination and also establishes RLs based on anticipated future land use. LUCs, including institutional controls, are a key element of the action. Major components of the remedy include:

- Assess data sufficiency for each EU and supplement data as necessary to determine if RLs are exceeded. Verify all acreage in Zone 2 as compliant with soil RLs established by the ROD.
- Remove soil up to 10 ft in depth that exceeds RLs set to protect a future industrial worker; remove soils to bedrock, water table, or acceptable levels of contamination to protect underlying groundwater to MCLs.
- Remove or decontaminate subsurface structures to average RLs met across an EU and maximum RLs met at any location to a depth of 10 ft.
- Remove the debris in the K-1070-B Burial Ground, regardless of depth, to minimize potential future impact to surface water; remove soil that exceeds RLs for protection of workers (upper 10 ft) or protection of groundwater (water table or bedrock).
- Remove the debris and soil in the K-1070-C/D Burial Ground that exceeds RLs for the protection of workers (upper 10 ft) or protection of groundwater (water table or bedrock).
- Implement LUCs to prevent exposure to residual soil contamination left on-site and/or to prevent residential use of the land.

Zone 2 was divided into 44 EUs for planning and evaluation purposes (See Figure 8.5). Final status assessments and associated data gap sampling efforts for accessible EUs in Zone 2 is being conducted using the DVS. Successful completion of the Zone 2 cleanup requires that each of these 44 EUs be characterized, evaluated against the Zone 2 risk criteria, remediated if necessary, and finally documented in a completion report. EUs in these areas are being addressed in annual PCCRs beginning in FY 2006 as outlined below and summarized in Table 8.8.

FY 2006 PCCR (EUs Z2-02, Z2-07, Z2-09, Z2-10, Z2-27, and Z2-42)

The FY 2006 PCCR (DOE 2006e) was approved in February 2007 and addresses 108.8 acres in six EUs (2, 7, 9, 10, 27, and 42). Based on the results of the DVS evaluation, approximately 93.2 acres are recommended for NFA. There were no RAs performed in FY 2006. Following completion of two recommended soil RAs in EU 42 (K-1004-J Underground Tanks Site Soil Excavation and K-1004-J Vaults Remedial Action), the remaining 15.6 acres will be suitable for NFA. There were no monitoring or LTS requirements specified in this PCCR.

FY 2007 PCCR (EUs Z2-01, Z2-03, Z2-08, Z2-23, Z2-24, Z2-28, Z2-34, Z2-37, Z2-41, Z2-43, and Z2-44)

The FY 2007 PCCR (DOE 2007h) was approved in June 2008. The PCCR addresses approximately 195.5 acres covering 11 EUs (1, 3, 8, 23, 24, 28, 34, 37, 41, 43, and 44), of which about 143 acres are recommended for NFA. The RAs performed in Zone 2 during FY 2007 include removal of Balance

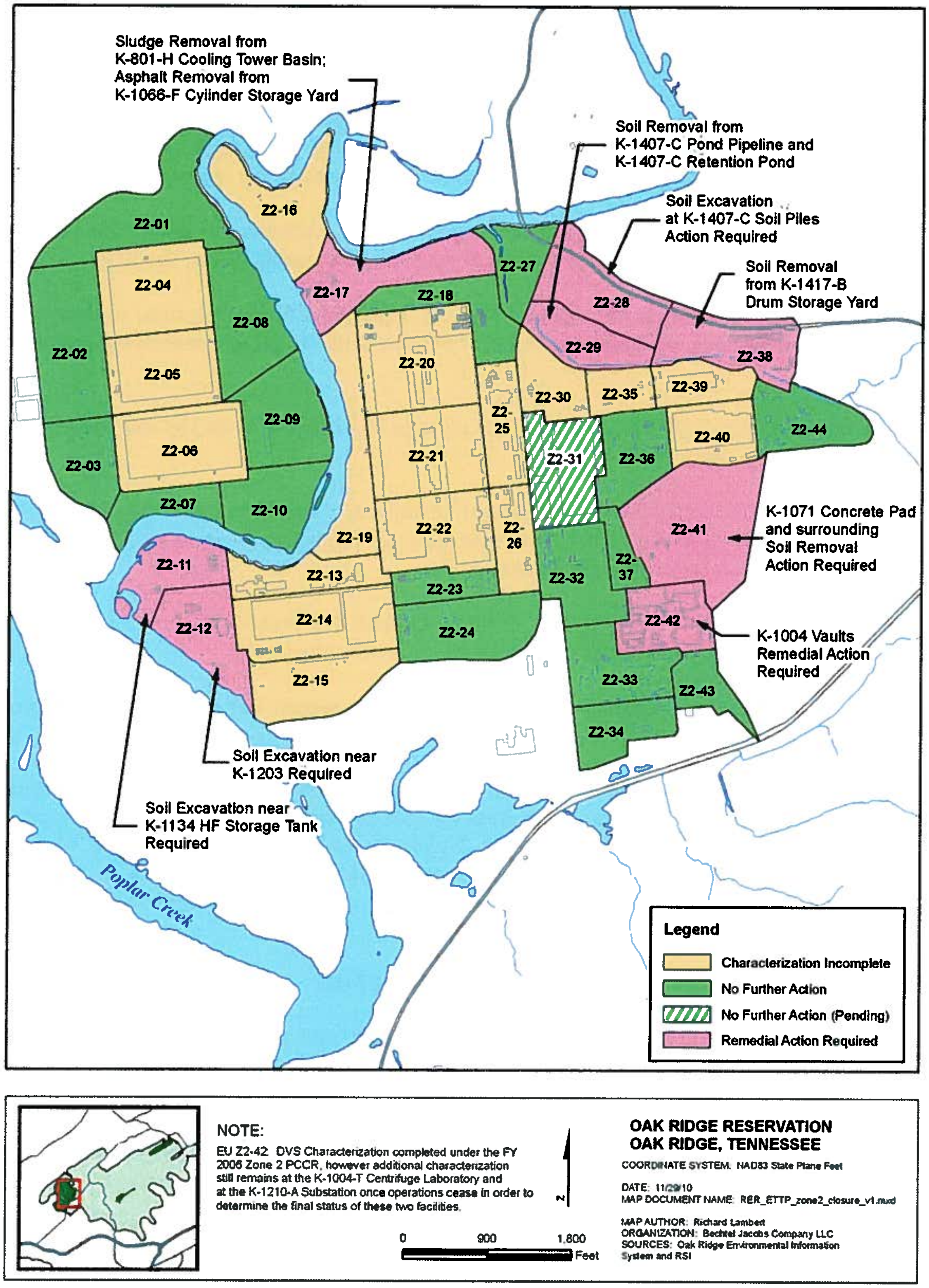


Figure 8.5. ETTP Zone 2 closure document and action status.

Table 8.8. ETTP Zone 2 completion documents and EU status

Fiscal Year of Completion Document	Evaluated		NFA		RA Required		RA Completed	RA Remaining
	# of EUs	# of Acres	# of EUs	# of Acres	# of EUs	# of Acres[a]	# of EUs	# of EUs
FY 2006 Zone 2 PCCR (EU-2, 7, 9, 10, 27, 42)	6	108.8	5	93.2	1 (EU-42)	15.5	0	1 (EU-42)
FY2006 Totals	**6**	**108.8**	**5**	**93.2**	**1**	**15.5**	**0**	**1**
FY 2007 Zone 2 PCCR (EU-1, 3, 8, 23, 24, 28, 34, 37, 41, 43, 44)	11	195.5	9	143.1	2 (EU-28, 41)	58.5	3[b] (EU-33,35,36)	3 (EU-28, 41, 42)
FY2007 Totals	**11**	**195.5**	**9**	**143.1**	**2**	**58.5**	**0**	**3**
FY 2008 Zone 2 PCCR (EU-33)	1	18	1	18	1 (EU-33)[c]	18	2 (EU-33 and 42[d])	3 (EU-28, 41, 42[d])
FY2008 Totals	**1**	**18**	**1**	**18**	**1**	**18**	**2**	**3**
FY 2009 Zone 2 PCCR (EU-36)	1	15	1	15	0	0	0[e]	3 (EU-28, 41, 42)
FY 2009 Zone 2 PCCR (EU-11, 12, 17, 18, 29, 38)	6	109	1	15.5	5 (EU-11,12,17, 29,38)	93.5	0	8 (EU-11,12,17, 28, 29, 38, 41, 42)
FY2009 Totals	**7**	**124**	**2**	**30.5**	**5**	**93.5**	**0**	**8**
FY 2010 Zone 2 PCCR (EU-32)	1	18.4	1	18.4	1 (EU-32)	18.4	1 (EU-32)	8 (EU-11,12,17, 28, 29, 38, 41, 42)
FY 2010 Zone 2 PCCR - Pending (EU-31)	1	21	1	21	1 (EU-31)	21	1 (EU-31)	8 (EU-11,12,17, 28, 29, 38, 41, 42)
FY 2010	**2**	**39.4**	**2**	**39.4**	**2**	**39.4**	**2**	**8**
As of 9/30/10	**27**	**485.7**	**19**	**324.2**	**11**	**224.9**	**4**	**8**
Zone 2 Totals	**44**	**819**						
Remaining for Evaluation	**17**	**333.3**	**EU-4-6, 13-16, 19-22, 25, 26, 30, 35, 39, 40**					

[a] Represents the sum of the acreages of all EUs in which a RA is required.
[b] RAs performed in EUs-33, 35, and 36 are documented in this PCCR. Performance of these RAs does not enable the EUs to meet the risk criteria of the Zone 2 ROD RAO. DVS characterization and/or additional RAs have not been completed. Therefore, these RAs do not factor in to the totals.
[c] A revision to the FY 2008 PCCR for EU-33 received regulatory approval on December 2, 2009 and added the K-1006 Development Laboratory north sump RA in EU-33 to the PCCR.
[d] EU-42 Soil RA completed under this PCCR. The K-1004-J vaults RA remains to be completed.
[e] There were no completed RAs in EU-36 documented in this PCCR. The backfilling of the building K-1501 basement and 2 small adjacent pits in EU-36 was described in the FY 2007 PCCR.

Sites-Laboratories (BOS-LABS) slabs and soil in EU 33; soil removal and backfilling of the K-1407 E&F Holding Ponds in EU 35; and demolition of the ETTP Steam Plant, Bldg. K-1501, in EU 36. After completion of two remaining RAs in EU 28 (Soil Excavation at the K-1407-C Soil Piles) and EU 41 (K-1071 Concrete Pad and surrounding soil Removal Action), the remaining 52 acres were recommended for NFA. There are no monitoring requirements specified in this PCCR. Native grasses requiring no maintenance were originally planted but failed to grow and have since been replaced with domestic grasses that require mowing.

FY 2008 PCCR (EU Z2-33 and Z2-42 RA)

The FY 2008 PCCR for EU 33 in Zone 2 (DOE 2008e) was approved in September 2009. The PCCR addressed approximately 18 acres in EU 33, of which all 18 acres are recommended for NFA. The RAs performed in Zone 2 during FY 2008 included the BOS Laboratories subgrade pits in EU 33, and two small surface soil areas south of K-1004-J Laboratory in the adjacent EU 42 (RA identified in the FY 2006 PCCR). A revision to the FY 2008 PCCR for EU-33 (DOE 2009q) received regulatory approval on December 16, 2009 and added the K-1006 Development Laboratory north sump RA in EU 33 to the PCCR. There are no monitoring requirements specified in this PCCR. Mowing is required at the BOS-LABS area until native/no maintenance grasses can be planted. Additionally, domestic grass that will require mowing was planted at the three surface soil RA areas south of Bldg. K-I004-J. The K-1006 sump will remain until the building is demolished. Currently this building is leased.

FY 2009 PCCR (EU Z2-36)

The FY 2009 PCCR for EU 36 in Zone 2 (DOE 2009r) was approved in June 2009. It addresses approximately 15 acres in EU 36, of which all 15 acres are recommended for NFA. There were no completed RAs in EU 36 to be addressed in this PCCR. The backfilling of the building K-1501 basement and two small adjacent pits in EU 36 was described in the FY 2007 PCCR. There are no monitoring or LTS requirements specified in this PCCR.

FY 2009 PCCR (EU Z2-11, Z2-12, Z2-17, Z2-18, Z2-29, Z2-38)

The FY 2009 PCCR for Zone 2 EUs 11, 12, 17, 18, 29, and 38 (DOE 2009m) received regulatory approval on April 2, 2010. The PCCR addresses approximately 109 acres in the EUs included in this PCCR, of which only 15.5 acres in EU 18 are recommended for NFA and unrestricted industrial use to 10 ft bgs. There are no competed RAs in the six EUs addressed in this PCCR. After completion of the remaining RAs in EU 11 (soil excavation near the former K-1134-A HF storage tank), EU 12 (soil excavation near the K-1203 Area), EU 17 (sludge removal from the K-801-H Cooling Tower Basin and removal of the K-1066-F Cylinder Storage Yard Pad), EU 29 (soil excavation at the K-1407-C Retention Basin and K-1407-C Pond Pipeline Sites), and EU 38 (soil removal in the K-1417-B Drum Storage Yard Site) the remaining 93.5 acres will be recommended for NFA. There are no monitoring or LTS requirements specified in this PCCR.

FY 2010 PCCR (EU Z2-32)

The FY 2010 PCCR for EU 32 in Zone 2 (DOE 2010l) was approved on April 8, 2010. The PCCR addresses 18.4 acres in EU 32, of which all 18.4 acres are recommended for NFA. The only RA performed was the removal of a small amount of contaminated soil and gravel in the K-1066-G Yard. In addition to the RA, Bldgs. K-1008-A through F and K-1020 slabs were removed so sufficient concrete was available to complete the backfill of the K-1401 basement in EU 31. There are no monitoring requirements specified in this PCCR. The K-1066-G Yard remains a fenced and graveled area that may require periodic mowing or herbicide application. The locations of former Bldgs. K-1008-A through F and K-1020 slabs are planted with domestic grass that will require mowing.

FY 2010 PCCR (EU Z2-31) - Pending

The FY 2010 PCCR for EU 31 (DOE 2010m) was submitted to the regulators on August 19, 2010. The PCCR addresses approximately 21 acres in EU 31 of which all 21 acres are recommended for NFA. The only RA conducted was the removal of the K-1035 building slab and sub-slab piping and the acid, neutralization and steam cleaning pits located immediately south of the building. The K-1401 building slab was removed and placed in the building basement. The slab removal was not performed as an RA to meet environmental cleanup criteria, but to remove a safety hazard posed by an open building basement and slab pits. There are no monitoring requirements specified in this PCCR. The locations of former Bldgs. K-l035, K-1401, K-1008-A through F, and K-l020 (see FY 2010 PCCR for EU 32 above) are planted with domestic grass that will require mowing.

As shown in Table 8.8, there currently are 19 EUs in Zone 2 that have been determined as NFA, with 8 EUs still requiring remedial action (EU-11, 12, 17, 28, 29, 38, 41, 42), and 17 EUs remaining for evaluation.

A complete discussion of the ETTP Zone 2 ROD and summary of actions is provided in Chap. 8 of Vol. 1 of the FY 2007 RER (DOE 2007a).

8.3.1 Performance Goals and Monitoring Objectives

The RAOs for Zone 2 are: (1) to protect human health under an industrial land use to an ECLR at or below 1×10^{-4} and non-cancer risk levels at or below a HI of 1, and (2) to protect groundwater to levels at or below MCLs. The industrial risk scenario is based on direct contact routes of exposure: (1) incidental ingestion, (2) inhalation of particulates and vapors, (3) dermal contact, and (4) external exposure. The industrial worker is assumed to have an exposure frequency of 2000 hours/year (8 hours/day for 250 days/year) and an exposure duration of 25 years (DOE 2005b). When soil removal actions are completed, they are deemed effective for industrial land use based on confirmatory sampling evaluated against the established RLs.

The monitoring requirements of the selected Zone 2 alternative include monitoring of groundwater adjacent to potential sources of groundwater contamination, including the K-1070-C/D Burial Ground (DOE 2005b). This monitoring will continue until a site-wide ROD at ETTP is approved. Monitoring of groundwater adjacent or downgradient of other contaminant sources throughout ETTP is addressed in Sect. 8.6 *Other Watershed Monitoring at East Tennessee Technology Park.*

8.3.2 Evaluation of Performance Monitoring Data – FY 2010

Monitoring locations, analytical parameters, and clean-up levels were not specified for groundwater monitoring at the K-1070-C/D Burial Ground, although the primary COCs in that area are VOCs. Semiannual samples are analyzed for VOCs and general water quality parameters in numerous wells and surface water locations outside the perimeter of the K-1070-C/D Burial Grounds. Monitoring at the site is focused on providing data for evaluating changes in contaminant concentrations near the source units or potentially discharging to surface water within the boundaries of the ETTP.

8.3.2.1 Results of Groundwater Monitoring Adjacent to Potential Source Areas

Monitoring wells UNW-114, TMW-011, and UNW-064 (Figure 8.6) monitor the VOC plume leaving the K-1070-C/D Burial Grounds. Results of monitoring at these wells show elevated VOC concentrations. VOC concentrations at these three wells were decreasing prior to the excavation of the G-Pit contents (during FY 2000) that were the source of this plume. VOC concentrations continued to decrease through about 2005 when concentrations stabilized. Concentrations at well UNW-064 (Figure 8.7) and UNW-114 (Figure 8.8) increased slightly during FY 2009 and FY 2010 in response to the above average rainfall that occurred during those years. The primary VOC detected in well UNW-114 near the K-1070-C/D Burial Grounds during FY 2010 was the degradation product 1,1-DCA at 260 – 330 μg/L. Significant concentrations of 1,1-DCA were detected in wells TMW-011 (Figure 8.9) (190 – 560 μg/L), and UNW-064 (110 – 160 μg/L). Other VOCs detected in concentrations ≥85 μg/L were 1,1-DCE (370 μg/L) and TCE (140 μg/L) at TMW-011 and chloroethane (99 μg/L) at UNW-064. MCLs were exceeded for 1,1-DCE (7 μg/L), TCE (5 μg/L), and vinyl chloride (2 μg/L) at all three wells. The PCE concentration in well TMW-011 and UNW-114 exceeded the MCL (5 μg/L) and the cis-1,2 DCE concentration in well TMW-011 increased to slightly above the MCL (70 μg/L). Slight increases in concentrations of several VOCs were observed during FY 2010, presumably as a result of the fluctuations in rainfall.

8.3.2.2 Performance Summary

Removal of soil and debris from the K-1070-C/D Burial Grounds in 1999 has reduced the concentration of VOCs in groundwater downgradient of the removal area. An evaluation of VOC concentrations in wells UNW-064, UNW-114, and TMW-011 over the past several years indicates that generally VOC concentrations in groundwater have declined and remain relatively stable with fluctuations related to climatic cycles. Increases in some VOC concentrations resulting in MCL exceedances were observed in FY 2010 likely due to fluctuations in precipitation.

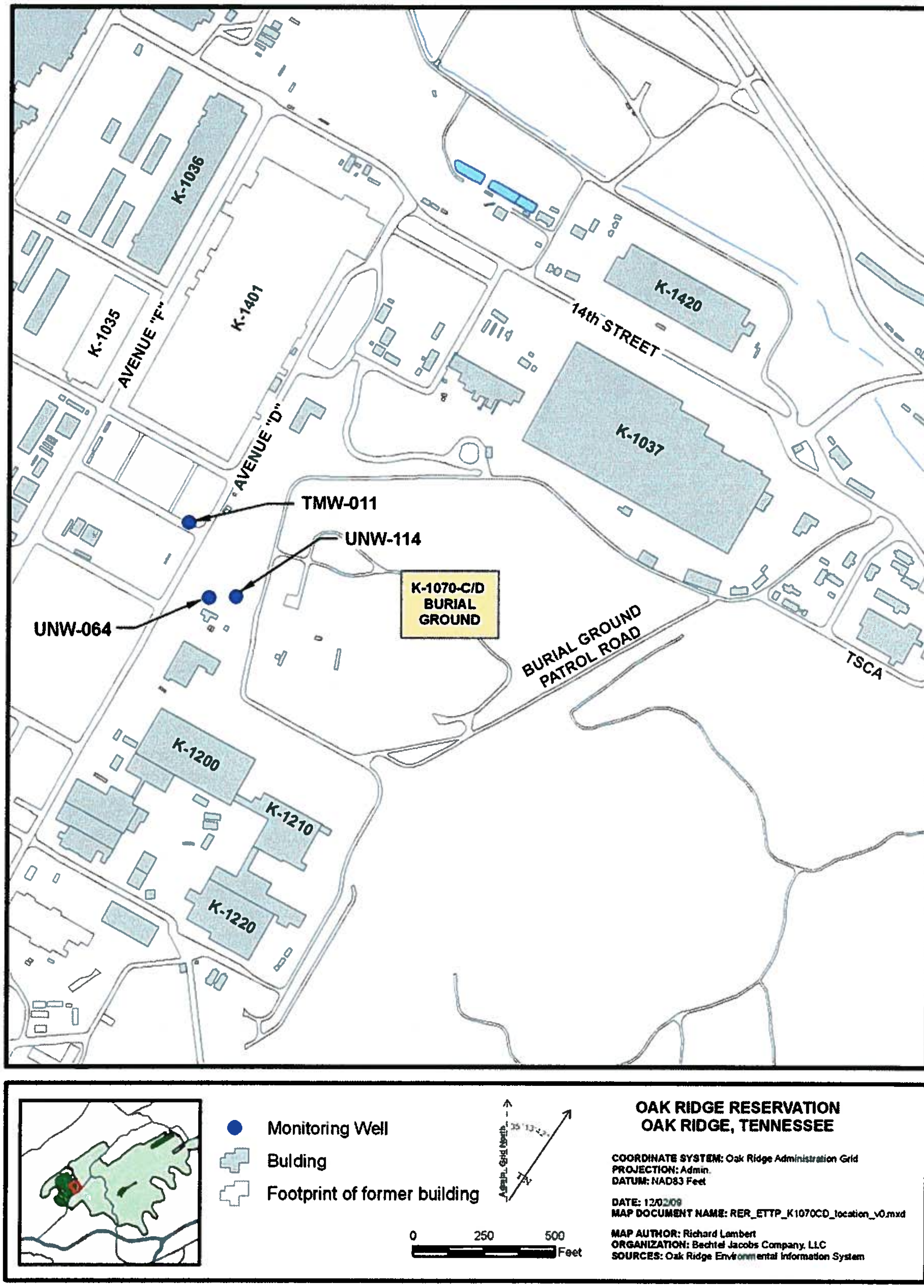


Figure 8.6. Location map for K-1070-C/D Burial Ground.

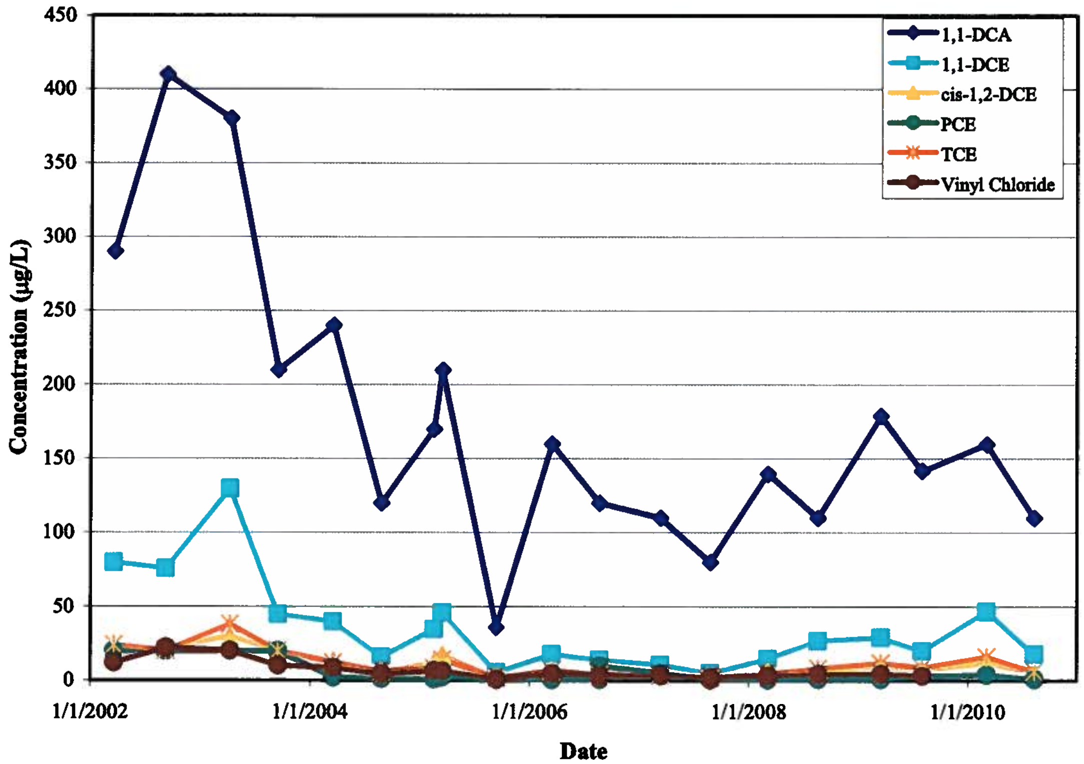


Figure 8.7. VOC concentrations in well UNW-064 for FY 2002 through FY 2010.

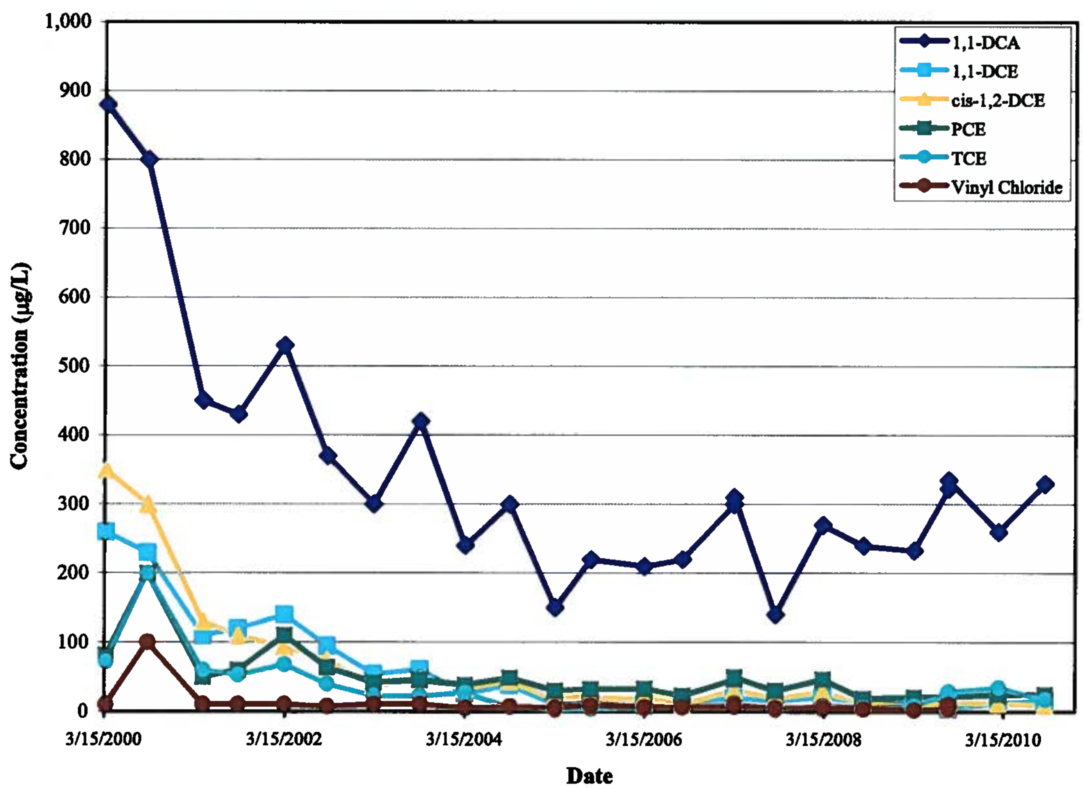


Figure 8.8. VOC concentrations in well UNW-114 for FY 2000 through FY 2010.

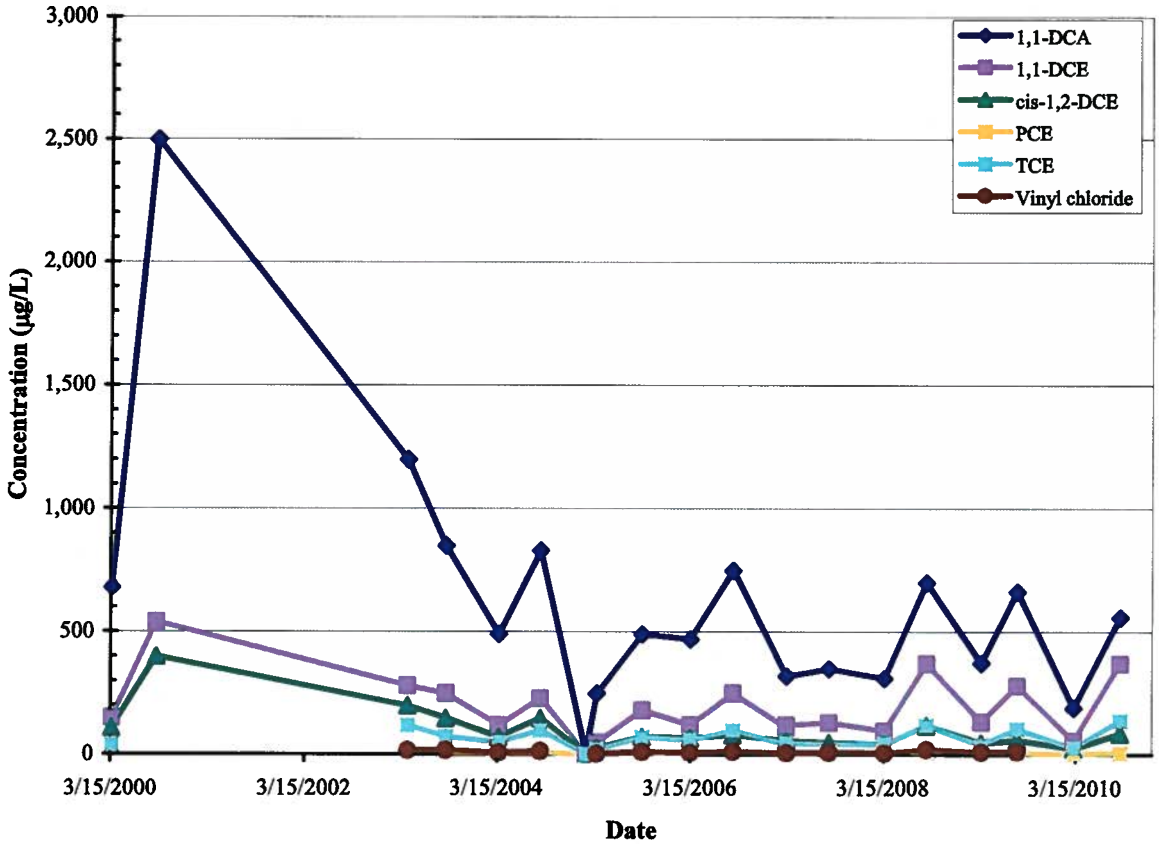


Figure 8.9. VOC concentrations in well TMW-011 for FY 2000 through FY 2010.

8.3.3 Compliance with LTS Requirements

8.3.3.1 Requirements

Zone 2-wide ROD Requirements

The Zone 2 ROD (DOE 2005b) establishes "industrial" as the land use to a depth of 10 ft. To implement restrictions that prohibit residential or agricultural use of this area under the Zone 2 ROD and to restrict access to this area until that end use has been achieved, seven LUCs will be implemented: (1) property record restrictions, (2) property record notices, (3) zoning notices, (4) EPP, (5) access controls, (6) signs, and (7) surveillance patrols. The objective of these controls are as follows:

- Control land use to prevent exposure to contamination by controlling excavations or soil penetrations below 10 ft, and prevent uses of the land involving exposures to human receptors greater than those from industrial use. Significant accumulations of material with residual contamination above unrestricted use levels will also be monitored and controlled. This will avoid accumulation of contamination placed in an area not currently designated for disposal that could re-establish a risk to a future industrial user.

- Prohibit the development and use of property for residential housing, elementary or secondary schools, childcare facilities, children's playground, other prohibited commercial uses, or agricultural use.

- Maintain the integrity of any existing or future monitoring system until the ETTP sitewide residual contamination RA is implemented.

- Control and restrict access to workers and the public to prevent unauthorized uses and maintain signs to provide notice or warning to prevent unauthorized access.

- Maintain the integrity of access controls and signs at the K-1070-C/D Burial Ground for as long as the residual debris represents a concern.

Until remediation is complete and the industrial land use is achieved, the seven LUCs mentioned above will be implemented to restrict residential or agricultural use of the land. Reliance will be primarily on property record and zoning notices, the EPP program, access controls, and surveillance patrols. Once remediation is complete, property record restrictions, property record and other public notices, zoning notices, excavation permits, and less intensive surveillance patrols and fences for the short term at the K-1070-C/D Burial Grounds will be used. In addition, when an area within Zone 2 is transferred, property record restrictions and notices will be implemented. Details of these LUCs will be included in the ETTP Zone 1 and Zone 2 RARs. Fences, signs, and surveillance patrols will be used to restrict access only in the short term until remediation is complete.

FY 2006 (EUs Z2-02, Z2-07, Z2-09, Z2-10, Z2-27, and Z2-42) PCCR-Specific Requirements

The FY 2006 PCCR completed under the Zone 2 ROD states that, consistent with the Zone 2 ROD, the NFA decision means that an EU is available for unrestricted industrial use to a depth of 10 ft. bgs. All EUs that have been cleared for industrial use to a depth of 10 ft bgs have a high probability of being cleared for industrial use to all depths, with the exception of EU 42. EU 42 required two RAs, 1) two small soil RAs south of K-1004-J Laboratory, and 2) K-1004-J vaults RA. This first action was documented under the FY2006 Zone 2 PCCR (DOE 2006e). The second action remains to be completed. EU 42 is considered NFA post-RA; however, due to substantial VOC contaminant concentrations present in the groundwater north of the K-1225 building, it is recommended that soils below 10 ft. bgs in EU 42 at this location be available for restricted use only. Because formerly contaminated groundwater is present at depths in this EU, LUCs are in place.

FY 2007 (EUs Z2-01, Z2-03, Z2-08, Z2-23, Z2-24, Z2-28, Z2-34, Z2-37, Z2-41, Z2-43, and Z2-44) PCCR-Specific Requirements

The FY2007 PCCR completed under the Zone 2 ROD states that, consistent with the Zone 2 ROD, the NFA decision means that an EU is available for unrestricted industrial use to a depth of 10 ft. bgs. All EUs that have been cleared for industrial use to a depth of 10 ft bgs have a high probability of being cleared for industrial use to all depths, with the exception of EUs 28, 34, 37, 41, and 44. EU 28 and 41 require remedial action. Both are considered NFA post-RA; however, following the proposed RA in EU 28 contaminated soils left in place will remain, and EU 41 contains the K-1070-C/D Burial Ground and K-1070 Pits. EUs 34, 37 and 44 all contain a VOC groundwater plume below 10 ft, therefore, it is recommended that soils below 10 ft. bgs in these EUs be available for restricted use only. Because formerly buried wastes and/or contaminated groundwater is present at depths in all of these EUs, LUCs are in place.

FY 2008 (EU Z2-33 and Z2-42 RA) PCCR-Specific Requirements

EU 33 evaluated in this PCCR is recommended for unrestricted industrial use to 10 ft bgs. However, a VOC groundwater plume is known to exist in the central portion of EU 33 at a depth of +/- 25 ft bgs. Therefore, it is proposed to retain land use restrictions below 10 ft for EU 33. Mowing is required at the BOS-LABS area in EU 33 until native/no-maintenance grasses can be planted. Because formerly contaminated groundwater is present at depths in these EUs, LUCs are in place.

FY 2009 (EU Z2-36) PCCR-Specific Requirements

EU 36 evaluated in this PCCR is recommended for unrestricted industrial use to 10 ft bgs. However, a VOC groundwater plume is known to exist in the central portion of EU 36 at a depth of +/- 25 ft bgs. Therefore, it is proposed to retain land use restrictions below 10 ft for EU 36. Because formerly buried wastes and/or contaminated groundwater is present at depths in all of these EUs, LUCs are in place.

FY 2009 (EU Z2-11, Z2-12, Z2-17, Z2-18, Z2-29, Z2-38) PCCR-Specific Requirements

The EUs evaluated in this PCCR are recommended for unrestricted industrial use to 10 ft bgs. However, VOC groundwater plumes are beneath the southeast portions of EUs 12 and 18, and radiologically contaminated soils lie below the 10 ft depth at the K-1407-C Retention Pond in EU 29. Therefore, it is proposed to retain land use restrictions below 10 ft for EUs 12, 18, and 29. Because formerly buried wastes and/or contaminated groundwater is present at depths in all of these EUs, LUCs are in place.

FY 2010 (EU Z2-32) PCCR-Specific Requirements

EU 32 evaluated in this PCCR is recommended for unrestricted industrial use to 10 ft bgs. Because there is no presence of buried waste or groundwater contamination, it is proposed that land use restrictions below 10 ft be lifted for EU 32.

The K-1066-G Yard remains a fenced and graveled area that may require periodic mowing or herbicide application. The locations of former Bldgs. K-1008-A through F and K-1020 slabs are planted with domestic grass that will require mowing.

FY 2010 (EU Z2-31) PCCR-Specific Requirements – Pending

EU 31 evaluated in this PCCR is recommended for unrestricted industrial use to 10 ft bgs. However, a VOC groundwater plume is known to exist in the central portion of EU 31 at a depth of +/- 25 ft bgs. Therefore, it is proposed to retain land use restrictions below 10 ft for EU 31. Because contaminated groundwater is present at depths in this EU, LUCs are in place.

8.3.3.2 Status of Requirements for FY 2010

Zone 2-wide ROD Requirements

Short-term restrictions were maintained for government-controlled industrial land use. Signs were maintained to control access, and surveillance patrols conducted as part of routine S&M inspections were effective in monitoring access by unauthorized personnel. The EPP program functioned according to established procedures and plans for the site. Signs and access controls at the K-1070-C/D Burial Ground were inspected annually by the ETTP S&M Program.

PCCR-Specific Requirements

General LUCs for Zone 2 remained in place (see above).

8.4 COMPLETED SINGLE ACTIONS AT ETTP WITH MONITORING AND/OR LTS REQUIREMENTS

8.4.1 K-1407-B/C Ponds Remedial Action

The ROD for the K-1407-B/C Ponds (DOE 1993b) addressed potential risks associated with residual wastes and soils remaining in the K-1407-B/C Ponds from the initial removal of sludge conducted as a previous RCRA closure action. The location of the K-1407-B/C ponds at ETTP is shown in Figure 8.1 and Figure 8.10.

Components of the selected remedy include the following activities:

- Placement of clean soil and rock fill for isolation and shielding,
- Maintenance of institutional controls, and
- Groundwater monitoring to assess performance of the action and develop information for use in reviewing the effectiveness of the remedy.

8.4.1.1 Performance Goals and Monitoring Objectives

The objective of the K-1407-B/C Ponds RA was to reduce potential threats to human health and the environment posed by residual metal, radiological, and VOC contamination within the pond soils (DOE 1993b).

The RAR (DOE 1995d) proposes semiannual groundwater monitoring for nitrate, metals, and selected radionuclides, including gross alpha and beta activity, ^{99}Tc, ^{90}Sr, ^{137}Cs, ^{230,232}Th, and ^{234,238}U. However, VOCs are the primary groundwater contaminant in the Mitchell Branch area of the ETTP. Remediation target concentrations were not established in the CERCLA decision documents for use in post-remediation monitoring. As recommended by EPA, with concurrence from TDEC, performance monitoring is conducted in wells UNW-003, UNW-009, and the Mitchell Branch weir (K-1700 Weir), shown on Figure 8.10.

8.4.1.2 Evaluation of Performance Monitoring Data

8.4.1.2.1 Monitoring Results – Groundwater (UNW-003, UNW-009)

The primary groundwater contaminants in the K-1407-B and -C ponds area of the ETTP are VOCs, which are widespread in this portion of the plant, including contaminant sources upgradient of the ponds. Groundwater samples were collected at UNW-003 and UNW-009 in March and August 2010. Monitoring results for FY 2010 at wells are generally consistent with results from previous years. Gross alpha activity was detected at 5.3 pCi/L in March and at 8.5 pCi/L in August at UNW-003 and was not detected at UNW-009 in March or August. Gross beta activity ranged from 9.29 to 15.4 pCi/L at UNW-003. The gross beta activity was detected in March at 7.9 pCi/L but not detected in August at UNW-009. The radionuclide ^{99}Tc was detected at 10.4 pCi/L in March and 15.7 pCi/L in August in UNW-003. ^{234}U was detected in both sampling events at activities less than 1 pCi/L in UNW-009, and at 3.47 pCi/L in March and 6.58 pCi/L in August in UNW-003. None of the metals having primary drinking water standards exceeded those levels. Iron was elevated above its secondary drinking water standard in all

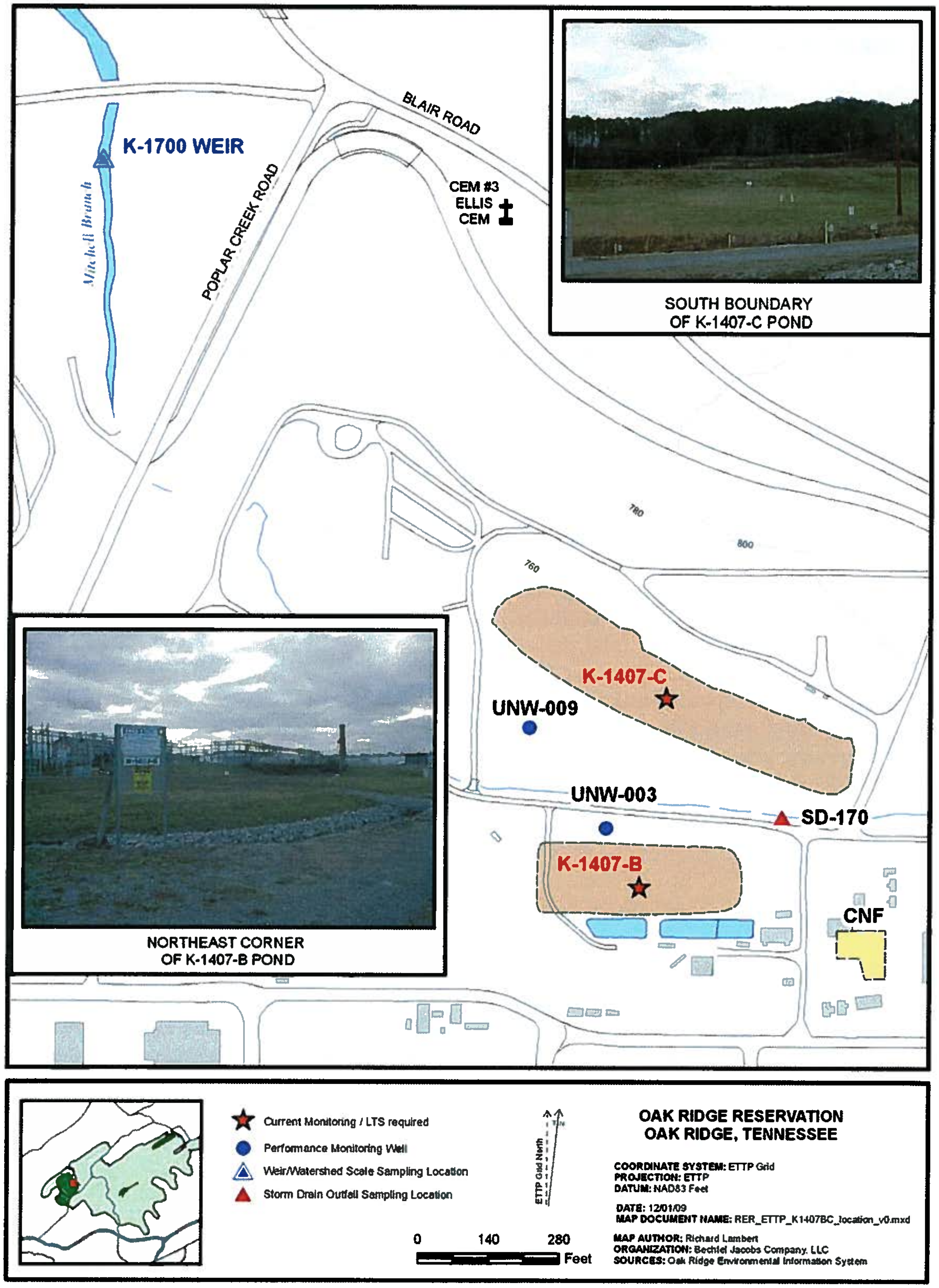


Figure 8.10. Location of K-1407-B/C Ponds.

unfiltered sample aliquots, but only the field-filtered (i.e., dissolved) samples for iron from UNW-009 exceeded its secondary standard. The secondary standard for aluminum was exceeded only in the unfiltered aliquot for March. Manganese exceeded its secondary drinking water standard in both filtered and unfiltered aliquots from both wells during both sampling events. The elevated manganese levels are likely caused by chemical reduction in the local groundwater induced by reductive dehalogenation of VOCs.

High concentrations of several VOCs are present in groundwater in well UNW-003 downgradient of the former K-1407-B Pond and adjacent to Mitchell Branch. Significant concentrations of parent compounds PCE (310 -360 µg/L) and TCE (> 3 mg/L) and the degradation products 1,1-DCE (500 - 640 µg/L), 1,1-DCA (620 – 740 µg/L) , cis-1,2-DCE (> 1 mg/L), and vinyl chloride (74 – 79) µg/L) were detected at UNW-003 in FY 2010. The detection of VOCs at concentrations well above 1,000 µg/L and the steady concentrations over recent years strongly suggest the presence of DNAPL in the vicinity of this well. The ETTP sitewide ROD will address groundwater contamination present in the area of the former ponds.

8.4.1.2.2 Monitoring Results – Surface Water (K-1700 weir)

Monitoring results for Mitchell Branch during FY 2010 are similar to the 2009 results. Chromium concentrations remained low during FY 2010 and ^{99}Tc activities were near the detection limit. VOCs were detected in surface water at the Mitchell Branch (K-1700) Weir (Figure 8.10), which is consistent with historical results for this location. Some, but not all of the VOC loading in Mitchell Branch originates from the former K-1407-B Pond. The VOCs detected included cis-1,2-DCE, 1,1-DCA, chloroform, TCE, carbon tetrachloride, and vinyl chloride (see Sect. 8.6 for a discussion of water quality trends at the K-1700 Weir). Tennessee fish and aquatic life Water Quality Criteria (WQC) [TDEC 2004a] have not been established for DCE, TCE, vinyl chloride, chloroform, or PCE; however, there are Tennessee WQC for recreation (organisms only criteria) for chloroform, 1,1-DCE, PCE, TCE, and vinyl chloride. Concentrations of each detected VOC at the K-1700 Weir are less than the Tennessee WQC for recreation, organisms only.

Metals detected at the K-1700 Weir in FY 2010 include aluminum, barium, chromium, iron, lead, manganese, mercury, and zinc. Of the detected metals, only mercury and hexavalent chrome exceeded the AWQC. During FY 2006, lead exceeded the fish and aquatic life criterion continuous concentration of 2.5 µg/L. During FY 2010, lead did not exceed the AWQC criterion. Arsenic, selenium, and cadmium were not detected at the K-1700 weir during FY 2010. Three of four samples contained mercury at concentrations greater than the 51 ng/L AWQC for organisms protection. The three values that exceeded the criteria ranged from 52.4 to 85.2 ng/L. The zinc results were less than 1 µg/L which is far below water quality criterion.

During FY 2007, hexavalent chromium was detected in surface water in Mitchell Branch in exceedance of the AWQC (11 µg/L) and was found to be discharging from Outfall 170 (SD-170 on Figure 8.10). In response to this condition, DOE conducted a TC RmA to install and operate groundwater seepage collection pumps to capture chromium-contaminated groundwater associated with the Outfall 170 discharge. Section 8.4.5 reports on the Removal Action and its associated monitoring. The instream sampling results at MIK 0.71/0.79 varied from nondetect levels to maximum of 0.0022J mg/L (estimated value) during FY 2010 (See Sect. 8.4.5.2.1).

8.4.1.3 Performance Summary

FY 2010 monitoring results for UNW-003 and UNW-009 are similar to historical monitoring results. Monitoring of surface water at K-1700 Weir in Mitchell Branch is consistent with historic trends with chromium below the AWQC in FY 2010. The presence of mercury at the Mithcell Branch water shed has been known for some time based on its accumulation in fish tissue; however, application of very low detection level laboratory methods was initiated during 2009 which allowed quantitation of mercury against the AWQC.

8.4.1.4 Compliance with LTS Requirements

8.4.1.4.1 Requirements

LTS requirements specified in the RAR (DOE 1995d) include maintenance of institutional controls (Table 8.2); specifically, conduct periodic inspections, radiological and industrial hygiene surveillances, ensure access and activity controls, and implement maintenance activities.

8.4.1.4.2 Status of Requirements for FY 2010

All components of the K-1407-B/C Ponds site were inspected in FY 2010 by the ETTP S&M Program, including access controls and sign conditions; condition of vegetation including dead spots, excessive weeds or deep rooted vegetation, grass mowing, discoloration or withering of vegetation; soil/surface condition including evidence of soil erosion, gullies or rills, staining, debris or trash. No maintenance was required.

8.4.2 K-901-A and K-1007-P1 Holding Ponds

The non-TC RmA actions for the K-901-A and K-1007-P1 Holding Ponds (Figures 8.1, 8.11 and 8.12) are provided in a new AM (DOE 2007i). The new AM for these ponds was approved in March 2007 and includes decisions for K-901-A Holding Pond, K-1007-P1 Holding Pond, K-720 Slough, and the K-770 Embayment. This new AM superseded the previous AM (DOE 1997d). An RmAWP (DOE 2008k) was prepared describing how the removal action was to be implemented.

Activities associated with the removal action for the ponds include:

- K-1007-P1 Holding Pond
    - Drain pond, modify the weir, kill undesirable fish, establish vegetation within the pond and the riparian zone, replace desirable fish, and adjust water quality to protect piscivorous wildlife and recreational fishermen.
    - Institutional controls to prevent residential use, monitoring.
- K-901-A Holding Pond - Institutional controls to prevent residential use, monitoring.
- K-720 Slough - Institutional controls to prevent residential use, monitoring.
- K-770 Embayment - No action (Institutional controls specified in Zone 1 ROD remain in effect).
- K-1007-P3, P4, and P5 Holding Ponds - No action (Institutional controls specified in Zone 1 ROD remain in effect).

The goal of K-1007-P1 Holding Pond RAs is to establish a new steady-state condition within the pond that reduces risks from PCBs by enhancing components of the ecology that minimize PCB uptake. Details of the pond RA were provided in the RmAWP (DOE 2008k) which received regulatory approval December 18, 2008. Once fully implemented, the ecological enhancement action was to reduce risks by interdicting contaminant exposure pathways associated with both human and ecological receptors.

The major K-1007-P1 Pond actions were conducted in spring and summer of 2009, with some actions continuing in 2010. During implementation of the removal action, the constructed fish barrier at the K-1007-P1 Holding Pond weir was damaged during December 2009 and May 2010 storm events. The May 2010 event resulted in the inadvertent reintroduction of undesirable fish species back into the pond. A temporary barrier was installed following the May 2010 storm event.

An addendum to the Removal Action Work Plan (*Addendum to the Removal Action Work Plan for the Removal Action at the Ponds at the East Tennessee Technology Park Oak Ridge, Tennessee,* DOE 2010t) was issued in July of 2010 describing how the damaged fish barrier was to be replaced with a more robust barrier system that maintains its effectiveness during high flow storm events. In addition, a description of measures to be taken to remove the undesirable fish that entered the pond was provided, as well as a plan to construct access ramps to launch boats at the K-720 Slough and K-901-A Holding Pond.

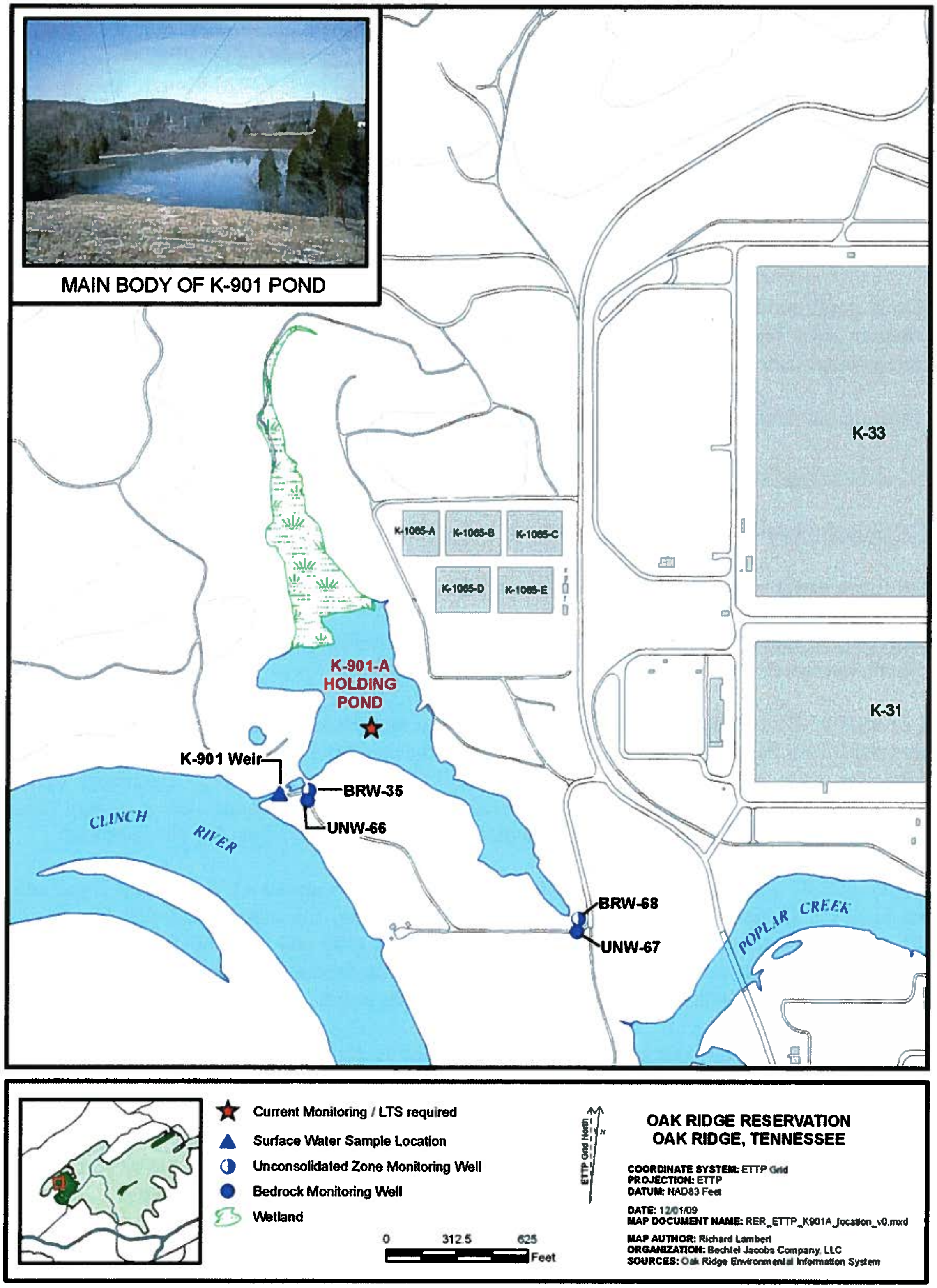


Figure 8.11. Location of K-901-A Holding Pond.

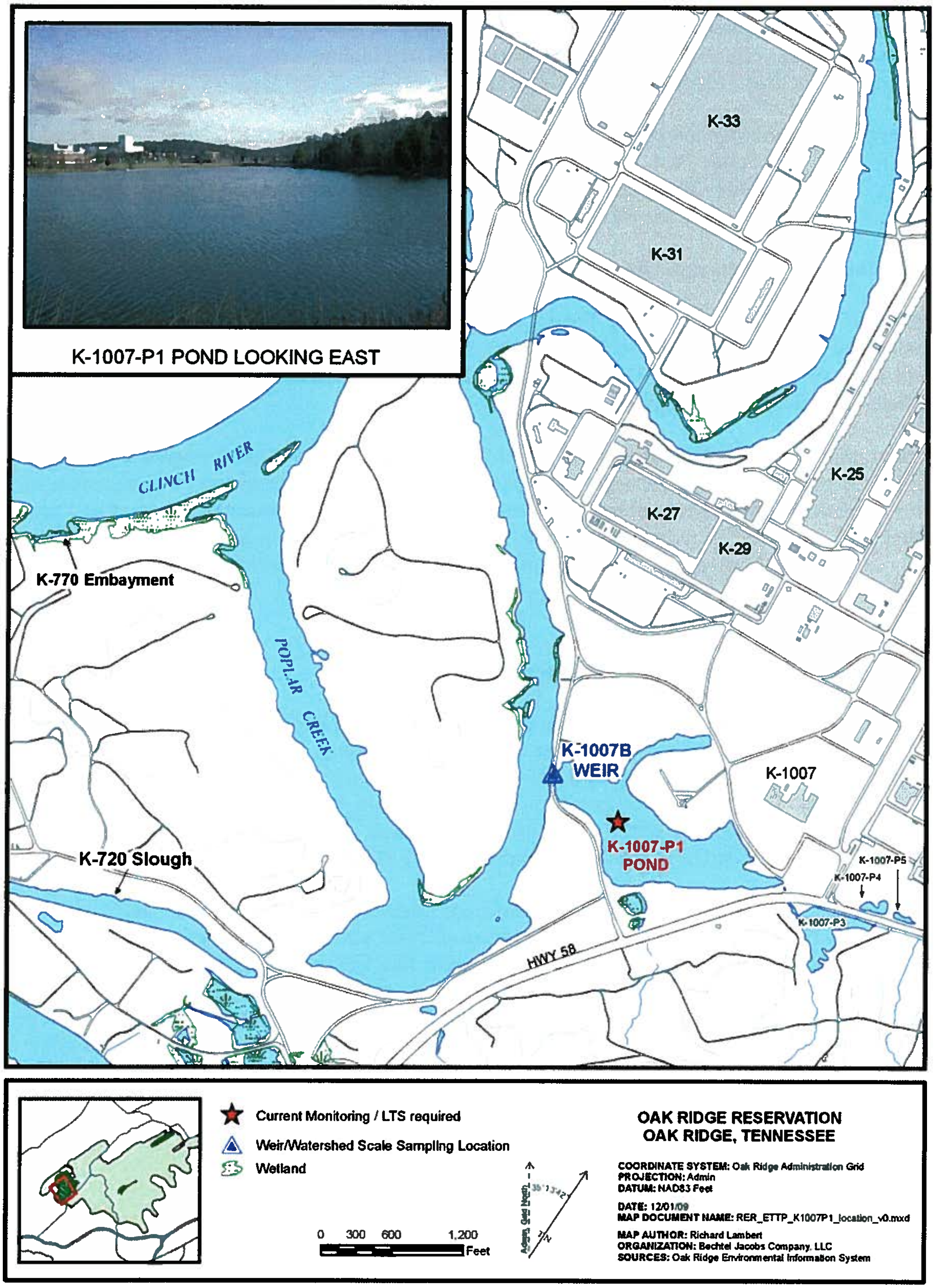


Figure 8.12. Location of K-1007-P1 Holding Pond.

A draft revised *Removal Action Report for the Ponds at the East Tennessee Technology Park* (DOE 2010u) was submitted documenting completion of a non-time critical removal action for four surface water bodies – K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment – at the East Tennessee Technology Park.

Both operational monitoring and performance monitoring were conducted in FY 2010, as specified in the September 2008 *ETTP Ponds Post-Action Sampling and Analysis Plan, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2008l). Results of operational and performance monitoring are evaluated in the RER and will be included in the FYR.

8.4.2.1 Monitoring Goals and Objectives

Monitoring of the K-1007-P1 Holding Pond will be performed in two phases (DOE 2009s). The first phase is operational monitoring that will begin after the pond has been restocked and will continue until the pond has achieved a state where aquatic vegetation and a desirable mix of fish species have been established. Operational monitoring was conducted in FY 2010.

The second phase of monitoring of the K-1007-P1 Holding Pond is called performance monitoring, and focuses on the changes in PCB concentrations in fish after the completed action and evaluation of fish PCB levels relative to the target concentrations. Per the AM, "*....A PCB concentration level of 1 mg/kg in fish fillets (2.3 mg/kg whole body) was set based upon levels shown to be protective of piscivorous wildlife, consistent with surrounding water bodies, and below FDA recommendations...*". This phase of monitoring is also performed in the K-901-A Holding Pond and the K-720 Slough. Performance monitoring was started in FY 2010.

8.4.2.2 Evaluation of Operational Monitoring Data

Operational monitoring is conducted at the K-1007-P1 Holding Pond to ensure that the ecological enhancement measures have been implemented as intended. Monitoring of fish, plants, wildlife, and water quality was conducted in FY 2010, following the ETTP Ponds Post-Action Sampling and Analysis Plan (DOE 2009s). The ecological information obtained is used to evaluate whether modifications are needed to attain the desired end state—i.e., a heavily vegetated, clear water pond dominated by sunfish with significantly diminished or at least downwardly trending PCB levels.

Fish communities in the K-1007-P1 Holding Pond were sampled in November 2009, approximately five months after the pond fish kill, and then again in June of 2010, after fish from Poplar Creek were able to enter the pond through a breach in the weir. The initial fish kill appeared to be highly successful in eliminating most of the undesirable fish species from the pond (Figure 8.13). After a breach in the weir which allowed fish from Poplar Creek to enter, the pond was resurveyed. At the time of the survey in June of 2010, the pond contained for the first time since the RA, low numbers of undesirable fish, including carp, buffalo, and gizzard shad. However, overall, the pond's fish community was still dominated by sunfish and small minnow species (~98%).

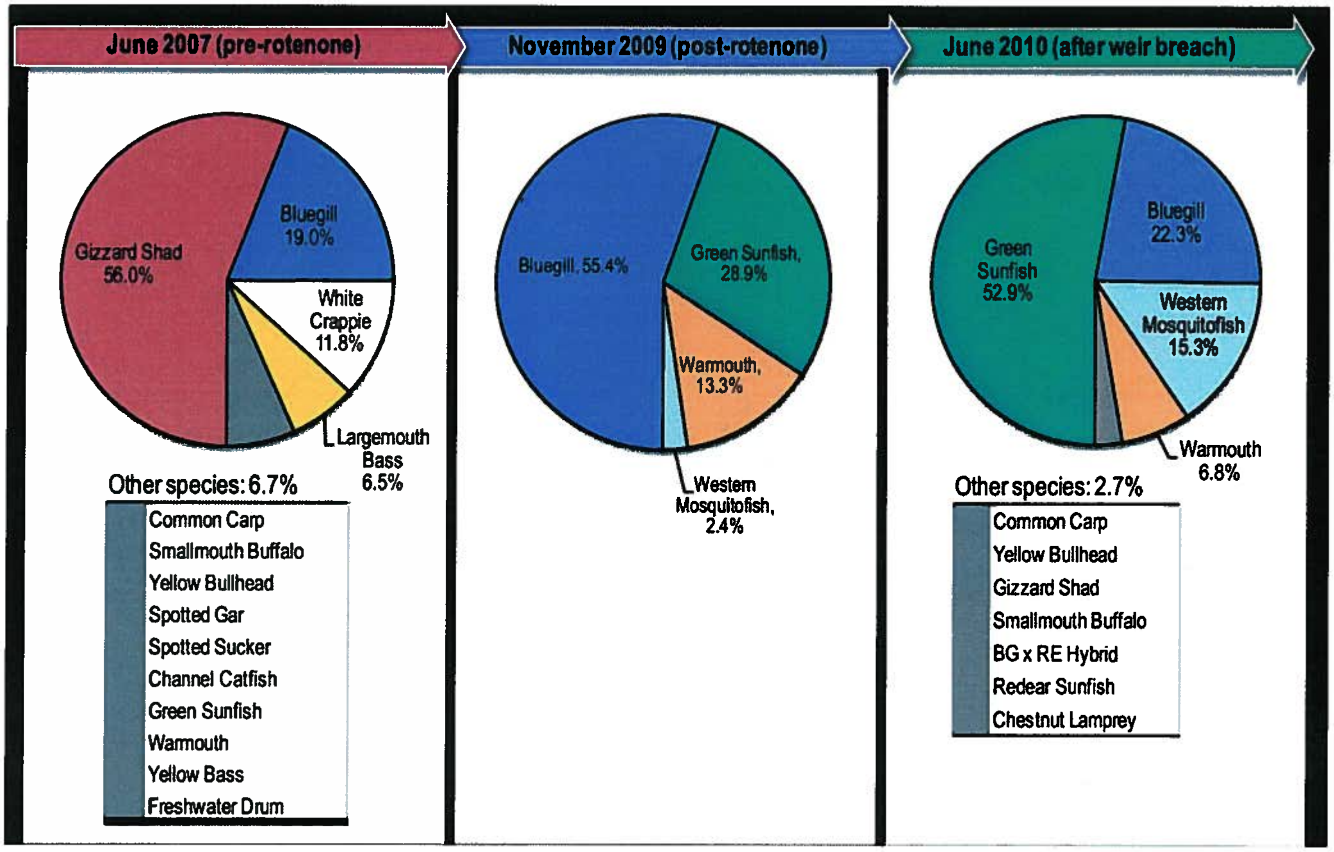


Figure 8.13. Percent composition of fish species as determined in timed boat electrofishing runs prior to and after fish management actions in the K-1007-P1 Pond. The June 2010 survey was conducted after the weir breach.

The percent plant cover along transects in the pond changed dramatically after the pond was re-contoured and vegetation planted as part of the RA (Figure 8.14). In 2007, the pond was largely devoid of plants except for algae. In 2010, surveys found coverage had increased as much as 7-fold along some transects. The increased vegetation reflected both species planted during the RA and volunteer species that may have been present along the periphery of the pond. The success of vegetation growth may be in part due to control of Canada geese (Figure 8.15), which are aggressive herbivores known to damage freshly planted aquatic vegetation, as well as removal of herbivorous fish species. Improvements in water clarity (Figure 8.16) since the action also aided submerged vegetation, as they are more likely to be successful with increased light penetration in the pond.

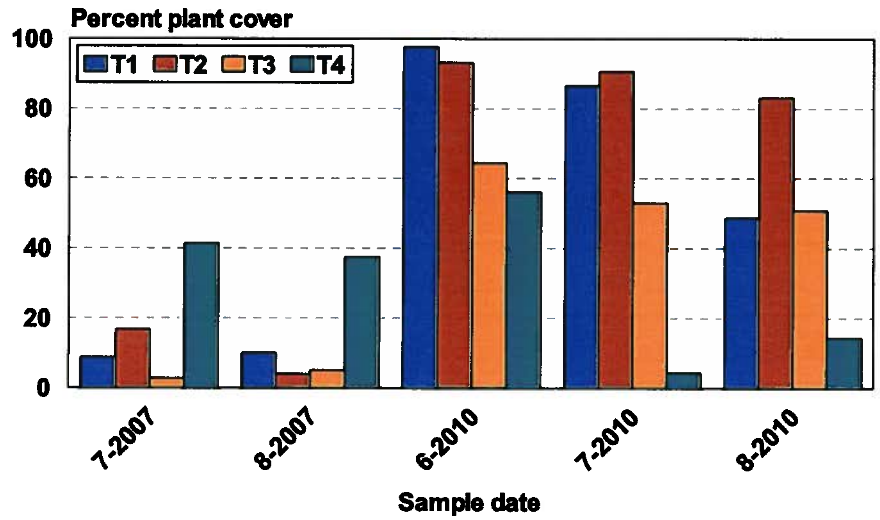


Figure 8.14. Percent plant cover for four transect survey lines prior to and after the action.

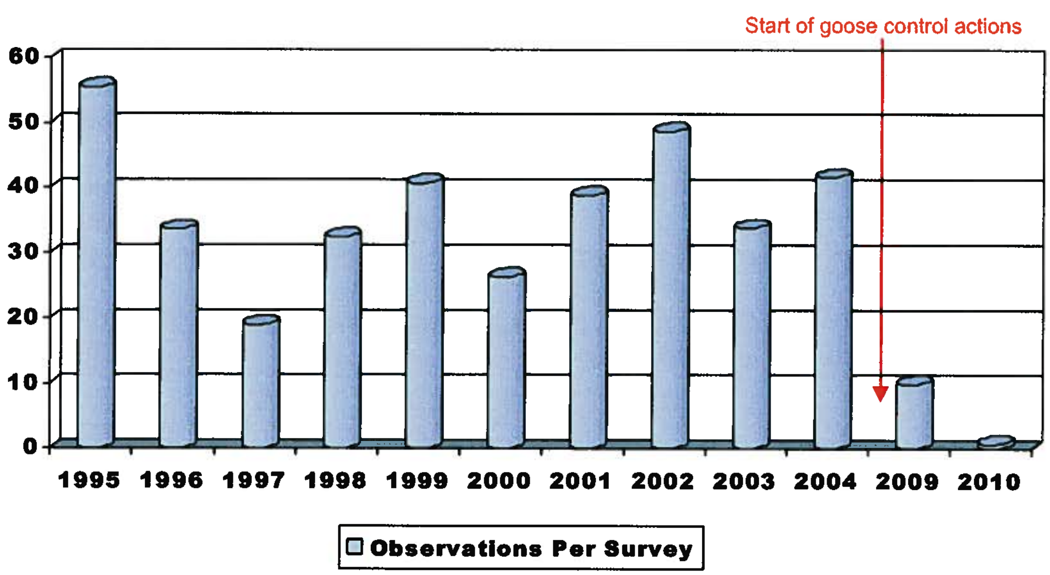
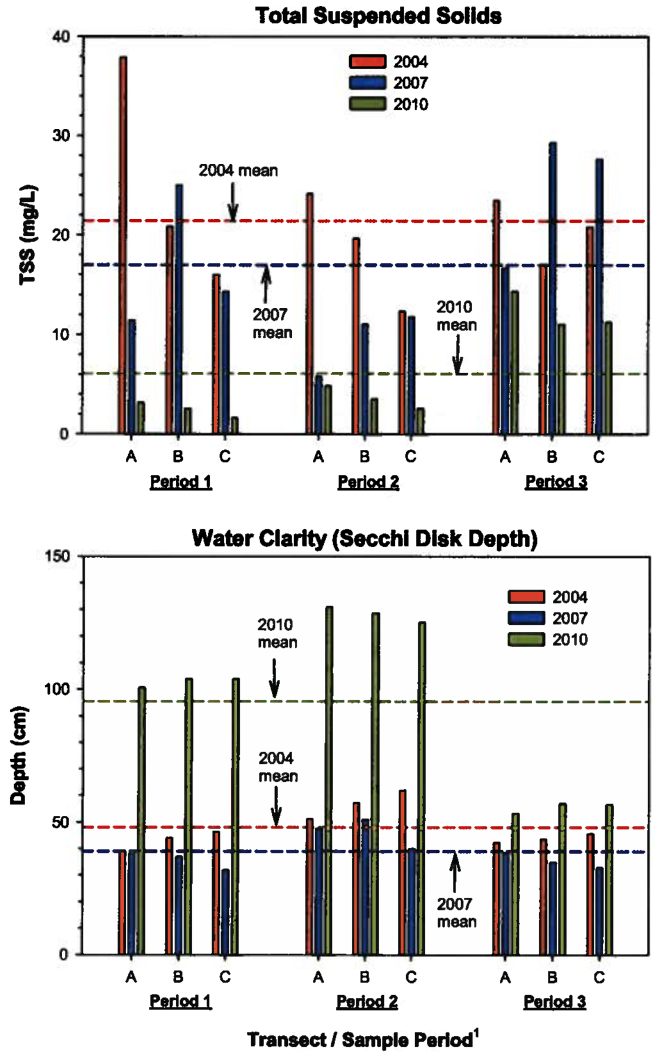


Figure 8.15. Number of geese reported in weekly waterfowl surveys, prior to and after the action.



[1]Sample periods 1 and 2 = July and August, respectively, in 2004 and 2007, and March and June, respectively, in 2010; period 3 = September.

Figure 8.16. Total suspended solids and water clarity results by transect and sample period, prior to and after the action.

A summary of the overall changes in the pond's ecology since the actions is provided in Table 8.9. Overall, the results to date suggest the pond's ecological conversion is progressing as designed. The weir breach did not appear to jeopardize the action, based on the latest fish community results. Continued fish community assessments will evaluate whether the entry of undesirable species in the pond is potentially problematic for the long-term.

Table 8.9. General summary of changes in pond attributes prior-to and after K-1007-P1 Pond RAs

Pond Attribute	Pre-Action	Actions (2009-2010)	2010 Status
Fish Community	Large number of grass carp and other undesirable fish species (80%)	FISH MANAGEMENT: remove grass carp that eat vegetation, remove undesirable fish species; stock desirable species	No grass carp -98% desirable fish
Plant Community	No aquatic emergent vegetation Poor riparian habitat	PLANT MANAGEMENT: Add stabilizing soil and plant native vegetation (70,000 specimens in 2009, 5000 in 2010) Improve riparian zones to limit goose use, prevent erosion	~70% plant cover in planted zones No obvious erosion; native species dominant
Wildlife	High goose population contributes to poor water quality	WILDLIFE MANAGEMENT: Removed or harassed geese and other herbivores, riparian habitat less suitable for geese	Geese now in low numbers; other waterfowl observations increased
Water Quality	High suspended algae, poor water clarity	WATER QUALITY CHANGES: No algaecide was used. Removed geese, added plants, modified riparian habitat	Substantial improvement in water clarity

8.4.2.3 Evaluation of Performance Monitoring Data

Assessment of PCB uptake and exposure in the K1007-P1 Holding Pond continued in FY 2010, and included the collection and analysis of fillets and whole body fish samples. Fish samples were also collected from the K-901-A Holding Pond and K-720 Slough for analysis of PCBs. The target species for bioaccumulation monitoring in 2010 in the K1007-P1 Pond was bluegill sunfish (*Lepomis macrochirus*). This represents a shift from previous efforts which 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 fish such as bass and restocking the pond with smaller, lower trophic-level fish which 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, three months before bioaccumulation sampling. Whole body composites (6 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 bluegill fillets were 2.13 mg/kg in bluegill fillets and 5.11 mg/kg in whole body composites. These levels are significantly lower than levels seen in 2008 and 2009 (Figure 8.17).

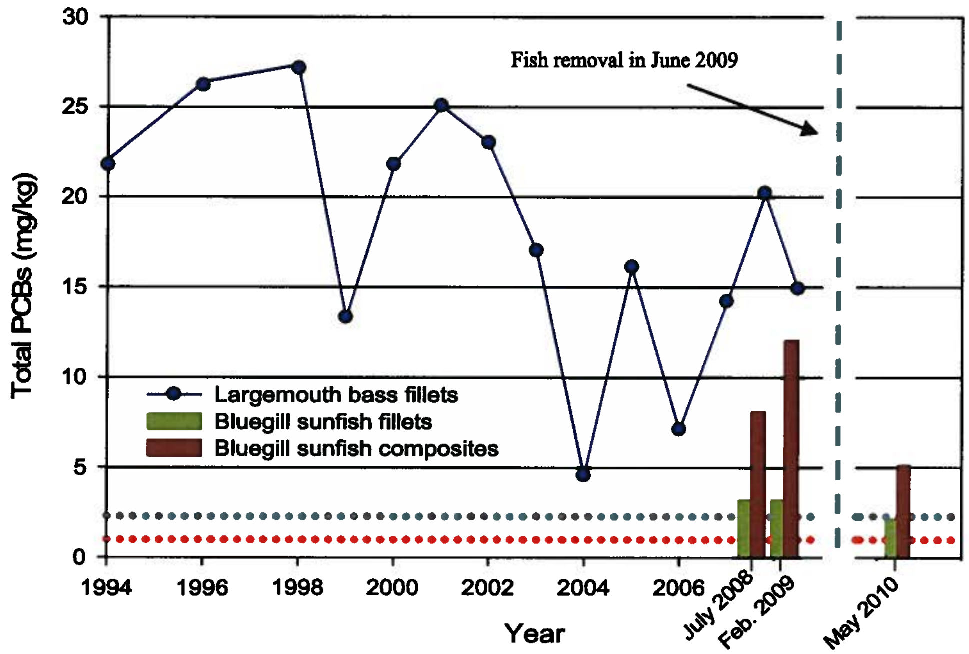


Figure 8.17. Mean concentrations of PCBs in fish from K-1007-P1 Holding Pond, 1993–2010. Dotted red line signifies PCB goal of 1 mg/kg in fillets, and dotted grey line signifies PCB goal of 2.3 mg/kg whole body.

The target fish species for analysis of PCBs in the K-901-A Holding Pond and K-720 Slough were gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*). It was not possible to collect the target number of bass (20) from each body of water, and so common carp (*Cyprinus carpio*) and smallmouth buffalo (*Ictiobus bubalus*) were collected to provide a combined total of 20 fish. Carp and buffalo were selected as surrogate species for bass because they are widely distributed, they are present at both locations, and they have been used historically in other monitoring efforts on the ORR for contaminant analyses.

Average levels of PCBs in largemouth bass from the K-901-A Pond (~ 0.3 mg/kg) were lower than in 2009 (0.48 mg/kg) (Figure 8.18), although carp (0.71 mg/kg) and gizzard shad (2.69 mg/kg) averaged substantially higher. PCB levels in fish collected from the K-720 Slough were significantly lower than in the K-901-A Holding Pond for the same species. PCB levels in shad from the K-901-A Pond continue to be high relative to other species in that pond. For instance, shad from K-901-A have nine times the concentration of PCBs than bass from the same pond, where shad from the K-720 Slough have only three times the concentration of PCBs compared with bass from this pond (Table 8.10).

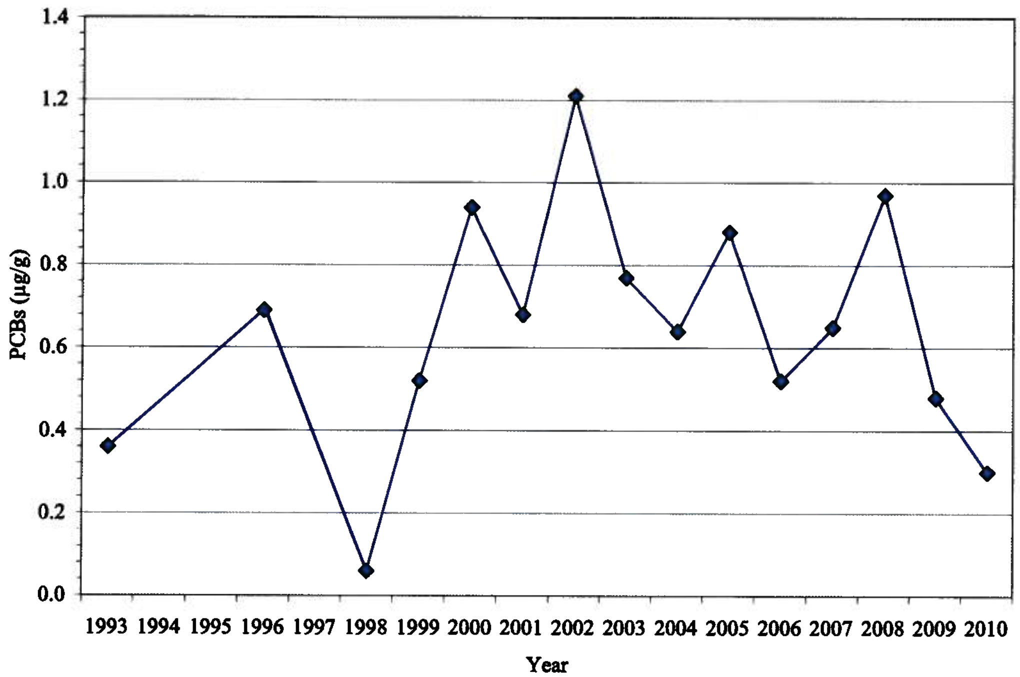


Figure 8.18. Mean concentrations of PCBs in largemouth bass from K-901-A Holding Pond, 1993–2010

Caged Asiatic clams (*Corbicula fluminea*) were placed near and within various storm drains at ETTP for a four-week exposure period (June – July 2010). All cages were successfully retrieved, but mortality was evident in some cages, potentially due to low water levels in the stream. As in previous years, PCB concentrations in clams were highest at the Mitchell Branch and K-1007-P1 Pond sites, with substantially lower PCB values in clams placed at the K-901-A Pond. Clams placed in upper SD-100 in the K1007-P1 Pond had ~0.2 to 0.3 ppm total PCBs in their soft tissues. This represents a ten-fold decrease in PCB concentrations at this location with respect to recent years, and upper SD-100 clams had the lowest concentrations of any site at the K-1007- P1 Pond. PCB levels in clams placed in lower SD-100 also decreased in 2010 (0.7 – 0.8 ppm compared to 1.3 – 1.7 ppm in 2009). However, clams placed at SD 120 had significantly higher PCB concentrations in 2010 (1.2 – 3.1 ppm) than in 2009 (0.3 – 0.6 ppm).

8.4.2.4 Performance Summary

Performance monitoring at the K-1007-P1 Holding Pond began in FY 2010. The baseline trends show PCBs in largemouth bass around 15 ppm as a long-term average. The current sunfish average in fillet is around 2 ppm, resulting in a decrease in potential human health risks associated with the change in species alone. Clam studies continue to indicate that storm drains are a source of PCBs to the K-1007-P1 Holding Pond, but resuspension of contaminated sediments in the pond are a more likely important source of PCBs to resident biota. The 2009 RAs at the K-1007-P1 Holding Pond were designed to reduce sediment mobilization and subsequent bioaccumulation in fish. It will take some time for the fish, plant, wildlife, and water quality conditions in the pond to stabilize, allowing a better assessment of whether PCB exposure in the pond has sufficiently decreased.

At the K-901-A Holding Pond in 2010, largemouth bass accumulated less PCBs than the recent past, but within the long-term average variability. At the K-901-A Holding Pond in 2010, largemouth bass accumulated PCB concentrations below the long-term average. There is little long-term data available to evaluate trends at the K-720 Slough.

Table 8.10. Total PCB (Aroclors 1248, 1254, and 1260) concentrations in fish from the K-1007-P1 Holding Pond, K-720 Slough, and K-901-A Holding Pond, 2010[a]

Site	Species	Sample type	Sample size (n)	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total PCBs[b] (mean ± SE)
K-1007-P1 Pond	Bluegill sunfish	Fillets	20	0.61 ± 0.05 *(0.30 - 0.92)*	1.01 ± 0.07 *(0.51 - 1.80)*	0.51 ± 0.04 *(0.22 - 0.83)*	2.13 ± 0.16 (1.07 - 3.63)
		Whole body composites	6	1.50 ± 0.08 *(1.30 - 1.70)*	2.63 ± 0.13 *(2.30 - 3.00)*	0.98 ± 0.06 *(0.81 - 1.20)*	5.11 ± 0.26 (4.41 - 5.90)
K-901-A Pond	Largemouth bass	Fillet	10	ND	0.06 ± 0.01 *(0.04 - 0.08)*	0.24 ± 0.04 *(0.09 - 0.51)*	0.30 ± 0.05 *(0.12 - 0.62)*
	Common carp	Fillet	10	ND	0.20 ± 0.05 *(0.08 - 0.63)*	0.51 ± 0.15 *(0.12 - 0.78)*	0.71 ± 0.20 *(0.20 - 2.33)*
	Gizzard shad	Whole body composites	6	ND	0.63 ± 0.08 *0.41 - 0.89*	2.07 ± 0.24 *(1.40 - 2.70)*	2.69 ± 0.32 *(1.81 - 3.49)*
K-720 Slough	Largemouth bass	Fillet	6	0.02 ± 0.004 *(0.015 - 0.04)*	0.07 ± 0.02 *(0.028 - 0.16)*	0.07 ± 0.02 *(0.016 - 0.17)*	0.17 ± 0.33 *(0.06 - 0.37)*
	Common carp	Fillet	7	0.04 ± 0.01 *(0.02 - 0.08)*	0.17 ± 0.04 *(0.06 - 0.30)*	0.17 ± 0.02 *(0.09 - 0.26)*	0.38 ± 0.07 *(0.20 - 0.64)*
	Smallmouth buffalo	Fillet	7	0.09 ± 0.03 *(0.03 - 0.25)*	0.41 ± 0.16 *(0.10 - 1.3)*	0.49 ± 0.23 *(0.06 - 1.8)*	0.99 ± 0.41 *(0.20 - 3.35)*
	Gizzard shad	Whole body composites	3	0.08 ± 0.003 (0.07 - 0.08)	0.22 ± 0.01 *(0.18 - 0.24)*	0.19 ± 0.02 *(15 - 0.22)*	0.49 ± 0.03 *(0.40 - 0.54)*

[a]Values are mean concentrations (µg/g) ± SE; range in parentheses.
[b]PCB Goals: 2.3 mg/kg whole body; 1 mg/kg fillet.

8.4.2.5 Compliance with LTS Requirements

8.4.2.5.1 Requirements

The RmAR (DOE 1999f) states that S&M personnel will conduct routine activities including verifying and repairing damage after storms or flooding, verifying signs are visible and in place, and maintaining the weirs between the K-1007-P1 Holding Pond and Poplar Creek and the K-901-A Pond and Clinch River.

8.4.2.5.2 Status of Requirements for FY 2010

Activities conducted at the ponds in FY 2010 included inspections by the ETTP S&M Program for visible evidence of storm or flood damage, inspections of the weirs for evidence of debris or vegetation or erosion of the banks, and inspections of the warning signs. The fish barrier was repaired following storm event damage in May 2010. This issue is discussed in more detail in Sect. 8.4.2.

8.4.3 K-1070-C/D G-Pit and Concrete Pad Remedial Action

The K-1070-C/D G-Pit is the primary source of organic contaminant releases to soil and groundwater in the area. The Concrete Pad, located in the southeastern portion of the K-1070-C/D area, was determined to pose an unacceptable health risk to workers from future exposure to soil radiological contaminants. The location of the area at ETTP is shown in figures 8.1 and 8.19. Components of the remedy included:

- Excavation of the G-Pit contents, interim storage of the material, treatment, and disposal, and
- Placement of a 2-ft soil cover over the Concrete Pad.

A complete discussion of the RA at K-1070-C/D G-Pit and Concrete Pad is provided in Chap. 8 of Vol. 1 of the FY 2007 RER (DOE 2007a).

8.4.3.1 Compliance with LTS Requirements

8.4.3.1.1 Requirements

The decision documents for this site require interim LTS activities including maintaining institutional controls (see Table 8.2). Specifically, inspections of the soil cover over the pad are to be conducted weekly to look for erosion, and the grass on the cover is to be mowed at an estimated frequency of five times a year. Annual radiological walkover surveys are to be conducted to confirm the effectiveness of the Concrete Pad soil cover in preventing exposure to ionizing radiation. Existing institutional controls will continue to include semiannual inspections of the fence, as well as ensuring the existing EPP Program remains in place. These controls are to continue until final decisions are made for the K-1070-C/D OU in the ETTP Zone 2 ROD.

8.4.3.1.2 Status of Requirements for FY 2010

The site was inspected by the ETTP S&M Program in FY 2010 for items including condition of the warning signs, condition of fencing and locked gate, condition of the Concrete Pad soil cover and maintenance of vegetation including the presence of excessive weeds or deep-rooted vegetation, need for grass mowing, or discoloration or withering of vegetation. No maintenance was required.

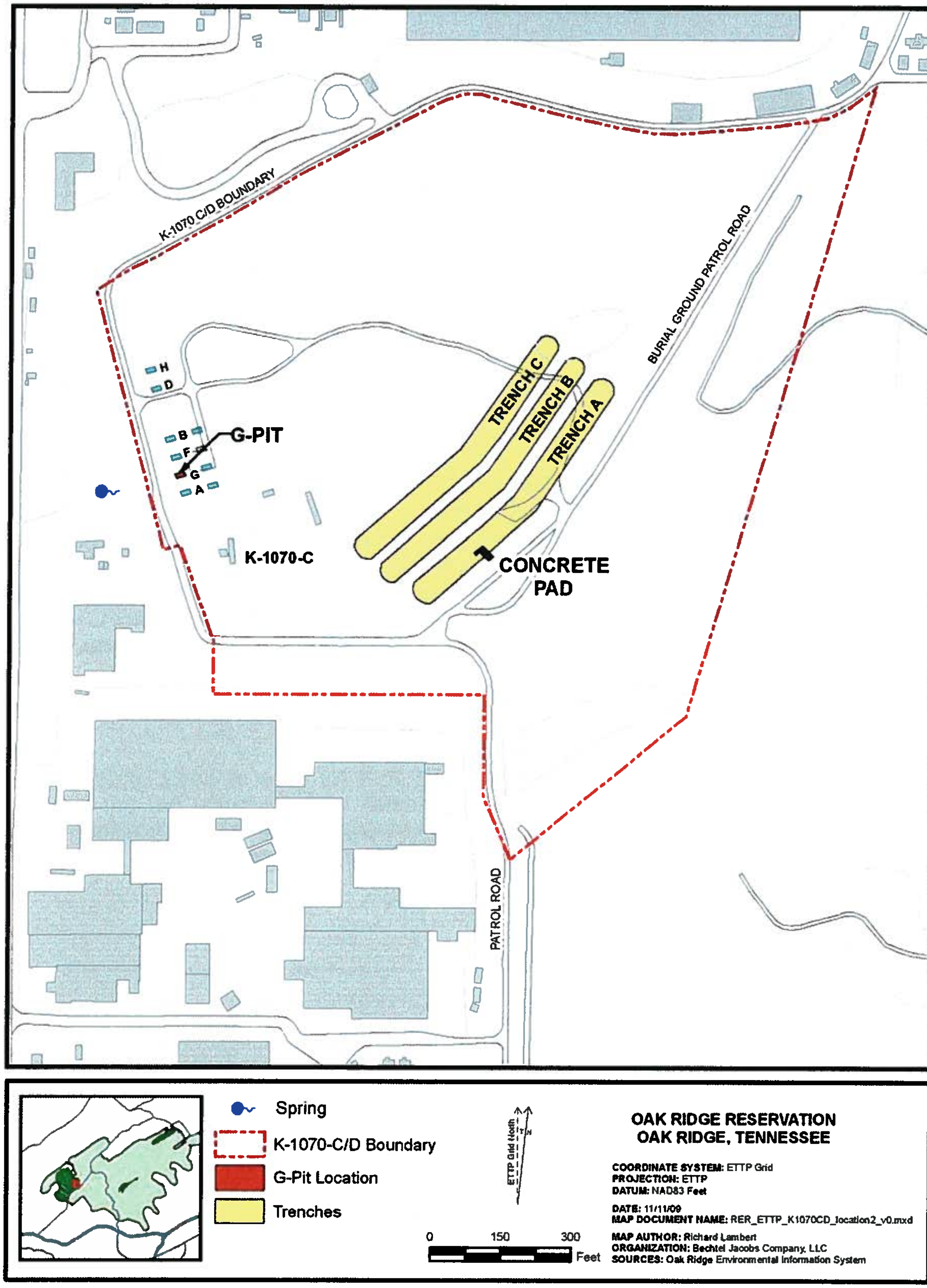


Figure 8.19. Location of K-1070-C/D G-Pit and Concrete Pad.

8.4.4 K-1070-A Burial Ground Remedial Action

The selected remedy in the ROD (DOE 2000e) for the K-1070-A Burial Grounds (figures 8.1 and 8.20) included waste removal and disposal, along with institutional controls. Major components of the remedy include:

- Waste characterization,
- Excavation and disposal,
- Residual soil characterization, and
- Backfilling excavated areas with clean fill.

The source removal action addressed the present and projected future principal threats posed by the K-1070-A Burial Ground, primarily by chlorinated VOCs and radionuclides. No known unacceptable residual risk from soils for industrial or recreational land use remain within the K-1070-A Burial Ground fenced area subsequent to completion of the RA defined in the ROD (DOE 2000e).

Post-action monitoring requirements are not specified for this action, and cleanup standards for environmental media were not identified (DOE 2003f). Until a groundwater decision is finalized, DOE monitors downgradient Spring 21-002 as an exit pathway point (Sect. 8.6).

A complete discussion of the RA at K-1070-A Burial Ground is provided in Chap. 8 of Vol. 1 of the 2007 RER (DOE 2007a).

8.4.4.1 Compliance with LTS Requirements

8.4.4.1.1 Requirements

The ROD states that following implementation of the RA, protectiveness at the site will be ensured through continuation of current ETTP sitewide controls including physical and administrative access restrictions, surveillance, security patrols, restrictions on excavation, and restrictions on groundwater and surface water use (DOE 2000e). In addition, the RAR (DOE 2003f) states that to maintain the effectiveness of the soil cover, the cover will be inspected monthly and the grass on the site will be mowed at an estimated frequency of five times a year. If erosion is found, "clean" soil will be used to repair the eroded area, and the area will be reseeded, if necessary.

8.4.4.1.2 Status of Requirements for FY 2010

In the spring of 2009, the K-1070-A area was seeded with switchgrass by DOE, TWRA, and CROET to support the State of Tennessee's biofuels initiative to use switchgrass as a feedstock for ethanol production. Monthly inspections of the site for subsidence and erosion per the RAR are no longer applicable. A recommendation was made in the 2010 FYR site visit to change the frequency of mowing and the inspections of the site. This recommendation was accepted during the August 11, 2010 Core Team Meeting and changes will be reflected in the Zone I Final ROD.

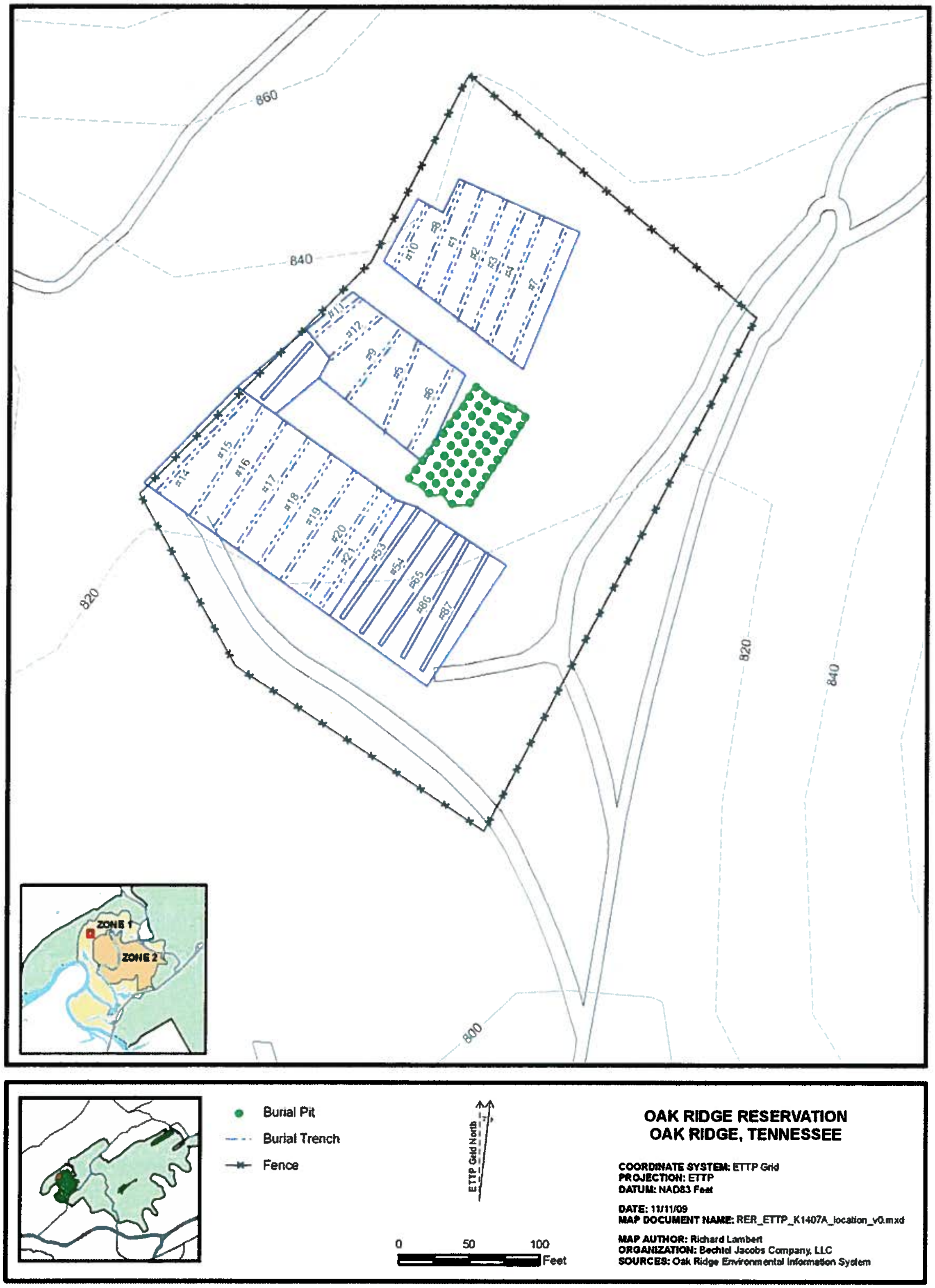


Figure 8.20. Location of former K-1070-A Burial Ground at ETTP.

8.4.5 Mitchell Branch Chromium Reduction

The TC RmA to address releases of chromium into Mitchell Branch was documented in the *Action Memorandum for Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE 2007e). The location of the removal action is noted on figures 8.1 and 8.21.

Figure 8.21 shows the locations of Mitchell Branch, relevant monitoring locations, the affected storm drain section and the hexavalent chromium plume area. The action was taken due to releases of hexavalent chromium into Mitchell Branch from the storm drain outfall SD-170 and from seeps at the headwall of the SD-170 discharge point. The plume discharge resulted in levels of hexavalent chromium that exceeded state AWQC. At MIK 0.71 and 0.79, which are locations in Mitchell Branch immediately downstream from the SD-170 discharge point, hexavalent chromium levels were measured at levels as high as 0.78 mg/L, which exceeded the state hexavalent chromium water quality chronic criterion of 0.011 mg/L for the protection of fish and aquatic life. On July 20, 2007, TDEC Division of Water Pollution Control issued a Notice of Violation to DOE for the hexavalent chromium release. Since hexavalent chromium has not been used in process operations at ETTP for over thirty years, the release of hexavalent chromium into Mitchell Branch is a legacy problem and not an ongoing, current operations issue. Therefore, DOE in coordination with EPA and TDEC determined that the appropriate response to this release was a CERCLA TC RmA. On November 5, 2007 DOE notified the EPA and TDEC of their intent to conduct a CERCLA TC RmA (DOE 2007e).

Activities associated with the removal action included:

- Located the chromium release path to the storm drain system and into Mitchell Branch.
- Installed a grout wall to impede the release of hexavalent chromium through SD-170 headwall seeps into Mitchell Branch.
- Installed two interception wells into the gravel bed that surrounds the SD-170 discharge pipes to collect the hexavalent chromium groundwater plume before it infiltrates the SD-170 collection system network piping.
- The system operations began in December 2007. The collected groundwater is treated at the Central Neutralization Facility, which is a NPDES permitted facility that currently provides services to CERCLA and non-CERCLA industrial operations at ETTP.

A RmAR for the TC RmA was issued in July 2008 (DOE 2008g).

8.4.5.1 Performance Goals and Monitoring Objectives

Monitoring of the removal action is documented in the RmAR (DOE 2008g). The water quality performance monitoring is performed and evaluated by the Environmental Compliance organization, and the data is presented in the Annual Site Environmental Report as well as the RER. The goals of the removal action are to collect and treat the hexavalent chromium contaminated groundwater to reduce its toxicity prior to discharge and to protect the water quality in Mitchell Branch at levels consistent with the AWQC. The chromium sampling points identified in the RmAR are as follows:

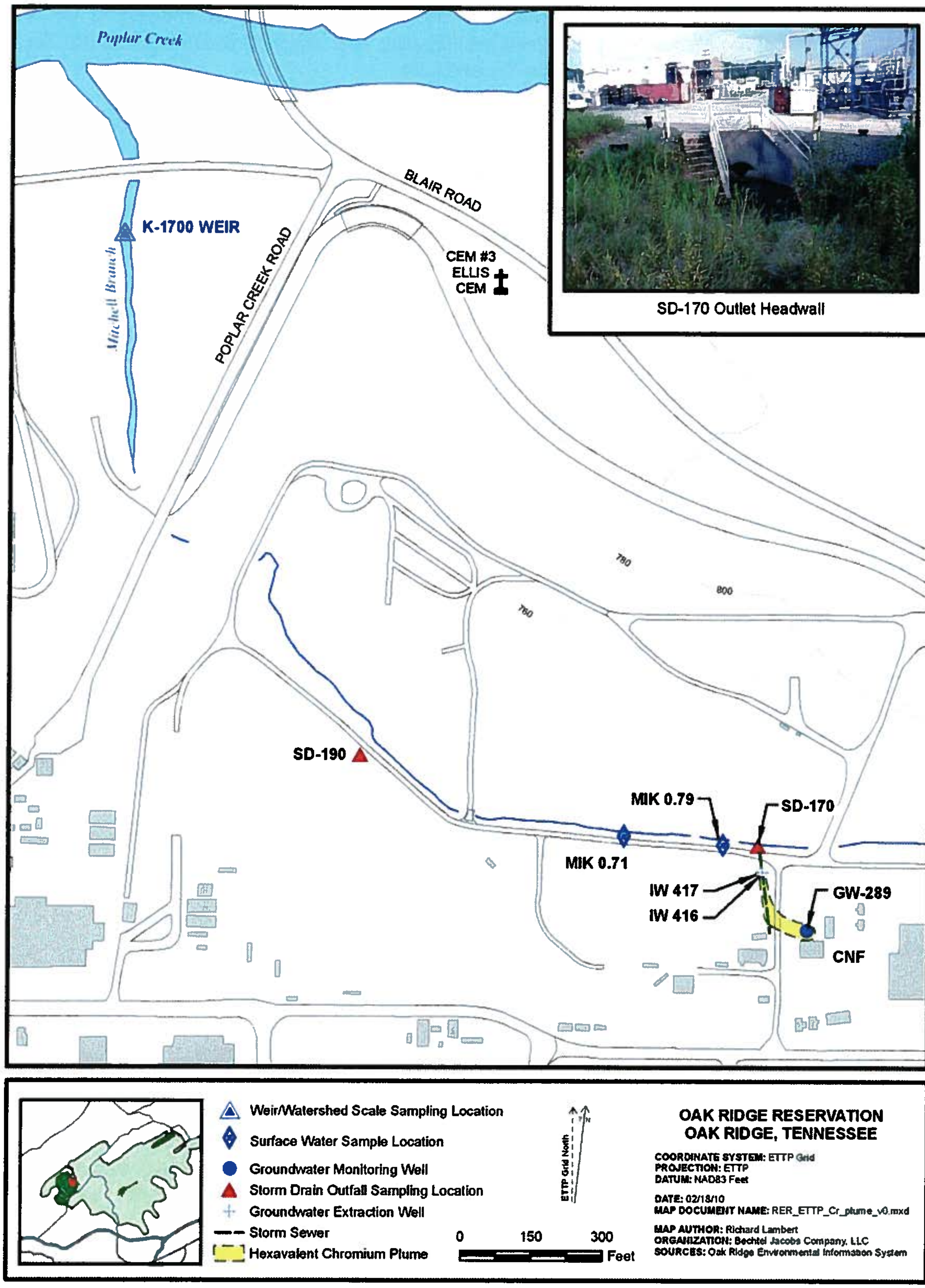


Figure 8.21. Location of chromium releases to Mitchell Branch.

- at the SD-170 discharge point.
- Mitchell Branch instream location (MIK 0.71 / MIK 0.79) that is downstream from SD-170. The instream location below SD-170 provides an opportunity for the discharges to mix with the Mitchell Branch receiving stream which is considered to be the appropriate location to compare hexavalent chromium concentrations with the AWQC value of 0.011 mg/L.
- Collection system that captures the combined flow from interception wells 416 and 417.
- Monitoring well 289 (location in the groundwater plume).

8.4.5.2 Evaluation of Performance Monitoring Data

The long-term water quality monitoring results in Mitchell Branch downstream from SD-170 at MIK 0.79 are provided in Figure 8.22.

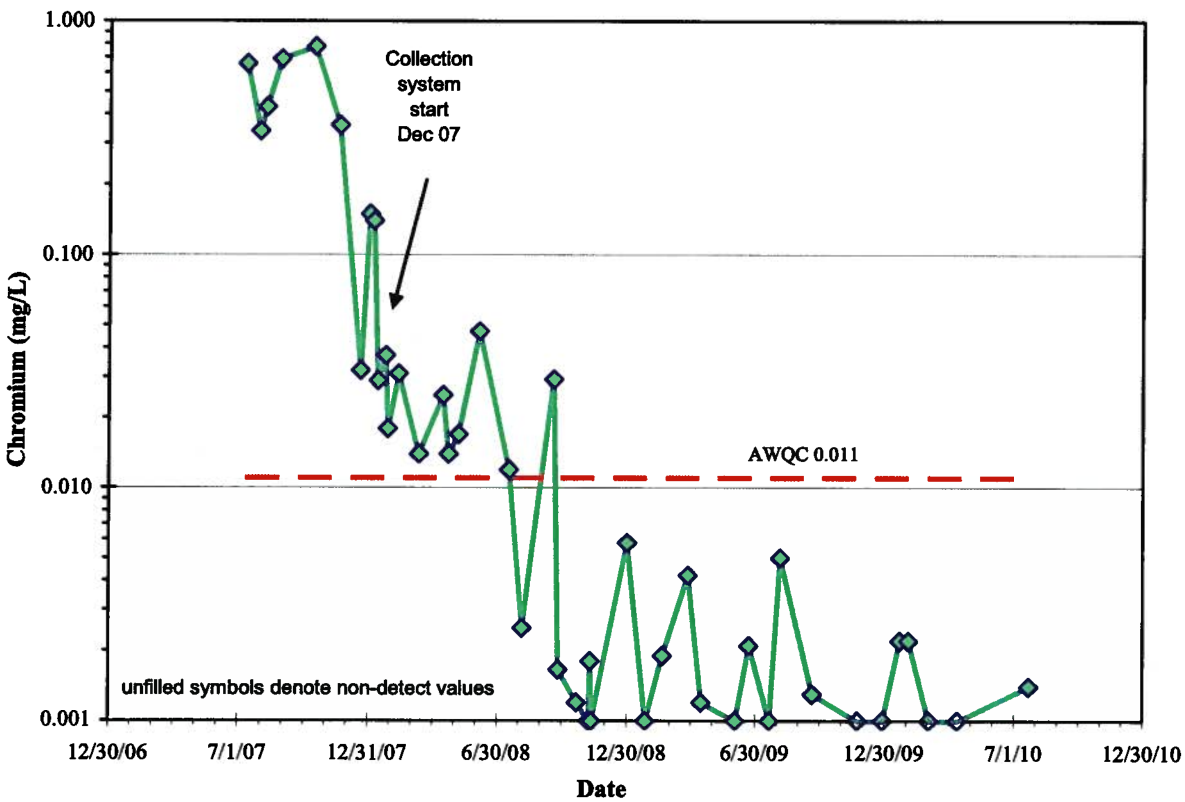


Figure 8.22. Mitchell Branch (MIK 0.79) chromium concentrations, FY 2007-2010.

The surface water results in Mitchell Branch show that the chromium collection system has been effective in reducing the levels of chromium from a maximum measured value of 0.78 mg/L to levels that are now consistently below the AWQC value of 0.011 mg/L during dry and wet weather periods.

Short-term results are discussed in the following section.

8.4.5.2.1 Surface Water Monitoring Short-Term Data

The chromium performance monitoring results for FY 2010 are presented in Table 8.11. Sampling and analysis of the chromium in the plume and in SD-170 established that essentially all of the detected chromium is hexavalent chromium with only a small proportion of the less hazardous trivalent chromium. Therefore, routine sampling and analysis utilizes the total chromium analysis which is less expensive and has less restrictive sample handling requirements and all the detected chromium is presumed to be hexavalent chromium. Periodic confirmatory hexavalent chromium analyses are conducted. The sampling schedule was modified to quarterly sampling following the April 2010 sampling event. The instream sampling results at MIK 0.71/0.79 varied from nondetect levels to a maximum of 0.0022 J mg/L (estimated value) during FY 2010. As noted, all results were less than the AWQC value of 0.011 mg/L.

The results at SD-170 varied from nondetect levels to a maximum amount of 0.0062 mg/L. Again, all results were less than the AWQC value of 0.011 mg/L.

The chromium results for the combined water flows that are collected in interception wells 416 and 417 varied from a low of 0.403 mg/L to a maximum value of 0.604 mg/L.

The chromium results at well GW-289 varied from a low of 1.20 mg/L to a maximum value of 2.88 mg/L.

8.4.5.2.2 Treatment System Performances

A significant upgrade was implemented for the chromium collection system in January of 2009. An enhancement to the chromium collection system was completed by replacing pneumatic pumps with electric pumps. The electric pumps provide the capacity for higher pump rate flows while also providing more consistent performance by reducing maintenance requirements.

During FY 2010, the chromium collection system operated 100% of the days without any significant operational periods where pumping volumes were limited. The average daily pumping rate over the full year period was 11.9 gpm. The maximum daily average pumping rate during the year was 14.6 gpm with a minimum pumping rate of 5.6 gpm. The lower range pumping rate of 5.6 gpm occurred during a cold and dry weather period in January 2010 when low temperatures limited the CNF treatment rates due to pump and line freezing. The collection system pump rates returned to the typical range of performance on the following days of operation as the CNF treatment lines and pumps thawed.

The evaluation of the effectiveness of the collection system is measured by the chromium levels in Mitchell Branch location MIK 0.79 which is the mixing zone point immediately downstream of SD-170 and the seeps at the SD-170 headwall. As previously noted in Figure 8.22 and Table 8.13, the maximum result measured at the instream MIK 0.79 location was 0.022 mg/L which is well below the AWQC level of 0.011 mg/L.

8.4.5.3 Performance Summary

Water sampling in FY 2010 indicates the removal action continues to be highly effective in achieving the goal to meet AWQC levels of 0.011 mg/L for hexavalent chromium in Mitchell Branch immediately downstream from the SD-170 discharge. The sampling schedule was modified to quarterly following months of analytical instream results an order of magnitude below AWQC value.

8.4.5.4 Compliance with LTS Requirements

8.4.5.4.1 Requirements

The RmAR (DOE 2008g) for the TC RmA did not include any LTS requirements.

8.4.5.4.2 Status of Requirements for FY 2010

No LTS requirements were specified in the decision document for this site.

Table 8.11. FY 2010 performance monitoring results for reduction of hexavalent chromium releases into Mitchell Branch

Sample Date	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10[a]	Jul-10
Location Description	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**	**Total Chromium (mg/L)**
Mitchell Branch kilometer 0.71/0.79 (MIK 0.71/0.79) downstream from SD-170	0.0013 J	0.001 U	0.001 U	0.0022 J	0.0022 J	0.0010 U	0.001 U	0.0014 J
SD-170	0.0047	0.0011 J	0.0023	0.005	0.0062	0.0010 U	0.001 J	0.0024 J
Collection System (Intercepter wells 416, 417)	0.603	0.604	0.541	0.403	0.443	0.479	0.456	0.476
Well 289	2.880	2.610	1.930	1.670	1.200	1.950	2.200	2.020
Collection System Pumping Rate, gpm	12.4	12.4	11.8	11.9	11.9	11.5	11.8	11.7
SD-170 Base Flow Rates, gpm	58	22	84	278	217	23	28	40
Weather Conditions	Dry	Dry	Dry	Wet	Wet	Dry	Dry	Wet

U flag indicates a nondetection at the analytical detection limit, J flag indicates estimated value.
N/A: No sample taken.
[a] Sampling schedule modified to quarterly after the April sampling event.

8.5 COMPLETED DEMOLITION PROJECTS WITH ACCESS CONTROLS AND LTS REQUIREMENTS

Over the past several years, most of the CERCLA actions at ETTP focused on completion of D&D activities documented by various PCCRs, some of which included interim requirements for monitoring and access controls because slabs or portions of foundations were left in place. If radiological surveys indicated a slab exceeded the release criteria of DOE Order 5400.5, then interim access controls were implemented and the slab was posted and became part of the radiological surveillance and monitoring program. Table 8.12 identifies the completed D&D projects with remaining contaminated media and the slabs/soil requiring interim LUCs and monitoring. Section 8.5.1 details these LTS requirements and their status. The ETTP Zone 1 and Zone 2 RODs will determine the final remedy for the contaminated slabs and soil.

Table 8.12. LTSmonitoring requirements for D&D facilities associated with remaining contaminated media

Area/action[a]	Slab/Foundation (annualradiological survey)[b]	Storm drain (characterize at least once every NPDES permit cycle)	Surface water (characterize annually)
Group II, Phase 2 RmAR for K-1064 Peninsula Area	K-1025-A slab K-1025-B slab K-1025-C slab K-1025-D slab K-1064-D slab K-1025-E K-1064 Salvage Material Yard soil (survey performed only when worker entries required)	SD-230 SD-240 SD-270 SD-280 SD-294 SD-296 SD-297	Surface water from Poplar Creek downstream (K-1007-P1 Holding Pond weir) and upstream from ETTP Mitchell Branch, and the K-901-A Pond.
Group II, Phase 3 PCCR, Bldg. K-1420	• K-1420 slab – storm flow runoff • Uranium Recovery Room and calciner room – quarterly radiological survey • Pad boundary – annual radiological survey	SD-158 SD-160 SD-170	Weir K-1700
Group II, Phase 3 FY 2006 PCCR for Low Risk/Low Complexity Facilities	K-723 slab	SD-780 SD-800 SD-820 SD-830	CRM 9.5 Brashear Island[c]
Group II, Phase 3 PCCR for K-29	K-29 slab	SD-490	Weir K-1007-B4
Group II, Phase 3 FY 2008 PCCR for Low Risk/Low Complexity Facilities	K-1024 slab - Fixed Contamination Area	SD-230 SD-240	Poplar Creek location K-716
Group II, Phase 3 FY 2007 PCCR for Low Risk/Low Complexity Facilities (K-736 slab in accordance with K-770 Scrap Removal PCCR)[d]	K-736 slab	SD-724 SD-730 SD-740 SD-760 SD-770 SD-780 SD-800 SD-820 SD-830	CRM 9.5 Brashear Island[c]

Table 8.12. LTS monitoring requirements for D&D facilities associated with remaining contaminated media (cont.)

Area/action[a]	Slab/Foundation (annualradiological survey)[b]	Storm drain (characterize at least once every NPDES permit cycle)	Surface water (characterize annually)
		SD-860 SD-870 SD-880 SD-890 SD-892	
	K-1232-D slab (survey performed only when worker entries required)	SD-362 SD-380	Poplar Creek location K-716
PCCR for Poplar Creek High-Risk Facilities K-1231, K-1233, and K-413	K-413 slab - Fixed Contamination Area K-1231 slab - Fixed Contamination Area	SD-362 SD-380	Poplar Creek location K-716

[a]The PCCR for the Group II, Phase 3 BOS-LABS D&D requires surveys and monitoring of the slabs from K-1004 and K-1015. These slabs were removed in FY 2007 and monitoring is no longer required. The long-term stewardship of these sites is no longer reported in the RER. Also, the PCCR for the Bldg. K-401 demolition requires LTS of the remaining slab. However, the slab was removed in 2009, making LTS no longer necessary.

[b]The PCCRs for these D&D projects require annual radiological surveillance, however, the PCCRs also state that contamination monitoring programs should be reviewed annually by the Project Health Physicists to ensure that appropriate surveys are performed at a frequency that is consistent with existing and potential hazards and activities planned in the area. Therefore, survey frequency may change from year to year.

[c]The PCCR requires monitoring at CR kilometer 16 Brashear Island, however, the actual sampling point is identified as CRM 9.5.

[d]The PCCR requires annual storm drain monitoring for the K-736 slab, however, the actual sampling frequency is once every NPDES permit cycle. The error was made in the K-770 Scrap Removal PCCR and mistakenly carried over into the FY 2007 LR/LC PCCR. Therefore, this table does not represent what is stated in the PCCRs. A revision to the PCCRs is planned.

8.5.1 Compliance with LTS Requirements

8.5.1.1 Requirements

Post-decision documents for the various D&D projects listed in Table 8.12 include the following requirements: (1) annual radiological surveillance, (2) storm drain characterization performed at least once within each NPDES permitting period (≤5 years) for representative outfalls in each storm groupings, and (3) annual surface water monitoring. Figure 8.4 shows the locations of the storm drains and surface water locations relative to areas containing the remaining contamination. Storm drain characterization and surface water monitoring results are used to verify the effectiveness of the Radiological Control Program.

If radiological contamination is found to be migrating out of the contamination area, then additional controls are implemented. The frequency and level of surveillance and monitoring is established at each site by the radiological engineers responsible for the program, in accordance with requirements and criteria set forth in 10 CFR §835, Occupational Radiation Protection.

In general, storm water runoff from concrete or asphalt pads is not sampled directly (the K-1420 slab is an exception). Instead, The ETTP Environmental Compliance Program verifies the effectiveness of the radiological control program through ongoing storm drain sampling and instream water sampling, i.e., monitoring in compliance with the ETTP NPDES permit and storm water runoff plans. Storm drain discharges are characterized at least once during each NPDES permitting period, a maximum of five years, for a minimum of gross alpha, gross beta, isotopic uranium, and ^{99}Tc. Instream water monitoring is conducted at least annually at Mitchell Branch Weir, K-1007-P1 Holding Ponds Weir (K-1007-B4), K-901-A Pond Weir, upstream of ETTP in Poplar Creek, and downstream of ETTP at CRM 9.5 (Brashear Island), and at Poplar Creek location K-716 for a minimum of gross alpha, gross beta, isotopic uranium, and ^{99}Tc. Data are compared to screening levels established at 4% of DOE Order 5400.5 DCG to maintain discharges ALARA.

8.5.1.2 Status of Requirements for FY 2010

Radiological monitoring of the facilities listed below (Table 8.13) is performed as part of the Radiological Compliance Monitoring, as required by 10 CFR §835 and adopted in the BJC RPP. All surveys are performed and documented in compliance with applicable BJC procedures. Limits that apply to the surveys performed are found in Attachment D to 10 CFR §835, as provided in Table 8.14.

Storm drain characterization sampling, as conducted as part of the ETTP NPDES permit compliance monitoring program, and surface water monitoring were performed as a means to verify the effectiveness of the Radiological Control Program (see Figure 8.4). A summary of the storm drain sampling and surface water monitoring conducted for these D&D areas, along with storm flow sampling at the K-1420 slab through January 2010, is included in Table 8.15 and is detailed below.

As required by the K-1064 Peninsula Area RmAR, storm water outfall SD-230 was sampled during FY 2010 and no results exceeded screening criteria. The results from the instream sampling in Poplar Creek downstream from the K-1064 Peninsula area were less than 1% of the allowable DCG.

Based upon low radiological sampling results observed during FY 2007 and 2008 sampling events, a recommendation was made in the 2009 RER to discontinue the sampling of storm water runoff from the K-1420 pad. The request to discontinue sampling was approved in April 2010. Therefore, the last of the annual SWPPP samples from the K-1420 pad was obtained in January 2010. Samples were collected at the north side of the K-1420 building footprint in an area near the former calciner room.

Table 8.13. Summary of radiological monitoring information for ETTP D&D sites

Facility/Location	Status	Survey frequency[a]	Survey date(s)	Survey summary
Group II, Phase 2 — RmAR for K-1064 Peninsula Area				
K-1025-A slab	Fixed Contamination Area	Quarterly	12/30/09, 3/9/10, 6/22/10, 9/1/10	No removable activity above CFR §835 limits detected.
K-1025-B slab	Fixed Contamination Area	Quarterly	12/30/09, 3/15/10, 6/22/10, 9/1/10	No removable activity above CFR §835 limits detected.
K-1025-C slab	Fixed Contamination Area	Quarterly	12/30/09,3/9/10, 6/22/10, 9/1/10	No removable activity above CFR §835 limits detected.
K-1025-D slab	Fixed Contamination Area	Quarterly	12/30/09, 3/9/10, 6/22/10, 9/1/10	No removable activity above CFR §835 limits detected.
K-1064-D slab	Fixed Contamination Area	Annually	4/23/10	No removable activity above CFR §835 limits detected.
K-1025-E	Fixed Contamination Area	Quarterly	12/30/09, 3/9/10, 6/23/10, 9/1/10	No removable activity above CFR §835 limits detected.
K-1064 Salvage Material Yard soil	Contamination Area	Survey performed only when worker entries required	N/A	N/A
Group II, Phase 3 — PCCR Bldg. K-1420				
K-1420 slab – storm flow runoff	N/A to Radiological Controls.	N/A to Radiological Controls.	N/A to Radiological Controls.	N/A to Radiological Controls.
Uranium Recovery Room and calciner room	Fixed Contamination Area	Annually	7/21/10	No removable activity above CFR §835 limits detected.
K-1420 Pad boundary	Fixed Contamination Area	Annually	7/21/10	No removable activity above CFR §835 limits detected.
Group II, Phase 3 — FY 2006 PCCR for Low Risk/Low Complexity Facilities				
K-723 slab	Fixed Contamination Area	Annually	12/15/09	No removable activity above CFR §835 limits detected.
Group II, Phase 3 — PCCR for K-29				
K-29 slab	Fixed Contamination Area	Annually	9/28/10	No removable activity above CFR §835 limits detected.
Group II, Phase 3 — FY 2008 PCCR for Low Risk/Low Complexity Facilities				
K-1024 slab	Fixed Contamination Area	Annually	4/28/10	No removable activity above CFR §835 limits detected.
Group II, Phase 3 — FY 2007 PCCR for Low Risk/Low Complexity Facilities				
K-736 asphalt pad	Located within K-770 CA and is not routinely surveyed	N/A	N/A	N/A
K-1232-D slab	Contamination Area	Survey performed only when worker entries requires	N/A	N/A

[a] The PCCRs for these D&D projects require annual radiological surveillance, however, the PCCRs also state that contamination monitoring programs should be reviewed annually by the Project Health Physicists to ensure that appropriate surveys are performed at a frequency that is consistent with existing and potential hazards and activities planned in the area. Therefore, survey frequency may change from year to year.

CFR = Code of Federal Regulations
N/A = not applicable

Table 8.14. 10 CFR §835 limits

Radionuclide	Removable dpm/100cm	Total (Fixed + Removable) dpm/100cm
U-Nat, U-235, U-238, and associated decay products	1,000	5,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-Nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1000
Beta-Gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1,000	5,000
Tritium and tritiated compounds	10,000	N/A

CFR = Code of Federal Regulations dpm = disintegrations per minute Nat = natural occurring

Table 8.15. Summary of storm drain and surface water monitoring information

Slab/Foundation	Storm drain locations (characterize at least once every NPDES permit cycle, ≤ 5 yrs)	2010 Storm drain monitoring summary[a]	Surface water locations (annually)	2010 Surface water monitoring summary
Group II, Phase 2 RmAR for K-1064 Peninsula Area[b]				
K-1025-A slab K-1025-B slab K-1025-C slab K-1025-D slab K-1025-E K-1064-D slab K-1064-H slab[c]	SD-230	Sampled in 2010; no results exceeded screening criteria	Surface water from Poplar Creek downstream and upstream from ETTP K-1064 Peninsula area	Less than 1% of the allowable DCG
	SD-240	Not sampled in 2010		
	SD-270	Not sampled in 2010		
	SD-280	Not sampled in 2010		
	SD-294	Not sampled in 2010		
	SD-296	Not sampled in 2010		
	SD-297	Not sampled in 2010		
Group II, Phase 3 PCCR for Bldg. K-1420				
K-1420 slab – storm flow runoff (requirement terminated April 2010)	SD-158	2010 results above screening criteria but similar to historical trends and below DCGs	Weir K-1700	Results during 2010 were less than 3% of the DCGs
	SD-160	2010 results above screening criteria but similar to historical trends and below DCGs		
	SD-170	2010 results above screening criteria but similar to historical trends and below DCGs		
Group II, Phase 3 FY 2006 PCCR for Low Risk/Low Complexity Facilities				
K-723 slab	SD-780	Not sampled in 2010	CRM 9.5 Brashear Island	Less than 1% of the allowable DCG
	SD-800	Not sampled in 2010		
	SD-820	Not sampled in 2010		
	SD-830	Not sampled in 2010		
Group II, Phase 3 PCCR for K-29				
K-29 slab	SD-490	Not sampled in 2010	K-1007-P1 Pond Weir (Weir K-1007-B4)	Less than 1% of the allowable DCG
Group II, Phase 3 FY 2008 PCCR for Low Risk/Low Complexity Facilities				
K-1024 slab	SD-230	Not sampled in 2010	Poplar Creek location K-716	Less than 1% of the allowable DCG
	SD-240	Not sampled in 2010		

Table 8.15. Summary of storm drain and surface water monitoring information (cont.)

Slab/Foundation	Storm drain locations (characterize at least once every NPDES permit cycle, ≤ 5 yrs)	2010 Storm drain monitoring summary[a]	Surface water locations (annually)	2010 Surface water monitoring summary
Group II, Phase 3 FY 2007 PCCR for Low Risk/Low Complexity Facilities				
K-736 asphalt pad	SD-724	2010 results above screening criteria but similar to historical trends	CRM 9.5 Brashear Island	Less than 1% of the allowable DCG
	SD-730	Not sampled in 2010		
	SD-740	Not sampled in 2010		
	SD-760	Not sampled in 2010		
	SD-770	Not sampled in 2010		
	SD-780	Not sampled in 2010		
	SD-800	Not sampled in 2010		
	SD-820	Not sampled in 2010		
	SD-830	Not sampled in 2010		
	SD-860	Not sampled in 2010		
	SD-870	Not sampled in 2010		
	SD-880	Not sampled in 2010		
	SD-890	Not sampled in 2010		
	SD-892	Not sampled in 2010		
K-1232-D slab	SD-362	Not sampled in 2010	Poplar Creek location K-716	Less than 1% of the allowable DCG
	SD-380	Not sampled in 2010		
Group II, Phase 3 PCCR for Poplar Creek High-Risk Facilities K-1231, K-1233, and K-413				
K-1231 slab	SD-362	Not sampled in 2010	Poplar Creek location K-716	Less than 1% of the allowable DCG
	SD-380	Not sampled in 2010		
K-413 slab	SD-380	Not sampled in 2010	Poplar Creek location K-716	Less than 1% of the allowable DCG
	SD-362	Not sampled in 2010		

[a]Storm drain monitoring performed at least once within each NPDES permitting period (≤ 5 years).

[b]K-1064 Salvage Material Yard soil requires radiological surveys under the K-1064 RmAR. However, it does not require storm water monitoring per the RmAR.

[c]K-1064-H slab requires storm water monitoring under the K-1064 RmAR. However, it does not require rad surveys per the RmAR.

As noted in the K-1420 PCCR, the acceptable dose rate in surface water for piscivorous wildlife is 100 mrad per day. The total uranium activity on the K-1420 pad that will result in a 100 mrad per day dose in Mitchell Branch is 2,600 pCi/L. As noted in Table 8.16 and Figure 8.23, analytical data collected since April 2007 through January 2010 indicates that concentrations of total uranium from storm runoff from the K-1420 pad are several orders of magnitude below the 2,600 pCi/L total uranium action level.

Table 8.16. K-1420 Slab Storm-Water Runoff Performance Monitoring

Sample Month	U-233/234 pCi/L	U-235/236 pCi/L	U-238 pCi/L	Total Uranium pCi/L	Action Level Total Uranium pCi/L
April 2007	194	12	25	231	2,600
November 2007	15	1	3	19	2,600
December 2007	29	2	5	35	2,600
January 2008	17	1	3	22	2,600
February 2008	12	0	2	14	2,600
March 2008	11	1	2	14	2,600
August 2008	11	1	2	14	2,600
December 2008	63 U	0.88 U	1.2 E	65	2,600
March 2009	63 U	2.45 U	6	71	2,600
September 2009	36	2	7	45	2,600
October 2009	69	5	13	87	2,600
January 2010	77.3	3.12	10.8	33.6	2,600

E = estimated value due to matrix interference
U = analyte not detected in sample

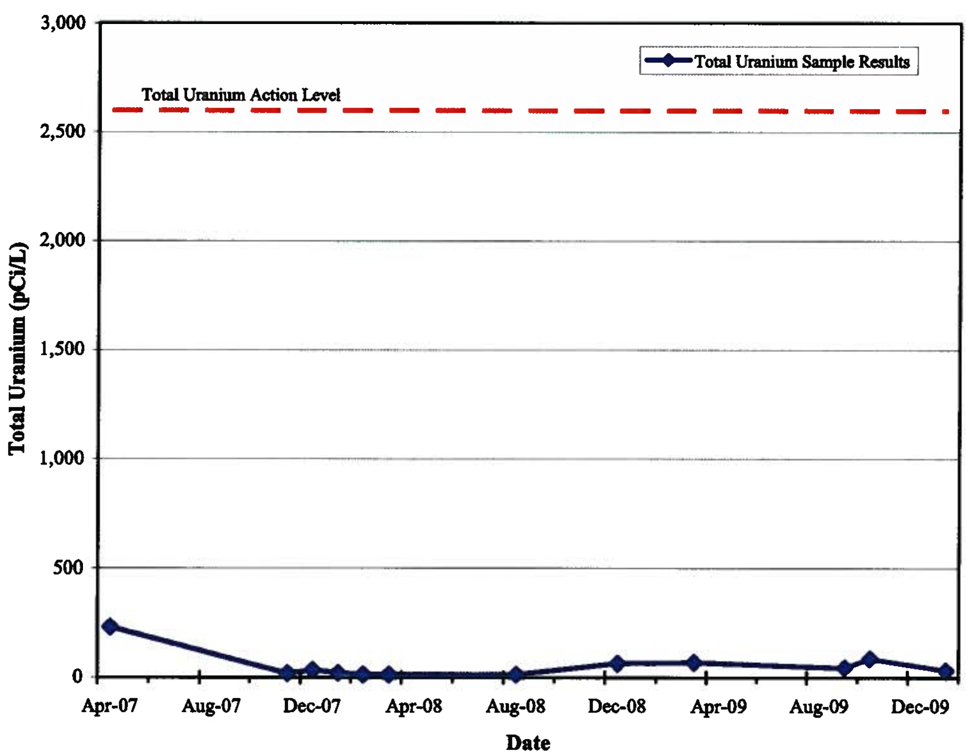


Figure 8.23. K-1420 Pad Storm Water Runoff Sample Results.

Per the K-1420 PCCR, if the concentration of total uranium is below 2,600 pCi/L, this will confirm that storm water runoff from Building K-1420 slab is stabilized, and sampling of the pad during rain events can be discontinued. Based upon the uranium levels that are well below the action level in the PCCR, it was recommended that storm water sampling runoff from the K-1420 pad be discontinued. This recommendation was submitted to the CERCLA Core Team for concurrence in FY 2010 and was approved in April 2010. Results from the January 2010 sampling event are provided in this RER, but no further monitoring is required.

As identified in the K-1420 PCCR and in addition to the K-1420 pad runoff sampling previously discussed, storm water samples from outfalls 158, 160, and 170 will be characterized during each NPDES permitting period and samples will be collected at least annually at the K-1700 weir. Data collected in FY 2010 from outfalls 158, 160, and 170 show that a number of the radiological parameters were detected at levels that exceeded the screening levels due to legacy soil contamination in the drainage areas that will be evaluated in accordance with the Zone 2 ROD. Although elevated above screening levels, the results from FY 2010 sampling events were fairly consistent with, or below, the levels found in historical analytical data. The samples from the K-1700 weir were below screening levels for all radiological parameters during FY 2010 and, as shown in Table 8.17, the cumulative results were less than 3% of the DCG.

As identified in the FY 2007 PCCR for the Low Risk/Low Complexity Facilities (DOE 2007j), storm water from outfalls 724 and 380 will be characterized at least once during each NPDES permitting period. Outfall 724 were sampled in FY 2010. The analytical results from both outfalls show that a number of the radiological parameters exceeded screening criteria. However, the results from the FY 2010 sampling event for outfall 724 were fairly consistent with, or below, the levels found in historical analytical data. The results from instream sampling in the Clinch River at CRM 9.5 downstream from the outfall 724 discharge points and from Poplar Creek location K-716 downstream from outfall 380 were less than 1% of the allowable DCG.

8.6 OTHER WATERSHED MONITORING AT EAST TENNESSEE TECHNOLOGY PARK

This section provides a summary of ETTP sitewide groundwater and surface water conditions, including a discussion of exit pathway contaminant migration. It includes an update on conditions as characterized by the biological monitoring in area surface water bodies.

The status of ETTP long-term CERCLA decision making is provided in Figure 1.5 of Vol. 1 of the 2007 RER (DOE 2007a).

8.6.1 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 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 (Figure 8.24). Each of these areas has significant VOC contamination in groundwater. The principal chlorinated hydrocarbon chemicals that were used at ETTP were PCE, TCE, and 1,1-DCA.

Figure 8.24 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.

8.6.2 Exit Pathway Monitoring

Groundwater exit pathway monitoring sites are shown in Figure 8.24. 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 8.25 shows the detected concentrations of TCE, 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 TCA are sometimes detected. VOC concentrations measured during FY 2010 were below TDEC recreational organisms only AWQC levels at K-1700.

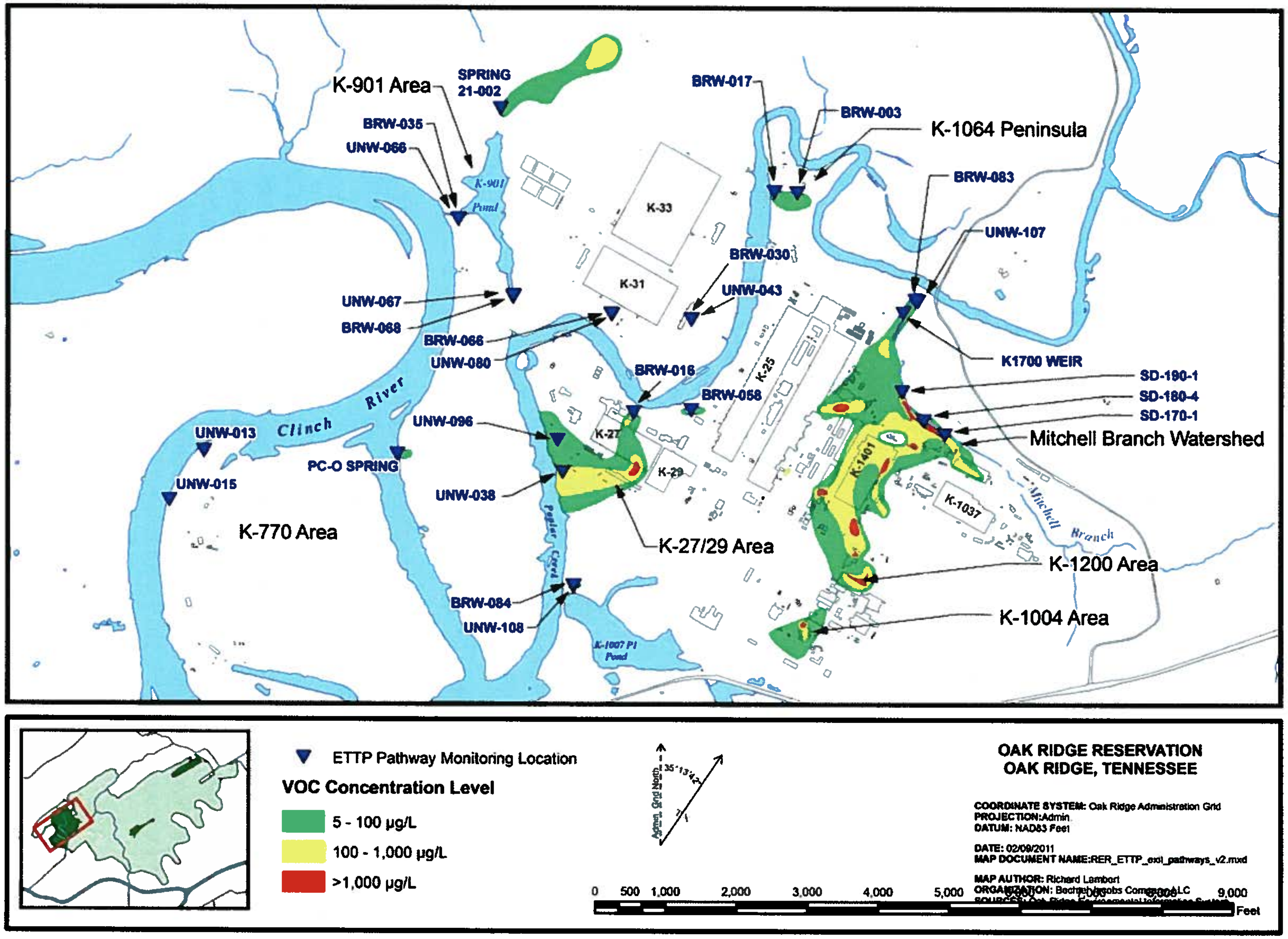


Figure 8.24. ETTP exit pathways monitoring locations.

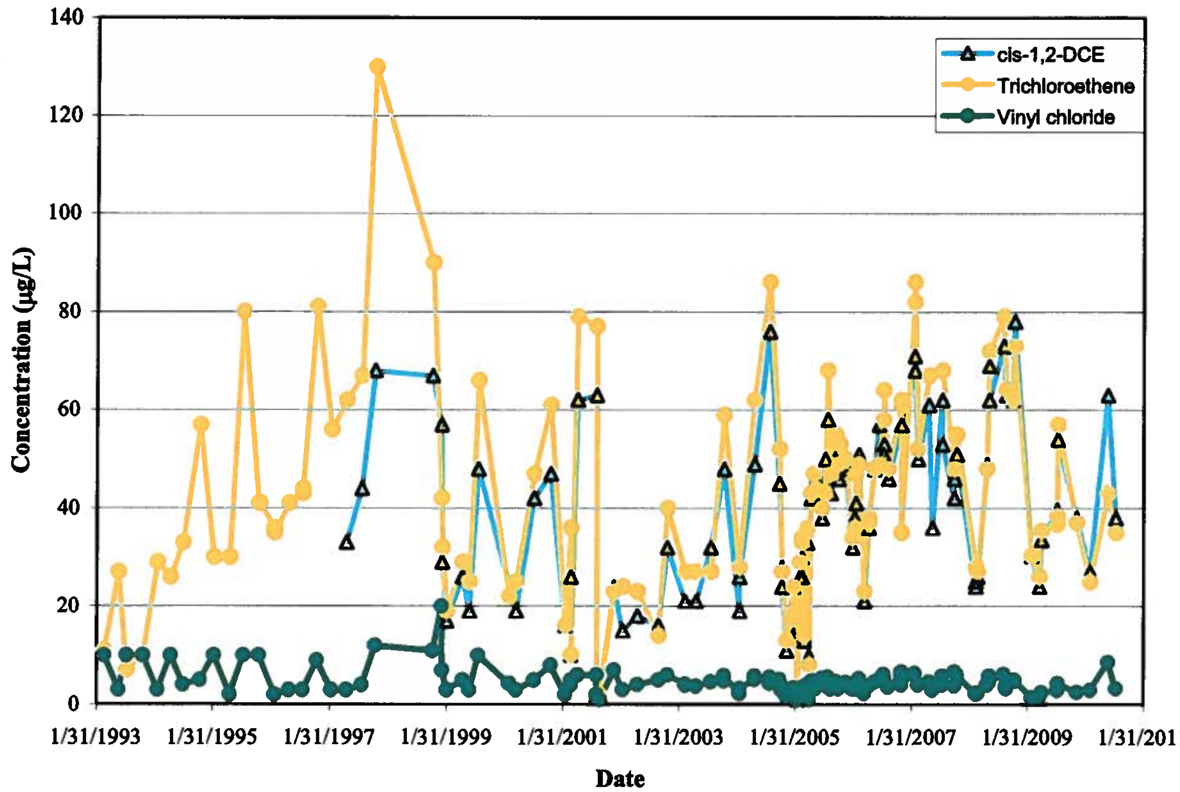


Figure 8.25. K-1700 Weir VOC concentrations.

Wells BRW-083 and UNW-107, located near the mouth of Mitchell Branch (Figure 8.24), have been monitored since 1994. Table 8.17 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 flowpaths 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.

Wells BRW-003 and BRW-017 (Figure 8.24) monitor groundwater at the K-1064 Peninsula burn area. Figure 8.26 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.

Table 8.17. VOCs detected in groundwater in the Mitchell Branch Exit Pathway

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

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)

All concentrations µg/L.

BRW = bedrock wells   J = estimated value   ND = Not Detected   UNW = unconsolidated wells

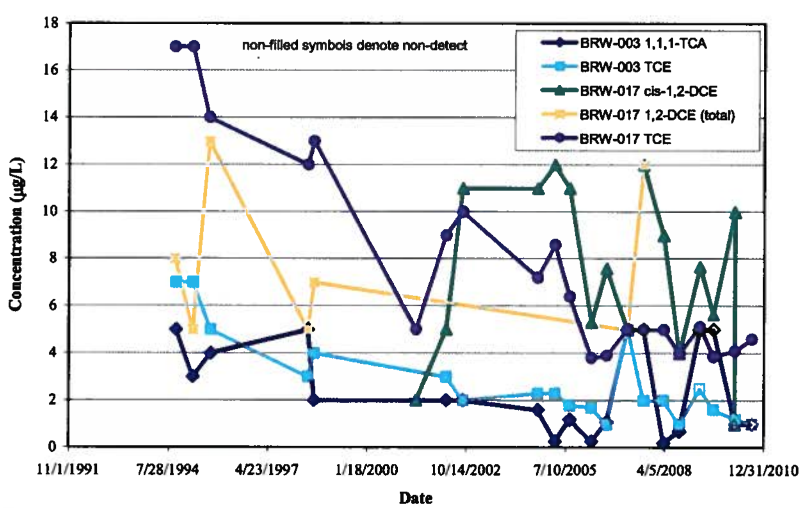


Figure 8.26. VOC concentrations in groundwater at K-1064 Peninsula area.

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 Figure 8.24. VOCs are not COCs in this area; however, leaks of recirculated cooling water in the past have left residual subsurface chromium contamination. Figure 8.27 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 Figure 8.27, 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.

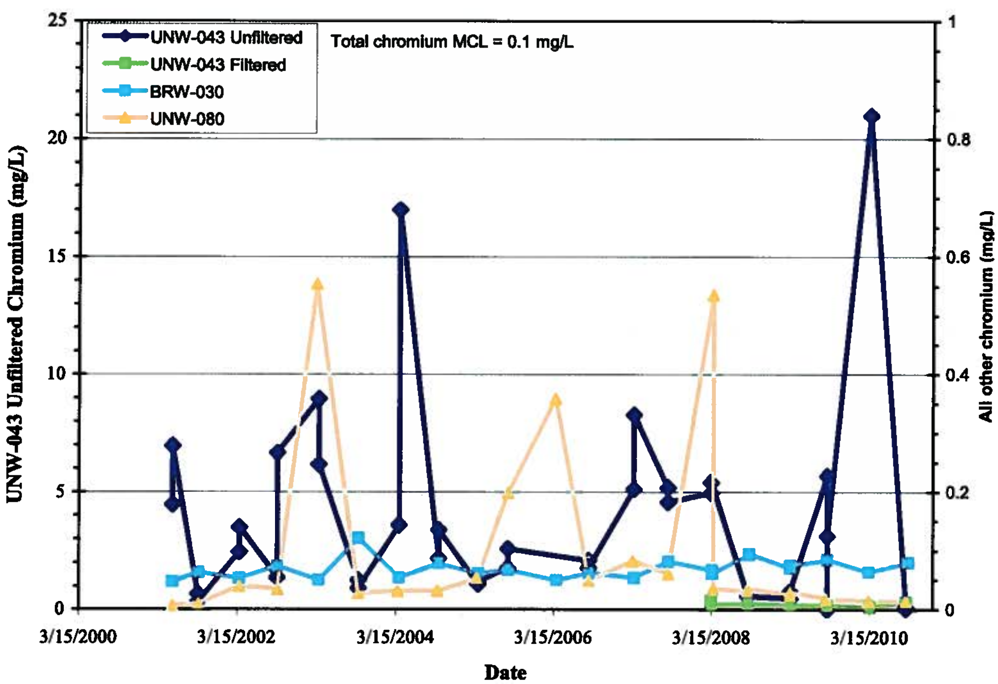


Figure 8.27. Chromium concentrations in groundwater in the K-31/K-33 area.

Several exit pathway wells are monitored in the K-27/K-29 area, as shown on Figure 8.24. Figure 8.28 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.

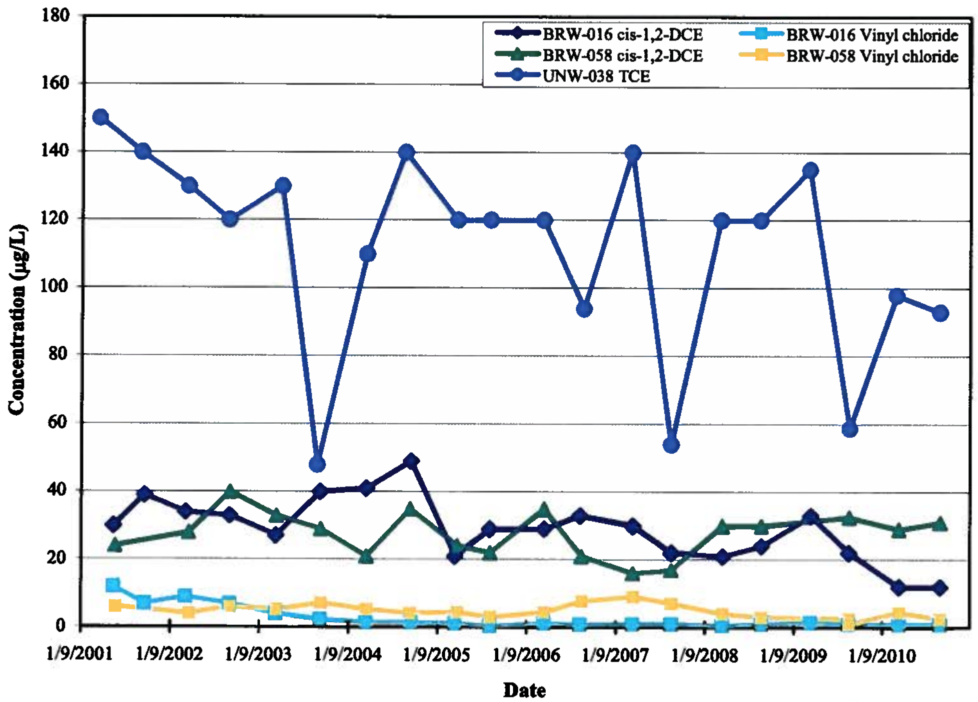


Figure 8.28. Detected VOC concentrations in groundwater exit pathway wells near K-27 and K-29.

Wells BRW-084 and UNW-108 are exit pathway monitoring locations at the northern edge of the K-1007-P1 Pond (see Figure 8.24). 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 (see Figure 8.24) 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 Figure 8.29. 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.

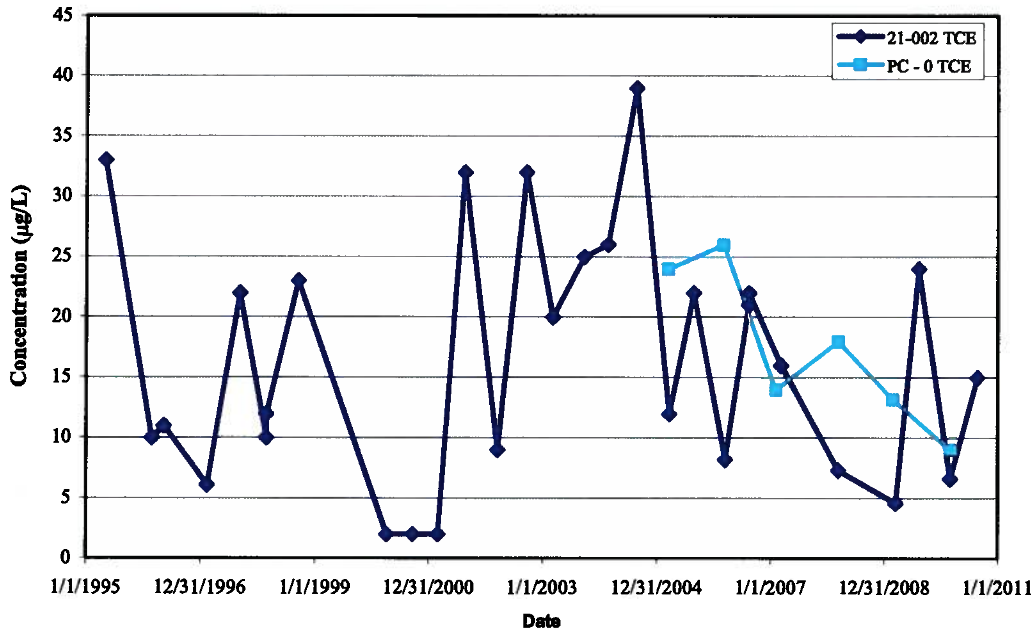


Figure 8.29. TCE concentrations in K-901 area springs.

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 (see Figure 8.24). Figure 8.30 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.

8.6.3 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, and 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, 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 in Sect. 8.4.1.2.2. 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 K-901 weir and in one sample at K-1700 weir at levels below criteria and hexavalent chrome was not detected in any of the samples. Nickel and zinc were detected at K-1700 and K-901 weirs but levels were below criteria.

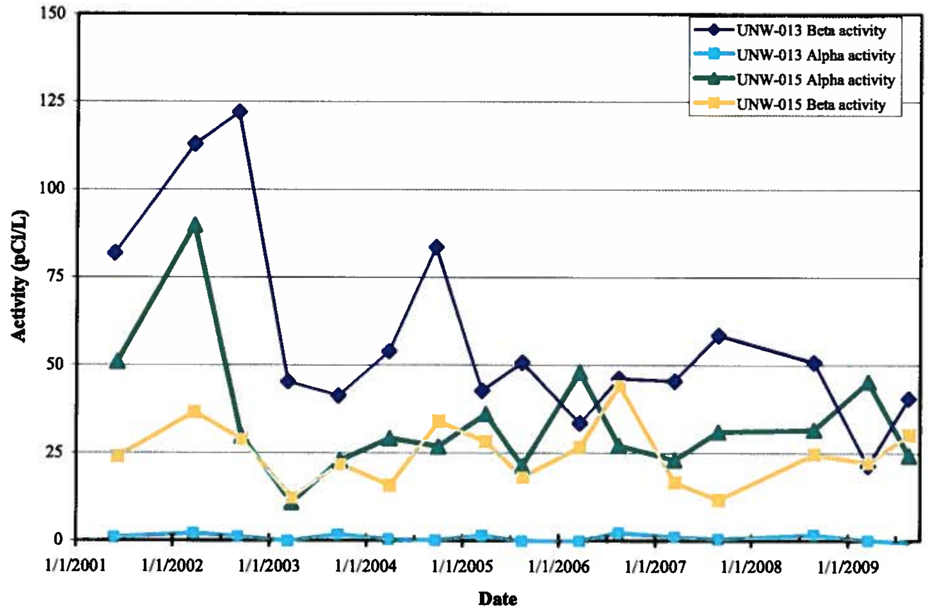


Figure 8.30. History of measured alpha and beta activity in the K-770 area.

Although TCE (4 samples), vinyl chloride (4 samples), and carbon tetrachloride (1 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, (2 samples) and carbon tetrachloride (1 sample) exceeded the water and organisms criteria but did not exceed the organisms 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. 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.

8.6.4 Aquatic Biological Monitoring

Long-term trends in PCB accumulation in fish from the K-901-A and K-1007-P1 ponds were presented in Sect. 8.4.2.3.

Biological monitoring in Mitchell Branch, conducted by the ETTP Biological Monitoring and Abatement Program (BMAP), includes: (1) contaminant accumulation in fish, (2) fish community surveys, and (3) benthic macroinvertebrate surveys. Mean PCB concentration in redbreast sunfish collected from Mitchell Branch in FY 2010 averaged 1.17 µg/g, within the range of values seen in recent years but well below historically high levels in the late 1990s and early 2000s when levels in fish were in the 3-4 µg/g range (Figure 8.31). The 1-2 µg/g range is still a relatively high level of PCBs for sunfish, which are low in lipids and don't accumulate PCBs to the same degree as species such as largemouth bass and channel catfish. Caged Asiatic clams (*Corbicula fluminea*) were placed in Mitchell Branch above and below storm drain discharges for a four-week exposure (June 22 – July 21, 2010) to evaluate the importance of PCB sources to the creek. The highest PCB concentrations in clams were found around SD-190 [MIK 0.2 (2.15 µg/g), MIK 0.3 (3.2 µg/g), and MIK 0.4 (2 µg/g)] The spatial pattern of PCB contamination in the creek in 2010 remains the same as past years, with the highest values in clams from downstream sites.

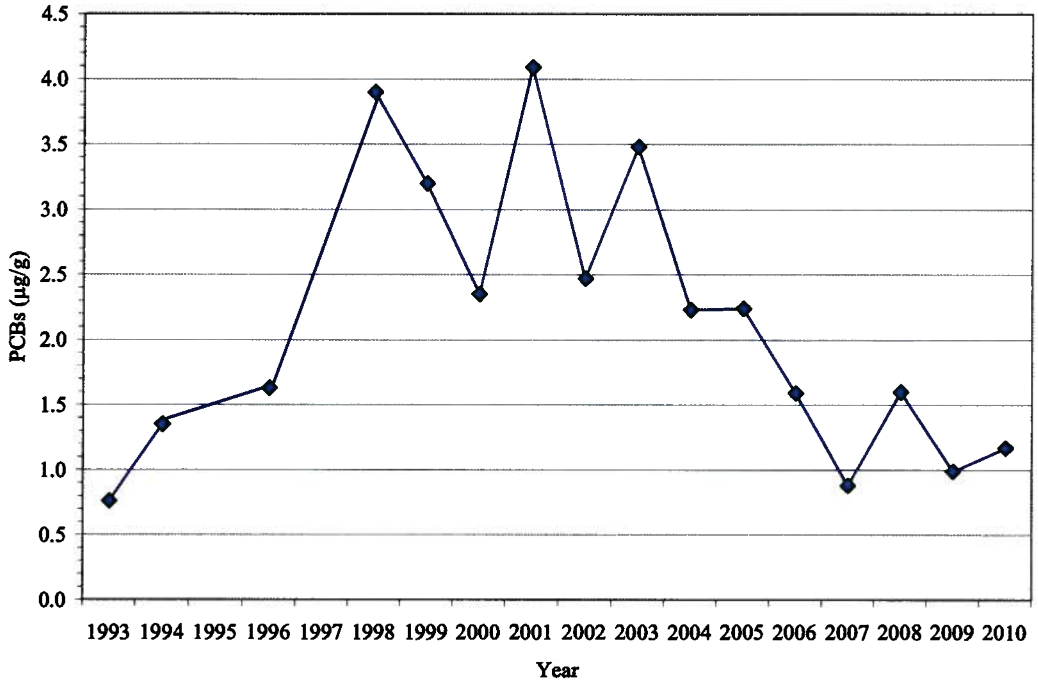


Figure 8.31. Mean PCB concentrations in redbreast sunfish from Mitchell Branch, 1993–2010.

The species richness (number of species) of the fish community in Mitchell Branch (MIK 0.45) has improved since construction of the interceptor trench in early 1998 (Figure 8.32), and has stabilized in recent samples. The trench was operational until February of 2005, at which time it was shut down. The fish community values for MIK 0.45 are close to the range of richness values of comparable reference streams. The 2010 sample may have been temporarily affected by a beaver dam that was just below the site, and had flooded the sample reach. Although similar in overall species richness, the fish community at MIK 0.45 does have fewer sensitive species and at lower densities than at comparable reference streams. The presence of sensitive species may increase as water quality improves and habitat stabilizes.

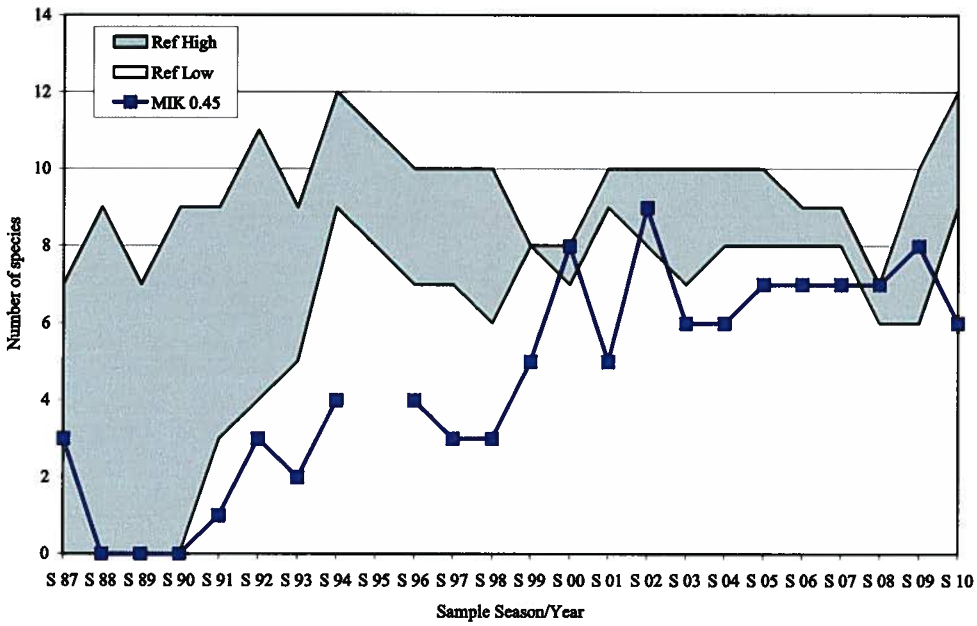
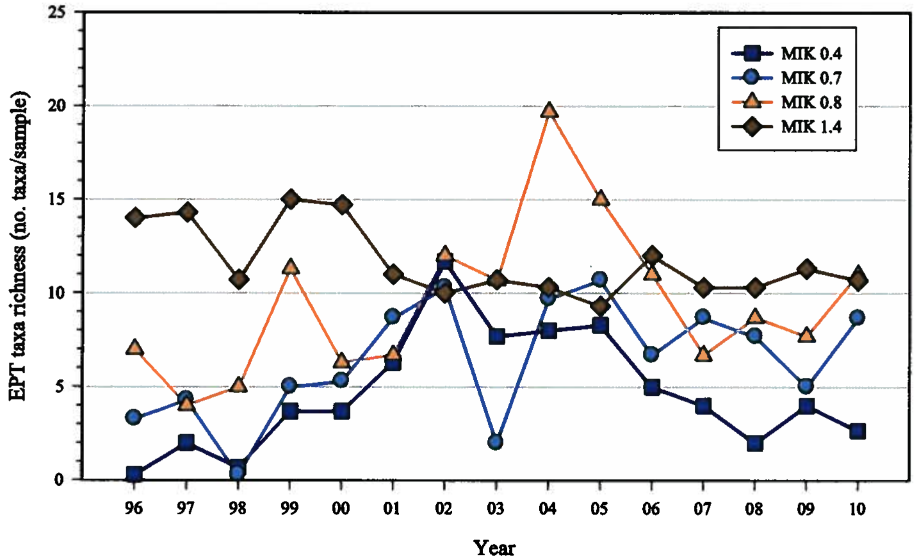


Figure 8.32. Species richness (number of species) in spring samples of the fish community in Mitchell Branch (MIK) and a range of reference streams (Ref. High-Low), 1986 to 2010.[a]

[a]Interruptions in data lines indicate missing samples.

Results from benthic macroinvertebrate assessments of Mitchell Branch continue to indicate that the conditions in the lower reaches of the stream are slightly to moderately degraded (Figure 8.33). The number of pollution-intolerant taxa at the downstream-most site continues to be considerably lower than at the reference site (MIK 1.4), while the difference at MIK 0.7 and MIK 1.4 is much less. The number of pollution-intolerant taxa at MIK 0.8 continues to exhibit a trend of fluctuating around the number at the reference site. Wide temporal fluctuations as seen at MIK 0.8 are often characteristic in a slightly to moderately degraded stream.



EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, caddisflies, and stoneflies.

Figure 8.33. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in Mitchell Branch at the ETTP, April sampling periods, 1996–2010.

8.6.5 Monitoring Summary

During FY 2010, monitoring results for the principal surface water and groundwater locations indicate that contaminant levels are generally stable to decreasing in most instances. The hexavalent chromium collection system and treatment functioned as planned and protected surface water quality in Mitchell Branch. Contaminants detected during previous years in exit pathway groundwater near the K-1007-P1 weir were not detected in FY 2010. Low concentrations of PCE and TCE greater than the MCL were detected in a bedrock well in the exit pathway at the mouth of Mitchell Branch. These contaminants have been detected previously but were not present during recent drought years. Most of the groundwater plumes monitoring results indicate stable contaminant levels compared to recent years.

8.7 EAST TENNESSEE TECHNOLOGY PARK MONITORING CHANGES AND RECOMMENDATIONS

Table 8.18 summarizes the issue(s) and associated recommendation(s) for the ETTP administrative watershed.

The fish barrier which was part of the K-1007-P1 Holding Pond RA was damaged in the spring of 2010 allowing previously removed undesirable species to re-enter the pond. The barrier was repaired and strengthened, the fish mostly removed, and operational monitoring initiated.

The BORCE located in the northern section of Zone 1 at ETTP is utilized for recreational use; however, the end use identified in the ETTP Zone 1 ROD is unrestricted industrial. DOE acknowledges the disparity in the land use and the initiation of an ESD and amendment to the Zone 1 Interim ROD (DOE 2002d) to change that portion of the land use from industrial to recreational is in progress.

The recommendation that additional monitoring of the K-1420 pad be discontinued, has been approved. This monitoring will be deleted from discussion in future RERs, and the issue will be listed as Completed/Resolved.

Table 8.18. Summary of technical issues and recommendations

Issue[a]	Action/ Recommendation
2010 Current Issue	
1. Fish barrier in K-1007-P1 Holding Pond was damaged during storm events allowing reintroduction of undesirable fish species into the pond.	1. Fish barrier was repaired and undesirable fish were removed to the extent practicable in FY 2010. Performance monitoring initiated.
Issues Carried Forward	
1. The northern section of ETTP Zone 1 has been identified as a conservation easement (BORCE). The BORCE is utilized for recreational use: hiking, bicycling, and select controlled deer hunts. The end use identified in the ETTP Zone 1 ROD is unrestricted industrial, i.e., recreational use was not designated. (2010 RER)[b]	1. DOE acknowledges the land use differences that exist between the BORCE use and that which is in the Zone 1. The end use of the portion of Zone 1 that is also identified as part of the BORCE will be changed from industrial to recreational in an ESD and amendment to the Zone 1 Interim ROD (DOE 2002d) with the appropriate level of public participation. The *Addendum to the Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2010s) includes the risk assessment to support this change.

Table 8.18. Summary of technical issues and recommendations (cont.)

Issue[a]	Action/ Recommendation
Completed/Resolved Issues	
1. Per the K-1420 PCCR, if the concentration of total uranium continues to show results below 2,600 pCi/L, this will confirm that storm water runoff from Building K-1420 slab is stabilized, and sampling of the pad during rain events will be discontinued. Based on results from the past year, additional monitoring of the K-1420 pad can be discontinued. (2009 RER)[b]	1. FY 2010 sampling discussed in 2011 RER with no further discussion in subsequent RERs. Regulators approved April 2010.

[a] An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

[b] The year in which the issue originated is provided in parentheses, e.g., (2006 FYR).

9. CERCLA ACTIONS AT OTHER SITES

9.1 INTRODUCTION AND OVERVIEW

This chapter presents the remedial effectiveness evaluation for CERCLA actions that are not physically situated within one of the five established watersheds or ChR, but are located on the ORR. Presently, only the White Wing Scrap Yard (WWSY) and the Oak Ridge Associated University (ORAU) South Campus Facility (SCF) fall into this category. Table 9.1 summarizes the status of these actions, and Table 9.2 provides a summary of the LTS requirements. Both remedies have been single-action decisions to address known or potential sources of releases.

9.1.1 Status of Updates

During FY 2010, no additional CERCLA actions were implemented or completed at the WWSY or at the ORAU SCF. Neither were there any FFA documents submitted or approved for CERCLA actions located on the ORR but physically located outside one of the five established watersheds.

9.2 WHITE WING SCRAP YARD (WAG 11) SURFACE DEBRIS REMEDIAL ACTION

The WWSY is located north of the western end of BCV, as is shown on Figure 9.1. The scope of this action (Table 9.1) included removal of contaminated surface debris retrievable without excavation. Some buried materials remain at the site. WWSY has only LTS requirements (Table 9.2). A review of compliance with these LTS requirements is included in Sect. 9.2.1. Background information on this remedy and performance standards are provided in Chap. 9 of Vol. 1 of the 2007 RER (DOE 2007a).

9.2.1 Compliance with LTS Requirements

9.2.1.1 Requirements

There are no requirements for post-remediation monitoring and no LTS requirements listed in the Interim Record of Decision (IROD) (DOE 1992). However, the Interim RA PCR (DOE 1994b) states, "because the interim remedial action was to remove debris, no operation and maintenance are necessary as a result of the interim action. However, long-term surveillance and maintenance will continue until decisions are made for future and/or final CERCLA remedial actions at the site."

9.2.1.2 Status of Requirements for FY 2010

The site underwent monthly inspections in FY 2010 performed by the Y-12 S&M Program to inspect components including damaged or missing radiation roping or signs delineating radiation areas; deteriorating access road conditions or damaged or missing gate locks; debris buildup or blockage at the fence/creek boundaries; unauthorized materials placed within the area; damage to site perimeter fencing; and unlocked gate or missing or damaged radiation signs. Additionally, inspections included the separate fenced-in area west of the scrap yard. S&M personnel inspected the fencing by walking the entire perimeter of the site and the west fenced area. Maintenance included clearing fallen trees from the fencing and roadway and routine mowing.

Table 9.1. CERCLA actions at other sites on the ORR

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status [a]	Monitoring/ LTS required	RER section
WWSY (WAG 11) Surface Debris RA	IROD (DOE/OR/1055&D4): 10/06/92	PCR[b] (DOE/OR01/-1263&D2) approved 09/14/94.	No/Yes	9.2
ORAU SCF	ROD (DOE/OR/02-1383&D3): 12/28/95	RAR (DOE/OR/02-1474&D2) approved 08/20/96.	Yes/Yes	9.3

[a] Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <http://www.bechteljacobs.com/ettp_ffa_appendices.shtml>.
[b] This action was completed prior to uniform adherence to the RAR process; hence, no RAR exists for this decision.

Table 9.2. LTS requirements for CERCLA actions at other sites on the ORR

Site/Project	LTS Requirements		Status	RER section
	LUCs	Engineering controls		
WWSY (WAG 11) Surface Debris RA	• Long-term S&M		• LUCs in place	9.2.1
ORAU SCF RA	• Environmental Notice filed at Register of Deeds		• LUCs in place	9.3.3

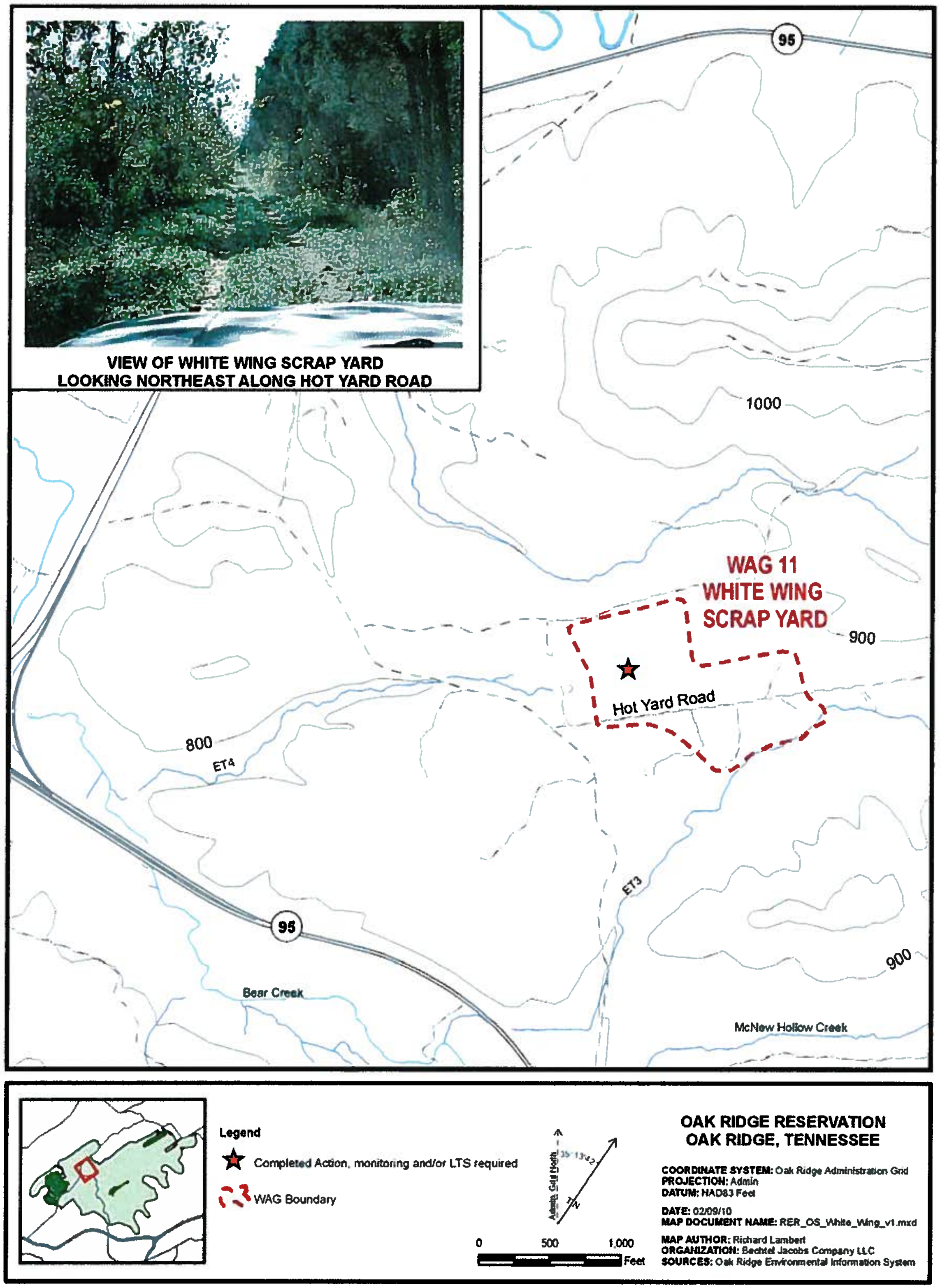


Figure 9.1. Location of White Wing Scrap Yard (WAG 11).

9.3 ORAU SOUTH CAMPUS FACILITY

The SCF is a former experiment station where the radionuclide effects on animals were studied (Figure 9.2). In 1995, a ROD was signed that specified groundwater monitoring in the vicinity of a VOC contaminated area and LUCs that include a groundwater-use restriction. The land use restrictions have been maintained and groundwater monitoring has been conducted at the site. These activities are specified in the documents listed in Table 9.1 and are discussed in this section. Table 9.2 provides a summary of LTS requirements. A complete discussion of the facility and CERCLA decision is provided in Chap. 7 of Vol. 1 of the 2007 RER (DOE 2007a).

9.3.1 Performance Goals and Monitoring Objectives

The SCF ROD (DOE 1995e) did not establish clear goals for groundwater quality; however, it did specify periodic monitoring of groundwater at selected wells and at a surface seep location. During the FY 2006 FYR of the decision, it was recommended that the remedy be redefined as a monitored natural attenuation remedy for groundwater with the ultimate goal of reaching MCLs for the volatile organic contamination in groundwater at the site. Additionally, in the FY 2006 FYR, continued annual sampling of two wells (GW-841 and GW-842) and a surface water location was recommended.

9.3.2 Evaluation of Performance Monitoring Data – FY 2010

During FY 2010, samples were collected from wells GW-841 and GW-842 and surface water locations SCF-WS1 and SCF-WS2 and were analyzed for VOCs. Figure 9.3 shows the concentrations of detected VOCs in wells GW-841 and GW-842 from FY 1994 through FY 2010. Volatile organic contaminant concentrations in wells GW-841 and GW-842 have exhibited a long-term decreasing concentration history. The 2010 results, which were below drinking water standard concentrations, show continuing decreased concentrations compared to the short-term increase observed during 2006 and 2007. No site-related VOCs were detected in the two surface water samples collected during FY 2010.

9.3.3 Compliance with LTS Requirements

9.3.3.1 Requirements

The ROD (DOE 1995e) requires that a notification of the contamination be placed in the property title to alert potential owners of risk. A notice was filed with the Anderson County Register of Deeds on August 28, 1996.

9.3.3.2 Status of Requirements for FY 2010

An on-line search of the Anderson County Register's of Deeds web site was conducted in FY 2010 and verified that the notice remains filed.

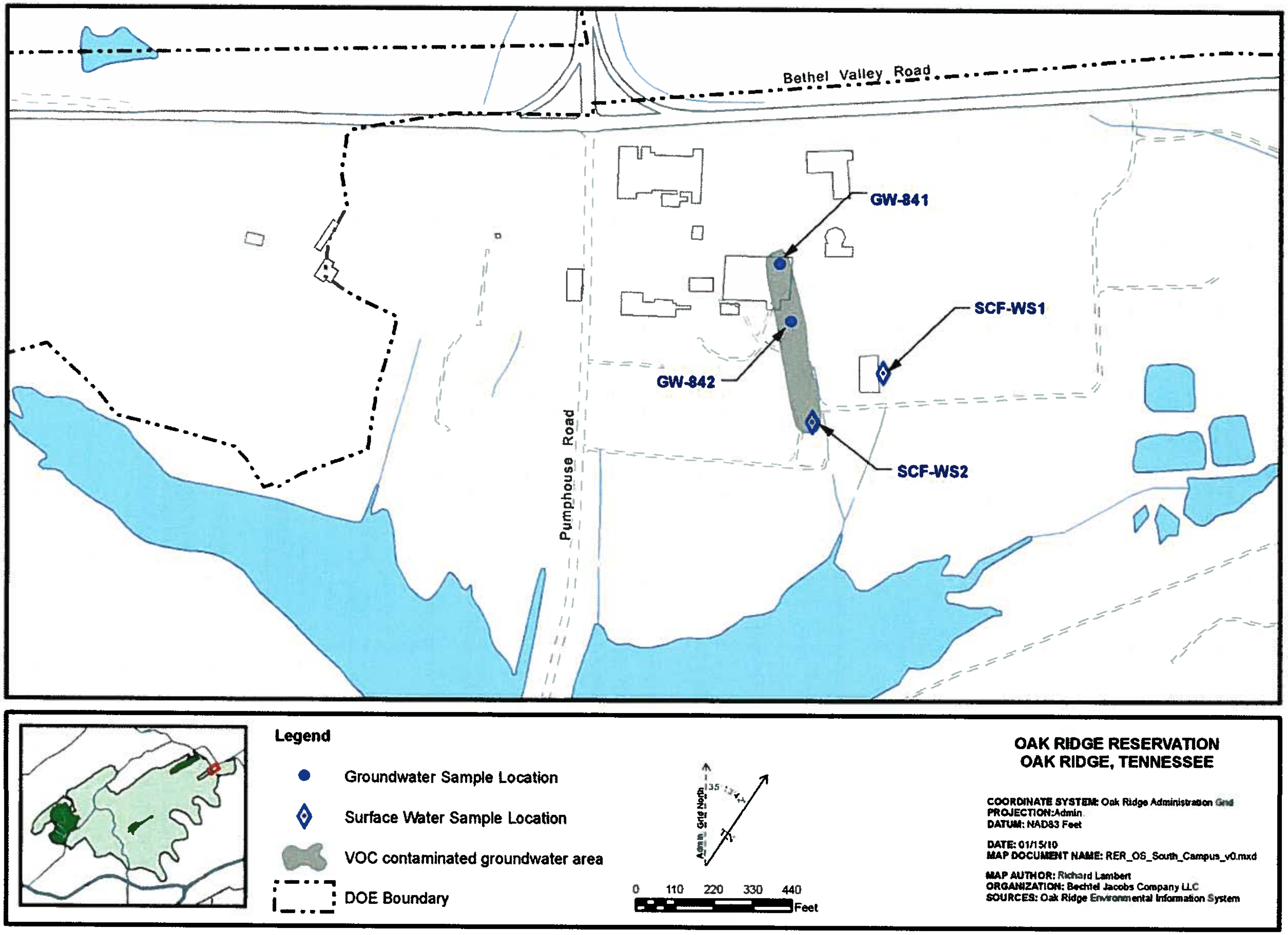


Figure 9.2. South Campus Facility monitoring locations and contaminated groundwater area.

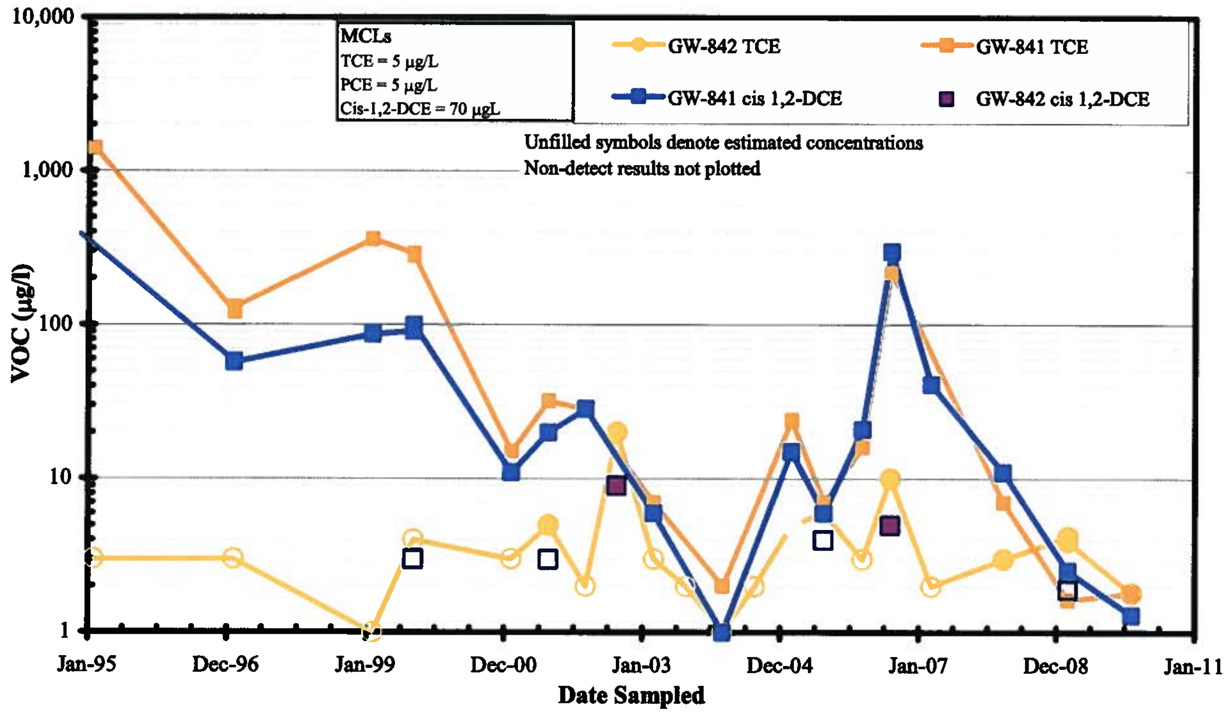


Figure 9.3. VOC concentrations in wells GW-841 and GW-842 at SCF.

9.3.4 Monitoring Changes and Recommendations for ORAU SCF

Volatile organic contaminant concentrations in groundwater at the SCF have exhibited a long-term decreasing concentration history, consistent with a monitored natural attenuation remedy. No monitoring changes at the site are recommended at this time, as reflected in Table 9.3.

Table 9.3. Summary of technical issues and recommendations

Issue[a]	Action/ Recommendation
2011 Current Issue	
None.	
Issue Carried Forward	
None.	
Completed/Resolved Issues	
None.	

[a] An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2010 data for inclusion in the 2011 RER. Issues are identified in the table as an "Issue Carried Forward" to indicate that the issue is carried forward from a previous year's RER so as to track the issue through resolution. Any additional discussion will occur at the appropriate CERCLA Core Team level.

10. REFERENCES

Barbour, M. T., J. Gerritsen, B. D. Snyder and J. B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Addition*. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington D.C.

BJC 2006. *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual*, BJC/OR-2288, Bechtel Jacobs Company LLC, Oak Ridge, TN.

BJC 2010. *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, BJC/OR/-235/R2/A2. Bechtel Jacobs Company LLC, Oak Ridge, TN.

DOE 1991a. *Record of Decision United Nuclear Corporation Disposal Site Declaration, Y-12 Plant, Oak Ridge, Tennessee*, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1991b. *Feasibility Study for the United Nuclear Corporation Disposal Site at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* ES/ER-15&D1, Y/ER/Sub-90/VK168/3&D1, U.S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1992. *Interim Record of Decision for the Oak Ridge National Laboratory, Waste Area Grouping 11, Surface Debris, Oak Ridge, Tennessee*, DOE/OR-1055&D4, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1993a. *Post-Construction Report for the United Nuclear Corporation Disposal Site at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1128&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1993b. *Record of Decision for the K-1407-B/C Ponds at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, DOE/OR/01-1125&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1994a. *Action Memorandum for the Waste Area Grouping 1 Corehole 8 Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1317&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1994b. *Interim Remedial Action Post-Construction Report for Waste Area Grouping 11 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1263&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995a. *Record of Decision for Kerr Hollow Quarry at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/02-1398&D2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1995b. *Record of Decision for the Lower Watts Bar Reservoir Operable Unit, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/02-1373&D3, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1995c. *Record of Decision for Lower East Fork Poplar Creek, Oak Ridge, Tennessee*, DOE/OR/02-1370&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995d. *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin, Oak Ridge, Tennessee*, DOE/OR/01-1371&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1995e. *Record of Decision for Oak Ridge Associated Universities, South Campus Facility, Oak Ridge, Tennessee*, DOE/OR/02-1383&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1996a. *Record of Decision for the Bear Creek Operable Unit 2 (Spoil Area 1 and SY-200 Yard) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/02-1435&D2, U. S. Department of Energy, Environmental Restoration and Waste Management Division, Oak Ridge, TN.

DOE 1996b. *Record of Decision for Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity), Oak Ridge, Tennessee*, DOE/OR/02-1410&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1996c. *Remedial Action Work Plan for Lower Watts Bar Reservoir in Tennessee*, DOE/OR/02-1376&D3, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1997a. *Remedial Action Report on Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1596&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997b. *Record of Decision for an Interim Action for Union Valley, Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, DOE/OR/02-1545&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997c. *Record of Decision for the Clinch River/Poplar Creek Operable Unit, Oak Ridge, Tennessee*, DOE/OR/02-1547&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997d. *Action Memorandum for the K-901-A Holding Pond and the K-1007-P1 Pond Removal Action, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1550&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998a. *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1641/V1-V4&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999a. *Memorandum of Understanding for Implementation of a Land Use Control Assurance Plan (LUCAP) for the United States Department of Energy Oak Ridge Reservation.* Attachment: *Land Use Control Assurance Plan for the Oak Ridge Reservation,* Oak Ridge, TN, DOE/OR/01-1824&D1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999b. *Action Memorandum Addendum for the Waste Area Grouping 1 Corehole 8 Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1831&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999c. *Action Memorandum for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume, Oak Ridge, Tennessee*, DOE/OR/01-1819&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999d. *Remedial Action Report for Clinch River/Poplar Creek in East Tennessee,* DOE/OR/02-1627&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999e. *Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River Poplar Creek Operable Units at the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1820&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999f. *Removal Action Report for the K-901-A Holding Pond and K-1007-P-1 Pond Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1767&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000a. *2000 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1858&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000b. *Record of Decision for Interim Actions for the Melton Valley Watershed, Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-1826&D3, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000c. *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1750&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000d. *Remedial Action Report on the Lower East Fork Poplar Creek Project, Oak Ridge, Tennessee,* DOE/OR/01-1680&D5, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000e. *Record of Decision for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1734&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001a. *Removal Action Report for Uranium Deposit Removal at the Molten Salt Reactor Experiment at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1918&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001b. *Removal Action Report on the Bear Creek Valley S-3 Ponds Pathways 1 and 2 at the Y-12 National Security Complex, Oak Ridge, Tennessee*, DOE/OR/01-1945&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002a. *Record of Decision for Interim Actions in Bethel Valley Watershed, Oak Ridge, Tennessee,* DOE/OR/01-1862&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002b. *Removal Action Report on the Gunite and Associated Tanks Stabilization Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2010&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002c. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, DOE/OR/01-1951&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002d. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-1997&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003a. *Department of Energy Oak Ridge Operations Environmental Management Program Long-Term Stewardship Program,* Office of Environmental Management, U.S. Department of Energy, Oak Ridge, TN.

DOE 2003b. *Remedial Action Report on the Surface Impoundments Operable Unit at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2086&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003c. *Removal Action Report for the Metal Recovery Facility, Building 3505, at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2000&D2/R1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003d. *Phased Construction Completion Report for the Bear Creek Valley Boneyard/Burnyard Remediation Project at the Y-12 National Security Complex, Oak Ridge, Tennessee*, DOE/OR/01-2077&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003e. *2003 Remediation Effectiveness Report for the U. S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2058&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003f. *Remedial Action Report for the K-1070-A Burial Ground at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2090&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004a. *Explanation of Significant Differences for the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*, DOE/OR/01-2194&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004b. *Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River Poplar Creek Operable Units at the Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1820&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005a. *Engineering Study Report for Groundwater Actions in Bethel Valley, Oak Ridge Tennessee*, DOE/OR/01-2219&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005b. *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2161&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005c. *Phased Construction Completion Report for the Remediation of Tanks T-1, T-2, and HFIR at the Oak Ridge National Laboratory, Oak Ridge,* Tennessee, DOE/OR/01-2238&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006a. *Land Use Control Implementation Plan for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-1977&D6, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006b. *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume, Oak Ridge, Tennessee,* DOE/OR/01-2297&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006c. *Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1 East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2261&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006d. *Phased Construction Completion Report for the K-1007 Ponds Area and Powerhouse North Area in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2294&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006e. *Fiscal Year 2006 Phased Construction Completion Report for the Zone 2 Soils, Slabs, and Subsurface Structures at East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2317&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007a. *2007 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE/OR/01-2337&D2/V1&V2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007b. *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE/OR/01-2289&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007c. *Melton Valley Surveillance and Maintenance Plan, Oak Ridge, Tennessee,* DOE/OR/01-2342&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007d. *Addendum to the Removal Action Report for the Bear Creek Valley Interception Trenches for the S-3 Uranium Plume, Pathway 1 and 2 at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR/01-1836&D1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007e. *Action Memorandum for Reduction of Hexavalent Chromium Releases Into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2369&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007f. *Remedial Action Work Plan for Dynamic Verification Strategy for Zone 1 East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2182&D4, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007g. *Phased Construction Completion Report for the K-770 Scrap Removal Project of the Zone 1 Remediation at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2348&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007h. *Fiscal Year 2007 Phased Construction Completion Report for the Zone 2 Soils, Slabs, and Subsurface Structures at East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2723&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007i. *Action Memorandum for the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee: K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment, Oak Ridge, Tennessee,* DOE/OR/01-2314&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007j. *Fiscal Year 2007 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2362&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008a. *Phased Construction Completion Report for the Removal and Transfer of the Uranium from the Molten Salt Reactor Experiment Facility at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2256&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008b. *Focused Feasibility Study for the Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2382&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008c. *Proposed Plan for the Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge, Tennessee*, DOE/OR/01-2383&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008d. *Remedial Design Report/Remedial Action Work Plan for Scrap Metal at the Y-12 Old Salvage Yard at the Y-12 National Security Complex, Oak Ridge, Tennessee*, DOE/OR/01-2376&D2, Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008e. *Fiscal Year 2008 Phased Construction Completion Report for EU Z2-33 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR-2368&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008f. *Phase I Treatability Study Work Plan for Sitewide Groundwater at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2387&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008g. *Removal Action Report for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2384&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008h. *Fiscal Year 2008 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2394&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008i. *FY 2008 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2395&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008j. FY *2008 Phased Construction Completion Report for Exposure Units Z1-01, Z1-03, Z1-38, and Z1-49 in Zone 1 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2367&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008k. *Removal Action Work Plan for the Removal Action at the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2359&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008l. *ETTP Ponds Post-Action Sampling and Analysis Plan, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2389&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009a. *Remedial Design Report/Remedial Action Work Plan for Soils, Sediments and Dynamic Characterization Strategy for Bethel Valley, Oak Ridge, Tennessee,* DOE/OR/01-2378&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009b. *Addendum to the Remedial Design Report/Remedial Action Work Plan for the Decontamination and Decommissioning of Non-Reactor Facilities in Bethel Valley at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2428&D2/A2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009c. *Time-Critical Removal Action Memorandum for the Facility 3026 C&D Wooden Superstructure at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2402&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009d. *Time-Critical Removal Action Memorandum for the 2000 Complex Facilities Demolition at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2412&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009e. *Time-Critical Removal Action Memorandum for Buildings 3074 and 3136, and the 3020 Stack at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2407&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009f. *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2343&D1/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009g. *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2343&D1/A2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009h. *Engineering Study Report for the West End Mercury Area (WEMA) Storm Sewer Remediation Project at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2429&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009i. *Characterization Plan for the 81-10 Area in the Upper East Fork Poplar Creek Area at the Oak Ridge Y-12 National Security Complex,* DOE/OR/01-2419&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009j. *Waste Handling Plan, Part 1 for Scrap Metal at the Y-12 Old Salvage Yard at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2385&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009k. *Upper East Fork Poplar Creek Soils Remedial Action Work Plan,* DOE/OR/01-2423&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009l. *Addendum to the Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1 East Tennessee Technology Park,* DOE/OR/01-2261&D2/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009m. *Fiscal Year 2009 Phased Construction Completion Report for Zone 2 Exposure Units 11, 12, 17, 18, 29, and 38 at East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2415&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009n. *Engineering Evaluation/Cost Analysis for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2422&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009o. *Phased Construction Completion Report for Fiscal Year 2008 Earned Value for the K-25/K-27 Decontamination and Decommissioning Project, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2396&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009p. *FY 2009 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities,* DOE/OR/01-2435&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009q. *Erratum to the Fiscal Year 2008 Phased Construction Completion Report for EU Z2-33 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2368&D2/R2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009r. *Fiscal Year 2009 Phased Construction Completion Report for EU Z2-36 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2399&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009s. *Erratum to the ETTP Ponds Post-Action Sampling and Analysis Plan, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2389&D1/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010a. *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2472&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010b. *Remedial Design Report/Remedial Action Work Plan for the Bethel Valley Burial Grounds at the Oak Ridge National Laboratory, Oak Ridge, Tennessee, Addendum 1, Wetlands and Streams*

Impacts, DOE/OR/01-2427&D2/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010c. *Treatability Study Work Plan for the 7000 Area in Bethel Valley, Oak Ridge, Tennessee, Oak Ridge, Tennessee,* DOE/OR/01-2475&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010d. *Remedial Design Report/Remedial Action Work Plan for the Bethel Valley (Corehole 8) Extraction System at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2469&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010e. *Explanation of Significant Differences from the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee, Bethel Valley Burial Grounds*, DOE/OR/01-2446&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010f. *Action Memorandum for Time-Critical Removal Action for Corrective Actions at White Oak Dam, Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2460&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010g. *Addendum to the Melton Valley Monitoring Plan, Oak Ridge, Tennessee, Appendix E,* DOE/OR/01-1982&D1/R4/A1/R2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010h. *Remedial Design Report/Remedial Action Work Plan for the West End Mercury Area (WEMA) Storm Sewer Remediation Project at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2447&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010i. *Addendum to the Upper East Fork Poplar Creek Soils Remedial Action Work Plan, DOE/OR/01-2423&D1/A1*, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010j. *Removal Action Work Plan for the Y-12 Facilities Deactivation/Demolition Project, Oak Ridge, Tennessee,* DOE/OR/01-2479&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010k. *Addendum to the Phased Construction Completion Report for the K-1007 Ponds Area and Powerhouse North Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2294&D2/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010l. *Fiscal Year 2010 Phased Construction Completion Report for EU Z2-32 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2452&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010m. *Fiscal Year 2010 Phased Construction Completion Report for EU Z2-31 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2443&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010n. *Addendum to the Phased Construction Completion Report for the K-770 Scrap Removal Project of the Zone 1 Remediation at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2348&D1/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010o. *Action Memorandum for the Long-Term of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tenn*essee, DOE/OR/01-2448&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010p. *Phased Construction Completion Report for Fiscal Year 2009 Earned Value for the K-25/K-27 Decontamination and Decommissioning, Project, East Tennessee Technology Park, Oak Ridge, Tennesse*e, DOE/OR/01-2436&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010q. *Fiscal Year 2009 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2434&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010r. *Phased Construction Completion Report for Poplar Creek High-Risk Facilities K-1231, K-1233, and K-413 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2444&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010s. Addendum to *Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1 East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2261&D2/A1/R1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010t. *Addendum to the Removal Action Work Plan for the Removal Action at the Ponds at the East Tennessee Technology Park Oak Ridge, Tennessee,* DOE/OR/01-2359&D2/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010u. *Removal Action Report for the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee: K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment,* DOE/OR/01-2456&D1/R1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Etnier, D. A. 1971. Food of three species of sunfishes (*Lepomis*, Centrarchidae) and their hybrids in three Minnesota lakes. Trans. Amer. Fish. Soc. 97:466-471.

Jensen, J. B., C. D. Camp, W. Gibbons and M. J. Elliott. 2008. Amphibians and Reptiles of Georgia. The University of Georgia Press, Athens, Georgia. 575 pp.

Nicholson, C. P. 1997. Atlas of the Breeding Birds of Tennessee. The University of Tennessee Press, Knoxville, TN. 426 pp.

Peterson, M. J., N. R. Giffen, M. G. Ryon, L. R. Pounds, and E. L. Ryan, Jr., 2005. *Environmental Survey Report for the ETTP: Environmental Management Waste Management Facility (EMWMF) Haul Road Corridor, Oak Ridge, Tennessee*, ORNL/TM-2005/215, Oak Ridge National Laboratory, Oak Ridge, TN.

Peterson, M. J., J. G. Smith, M. G. Ryon, W. K. Roy, and J. A. Darby, 2009. *Stream Mitigation Monitoring of North Tributary 3 (NT-3), Bear Creek Valley, Oak Ridge, Tennessee.* ORNL/TM-2009/053.

Peterson, M. J., B. Looney, G. Southworth, C. Eddy-Dilek, D. Watson, R. Ketelle, and M. Bogle, Publication Pending, *Conceptual Model of Primary Mercury Sources, Transport Pathways, and Flux at the Y-12 Complex and Upper East Fork Poplar Creek, Oak Ridge, Tennessee.*

Porej, D. and T. E. Hetherington. 2005. *Designing wetlands for amphibians: The importance of predatory fish and shallow littoral zones in structuring of amphibian communities.* Wetlands Ecology and Management. 13:445-455.

Southworth, G., M. Greeley, M. Peterson, K. Lowe, and R. Ketelle, 2010. *Sources of Mercury to East Fork Poplar Creek Downstream from the Y-12 National Security Complex: Inventories and Export Rates*, ORNL/TM-2009/231, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

TDEC 1996. *Post-Closure Permit for the Chestnut Ridge Hydrogeologic Regime, TNHW-088, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* EPA I.D. No. TN 3 89 009 0001, June 1996, Tennessee Department of Environment and Conservation-Division of Solid Waste Management.

TDEC 2004a. Revised *Rules of Tennessee Department of Environment and Conservation*, Tennessee Water Pollution Control Board, Division of Water Pollution Control, Chap. 1200-4-3, "General Water Quality Criteria," Nashville, TN, January (revised).

TDEC 2006. RCRA *Post-Closure Permit for Chestnut Ridge Hydrogeologic Regime, TNHW-128, Y-12 National Security Complex, Oak Ridge, Tennessee*, EPA I.D. No. TN3 89 009 0001, September 2006, Tennessee Department of Environment and Conservation-Division of Solid Waste Management, Nashville, TN.

11. BIBLIOGRAPHY

11.1. GENERAL

DOE 1996. *1996 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1491&D1, U.S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1997. *1997 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1584&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998. *1998 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1693&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Memorandum of Understanding for Implementation of a Land Use Control Assurance Plan (LUCAP) for the United States Department of Energy Oak Ridge Reservation.* Attachment: *Land Use Control Assurance Plan for the Oak Ridge Reservation,* Oak Ridge, TN, DOE/OR/01-1824&D1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *1999 Remediation Effectiveness Report, U.S. Department of Energy Oak Ridge Reservation*, DOE/OR/01-1790&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000. *2000 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1858&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *2001 Remediation Effectiveness Report/CERCLA Five Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1941&D2/R1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002. *2002 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2011&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *2003 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2058&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004. *2004 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,*DOE/OR/01-2133&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE/OR/01-2289&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *2007 Remedial Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Volume 2: Data and Evaluations*, DOE/OR/01-2337&D2/V2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *2008 Remedial Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Volume 2: Data and Evaluations,* DOE/OR/01-2366&D2/V2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *2009 Remedial Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Data and Evaluations*, DOE/OR/01-2393&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *2010 Remedial Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Data and Evaluations*, DOE/OR/01-2437&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.2. BETHEL VALLEY WATERSHED DOCUMENTS

BV Interim Actions

DOE 2002. *Record of Decision for Interim Actions in Bethel Valley Watershed, Oak Ridge, Tennessee,* DOE/OR/01-1862&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Adler, D. G., July 12, 2004, DOE-ORO, letter to Ms. Mary McKee, Bechtel Jacobs Company, Subject: Bethel Valley Administrative Record, Reference: Letter from Steve J. Smith, DE-AC05-98OR22700: *Transmittal of the D1 Version of the Notification of Non-Significant Change to the Record of Decision for Interim Actions in Bethel Valley: Addition of Hot Storage Garden (3597)* (DOE/OR/01-2152&D1) dated June 28, 2004.

Adler, D. G., December 3, 2004, DOE-ORO, letter to J. Crane, Region IV, and D. McCoy, TDEC DOE Oversight Div., Subject: Notice of Non-Significant Change to the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee (DOE/OR/01-1862&D4).

Kopotic, J. and Adler, D. G., September 10, 2009, DOE-ORO, letter to J. Crane, Region IV, and R. Petric, TDEC DOE Oversight Div., Subject: Notice of Non-Significant Change to the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee (DOE/OR/01-1862&D4).

Kopotic, J. and Adler, D. G., October 26, 2009, DOE-ORO, letter to J. Crane, Region IV, and R. Petric, TDEC DOE Oversight Div., Subject: Notice of Non-Significant Change Errata Pages to the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee (DOE/OR/01-1862&D4).

DOE 2005. *Phased Construction Completion Report for the Remediation of Tanks T-1, T-2, and HFIR at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2238&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Remedial Design Report/Remedial Action Work Plan for Soils, Sediments and Dynamic Characterization Strategy for Bethel Valley, Oak Ridge, Tennessee,* DOE/OR/01-2378&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion, Oak Ridge, Tennessee*, DOE/OR/01-2472&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Remedial Design Report/Remedial Action Work Plan for the Bethel Valley Burial Grounds at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2427&D2/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Explanation of Significant Differences from the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee, Bethel Valley Burial Grounds*, DOE/OR/01-2446&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Treatability Study Work Plan for 7000 Area in Bethel Valley, Oak Ridge, Tennessee*, DOE/OR/01-2475&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

WAG 1 Corehole 8 Plume Removal Action (Plume Collection)

DOE 1994. *Action Memorandum for the Waste Area Grouping 1 Corehole 8 Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1317&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995. *Remedial Action Report for the Corehole 8 Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1380&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1999. *Action Memorandum Addendum for the Waste Area Grouping 1 Corehole 8 Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1831&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Phase I Operations Letter Report for Construction of a Groundwater Pre-Treatment System and Groundwater Extraction at Well 4411* (DOE/OR/01-1832&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 2000. *Phase II Operations Report for Groundwater Extraction at Well 4411, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1882&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Building 3001 Canal Removal Action

DOE 1996. *Action Memorandum for Building 3001 Canal, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1533&D2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1997. *Removal Action Report on the Building 3001 Canal at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1599&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

SIOU RA

DOE 1997. *Record of Decision for the Surface Impoundments Operable Unit, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1630&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Remedial Action Report on the Surface Impoundments Operable Unit C (3539) and D (3540) at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1784&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Remedial Action Report on the Surface Impoundments Operable Unit at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2086&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

MRF RA

DOE 2000. *Action Memorandum for the Demolition of the Metal Recovery Facility, Building 3505 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1843&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Removal Action Report for the Metal Recovery Facility, Building 3505, at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2000&D2/R1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

WAG 1 Tank WC-14 Time-Critical Removal Action (Liquid removal)

DOE 1995. *Action Memorandum for the Waste Area Grouping 1 Tank WC-14 Removal at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1322&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995. *Remedial Action Report for the Waste Area Grouping 1 Tank WC-14 Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1397&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

WAG 1 Tank WC-14 Time-Critical Removal Action (Sludge removal)

DOE 1997. *Time-Critical Removal Action Memorandum for the Waste Area Grouping 1 Tank WC-14 at the Oak Ridge National Laboratory*, DOE/OR/02-1598&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998. *Removal Action Report on Tank WC-14 at Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1738&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Waste Evaporator Facility Removal Action

DOE 1995. *Action Memorandum for the Building 3506 Waste Evaporator Facility Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1381&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1996. *Removal Action Report on the Waste Evaporator Facility, Building 3506 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1460&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

GAAT OU Interim Removal Action

DOE 1997. *Record of Decision for Interim Action: Sludge Removal from the Gunite and Associated Tanks Operable Unit, Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1591&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *Remedial Action Report on the Gunite and Associated Tanks Interim Remedial Action Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1955&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Inactive LLLW Tanks Removal Action

DOE 1994. *Action Memorandum for the Bethel Valley Main Plant Inactive Liquid Low-Level Radioactive Waste Tanks at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1813&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Action Memorandum Addendum for the Bethel Valley Main Plant Inactive Liquid Low-Level Radioactive Waste Tanks, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1833&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *Removal Action Report for the Bethel Valley Main Plant Inactive Liquid Low-Level Radioactive Waste Tanks at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1953&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

GAAT Stabilization Removal Action (Shells/Risers)

DOE 2001. *Action Memorandum to Stabilize Gunite and Associated Tanks at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1957&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002. *Removal Action Report on the Gunite and Associated Tanks Stabilization Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2010&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Corehole 8 Plume Source (Tank W-1A) Removal Action

DOE 1998. *Action Memorandum for the Corehole 8 Plume Source (Tank W-1A) Removal Action at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1749&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *Removal Action Report for the Corehole 8 Plume Source (Tank W-1A) at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1969&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Remedial Design Report/Remedial Action Work Plan for the Bethel Valley (Corehole 8) Extraction System at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2469&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Non-Reactor Facilities D&D

DOE 2009. *Time-Critical Removal Action Memorandum for the 2000 Complex Facilities Demolition at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2412&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Time-Critical Removal Action Memorandum for Buildings 3074 and 3136, and the 3020 Stack at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2407&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Remedial Design Report/Remedial Action Work Plan for the Decontamination and Decommissioning of Non-Reactor Facilities in Bethel Valley at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2428&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. Addendum to the *Remedial Design Report/Remedial Action Work Plan for the Decontamination and Decommissioning of Non-Reactor Facilities in Bethel Valley at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2428&D2/A2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

BV Isotopes Facilities D&D

DOE 2009. *Time-Critical Removal Action Memorandum for the Facility 3026 C&D Wooden Superstructure at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2402&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.3. MELTON VALLEY WATERSHED DOCUMENTS

MV Interim Actions

DOE 2000. *Record of Decision for Interim Actions for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1826&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Explanation of Significant Differences for the Record of Decision for Interim Actions for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2040&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004. *Amendment to the Record of Decision for Interim Actions for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee: Revised Remedial Action for Seepage Trenches 5 and 7*, DOE/OR/01-2170&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004. *Explanation of Significant Differences for the Record of Decision for Interim Actions for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee, Addition of Units to the Selected Remedy*, DOE/OR/01-2165&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005. *Explanation of Significant Difference for the Record of Decision for Interim Actions for the Melton Valley Watershed, Deletion of Molten Salt Reactor Experiment Ancillary Facilities from the Selected Remedy*, DOE/OR/01-2249&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 2006. *Land Use Control Implementation Plan for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge Tennessee,* DOE/OE/01-1977&D6, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report (PCCR) for the Old Hydrofracture Facility Decontamination and Decommissioning Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2014&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the Hydrofracture Well Plugging and Abandonment Project at the Oak Ridge National Laboratory Oak Ridge, Tennessee,* DOE/OR/01-2138&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the Hydrologic Isolation at Solid Waste Storage Area 6 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2285&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for Hydrologic Isolation of Solid Waste Storage Area 5 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2286&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report (PCCR) for the Solid Waste Storage Area 4 and the Intermediate Holding Pond at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2300&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for Trenches 5 and 7 and HRE Fuel Wells, In-Situ Grouting Project, Oak Ridge, Tennessee,* DOE/OR/01-2302&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the New Hydrofracture Facility Decontamination and Decommissioning Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2306&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the Homogeneous Reactor Experiment Ancillary Facilities Decontamination and Decommissioning Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2307&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for Hydrologic Isolation at the Seepage Pits and Trenches Area at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2310&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the Melton Valley Soils and Sediments Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2315&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the 7841 Equipment Storage Area and 7802F Storage Shed Decontamination and Decommissioning Project at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2323&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Explanation of Significant Differences for the Record of Decision for Interim Actions for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee: Deletion of STTs From the Selected Remedy,* DOE/OE/01-2333&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Remedial Action Report for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2343&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2343&D1/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2343&D1/A2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Action Memorandum for Time-Critical Removal Action for Corrective Actions at White Oak Dam, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2460&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Addendum to the Melton Valley Monitoring Plan, Oak Ridge, Tennessee, Appendix E,* DOE/OR/01-1982&D1/R4/A1/R2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

WOCE

ORNL 1992. *White Oak Creek Embayment Time-Critical CERCLA Removal Action Sediment-Retention Structure,* ORNL/ER/Sub/91-KA931/4, Oak Ridge National Laboratory, Oak Ridge, TN.

WAG 13 Cesium Plots

DOE 1992. *Interim Record of Decision for Oak Ridge National Laboratory, Waste Area Grouping 13, Cesium Plots, Oak Ridge, Tennessee*, DOE/OR-1059&D4, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1994. *Interim Remedial Action Post-Construction Report for Waste Area Grouping 13 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1218&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

WAG 5 Seep C

DOE 1994. *Action Memorandum for the Waste Area Grouping 5 Seep C at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1235&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995. *Post-Construction Report for Waste Area Grouping 5 Seeps Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1334&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

WAG 5 Seep D

DOE 1994. *Action Memorandum for the Waste Area Grouping 5 Seep D at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1283&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995. *Post-Construction Report for Waste Area Grouping 5 Seeps Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1334&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

WAG 4 Seep Control

DOE 1996. *Action Memorandum for the Waste Area Grouping 4 Seeps at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1440&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1996. *Removal Action Report on Waste Area Grouping 4 Seeps 4 and 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1544&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

MSRE D&D Reactive Gas

DOE 1997. *Removal Action Report on the Molten Salt Reactor Experiment Time-Critical Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1623&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

MSRE D&D Uranium Deposit Removal

DOE 1996. *Action Memorandum for Uranium Deposit Removal at the Molten Salt Reactor Experiment*, DOE/OR/02-1488&D2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 2001. *Removal Action Report for Uranium Deposit Removal at the Molten Salt Reactor Experiment at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1918&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Phased Construction Completion Report for the Removal and Transfer of the Uranium from the Molten Salt Reactor Experiment Facility at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-2256&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

OHF Tank Sludges

DOE 1996. *Action Memorandum for Waste Area Grouping 5 Old Hydrofracture Facility Tanks at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/02-1487&D2, U. S. Department of Energy, Office of Environmental Restoration and Watershed Management, Oak Ridge, TN.

DOE 1998. *Removal Action Report for the Contents Removal of the Old Hydrofracture Facility Tanks*, DOE/OR/01-1759&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

OHF Tanks and Impoundment

DOE 1999. *Action Memorandum for the Old Hydrofracture Facility Tanks and Impoundment at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1751&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000. *Action Memorandum Addendum for the Old Hydrofracture Facility Tanks and Pond at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1866&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *Removal Action Report for the Old Hydrofracture Facility Tanks and Pond, Process Waste Sludge Basin, and T-4 Waste Pit at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1908&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

MSRE D&D Fuel Salt Removal

DOE 1998. *Record of Decision for Interim Action to Remove Fuel and Flush Salts from the Molten Salt Reactor Experiment Facility*, DOE/OR/02-1671&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Explanation of Significant Differences for the Record of Decision for Interim Action to Remove Fuel and Flush Salts From the Molten Salt Reactor Experiment Facility at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* DOE/OR/01-2088&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.4. BEAR CREEK WATERSHED DOCUMENTS

BCV Phase I ROD

DOE 2000. *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1750&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *Phased Construction Completion Report for the Bear Creek Valley Oil Landfarm Soil Containment Pad at the Y-12 National Security Complex Oak Ridge, Tennessee,* DOE/OR/01-1937&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Phase Construction Completion Report for the Bear Creek Valley Boneyard/Burnyard Remediation Project at the Y-12 National Security Complex Oak Ridge, Tennessee,* DOE/OR/01-2077&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Land Use Control Implementation Plan for Phase I Activities in the Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-2320&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

BCV OU 2 RA Spoil Area 1, SY-200 Yard

DOE 1996. *Record of Decision for Bear Creek Operable Unit 2 (Spoil Area 1 and SY-200 Yard) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/02-1435&D2, U. S. Department of Energy, Environmental Restoration and Waste Management Division, Oak Ridge, TN.

S-3 Site Tributary Interception (Pathways 1 & 2)

DOE 1998. *Action Memorandum for the Bear Creek Valley Tributary Inspection Trenches for the S-3 Uranium Plume, Oak Ridge, Tennessee*, DOE/OR/01-1739&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000. *Addendum to the Action Memorandum for the Bear Creek Valley Tributary Interception Trenches for the S-3 Uranium Plume, Oak Ridge, Tennessee,* DOE/OR/01-1739&D1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2001. *Removal Action Report on the Bear Creek Valley S-3 Ponds Pathways 1 and 2 at the Y-12 National Security Complex, Oak Ridge, Tennessee*, DOE/OR/01-1945&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Addendum to the Removal Action Report for the Bear Creek Valley Interception Trenches for the S-3 Uranium Plume, Pathways 1 and 2 at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1836&D1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

BCBG Unit D-East

DOE 2002. *Action Memorandum for Cover Repair and Revegetation of Burial Ground D-East at the Y-12 National Security Complex, Oak Ridge, Tennessee*, DOE/OR/01-2036&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Removal Action Report for Burial Ground D-East Revegetation at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2048&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.5. CHESTNUT RIDGE

UNC Disposal Site RA

DOE 1991. *Record of Decision United Nuclear Corporation Disposal Site Declaration, Y-12 Plant, Oak Ridge, Tennessee*, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1993. *Post-Construction Report for the United Nuclear Corporation Disposal Site at the Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1128&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

KHQ RA

DOE 1995. *Record of Decision for Kerr Hollow Quarry at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/02-1398&D2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

FCAP/Upper McCoy Branch RA

DOE 1996. *Record of Decision for Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity), Oak Ridge, Tennessee*, DOE/OR/02-1410&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1997. *Remedial Action Report on Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1596&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.6. UEFPC WATERSHED DOCUMENTS

Phase I Interim Source Control Actions

DOE 2002. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, DOE/OR/01-1951&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Lopez-Ferre′, M., and Adler, D. G., DOE-ORO, August 30, 2006, letter to J. Crane, Region IV, and D. McCoy, TDEC DOE Oversight Div., Proposed Changes in Upper East Fork Poplar Creek Mercury Monitoring, Non-Significant Change to the "Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee." NSC approved October 5, 2006.

Adler, D.G., DOE-ORO, December 20, 2006, letter to J. Crane, Region IV, and D. McCoy, TDEC DOE Oversight Div., re: Proposed Non-Significant Changes to Two Signed Records of Decisions, Discontinuation of Building 9205-1 Sump Water Treatment, Non-Significant Change to the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, (DOE/OR/01-1951&D3). Change to the *Record of Decision for Oak Ridge Associated Universities South Campus Facility, Oak Ridge, Tennessee*, (DOE/OR/02-1383&D3). NSC approved May 17, 2007.

Lopez-Ferre′, M., and Adler, D. G., DOE-ORO, September 17, 2007, letter to J. Crane, Region IV, and D. McCoy, TDEC DOE Oversight Div., Erratum to the Mercury Monitoring Non-Significant Change to the "Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee." NSC approved June 9, 2008.

DOE 2005. *Phased Construction Completion Report for the Big Spring Water Treatment System at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2218&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Record of Decision for Phase II Interim Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek, Oak Ridge, Tennessee*, DOE/OR/01-2229&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Remedial Design Report/Remedial Action Work Plan for Scrap Metal at the Y-12 Old Salvage Yard at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2376&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Remedial Design Report/Remedial Action Work Plan for the West End Mercury Area (WEMA) Storm Sewer Remediation Project at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2447&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Dynamic Work Plan for Soils at the Old Salvage Yard at the Oak Ridge Y-12 National Security Complex, Oak Ridge, Tennessee, Attachment A.1 to the Upper East Fork Poplar Creek Soils Remedial Action Work Plan,* DOE/OR/01-2423&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Y-12 Plant EEVOC Plume Removal Action

DOE 1999. *Action Memorandum for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume, Oak Ridge, Tennessee,* DOE/OR/01-1819&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Plume, Oak Ridge, Tennessee,* DOE/OR/01-2297&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Union Valley

DOE 1997. *Record of Decision for an Interim Action for Union Valley, Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee,* DOE/OR/02-1545&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Mercury Tanks Interim Remedial Action

DOE 1991. *Record of Decision, Interim Action for the Mercury Tank Remediation,* DOE/OR/02-1164, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1993. *Post-Construction Report for the Mercury Tanks Interim Action at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR/01-1169&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

Plating Shop Container Areas Remedial Action

DOE 1992. *Record of Decision for the Y-12 Plating Shop Container Areas, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR-1049&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

ANAP (UEFPC OU 2)

DOE 1994. *Record of Decision for the Upper East Fork Poplar Creek Operable Unit 2 (Abandoned Nitric Acid Pipeline) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR/02-1265&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

Building 9201-4 Exterior Process Piping

DOE 1997. *Action Memorandum for Building 9201-4, Exterior Process Piping Removal at the Y-12 Plant, Oak Ridge,Tennessee*, DOE/OR/02-1571&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997. *Removal Action Report for Building 9201-4 Exterior Process Piping Removal at the Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/02-1650&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Lead Source Removal at the Former YS-860, Firing Ranges Removal Action

DOE 1997. *Action Memorandum for Lead Source Removal at the Former YS-860 Firing Ranges, Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/02-1622&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Removal Action Report for the Lead Source Removal at the Former YS-860 Firing Ranges, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1774&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

9822 Sediment Basin and 81-10 Sump Removal Action

DOE 1998. *Action Memorandum for the Y-12 Plant 9822 Sediment Basin and Building 81-10 Sump, Oak Ridge, Tennessee*, DOE/OR/01-1716&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Removal Action Report for the 9822 Sediment Basin and Building 81-10 Sump at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1763&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Y-12 Building D&D

DOE 2009. *Action Memorandum for Time-Critical Removal of Legacy Materials from Buildings 9201-5 and 9204-4 at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2404&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Action Memorandum for Time-Critical Removal Action for Demolition of Building 9735 and the Building 9206 Filter House at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2405&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Action Memorandum for Time-Critical Removal Action for Demolition of Buildings 9211, 9220, 9224 and 9769 (Biology Complex) at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2406&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Removal Action Work Plan for the Y-12 Facilities Deactivation/Demolition Project, Oak Ridge, Tennessee*, DOE/OR/01-2479&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.7. OFF-SITE LOCATIONS DOCUMENTS

LEFPC

DOE 1995. *Record of Decision for Lower East Fork Poplar Creek, Oak Ridge, Tennessee*, DOE/OR/02-1370&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1996. *Explanation of Significant Differences for the Lower East Fork Poplar Creek Record of Decision, Oak Ridge, Tennessee*, DOE/OR-02-1443&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 2000. *Remedial Action Report on the Lower East Fork Poplar Creek Project, Oak Ridge, Tennessee*, DOE/OR/01-1680&D5, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

CR/PC

DOE 1997. *Record of Decision for the Clinch River/Poplar Creek Operable Unit, Oak Ridge, Tennessee*, DOE/OR/02-1547&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Remedial Action Report for Clinch River/Poplar Creek in East Tennessee*, DOE/OR/02-1627&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

LWBR

DOE 1995. *Record of Decision for the Lower Watts Bar Reservoir*, DOE/OR/02-1373&D3, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1996. *Remedial Action Work Plan for Lower Watts Bar Reservoir*, DOE/OR/02-1376&D3, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

11.8. ETTP DOCUMENTS

Zone 1 Selected Contaminated Areas Interim Removal Actions

DOE 2002. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1997&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2261&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Phased Construction Completion Report for the K-1007 Ponds Area and the Powerhouse North Area in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2294&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Phased Construction Completion Report for the K-770 Scrap Removal Project of the Zone 1 Remediation at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2348&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *FY 2008 Phased Construction Completion Report for Exposure Units Z1-01, Z1-03, Z1-38, and Z1-49 in Zone 1 at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2367&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. Addendum to the *Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2261&D2/A1/R1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Addendum to the Phased Construction Completion Report for the K-1007 Ponds Area and Powerhouse North Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2294&D2/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Addendum to the Phased Construction Completion Report for the K-770 Scrap Removal Project of the Zone 1 Remediation at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2348&D1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Zone 2 Soil, Buried Waste, and Subsurface Structure Removal Actions

DOE 2005. *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2161&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Fiscal Year 2006 Phased Construction Completion Report for the Zone 2 Soils, Slabs, and Subsurface Structures at East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2317&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Fiscal Year 2007 Phased Construction Completion Report for the Zone 2 Soils, Slabs, and Subsurface Structures at East Tennessee Technology Park, Oak Ridge, Tennessee.* DOE/OR/01-2723&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Fiscal Year 2008 Phased Construction Completion Report for EU Z2-33 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR-2368&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Fiscal Year 2008 Phased Construction Completion Report for EU Z2-33 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2368&D2/R1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Erratum to the Fiscal Year 2008 Phased Completion Report for EU Z2-33 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2368&D2/R2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Fiscal Year 2009 Phased Construction Completion Report for EU Z2-36 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2399&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Fiscal Year 2009 Phased Construction Completion Report for Zone 2 Exposure Units 11, 12, 17, 18, 29, and 38 at East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2415&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Fiscal Year 2010 Phased Construction Completion Report for EU Z2-31 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2443&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Fiscal Year 2010 Phased Construction Completion Report for EU Z2-32 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2452&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

ETTP Ponds

DOE 2007. *Action Memorandum for the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee: K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment, Oak Ridge, Tennessee,* DOE/OR/01-2314&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Removal Action Work Plan for the Removal Action at the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2359&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Addendum to the Removal Action Work Plan for the Removal Action at the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2359&D2/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Removal Action Report for the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee: K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment,* DOE/OR/01-2456&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Mitchell Branch Chrome Reduction

DOE 2007. *Action Memorandum for Reduction of Hexavalent Chromium Releases Into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2369&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Removal Action Report for the Reduction of Hexavalent Chromium Releases Into Mitchell Branch at the East Tennessee Technology Park,* DOE/OR/01-2384&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Action Memorandum for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2448&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-1417-A/B Drum Storage Yards Interim RA

DOE 1991. *Interim Action Record of Decision for the K-1417-A and K-1417-B Drum Storage Yards, Oak Ridge K-25 Site*, DOE/OR-991, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

K-1070 C/D SW-31 Spring RA

DOE 1992. *Interim Record of Decision for the Oak Ridge K-25 Site K-1070 Operable Unit SW-31 Spring, Oak Ridge K-25 Site*, DOE/OR-1050&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1993. *Explanation of Significant Differences for the Interim Record of Decision for the Oak Ridge K-25 Site, K-1070 Operable Unit SW31 Spring, Oak Ridge, Tennessee,* DOE/OR/02-1132&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 2007. *Addendum to the Remedial Action/Effectiveness Report for the K-1070 Operable Unit SW31 Spring Phase 2 Remedial Action at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, DOE/OR/01-1520&D1/R1/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-1407-B/C Ponds RA

DOE 1993. *Record of Decision for the K-1407-B/C Ponds at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, DOE/OR/02-1125&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1995. *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin*, DOE/OR/01-1371&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-1401 and K-1420 Sumps Removal Action

DOE 1997. *Action Memorandum for Rerouting of Sump Discharge from Buildings K-1401 and K-1420, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1610&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998. *Removal Action Report on the K-1401/K-1420 Sumps Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1754&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Addendum for Removal Action Report on the K-1401/K-1420 Sumps Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1754&D2/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

January 2007. *Notification of Non-Significant Change to the Action Memorandum for Rerouting of Sump Discharge from Buildings K-1401 and K-1420: Change of Treatment and Discharge Location*, DOE/OR/02-1610&R1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-1070-C/D and Mitchell Branch Removal Action

DOE 1997. *Action Memorandum for Mitchell Branch and K-1070-C/D Removal Action East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1611&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998. *Removal Action Report on the Mitchell Branch and K-1070-C/D Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1728&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-901-A and K-1007-P Pond Removal Action

DOE 1997. *Action Memorandum for the K-901-A Holding Pond and the K-1007-P1 Pond Removal Action, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1550&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999. *Removal Action Report for the K-901-A Holding Pond and K-1007-P-1 Pond Removal Action at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1767&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-1070-C/D G-Pit and Concrete Pad RA

DOE 1998. *Record of Decision for the K-1070-C/D Operable Unit, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1486&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002. *Remedial Action Report for the K-1070-C/D G-Pit and Concrete Pad, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1946&D2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

K-1070-A Burial Ground RA

DOE 2000. *Record of Decision for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1734&D3, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Remedial Action Report for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2090&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-1085 Old Firehouse Burn Area Drum Burial Site

DOE 2001. *Action Memorandum for the K-1085 Old Firehouse Burn Area Drum Burial Site, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1938&D1, U. S. Department of Energy, Office of Environmental Management.

DOE 2002. *Removal Action Report for the K-1085 Old Firehouse Burn Area Drum Burial Site, East Tennessee Technology Park*, DOE/OR/01-2050&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Outdoor LLW Removal Action

DOE 2003. *Action Memorandum for the Outdoor Low-Level Waste East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2109&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005. *Removal Action Report for the Legacy Low-Level Waste Stored Outdoors at East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2225&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-25 Auxiliary Facilities Group I Building Demolition (KAFaD)

DOE 1997. *Action Memorandum for the Group I Auxiliary Facilities, K-25 Site, Oak Ridge, Tennessee,* DOE/OR/02-1507&D2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1999. *Removal Action Report for the K-25 Auxiliary Facilities Decommissioning Group I Buildings Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-1829&D1, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 2005. *Removal Action Report Addendum (Waste Disposition) for the K-25 Auxiliary Facilities Decommissioning Group I Building Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-1829&D1/A1, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 2006. *Addendum II for Waste Disposition to the Removal Action Report for the K-25 Auxiliary Facilities Decommissioning Group I Building Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-1829&D1/A2, U. S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

K-29, K-31, and K-33 Equipment Removal and Building Decontamination

DOE 1997. *Action Memorandum for Equipment Removal and Building Decontamination for Buildings K-29, K-31, and K-33 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1646&D1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 2007. *Removal Action Report for Equipment Removal and Building Decontamination for Buildings K-29, K-31, and K-33, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2290&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 2007. *Addendum to the Removal Action Report for Equipment Removal and Building Decontamination for Buildings K-29, K-31, and K-33, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2290&D3/A1, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

K-25 Auxiliary Facilities Group II, Phase I, Building Demolition, Main Plant

DOE 2000. *Action Memorandum for the K-25 Auxiliary Facilities Demolition Project Main Plant Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1868&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004. *Removal Action Report for the K-25 Auxiliary Facilities Demolition Project Main Plant Buildings at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2116&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-25 and K-27 Buildings D&D

DOE 1988. *Action Memorandum for the Decontamination and Decommissioning of the K-25 and K-27 Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1988&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005. *Notification of Non-Significant Change to the Action Memorandum for the Decontamination and Decommissioning of the K-25 and K-27 Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee: Preservation of North Wing and Placement of Concrete Rubble in East and West Wing Vaults of the K-25 Building*, DOE/OR/01-2259&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005. *Phased Construction Completion Report for Phase I, Hazardous Materials Abatement, of the Decontamination and Decommissioning of the K-25 and K-27 Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2275&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Phased Construction Completion Report for Fiscal Year 2008 Earned Value for the K-25/K-27 Decontamination and Decommissioning Project East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2396&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2009. *Erratum to the Phased Construction Completion Report for Fiscal Year 2008 Earned Value for the K-25/K-27 Decontamination and Decommissioning Project East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2396&D2/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Phased Construction Completion Report for Fiscal Year 2009 Earned Value for Buildings K-25 and K-27 East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2436&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-25 Auxiliary Facilities Group II, Phase II Building Demolition, K-1064 Peninsula Area

DOE 2002. *Action Memorandum for the Group II Buildings, Phase II Demolition Project East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-1947&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Removal Action Report for the Group II Buildings, Phase II Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2339&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

K-25 Group II, Phase 3 Building Demolition, Remaining Facilities

DOE 2003. *Action Memorandum for the Remaining Facilities Demolition Project at East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2049&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005. *Fiscal Year 2004 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2193&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2005. *Fiscal Year 2005 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2269&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2006. *Fiscal Year 2005 Phased Construction Completion Report for the Low-Risk/Low-Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2270&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Phased Construction Completion Report for the Laboratory Area Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2309&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Fiscal Year 2006 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2327&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Phased Construction Completion Report for Building K-29 of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2336&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Phased Construction Completion Report for Building K-1420 of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2341&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2007. *Fiscal Year 2007 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2362&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Fiscal Year 2007 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2363&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Erratum to the Phased Construction Completion Report for Building K-1401 of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2365&D2/A1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Fiscal Year 2008 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park,* *Oak Ridge, Tennessee*, DOE/OR/01-2394&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2008. *Fiscal Year 2008 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2395&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Fiscal Year 2009 Phased Construction Completion Report for the Low Risk/Low Complexity Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2434&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Fiscal Year 2009 Phased Construction Completion Report for the Predominantly Uncontaminated Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2435&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2010. *Phased Construction Completion Report for Poplar Creek High-Risk Facilities K-1231, K-1233, and K-413 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2444&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

11.9. OTHER SITES

WWSY (WAG 11) Surface Debris Interim RA

DOE 1992. *Interim Record of Decision for the Oak Ridge National Laboratory, Waste Area Grouping 11, Surface Debris, Oak Ridge, Tennessee,* DOE/OR-1055&D4, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1994. *Interim Remedial Action Post-Construction Report for Waste Area Grouping 11 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1263&D2, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

ORAU SCF

DOE 1995. *Record of Decision for Oak Ridge Associated Universities, South Campus Facility, Oak Ridge, Tennessee*, DOE/OR/02-1383&D3, U. S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

Adler, D.G., December 20, 2006, DOE-ORO, letter to J. Crane, Region IV, and D. McCoy, TDEC DOE Oversight Div., re: Proposed Non-Significant Changes to Two Signed Records of Decisions, Discontinuation of Building 9205-1 Sump Water Treatment, Non-Significant Change to the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, (DOE/OR/01-1951&D3). Change to the *Record of Decision for Oak Ridge Associated Universities South Campus Facility, Oak Ridge, Tennessee*, (DOE/OR/02-1383&D3).

DOE 1996. *Remedial Action Report for Post-Record of Decision Monitoring at Oak Ridge Associated Universities, South Campus Facility, Oak Ridge, Tennessee*, DOE/OR/02-1474&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

APPENDIX A:
CERTIFICATION OF LAND USE CONTROL IMPLEMENTATION
FY 2010

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CERTIFICATION OF LAND USE CONTROL IMPLEMENTATION
FY 2010

The Land Use Control Assurance Plan (LUCAP) requires that the Manager, Department of Energy (DOE) Oak Ridge Office (ORO) annually certify in the Remediation Effectiveness Report (RER) that Land Use Control Implementation Plans (LUCIPs) included as Appendix A of the LUCAP (i.e., approved LUCIPs) are being implemented on the Oak Ridge Reservation. This certification will identify any non-compliance with these LUCIPs and describe steps taken to address any such non-compliance(s). Certification is provided for fiscal year (FY) 2010, comprising the period October 1, 2009, through September 30, 2010. The LUCAP also requires that the annual report serve to notify the EPA and TDEC of any change in the designated officials or of land use changes that are not considered major, as described in Section 2.8 of the LUCAP.

The LUCIP for Melton Valley watershed was approved by EPA and TDEC in May, 2006, and revised through errata to the Melton Valley Remedial Action Report in 2009. Land use controls that were implemented in Melton Valley during FY 2010 are identified in Table A.1.

In accordance with Section 2.9 of the LUCAP (DOE 1999a), I certify based on the information and belief formed after reasonable inquiry that all required land use controls in Melton Valley have been implemented in accordance with the approved LUCIP for the watershed (DOE 2006b). The Land Use Controls in Table A.1 have been implemented, as required.

Gerald Boyd

Gerald G. Boyd, Manager

3/15/11

Date

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Table A.1. Verification of Land Use Controls for the Melton Valley Watershed LUCIP requirements being certified as of September 30, 2010[1]

MV LUCIP Requirements					
Type of control	**Affected areas**	**Implementation**	**Frequency**	**Verification Requirements**	**Certification Documentation[2]**
1. DOE land notation (property record restrictions) A. Land use B. Groundwater	All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.	To be drafted and implemented by DOE upon completion of all remediation activities or transfer of affected areas. Filed within 90 days after EPA and TDEC approval of the RAR.	Verify annually that information is being maintained properly.	Verify information properly recorded at County Register of Deeds Office(s).	Certified. WRRP personnel verified that the MV Land Notation is being maintained properly with the Roane County Register of Deeds office.
2. Property Record notices	SWSA 6 ICMAs/HTF; All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions.	Notice provided by DOE EM to the public as soon as practicable, but no later than 90 days after approval of the LUCIP. This notice will be supplemented with the DOE Land Notation after completion of remediation (see above).	Verify annually that information is being maintained properly.	Verify information properly recorded at County Register of Deeds Office(s).	Certified. WRRP personnel verified that the MV Property Record Notice, as well as the DOE Land Notation and survey plat, are being maintained properly on the EM website and at the DOE Information Center and that the DOE Land Notation remains properly recorded at the Roane County Register of Deeds office. The MV Property Record Notice was placed in local newspapers during December 2007.
4. Excavation/ penetration permit program	Remediation systems and all waste management areas and areas where hazardous substances/structures remain after remediation at levels requiring land use and/or groundwater restrictions.	Currently established and functioning.	Monitor annually to ensure it is functioning properly.	Verify functioning of permit program against existing procedures.	Certified. MV Engineer verified that the EPP program was functioning during FY 10 against existing procedures.

Table A.1. Verification of Land Use Controls for the Melton Valley Watershed LUCIP requirements being certified as of September 30, 2010 (cont.)[1]

MV LUCIP Requirements					
Type of control	**Affected areas**	**Implementation**	**Frequency**	**Verification Requirements**	**Certification Documentation[2]**
5. State advisories/ postings (e.g., no fishing or contact advisory)	White Oak Lake and White Oak Creek Embayment	Although not a requirement, advisories and postings may be established by TDEC in the future.	Inspect no less than annually.	Conduct field survey and assess signs condition (i.e., remain intact, erect, and legible).	Certified. MV S&M manager conducted field survey and verified that adequate warning signs have been posted by DOE at White Oak Lake dam and at access to the White Oak Creek Embayment and meet the intent of the State advisories/postings. Per the description of the control in the RAR, although not a requirement, advisories and postings may be established by TDEC in the future.
6. Access controls (e.g., fences, gates, portals)	At 20 locations throughout Melton Valley Watershed near major access points.	If necessary, selected in the design or construction completion reports.	Inspect no less than annually.	Conduct field surveys of all controls to assess condition (i.e., remain erect, intact, and functioning).	Certified. MV S&M manager conducted field survey and verified that access controls are in place around MV.
7. Signs	At 20 locations throughout Melton Valley Watershed near major access points. At 6 of the 20 locations around the White Oak Lake and White Oak Creek Embayment at major access points.	In place within 6 months of approval of the LUCIP.	Inspect no less than annually.	Conduct field survey of all signs to assess condition (i.e., remain erect, intact, and legible).	Certified. MV S&M manager conducted field survey and verified that signs are in place at 20 locations around MV, and that 6 of the 20 sign locations around the White Oak Lake and White Oak Creek Embayment also provide notice to resource users of contamination and prohibit fishing/contact

Table A.1. Verification of Land Use Controls for the Melton Valley Watershed LUCIP requirements being certified as of September 30, 2010 (cont.)[1]

MV LUCIP Requirements					
Type of control	**Affected areas**	**Implementation**	**Frequency**	**Verification Requirements**	**Certification Documentation[2]**
8. Surveillance patrols	Patrol of selected areas throughout Melton Valley, as necessary.	Effective immediately following LUCIP approval and conducted no less frequently than once a quarter.	Adequacy of necessary patrols assessed no less than annually.	Verify against procedures/plans that routine patrols conducted.	Certified. MV S&M manager verified that surveillance patrols were conducted according to S&M procedure.
Additional Project-Specific PCCR Requirements					
None specified [(3)]	MV ISG Trenches 5 & 7 SWSA 6 SWSA 4 Pit and Trenches SWSA 5 TRU Trenches, Soils and Sediments				

[1]Zoning notice to City Planning Commission will be completed if/when Melton Valley contaminated areas are transferred out of DOE federal control.
[2]Documentation of verification completed by WRRP annually.
[3]No attachments to Appendix A of the MV LUCIP as of September 30, 2010.

APPENDIX B
MELTON VALLEY GROUNDWATER DATA

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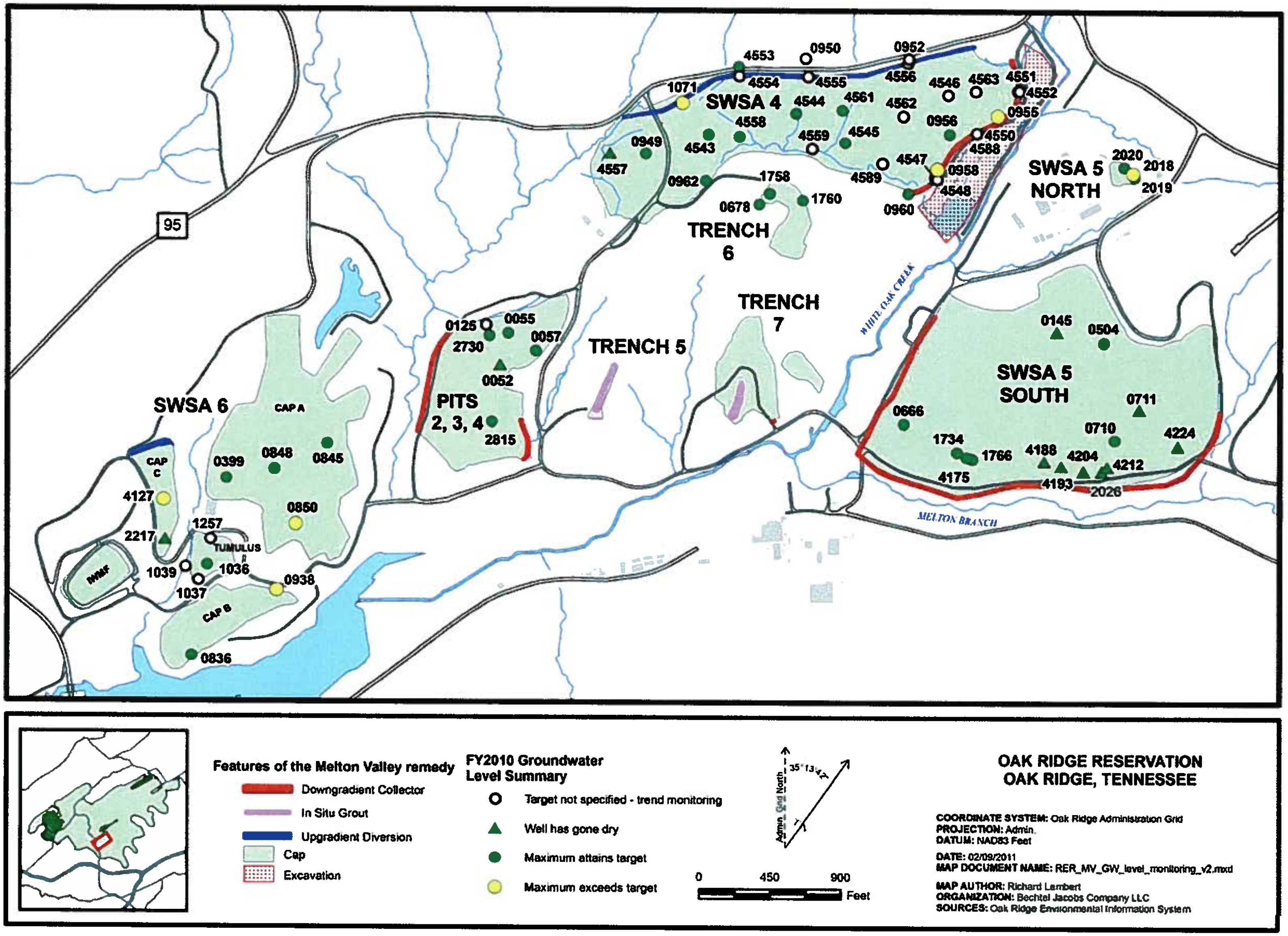


Figure B.1. Locations of groundwater elevation monitoring in Melton Valley.

B.1. FY 2010 Melton Valley Groundwater Level Summary

Well	Area	Meas Freq	Maximum Elevation	Observed Range	Target Elevation	Target Range	Meets TE	Meets Fluct	Comment
0052	PT-2,3,4	M	dry	--	791.0	--		--	
0055	PT-2,3,4	C	786.87	0.95	795.00	--	Y	--	Fluctuates below waste zone
0057	PT-2,3,4	M	783.81	2.49	795.00	--	Y	--	Fluctuates below waste zone
0125	PT-2,3,4	M	785.20	1.55	778.70	1.83	--	--	Outside Cap
2730	PT-2,3,4	M	778.47	1.06	791.00	--	Y	--	Fluctuates below waste zone
2815	PT-2,3,4	M	770.28	1.43	789.00	--	Y	--	Fluctuates below waste zone
0678	PT-Trench 6	M	822.70	3.52	836	1.35	--	--	Outside Cap
1758	PT-Trench 6	M	829.94	4.58	836	4.42	Y	N	Fluctuates below waste zone
1760	PT-Trench 6	M	821.04	2.18	836	1.00	Y	N	Fluctuates below waste zone
0949	SWSA 4	C	803.67	1.16	813.78	1.48	Y	--	Fluctuates below waste zone
0950	SWSA 4	C	830.56	8.22	--	--	--	--	Outside Cap, UGT Monitoring
0952	SWSA 4	M	814.96	4.01	810.44	--	--	--	Outside Cap, UGT Monitoring
0955	SWSA 4	M	761.65	2.90	759.42	1.03	N	N	Near SWSA 4 DGT-- fluctuates with DGT level
0956	SWSA 4	C	768.19	0.26	770.49	0.40	Y	Y	
0958	SWSA 4	Q	761.47	1.26	761.25	0.72	N	N	Near SWSA 4 DGT-- fluctuates with DGT level
0960	SWSA 4	Q	765.13	2.25	--	--	--	--	Outside Cap
0962	SWSA 4	Q	820.47	2.91	822.85	0.57	Y	N	At cap edge
1071	SWSA 4	Q	802.55	0.38	802.44	0.79	N	Y	
4543	SWSA 4	C	799.62	1.98	803.31		Y	--	
4544	SWSA 4	C	789.52	0.29	791.89		Y	--	
4545	SWSA 4	C	dry		777.25		Y		
4546	SWSA 4	C	dry		--	1.1	Y		
4553	SWSA 4	M	818.64	1.58			--		Outside Cap, UGT Monitoring
4554	SWSA 4	M	810.64	0.97			--		UGT Monitoring
4555	SWSA 4	C	810.69	1.83	NA	1.25	--		UGT Monitoring
4556	SWSA 4	C	807.70	2.34	NA		--		UGT Monitoring
4557	SWSA 4	M	dry	--	NA	--	Y	--	
4558	SWSA 4	M	789.92	0.17		0.18	--	Y	
4559	SWSA 4	M	777.65	0.14		0.38	--	Y	
4561	SWSA 4	M	791.84	0.31					
4562	SWSA 4	M	783.01	0.27					

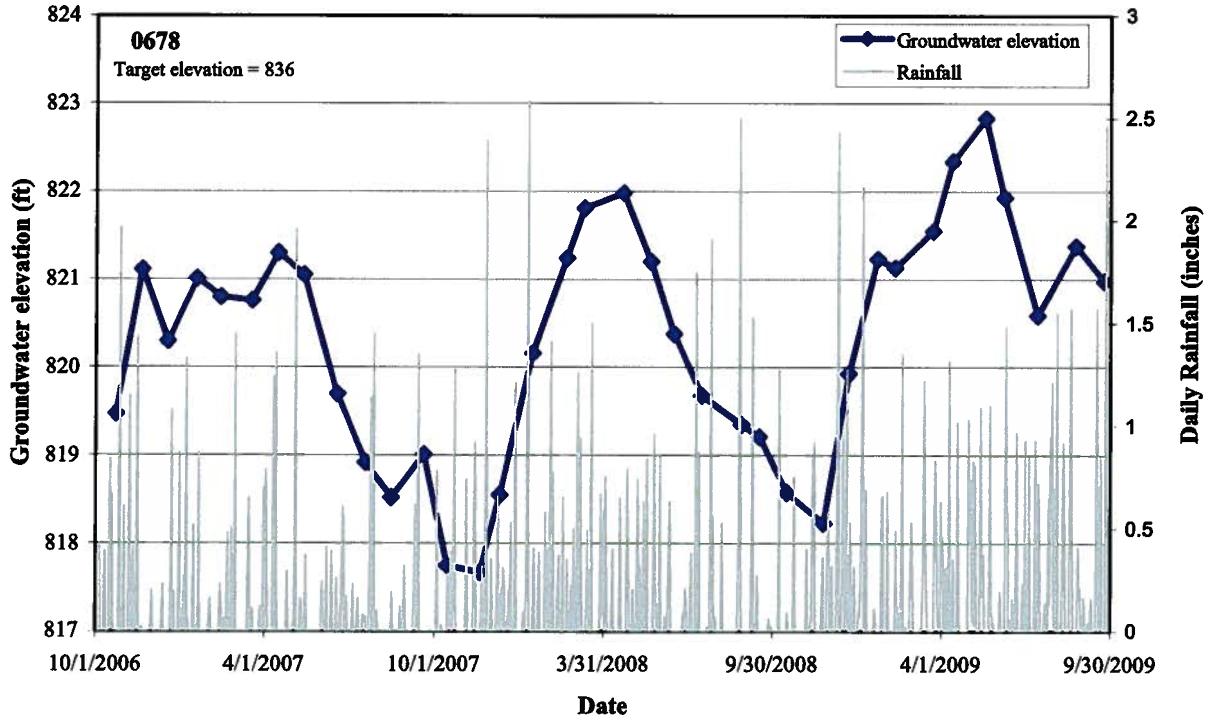
B.1. FY 2010 Melton Valley Groundwater Level Summary (cont.)

Well	Area	Meas Freq	Maximum Elevation	Observed Range	Target Elevation	Target Range	Meets TE	Meets Fluct	Comment
4563	SWSA 4	C	778.22	0.57					
4588	SWSA 4	C	761.96	3.82					DGT Monitoring
4589	SWSA 4	C	772.26	0.50					DGT Monitoring
4547	SWSA 4 DGT	C	763.02	5.62					DGT Monitoring
4548	SWSA 4 DGT	C	765.60	6.91					DGT Monitoring
4550	SWSA 4 DGT	C	762.87	4.30					DGT Monitoring
4551	SWSA 4 DGT	C	764.41	5.33					DGT Monitoring
4552	SWSA 4 DGT	C	764.91	4.66					DGT Monitoring
4595	SWSA 4 DGT	C	763.10	3.69					DGT Monitoring
4596	SWSA 4 DGT	C	763.09	6.99					DGT Monitoring
4598	SWSA 4 DGT	C	761.91	4.94					DGT Monitoring
4599	SWSA 4 DGT	C	762.49	1.86					DGT Monitoring
4605	SWSA 4 DGT	C	762.1	3.68					DGT Monitoring
4606	SWSA 4 DGT	C	764.56	5.78					DGT Monitoring
4607	SWSA 4 DGT	C	763.2	4.25					DGT Monitoring
4611	SWSA 4 DGT	C	764.62	4.88					DGT Monitoring
2018	SWSA 5-N	M	822.43	0.32	822.2	2.5	N	Y	
2019	SWSA 5-N	M	811.94	5.58	824.30	1.67	Y	N	Fluctuates below waste zone
2020	SWSA 5-N	M	dry	--	828.20	0.78	Y	--	
0145	SWSA 5-S	C	dry	--	829.10	1.9	Y	--	
0436	SWSA 5-S	M	767.84	0.56	773.90	2.35	Y	Y	
0504	SWSA 5-S	M	810.76	0.10	813.10	1.83	Y	Y	
0666	SWSA 5-S	M	769.31	0.42	776.10	1.35	Y	Y	

B.1. FY 2010 Melton Valley Groundwater Level Summary (cont.)

Well	Area	Meas Freq	Maximum Elevation	Observed Range	Target Elevation	Target Range	Meets TE	Meets Fluct	Comment
0710	SWSA 5-S	M	781.22	0.66	791.50	1.10	Y	Y	
0711	SWSA 5-S	M	796.45	0.17	806.1	2.9	Y	Y	
1734	SWSA 5-S	C	dry	--	776.70	2.2	Y	--	
1766	SWSA 5-S	M	dry	--	773.9	2.1	Y	--	
2026	SWSA 5-S	C	dry	--	773.3	1.2	Y	--	
4175	SWSA 5-S	M	dry	--	775.80	4.10	Y	--	
4188	SWSA 5-S	M	dry	--	772.90	1.63	Y	--	
4193	SWSA 5-S	M	dry	--	775.40	1.32	Y	--	
4204	SWSA 5-S	M	dry	--	773.00	1.40	Y	--	
4212	SWSA 5-S	M	771.89	--	773.7	1.68	Y	--	Water only observed in one monthly measurement
4224	SWSA 5-S	M	dry	--	781.6	1.88	Y	--	
0399	SWSA 6	M	776.48	0.92	782.90	1.36	Y	Y	
0836	SWSA 6	M	747.18	2.35	753.00	--	Y	--	Near cap edge, fluctuates below waste zone
0845	SWSA 6	M	782.14	1.27	784.10	0.82	Y	N	Bedrock well, fluctuates below waste zone
0848	SWSA 6	M	778.10	0.42	779.20	0.27	Y	N	Bedrock well, Steadily declining
0850	SWSA 6	C	767.12	1.61	765.90	2.1	N	Y	Seasonally exceeds target elevation
0938	SWSA 6	M	756.89	2.62	753.80	--	N	--	Outside cap, bedrock well
1036	SWSA 6	C	763.99	3.52	768.00	--	Y	--	
1037	SWSA 6	M	758.98	3.5	767.00	--	--	--	Outside cap
1039	SWSA 6	M	762.78	1.24	768.00	--	--	--	Outside cap
1257	SWSA 6	M	769.58	2.71	769.00	--	--	--	Outside cap
2217	SWSA 6	C	dry	--	767.6	2.5	Y	--	
4127	SWSA 6	M	774.17	1.03	772.30	2.25	N	Y	Bedrock well

C=continuous groundwater level monitoring using pressure transducer and data logger
M=monthly manual groundwater level measurements
Q=quarterly manual groundwater level measurements



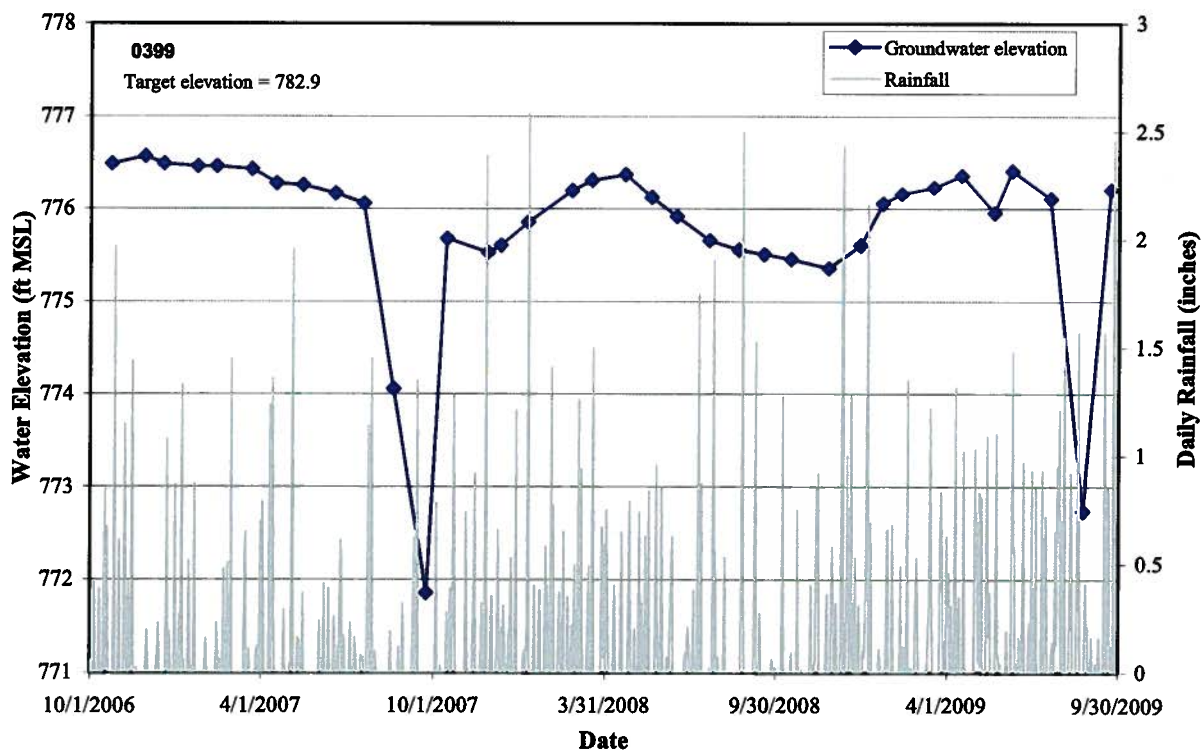
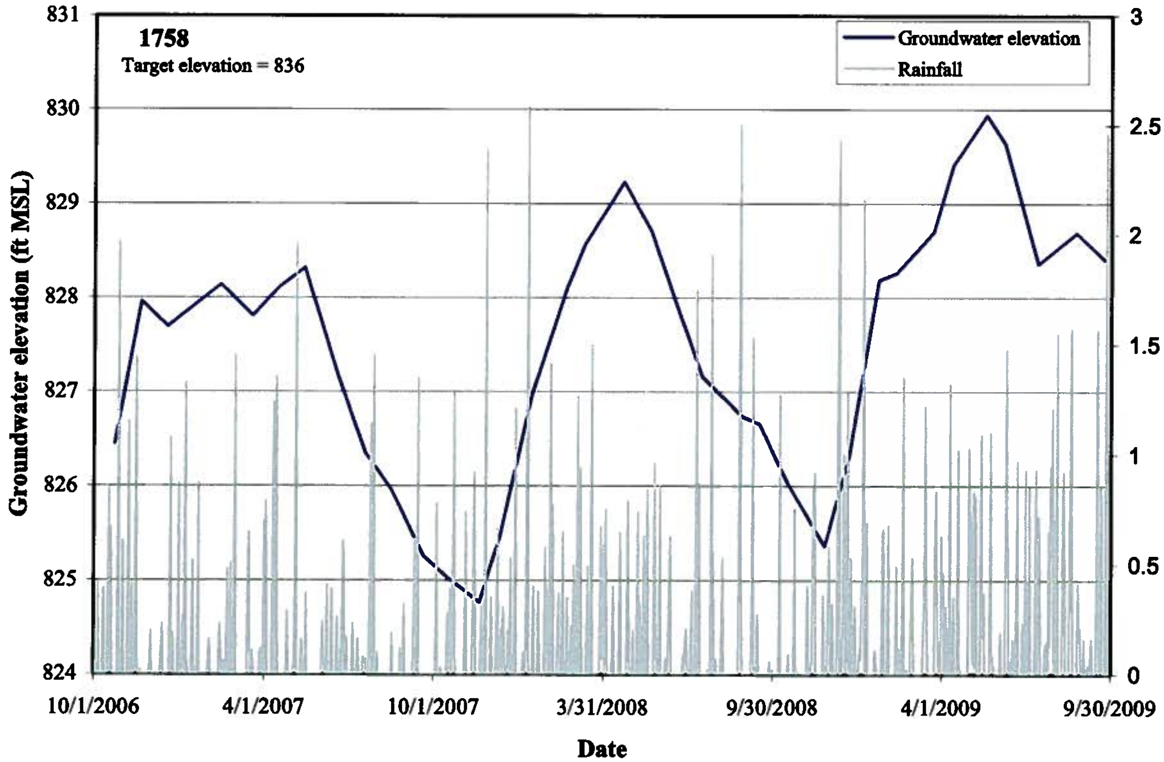


Figure B.2. Well hydrographs for wells 0678 and 0399.



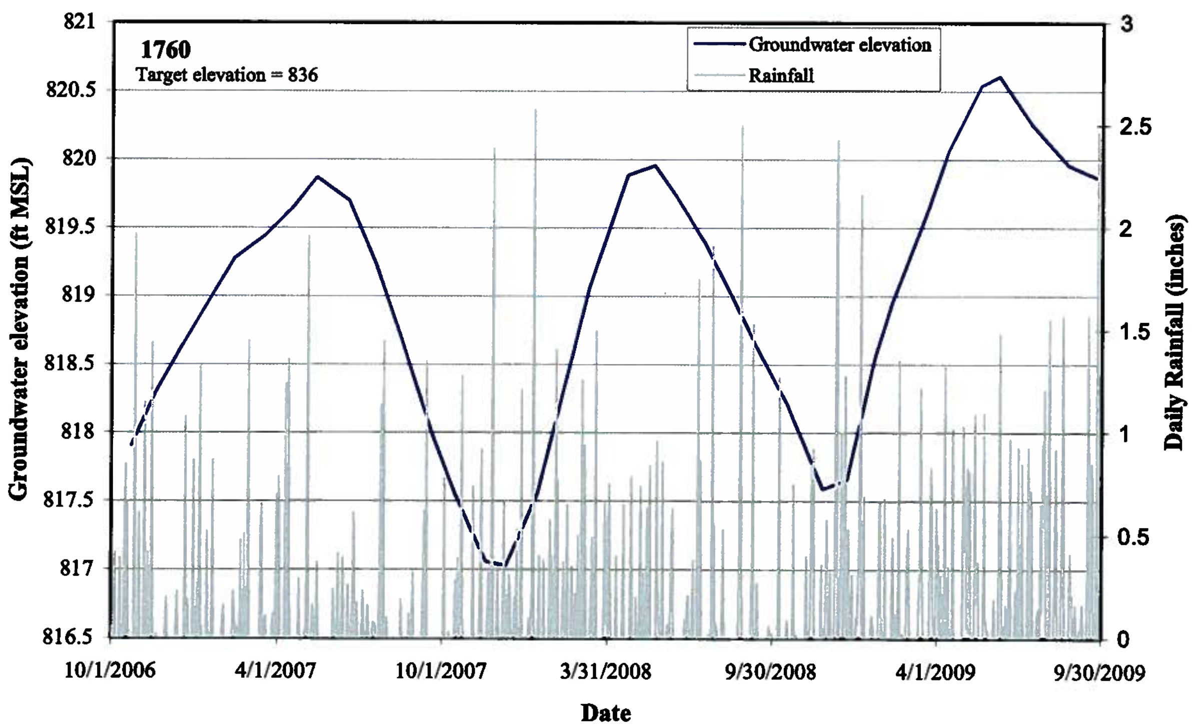
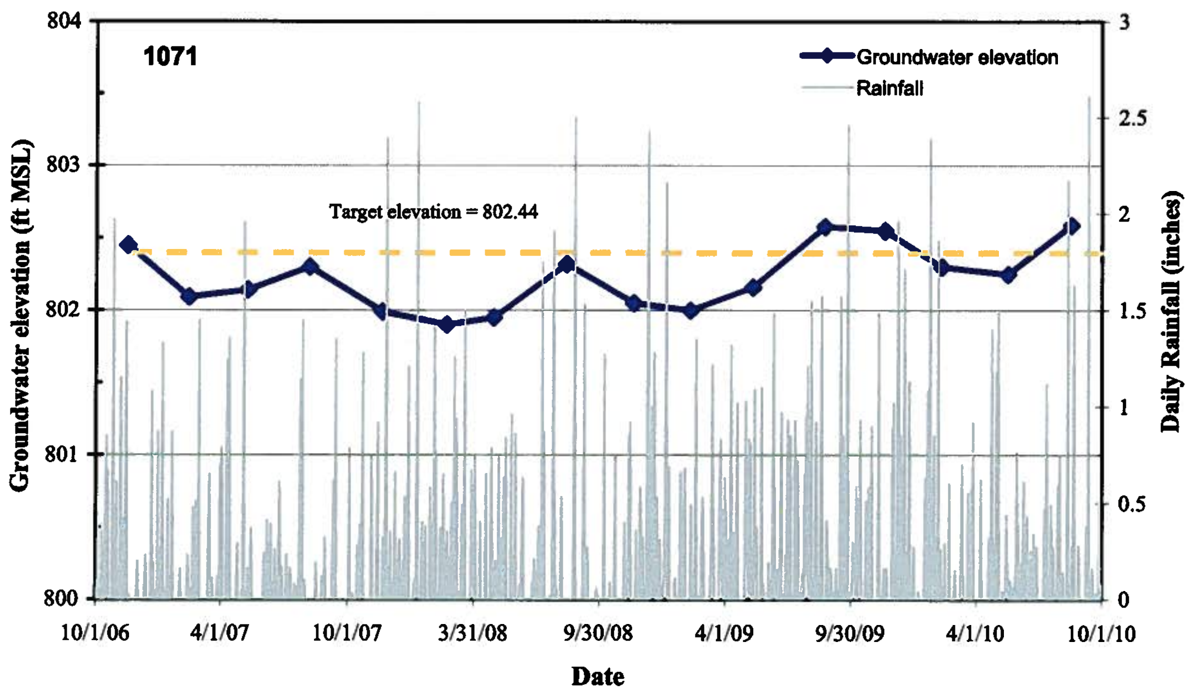


Figure B.3. Well hydrographs for wells 1758 and 1760.



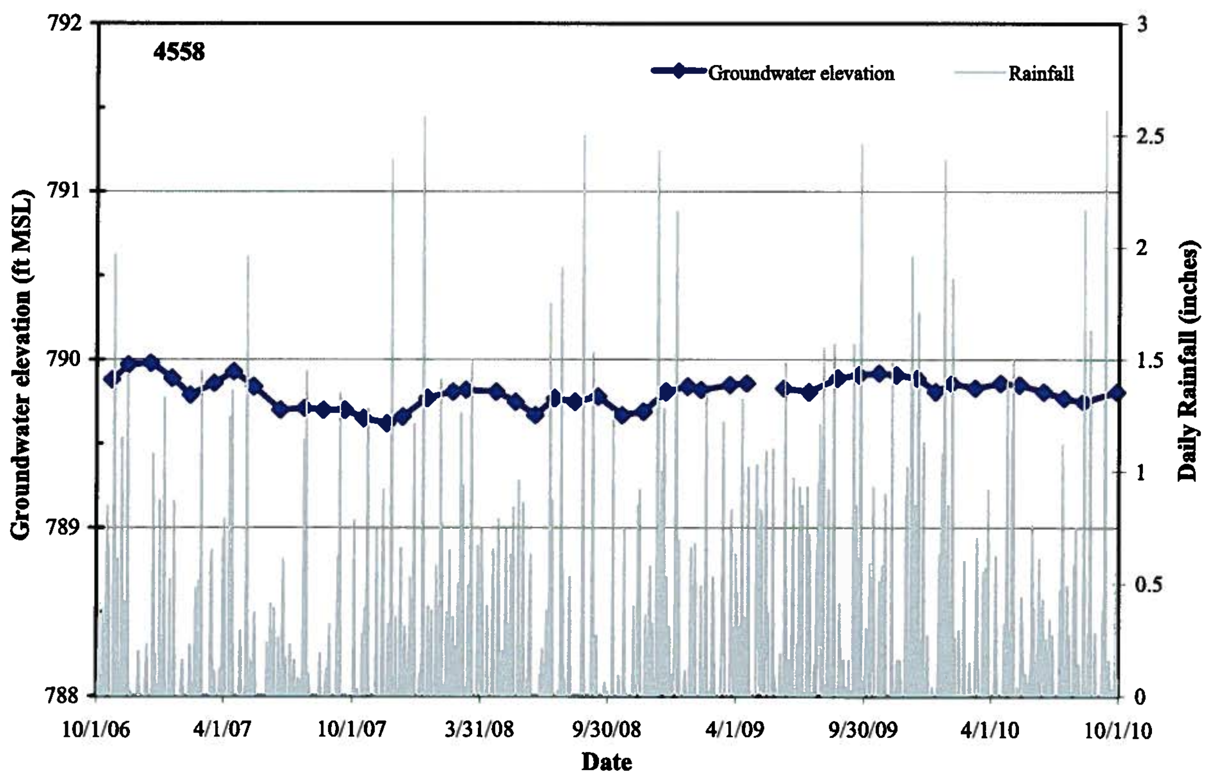
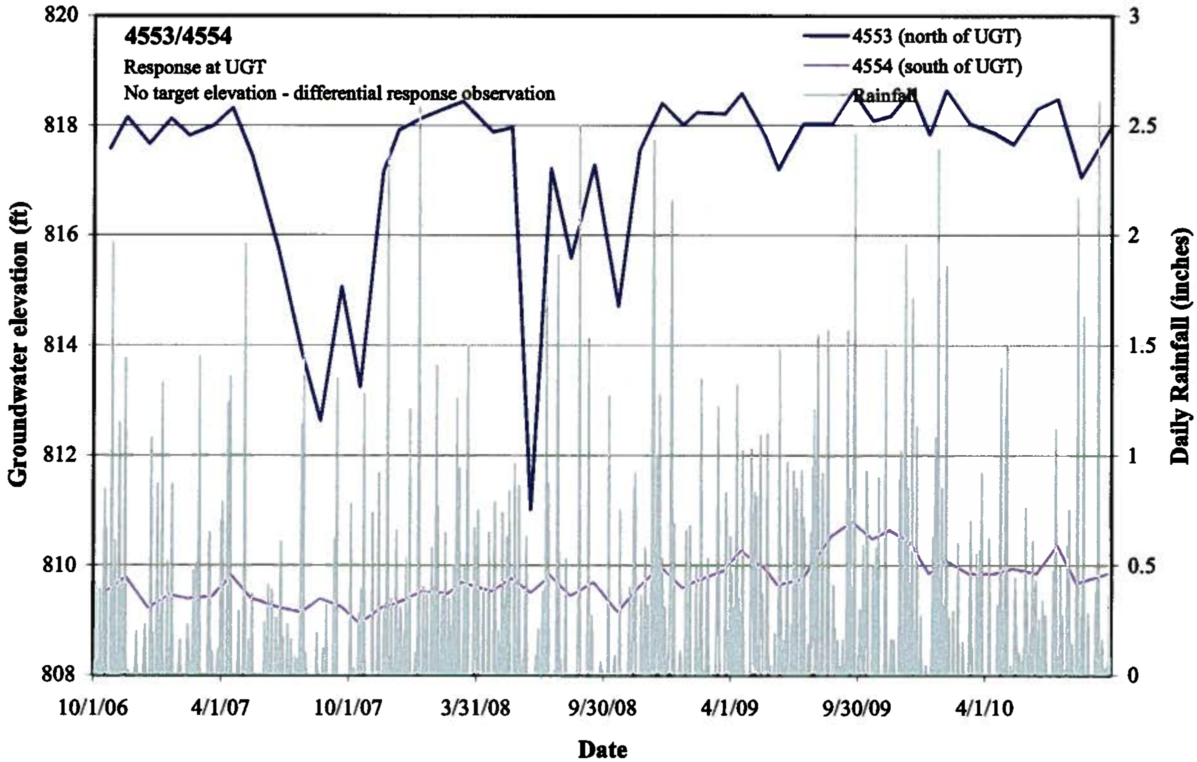


Figure B.4. Well hydrographs for wells 1071 and 4558.



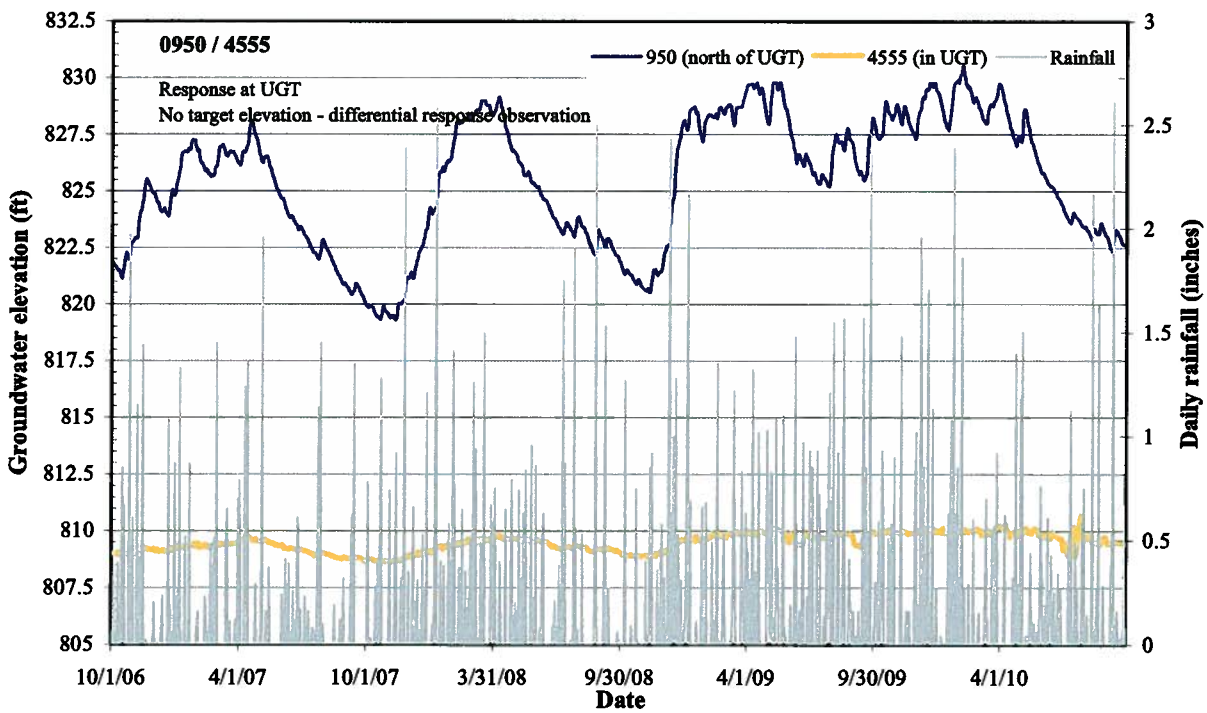


Figure B.5. Well hydrographs for wells 4553/4554 and 0950/4555.

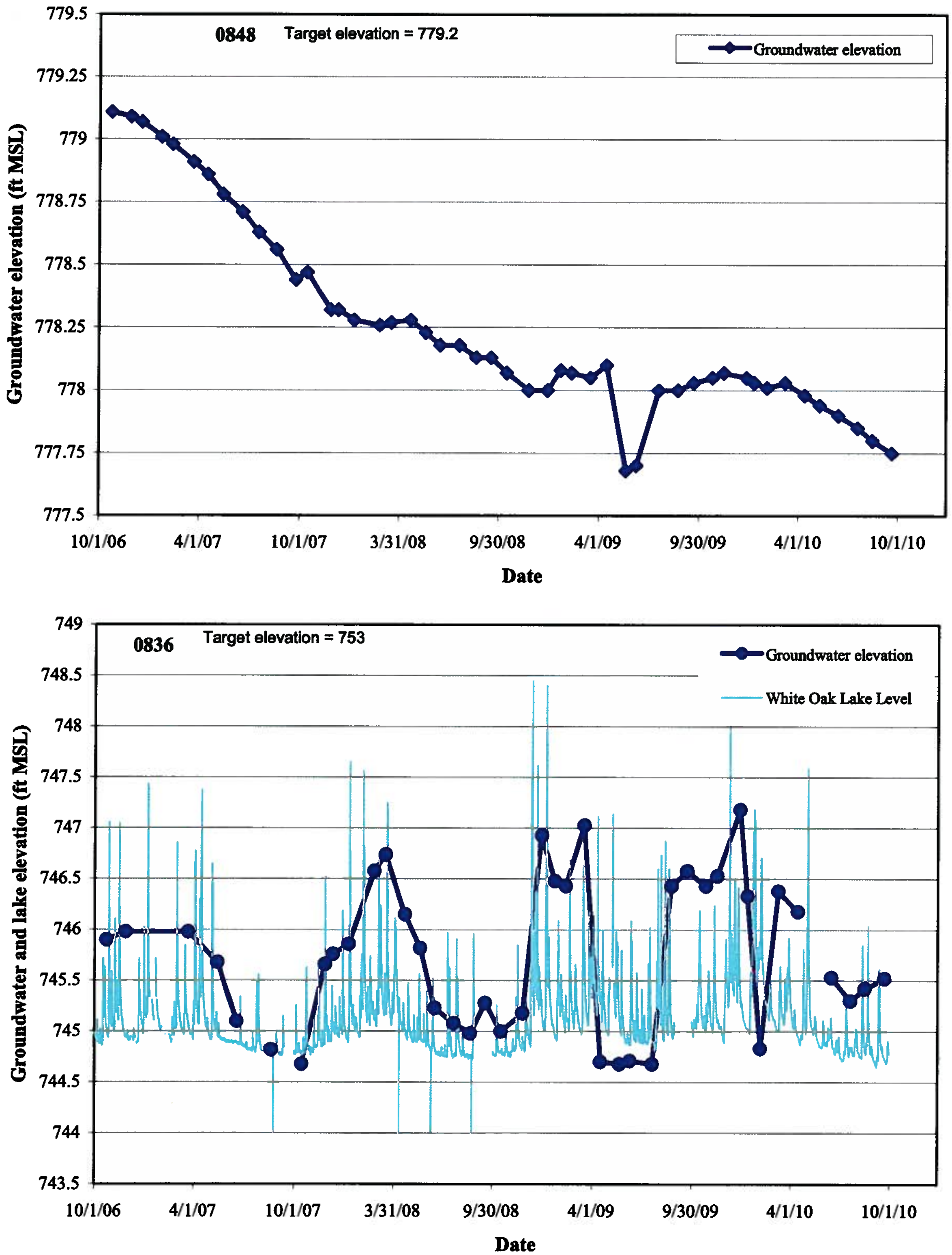
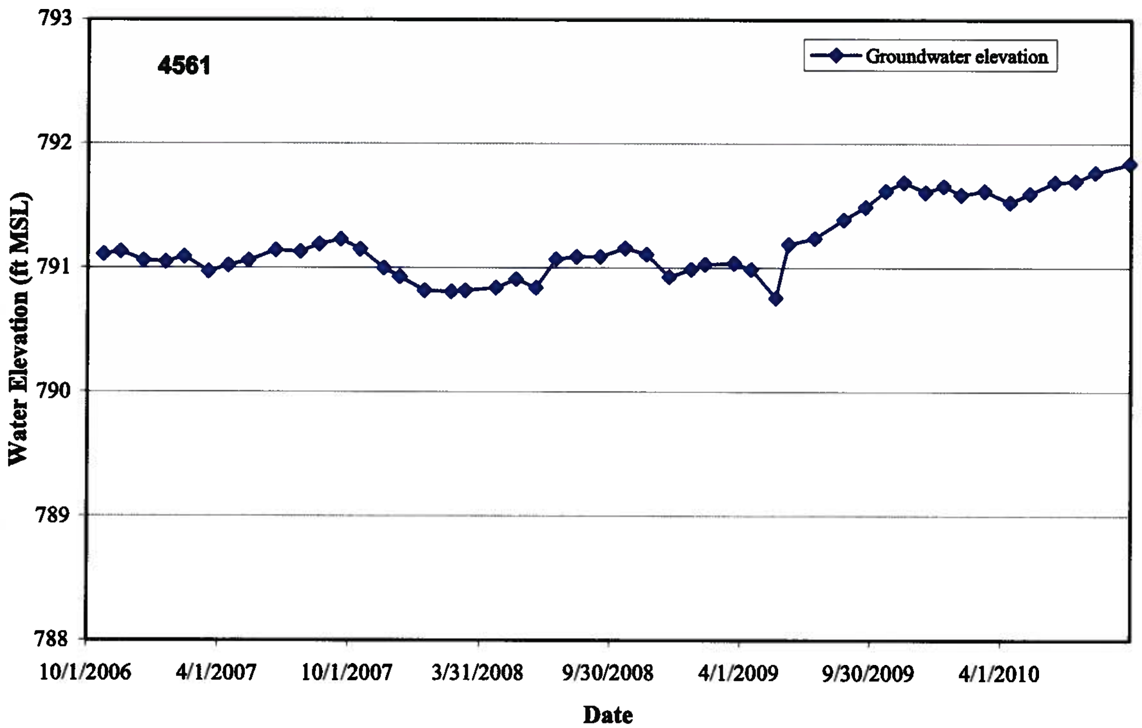


Figure B.6. Well hydrographs for well pairs 0848 and 0836.



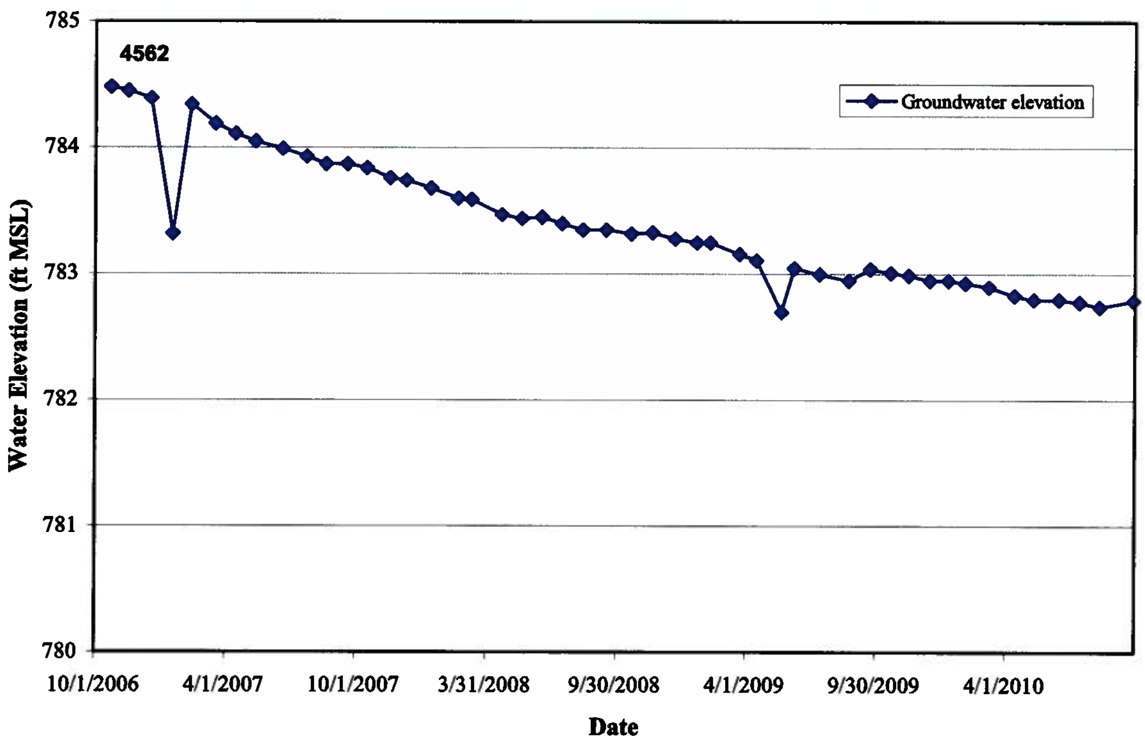
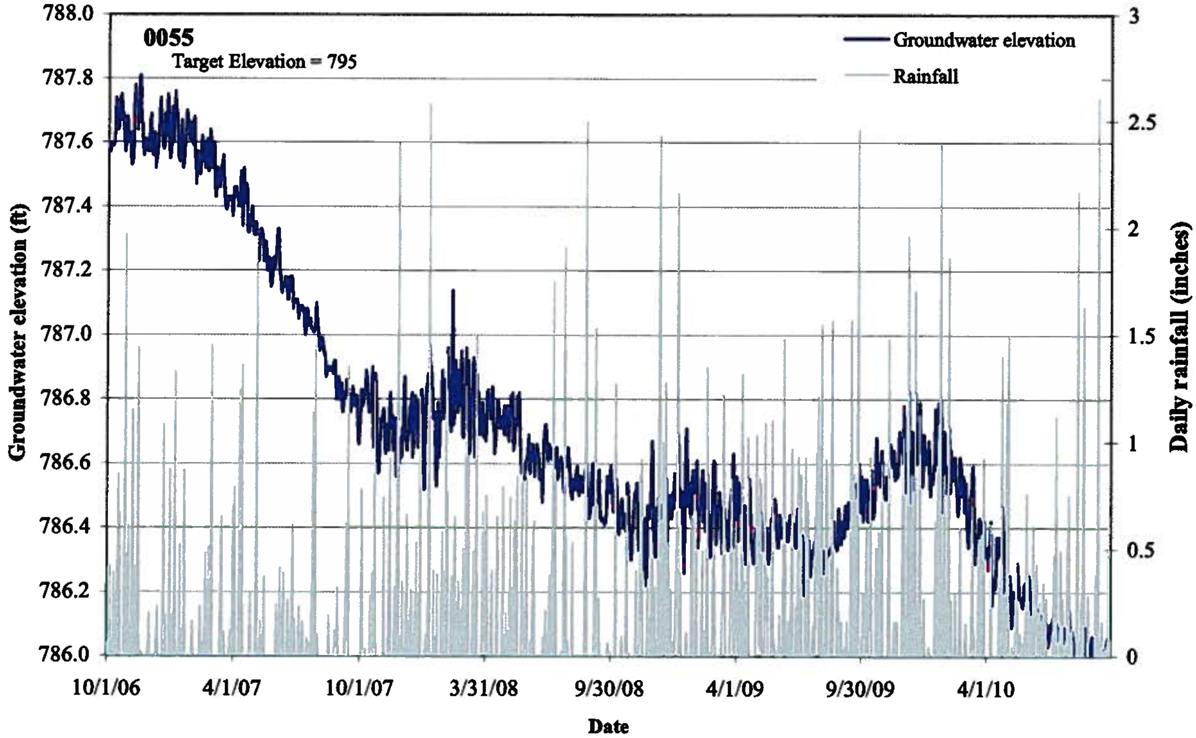


Figure B.7. Well hydrographs for wells 4561 and 4562.



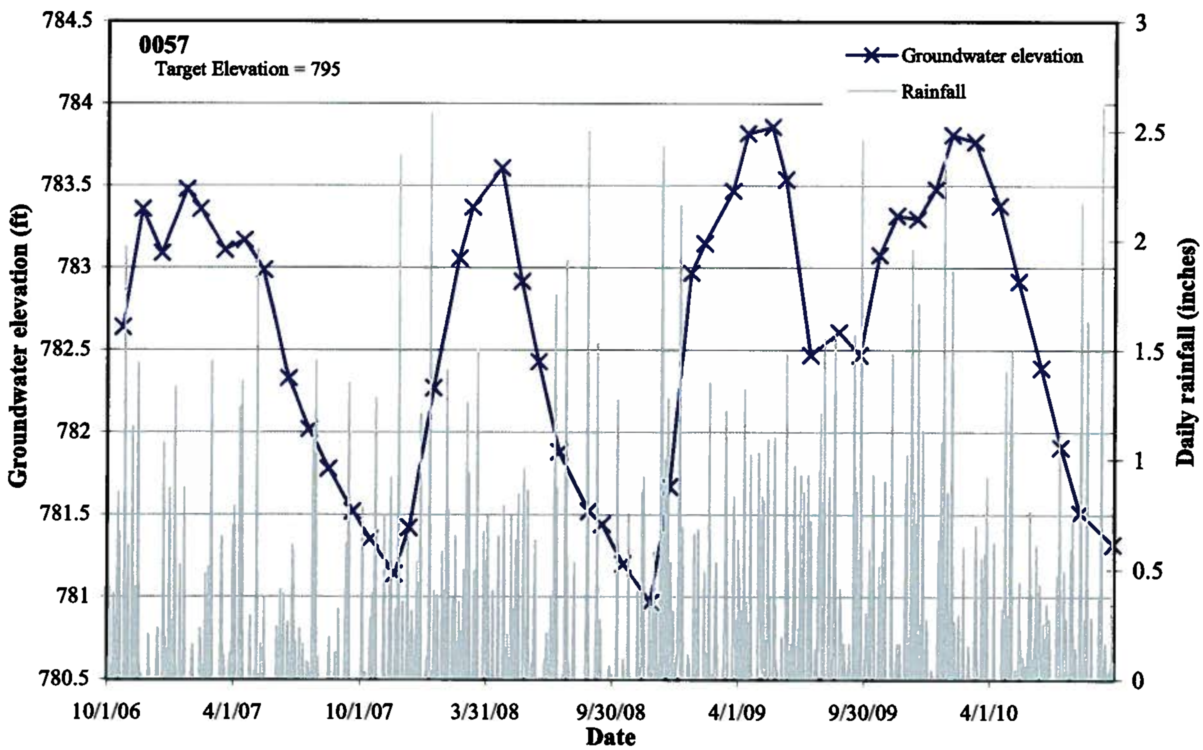
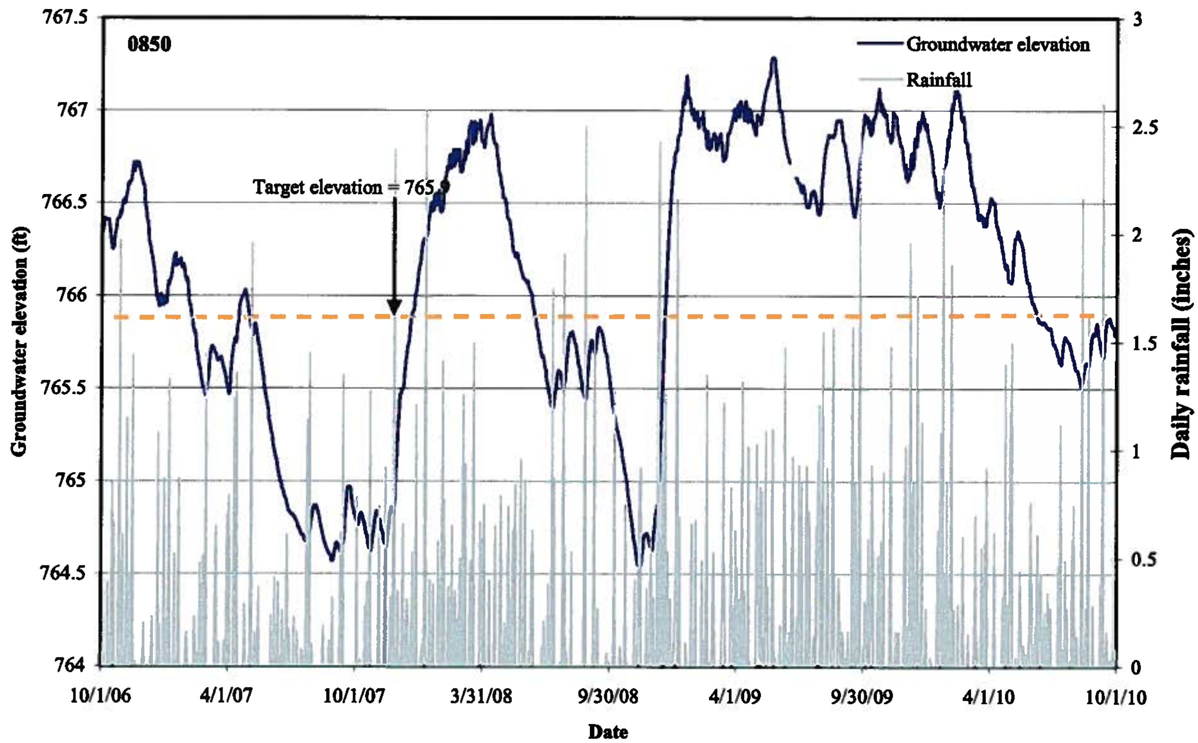


Figure B.8. Well hydrographs for wells 0055 and 0057.



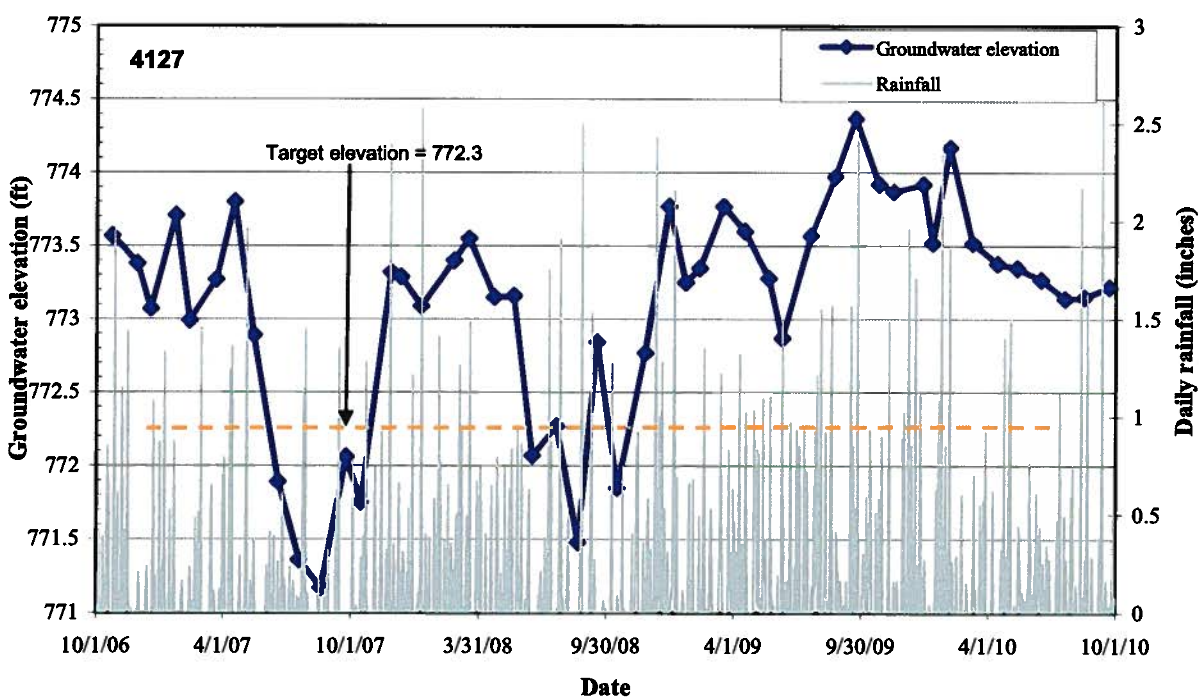


Figure B.9. Well hydrographs for wells 0850 and 4127.

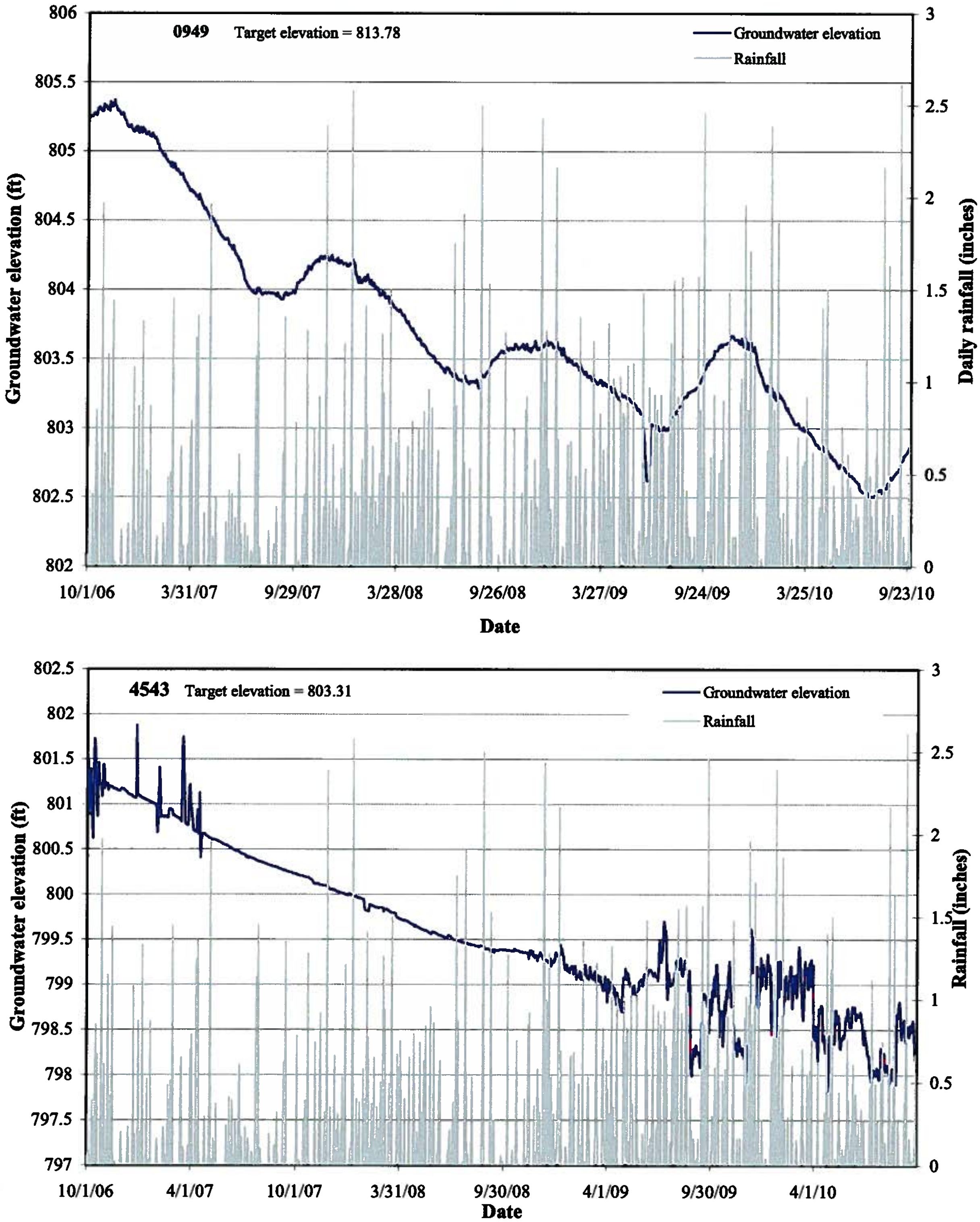
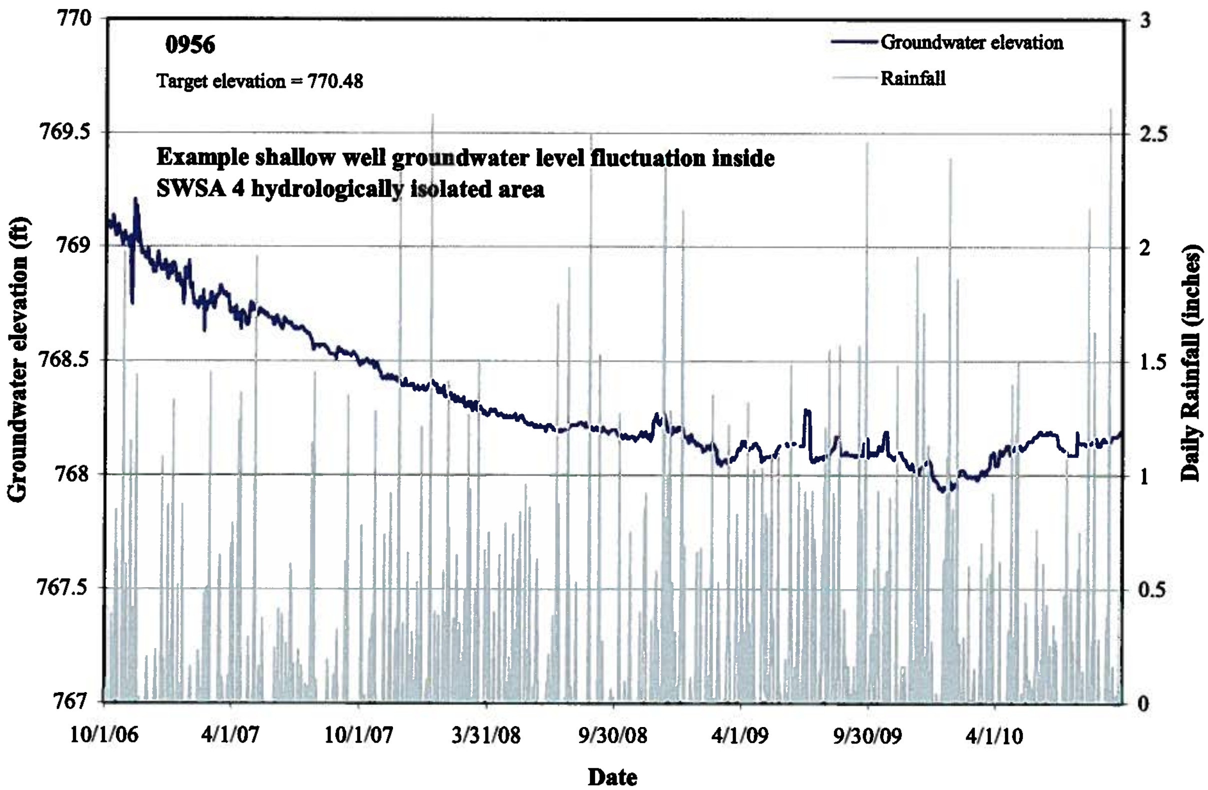


Figure B.10. Well hydrographs for wells 0949 and 4543.



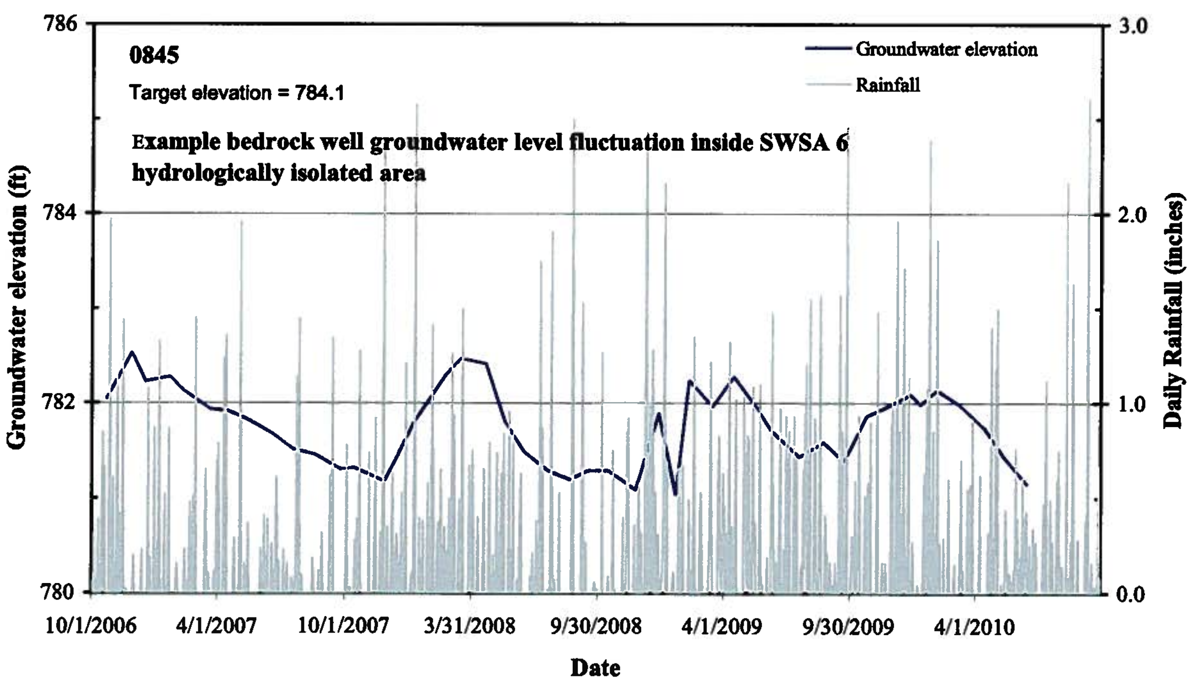
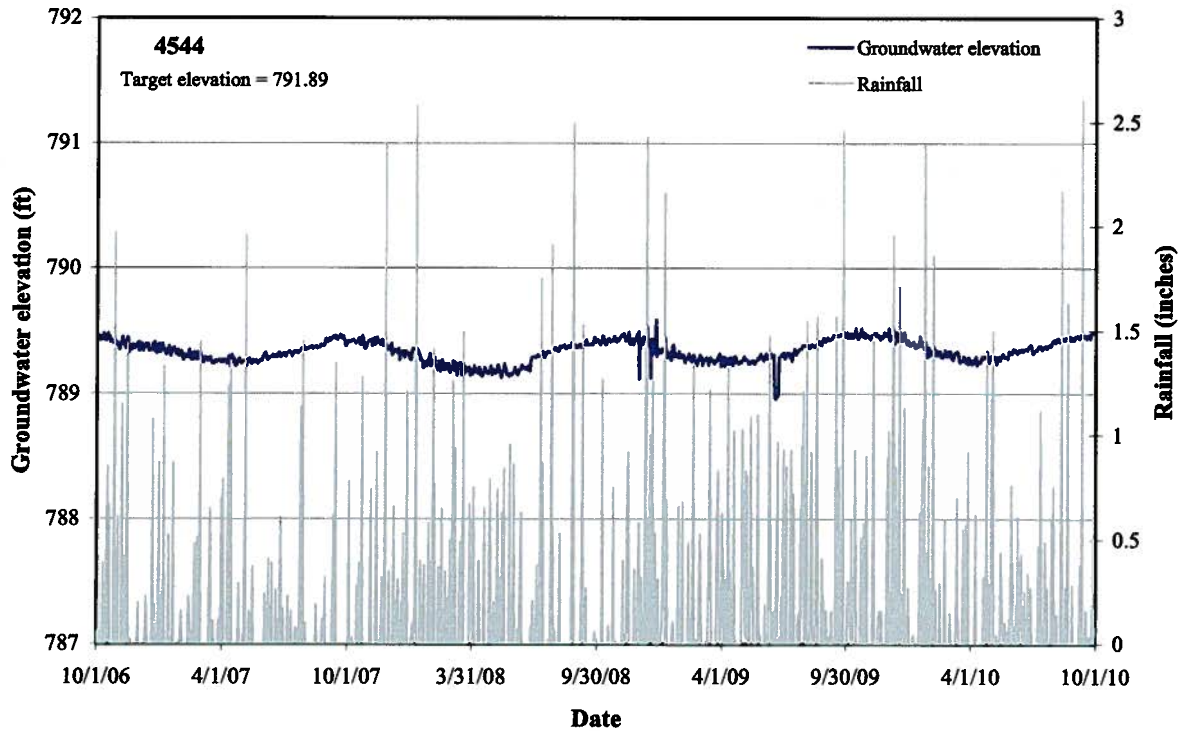


Figure B.11. Well hydrographs for well pair 0956 and well 0845.



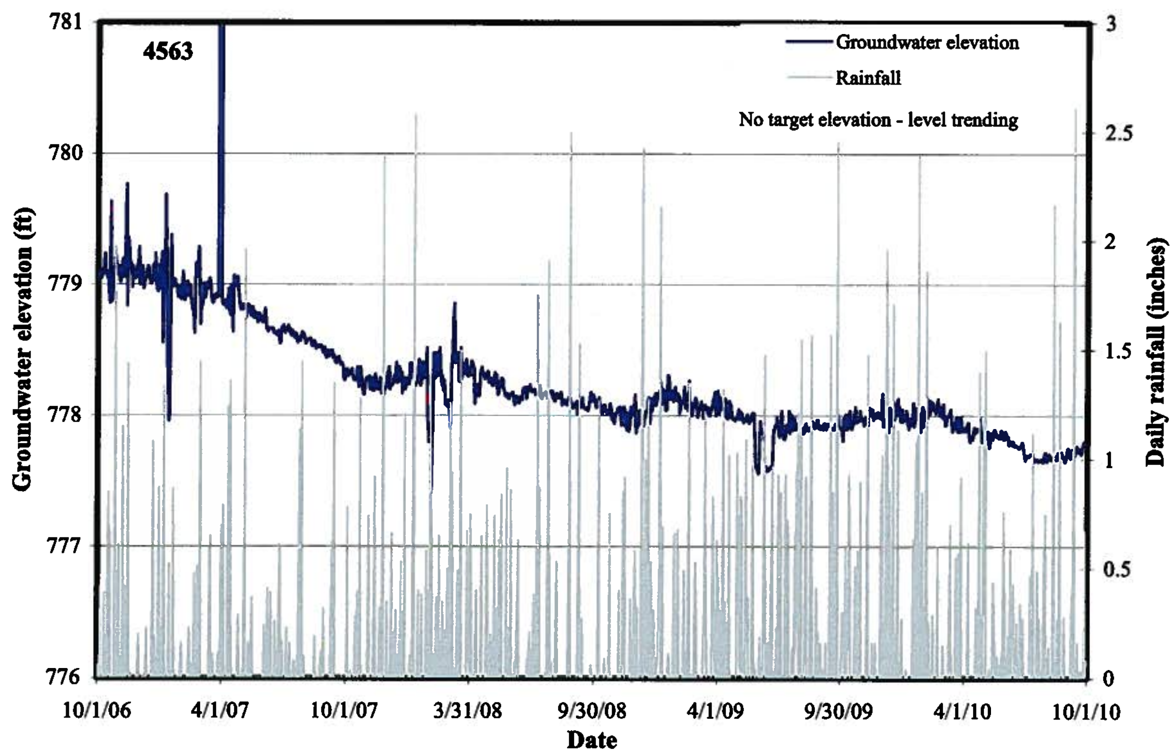
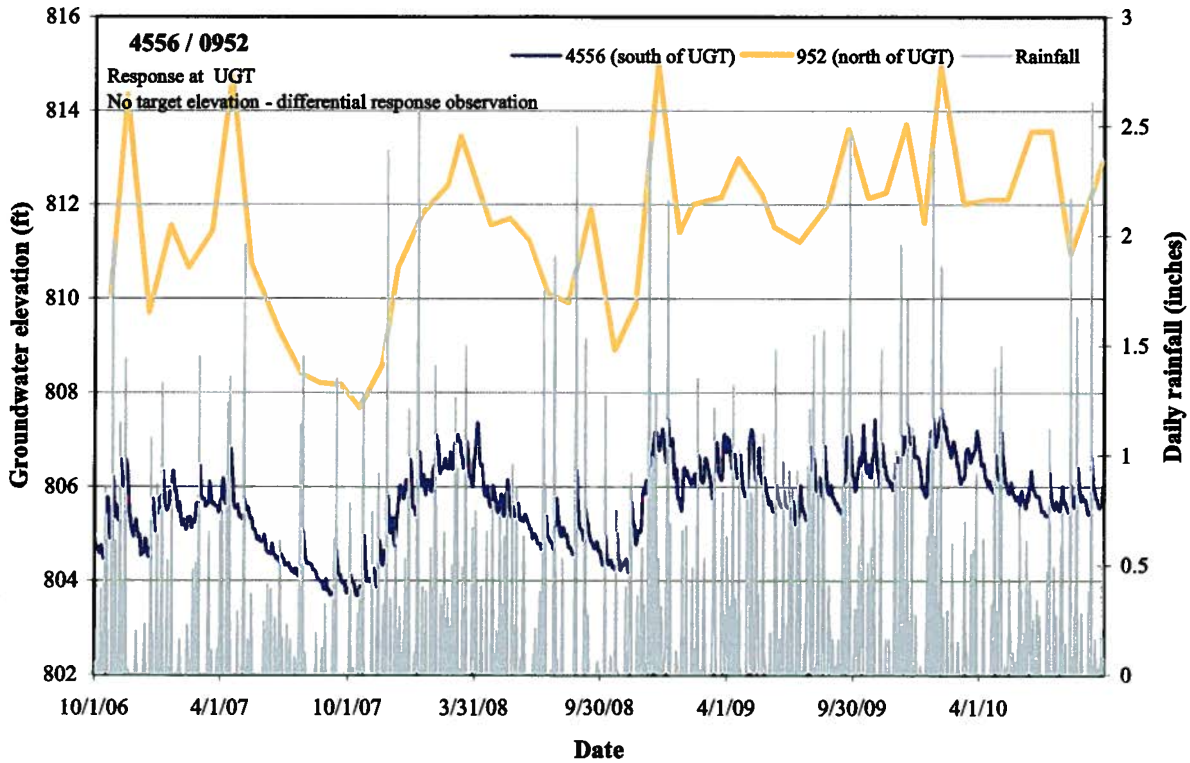


Figure B.12. Well hydrographs for wells 4544 and 4563.



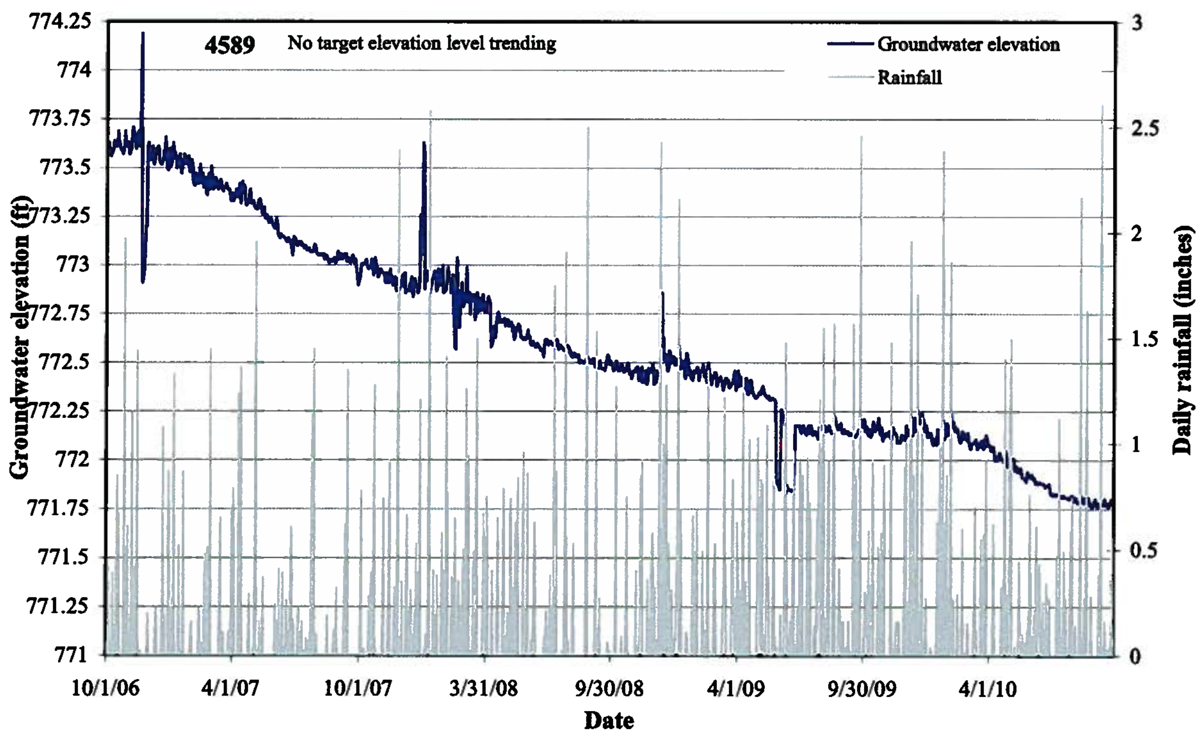


Figure B.13. Well hydrographs for wells 4556/0952 and 4589.

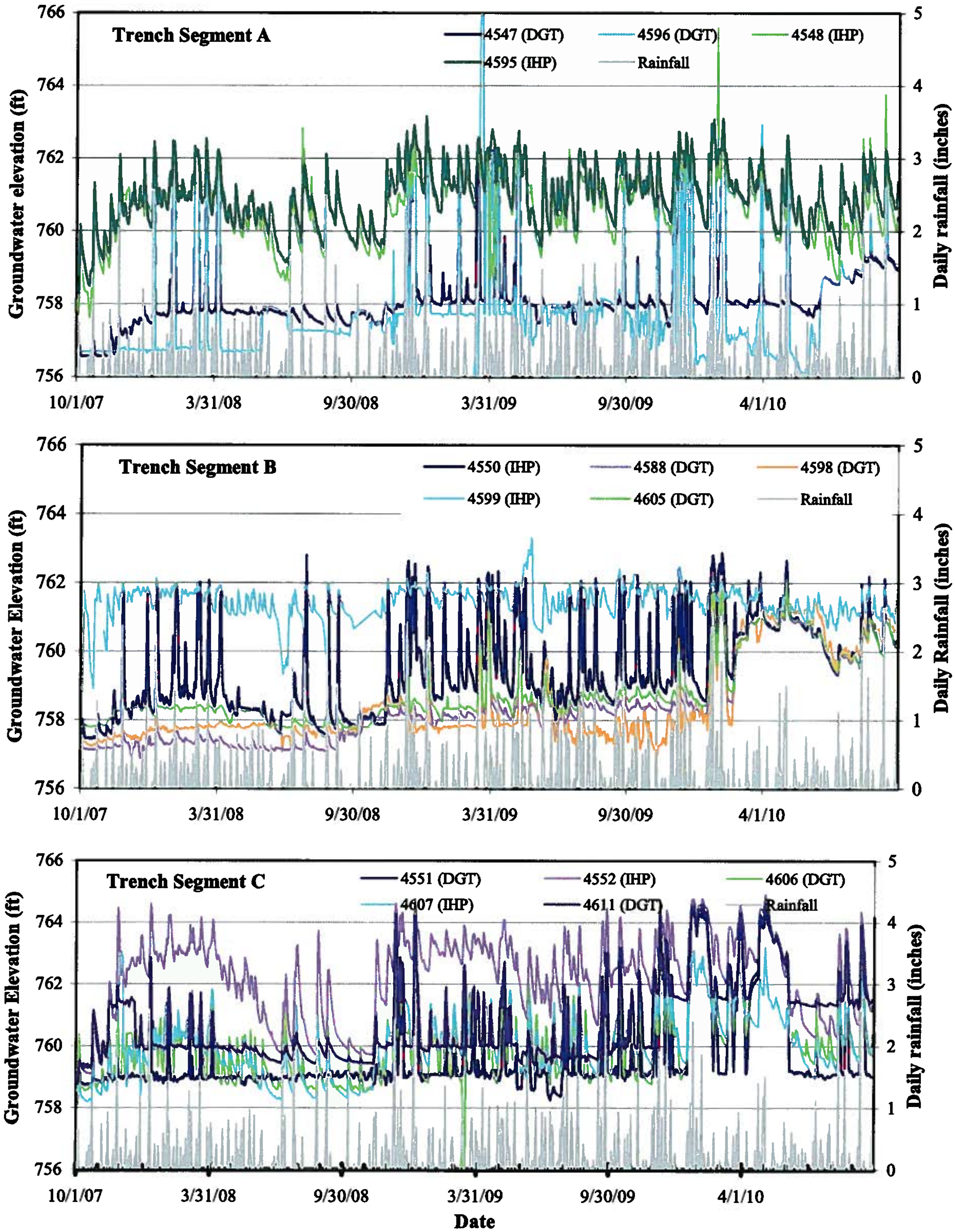


Figure B.14. Well hydrographs for wells at the SWSA 4 downgradient trench (FY 2010).

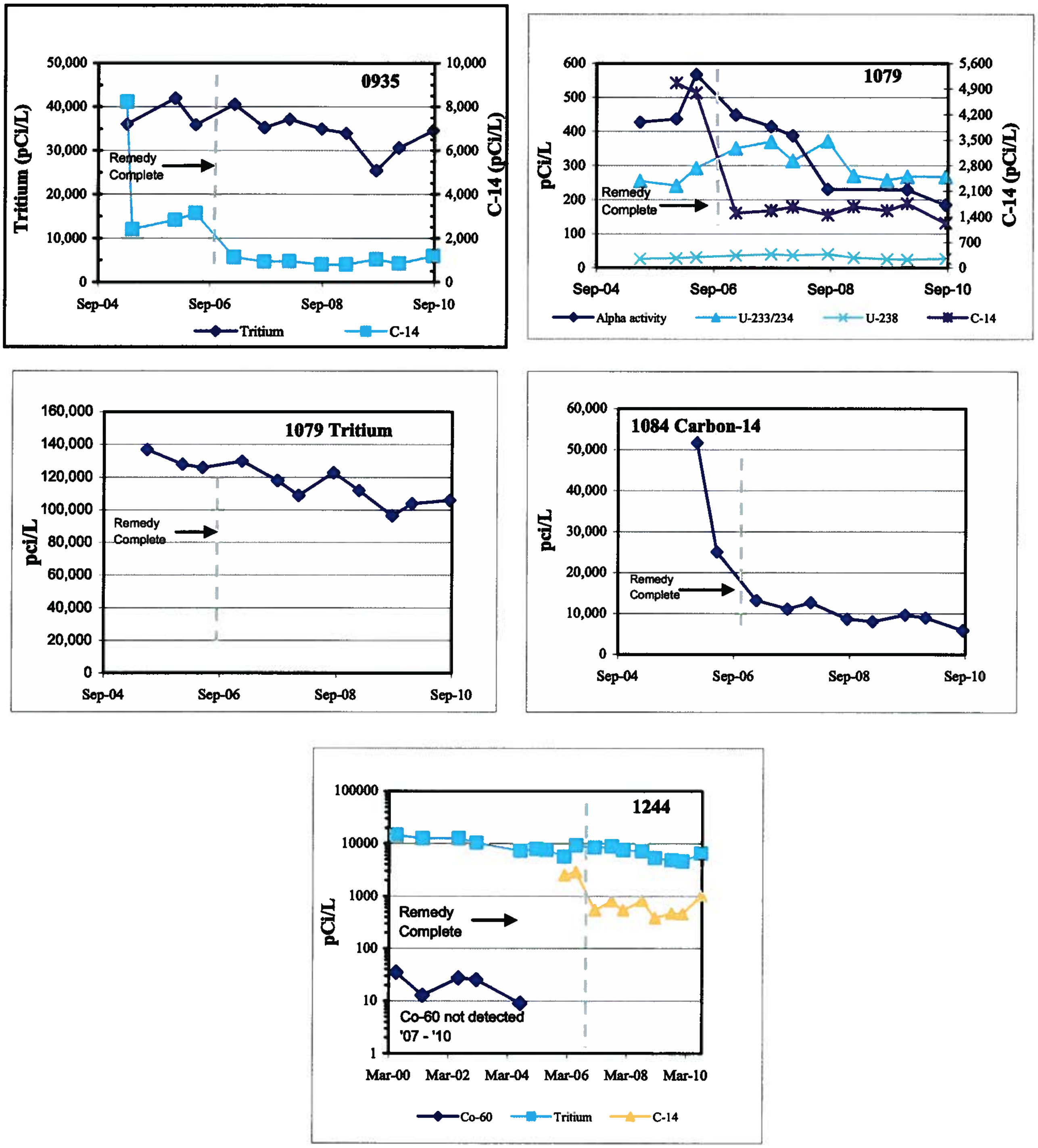


Figure B.15. Concentration trends for selected radionuclides at Pits and Trenches wells 0935, 1079, 1084, and 1244.

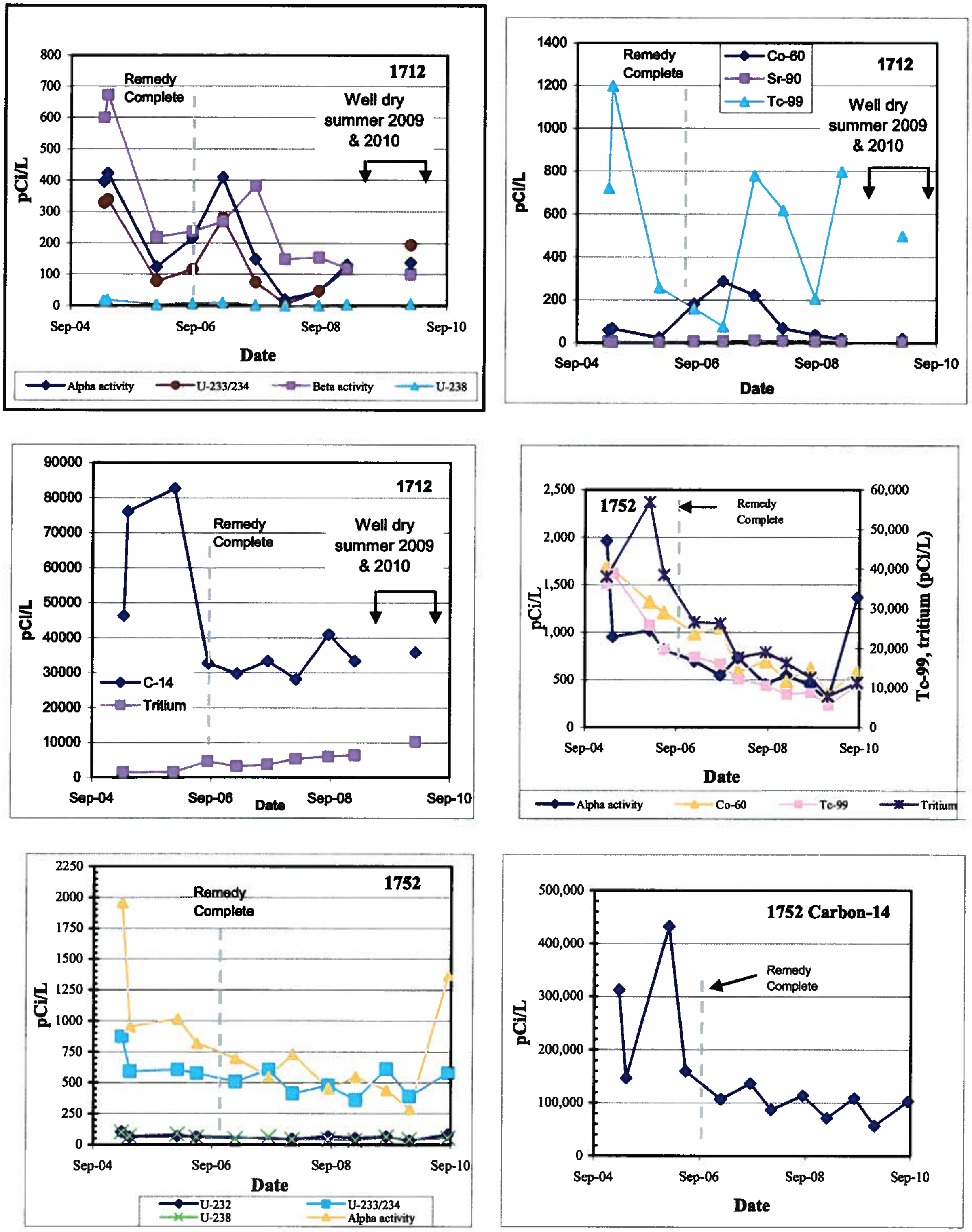


Figure B.16. Concentration histories for selected radionulicides at Pits and Trenches wells 1712, and 1752.

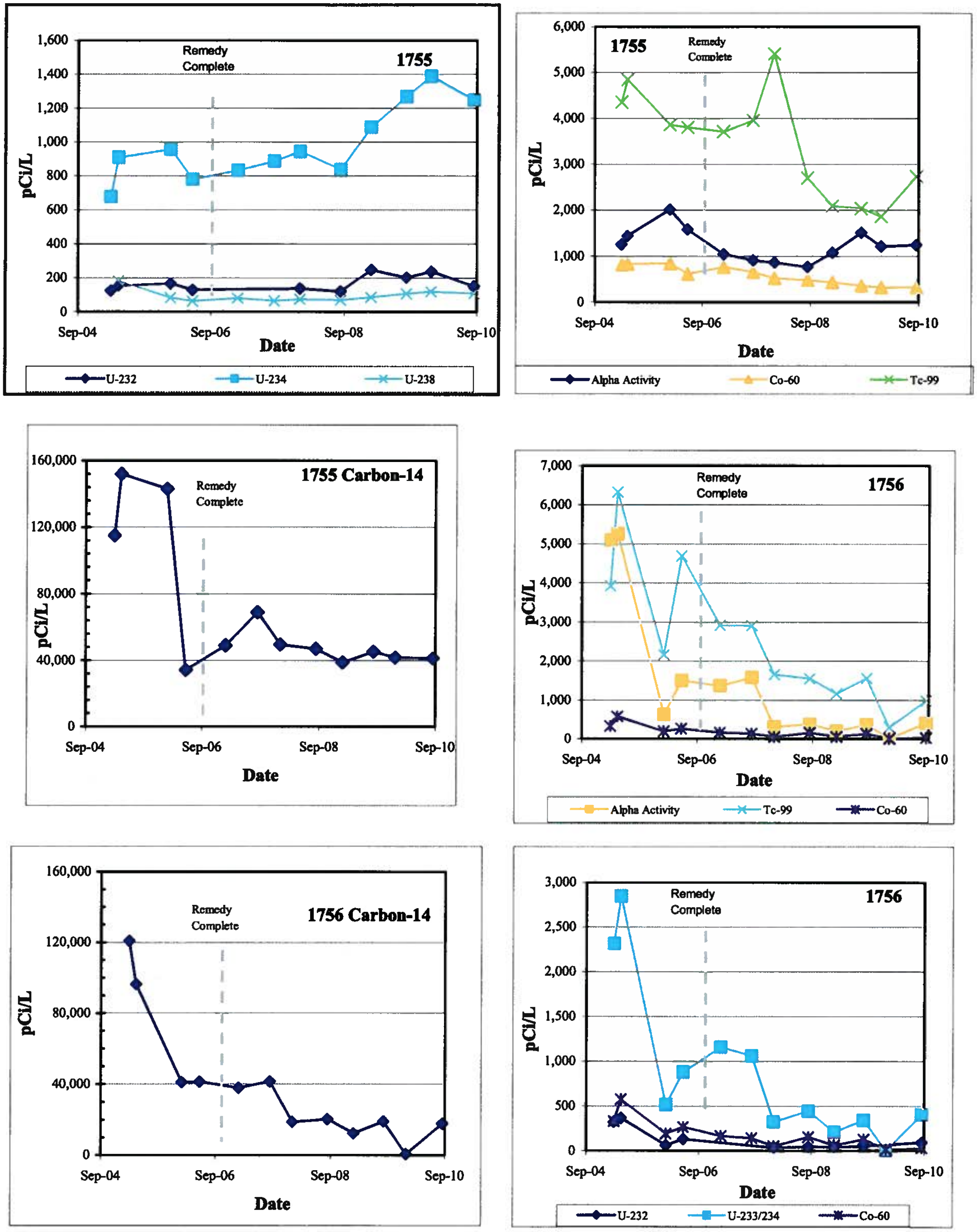


Figure B.17. Concentrations histories for selected radionuclides in Pits and Trenches wells 1755 and 1756.

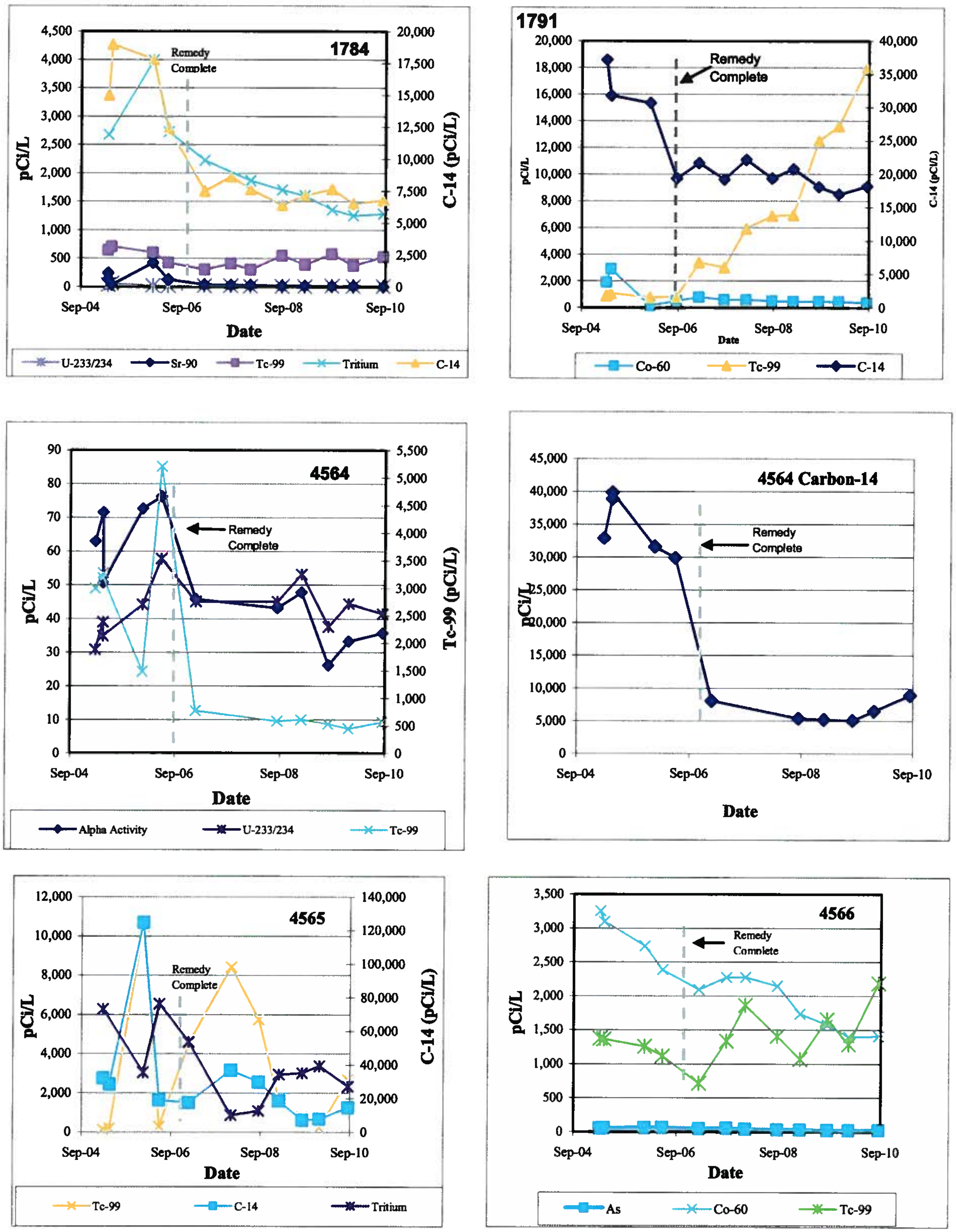
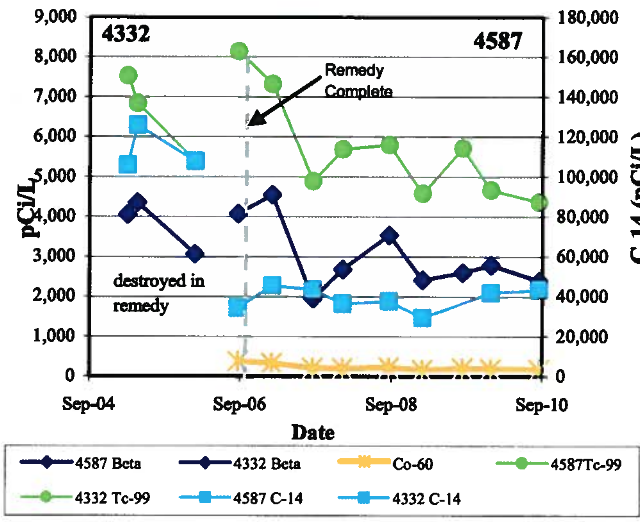


Figure B.18. Concentrations histories for selected radionuclides in Pits and Trenches wells 1784, 1791, 4564, 4565, and 4566.



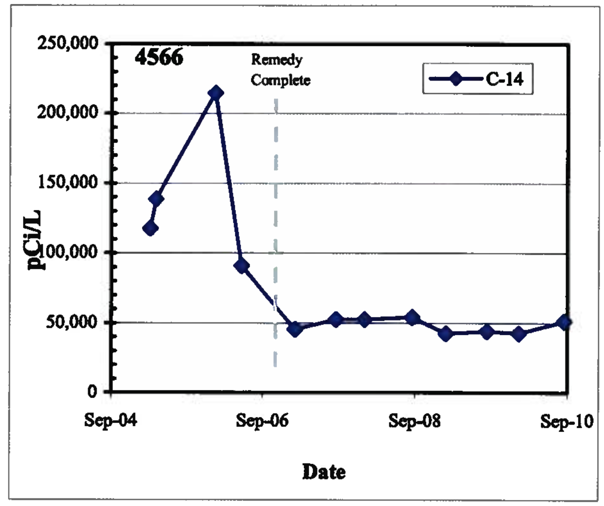


Figure B.19. Concentration histories for selected radionuclides in Pits and Trenches wells 4566, 4332, and 4587.

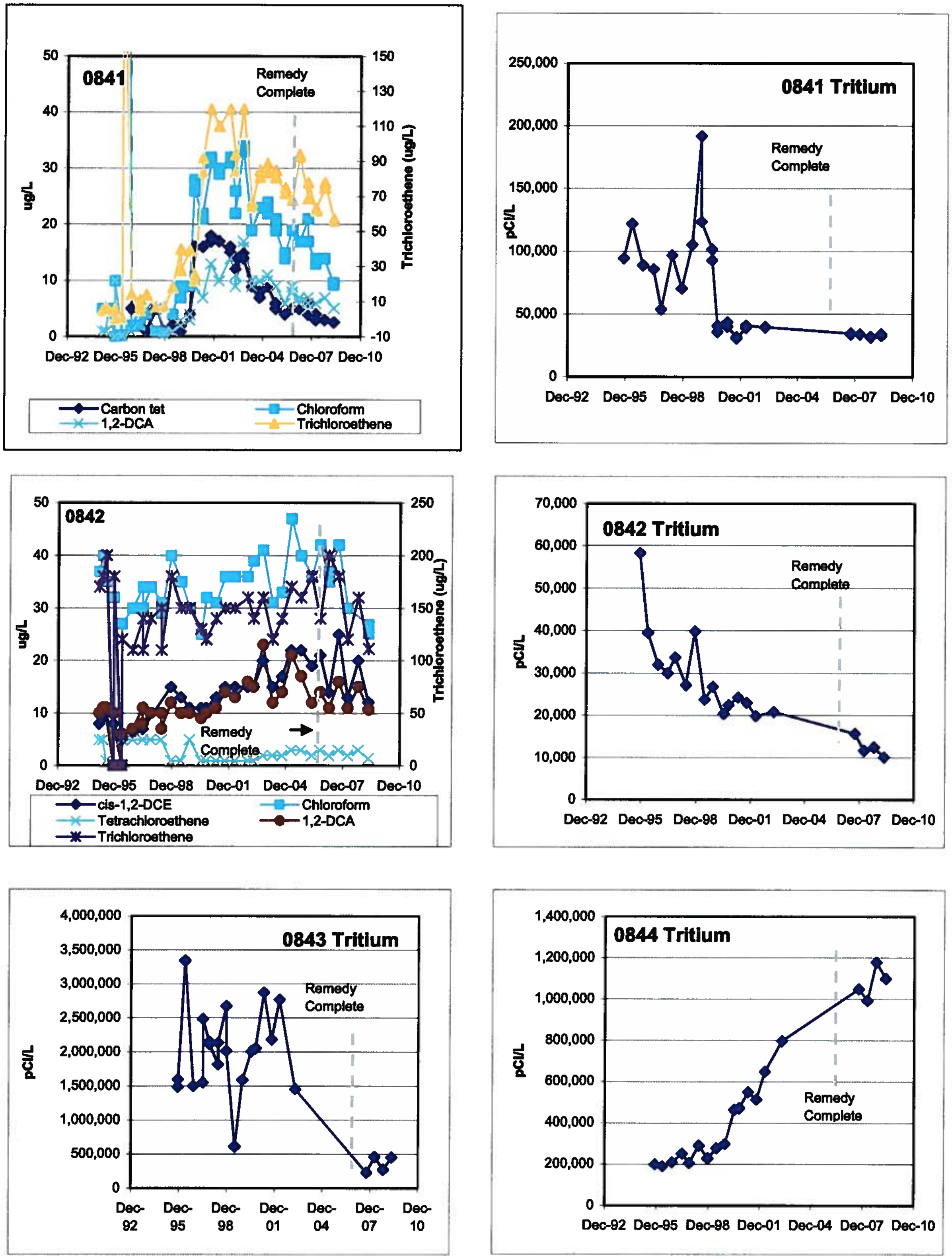
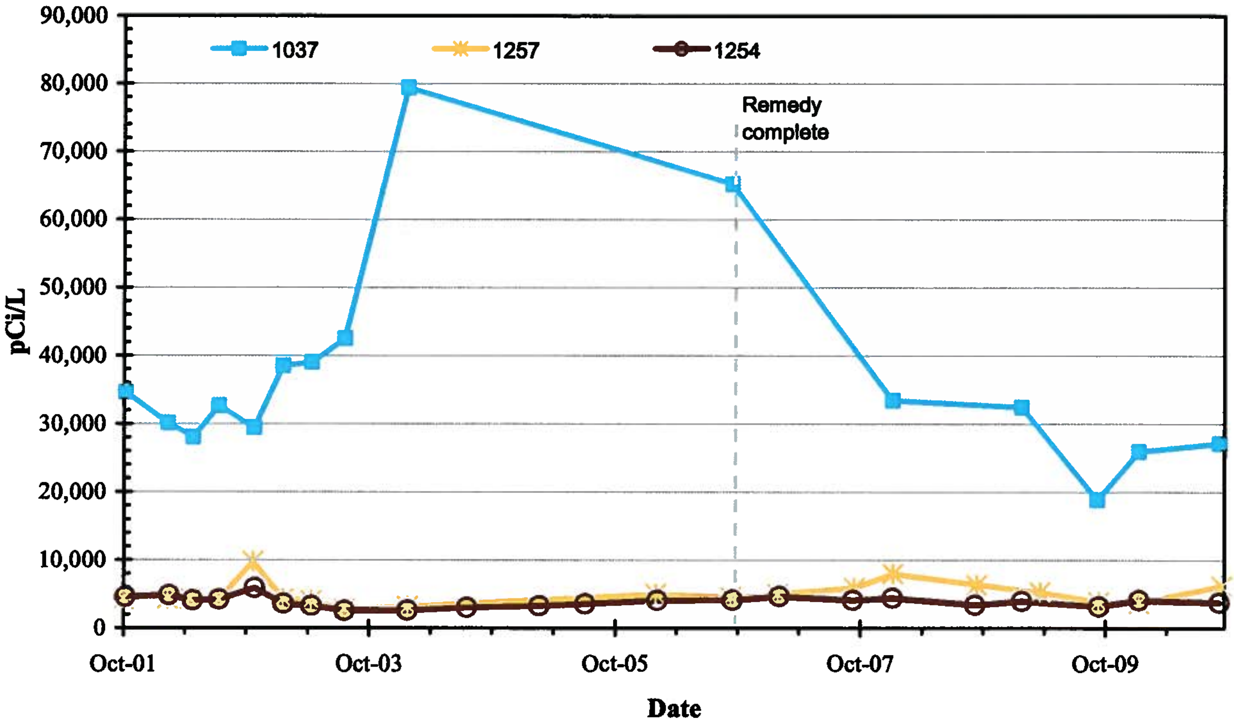


Figure B.20. Concentration trends for contaminants in SWSA 6 wells 0841, 0842, 0843, and 0844.



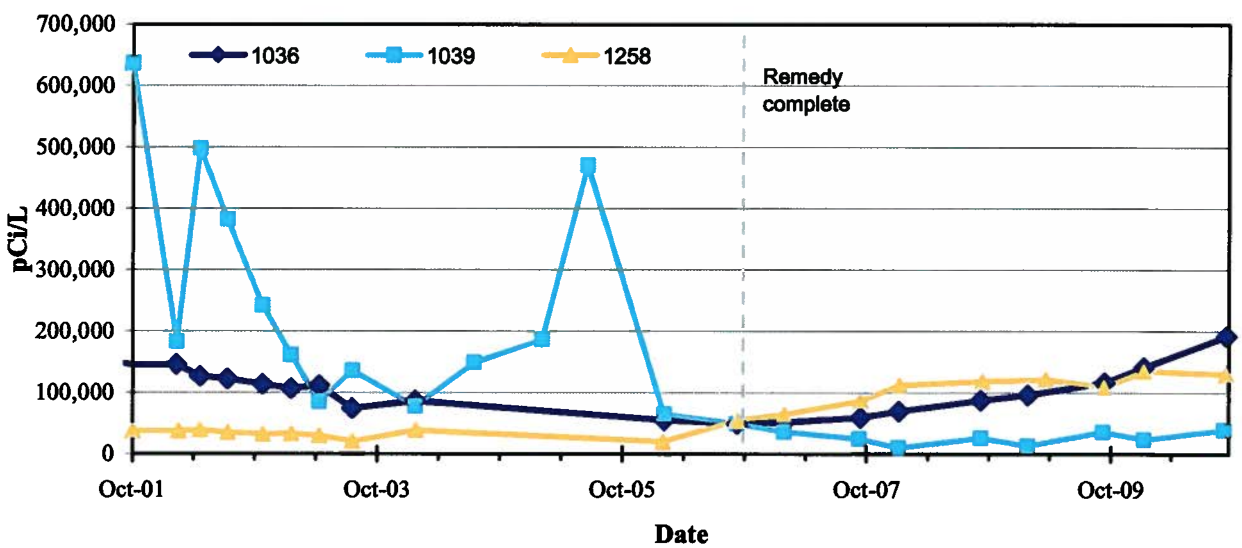


Figure B.21. Tritium trends in groundwater near the Tumulus facility.