DOE/OR/01-2675&D2

2015 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation Oak Ridge, Tennessee

Data and Evaluations

DOI/OR/01-2675&D2

2015 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation Oak Ridge, Tennessee

Data and Evaluations

Date Issued—September 2015

Prepared by the
Water Resources Restoration Program
URS | CH2M Oak Ridge LLC

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

URS | CH2M Oak Ridge LLC
Managing and Safely Delivering the Department of Energy's Vision
for the East Tennessee Technology Park Mission
under contract DE-SC-0004645

This page intentionally left blank.

CONTENTS

FIGURES

TABLES

This page intentionally left blank.

ACRONYMS

AM	Action Memorandum
aMSL	above Mean Sea Level
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
B&W	Babcock & Wilcox
BCBG	Bear Creek Burial Ground
BCK	Bear Creek kilometer
BCV	Bear Creek Valley
BFK	Brushy Fork kilometer
bgs	below ground surface
BMAP	Biological Monitoring and Assessment Program
BORCE	Black Oak Ridge Conservation Easement
BSWTS	Big Spring Water Treatment System
BVBGs	Bethel Valley Burial Grounds
BYBY	Boneyard/Burnyard
CCC	Criterion Continuous Concentration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CMTS	Central Mercury Treatment System
CNF	Central Neutralization Facility
CNS	Consolidated Nuclear Solutions, LLC
COC	contaminant of concern
CRK	Clinch River kilometer
CRM	Clinch River mile
CWA	Clean Water Act of 1972
CWTS	Chromium Water Treatment System
D&D	decontamination and decommissioning
DARA	Disposal Area Remedial Action
DCA	dichloroethane
DCE	dichloroethene
DCS	Derived Concentration Standard
DHC	*Dehalococcoides*
DNAPL	dense non-aqueous phase liquid
DOE	U.S. Department of Energy
DVS	Dynamic Verification Strategy
ECU	Electrocoagulation Unit
EEVOC	East End Volatile Organic Compound
EFK	East Fork kilometer
ELCR	excess lifetime cancer risk
EM	Environmental Management
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
EPP	excavation/penetration permit
EPT	Ephemeroptera, Plecoptera, and Trichoptera
ETTP	East Tennessee Technology Park
EU	exposure unit
EWQP	ETTP Water Quality Program
FCAP	Filled Coal Ash Pond

FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreement
FS	feasibility study
FY	fiscal year
FYR	Five-Year Review
GAC	granular activated carbon
GWPP	Groundwater Protection Program
HCK	Hinds Creek kilometer
HI	hazard index
HQ	Hazard Quotient
HRE	Homogeneous Reactor Experiment
IHP	Intermediate Holding Pond
IW	interception well
KHQ	Kerr Hollow Quarry
LEFPC	Lower East Fork Poplar Creek
LLW	low-level waste
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
LUM	Land Use Manager
LWBR	Lower Watts Bar Reservoir
MBK	Mill Branch kilometer
MBWEIR	Melton Branch Weir
MCK	McCoy Branch kilometer
MCL	maximum contaminant level
MCL-DC	maximum contaminant level derived concentration
MCLG	maximum contaminant level goal
MEK	Melton Branch kilometer
MIK	Mitchell Branch kilometer
MMS	Moment Magnitude Scale
MSL	mean sea level
MSRE	Molten Salt Reactor Experiment
MTF	Mercury Treatment Facility
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDA	nondestructive assay
NFA	No Further Action
NNSS	Nevada National Security Site
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSC	Non-Significant Change
NT	North Tributary
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Office
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PCCR	Phased Construction Completion Report
PCE	perchloroethene/tetrachloroethene
PCK	Poplar Creek kilometer

PCM	Poplar Creek mile
PCP	Post-Closure Permit
PHK	Pinhook Branch kilometer
PLFA	phospholipid fatty acids
PNNL	Pacific Northwest National Laboratory
POC	point-of-compliance
psig	pounds per square inch gauge
PVC	polyvinyl chloride
PWTC	Process Waste Treatment Complex
QAPP	Quality Assurance Project Plan
RA	remedial action
RAIS	Risk Assessment Information System
RAO	remedial action objective
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act of 1976
RDR	Remedial Design Report
RER	Remediation Effectiveness Report
RI	Remedial Investigation
RmAR	Removal Action Report
ROD	Record of Decision
RmSE	Removal Site Evaluation
S&M	surveillance and maintenance
SAP	sampling and analysis plan
SD	storm drain
SDWA	Safe Drinking Water Act of 1974
SE	standard error
SNS	Spallation Neutron Source
STP	Sewage Treatment Plant
SWPP	Storm Water Pollution Prevention
SWSA	Solid Waste Storage Area
TCA	trichloroethane
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TRM	Tennessee River mile
TSCA	Toxic Substances Control Act of 1976
TSS	total suspended solids
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
UCOR	URS | CH2M Oak Ridge LLC
UEFPC	Upper East Fork Poplar Creek
UNC	United Nuclear Corporation
UT-B	University of Tennessee-Battelle, LLC
UU/UE	unlimited use/unlimited exposure
VC	vinyl chloride
VOC	volatile organic compound
WAC	waste acceptance criteria

WAG	Waste Area Group
WBIWG	Watts Bar Interagency Working Group
WCK	White Oak Creek kilometer
WCWEIR	White Oak Creek Weir
WEMA	West End Mercury Area
WHP	Waste Handlin Plan
WOC	White Oak Creek
WOCE	White Oak Creek Embayment
WOL	White Oak Lake
WRRP	Water Resources Restoration Program
Y-12	Y-12 National Security Complex

EXECUTIVE SUMMARY

Under the requirements of the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014) 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), all environmental restoration activities on the Oak Ridge Reservation (ORR) are performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This *2015 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*:

- evaluates the performance of completed and ongoing CERCLA actions on and around the DOE ORR.
- evaluates the effectiveness of and compliance with the long-term stewardship (LTS) requirements for each of the completed actions.
- summarizes watershed monitoring results.

First issued in 1997, the Remediation Effectiveness Report (RER) has been reissued annually to update the performance of completed actions and to add descriptions of new CERCLA actions. Generally, the data reported in the 2015 RER were collected prior to or in fiscal year (FY) 2014.

Remedial decisions on the ORR have been made at the watershed scale in recognition of surface water being the major pathway for off-site contaminant transport and to ensure that the evaluation considers the cumulative resources needed for cleanup and the resource implications for alternate end uses. While waiting for the watershed decisions to be made with the associated series of remedial actions (RAs), single-project actions were performed primarily to mitigate immediate risks and to reduce further migration of contaminants off-site. The watershed Records of Decision (RODs) contain performance goals to be met and a series of RAs designed to achieve the goals. Since the implementation of these watershed RODs can take many years to complete, evaluation of performance must consider completed actions, actions not yet implemented, and actions which are in progress.

Monitoring information used to assess performance was compiled by DOE Environmental Management (EM) through the Water Resources Restoration Program (WRRP) that was established to implement a comprehensive, integrated environmental monitoring and assessment program for the 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 performance assessment data, baseline data also is collected to gauge the effectiveness of future actions once implemented.

Most of the remediation decisions do not allow unrestricted end use, therefore LTS will be required at these sites. LTS is the set of activities necessary to protect human health and the environment from physical hazards, residual contamination, and wastes remaining following remediation. The RER evaluates the performance of LTS activities that are required by CERCLA documents to protect human health and the environment.

A chapter is devoted to each of the watersheds, to Chestnut Ridge, to off-site actions, and to other sites. Rather than forming a single defined hydrologic watershed, Chestnut Ridge and the East Tennessee Technology Park (ETTP) comprise several individual sub-watersheds but are treated as a single unit for decision-making and performance assessment. Each chapter identifies completed single-project actions and completed watershed-scale actions with LTS requirements.

A summary of the effectiveness evaluation follows. Issues and recommendations including closed out issues and the status of Five-Year Review (FYR) issues are summarized in Chapter 1 and included in Tables 1.2, 1.3 and 1.4. More detailed discussion of the issues and recommendations are in each Chapter. FYR Action Plans are in Appendix C.

Bethel Valley

Following is a summary of the Bethel Valley watershed assessment:

- Strontium-90 and ^{137}Cs concentrations at the Bethel Valley watershed integration point (7500 Bridge) met their risk reduction goals. The Corehole 8 Extraction System met its performance goal based on ^{90}Sr flux reduction at First Creek during FY 2014, which contributed to the risk reduction goal for ^{90}Sr being met downstream at the 7500 Bridge.

- Surface water discharges of ^{90}Sr in Northwest Tributary and Raccoon Creek have decreased significantly as a result of hydrologic isolation of shallow buried waste at SWSA 3 and the Contractor's Landfill. Comparison of pre-remediation to FY 2014 groundwater contaminant concentrations shows that levels are decreasing or stable. Although three of nine wells have not yet attained design target groundwater levels, the groundwater level fluctuations within the waste depth zone in the hydrologic isolation area show that direct infiltration of rainwater into buried waste has been controlled.

- Mercury concentrations at the Bethel Valley watershed integration point (7500 Bridge) continue to meet the ambient water quality criteria (AWQC) of 51 ng/L. CERCLA actions at Building 4501 to re-route and pre-treat mercury contaminated building sump water are shown to be effective at reducing mercury concentrations in the receiving reach of White Oak Creek (WOC). Mercury concentrations measured at WOC-105, located a short distance downstream from the former storm drain discharge from Building 4501, were less than the AWQC level in FY 2014 samples.

- Low levels of ^{90}Sr were detected in wells 4645 and 4646 in the headwaters of Raccoon Creek for the first time since the wells were installed in 2010. Detected levels were approximately 25% of the maximum contaminant level derived concentration (MCL-DC) of 8 pCi/L.

- The observed improvement in fish mercury concentrations to levels below the EPA recommended fish based AWQC for mercury continued in WOC. Biological monitoring of the Bethel Valley watershed indicates moderate ecological recovery since 1987. Invertebrate community monitoring shows there is little evidence of improvement since 2002. Recent introductions of new fish species, however, have been partially successful.

- Land use controls (LUCs) in Bethel Valley were maintained. Signs were maintained to control access and surveillance patrols were conducted as part of routine surveillance and maintenance (S&M) inspections. The Excavation/Penetration Permit (EPP) Program functioned according to established procedures and plans.

Melton Valley

Following is a summary of the Melton Valley watershed assessment:

- Radiological goals for ^{137}Cs, ^{90}Sr, and tritium, which are the principal surface water contaminants in the Melton Valley watershed, were met at the watershed integration point (White Oak Dam). Principal contaminant concentrations at tributary and mainstem monitoring locations remained compliant with goals of the *Record of Decision for Interim Actions for the Melton Valley Watershed, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-1826&D3).

- Strontium-90 levels in the Homogeneous Reactor Experiment (HRE) Tributary downstream of the HRE facility trended downward during FY 2014 from elevated levels measured during FY 2012 and FY 2013. DOE conducted surface water sampling during FY 2014 that identified the probable source of increased ^{90}Sr as contamination entering a tributary immediately northeast of the HRE facility near an abandoned and remediated liquid low-level waste (LLLW) transfer pipeline. Contaminated soil from a pipeline leak in the area was excavated and disposed during the Melton Valley Closure Project completed in 2006. Apparently after several years of above-average rainfall, contamination has reoccurred in the area. Monitoring in the HRE tributary will continue to observe ongoing trends. This closes an issue identified in the 2014 RER.

- Groundwater level monitoring of the hydrologic isolation areas in Melton Valley showed that performance criteria were met at 47 of 52 locations. Although operation of the Solid Waste Storage Area (SWSA) 4 downgradient groundwater collection trench remains challenging, discharges from the area in surface water met ROD goals. For the five locations that did not attain the ROD goal, an issue has been identified to review conditions, including potential modification to monitoring and applicable CERCLA documentation.

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

- Groundwater analyses conducted on samples from the on-site exit pathway wells since their construction in 2004 and off-site wells have resulted in a number of radionuclides and volatile organic compounds (VOCs) being detected periodically in different monitoring locations. An off-site detection of low concentrations of VOCs occurred early in the sampling history from one sampling event in 2010 at one well. It is suspected to have occurred because of well development pumping stresses in the off-site well during construction that caused low head in a discrete fracture zone connected to the vicinity of an on-site exit pathway well where detection of similar VOCs occurred. Neither well has experienced subsequent detections of the VOCs detected in 2010. This detection is considered to exemplify the vulnerability of off-site wells in close proximity to areas of groundwater contamination and highlights the importance of man-induced pumping stresses on influencing contaminant movement in groundwater.

  - During FY 2014, drinking water maximum contaminant levels (MCLs) were exceeded for alpha activity (15 pCi/L MCL) in four on-site exit pathway well sampling zones and two off-site wells, both of which produce highly saline groundwater samples and high dissolved solids samples are known to cause high bias in the analytical result. The MCL for total radium alpha activity (5 pCi/L) was exceeded in three deep monitoring zones in on-site exit pathway wells and in one deep off-site monitoring well. Beta activity exceeded the 50 pCi/L screening level during FY 2014 in two of the deepest sampling zones in on-site exit pathway wells and in one deep off-site well. Similar to the alpha activity, high dissolved solids content in the saline zone contributes to elevated beta activity in the analyses.

  - Strontium-90 was not detected in any off-site wells during FY 2014 and was detected in samples from three on-site exit pathway sampling zones at levels less than half the MCL-DC of 8 pCi/L.

  - The MCL for antimony was exceeded in one off-site well (in the deepest sampling interval of the well) and in none of the on-site exit pathway wells. The arsenic MCL was exceeded in two off-site wells and three on-site exit pathway wells, MCLs were exceeded for barium in four on-site deep exit pathway monitoring zones and in two deep off-site monitoring zones, for benzene in one deep off-site well, for fluoride in 20 on-site exit pathway wells and four off-site wells, and for thallium in one shallow off-site well. The barium and benzene MCL exceedances occur in deep groundwater samples collected from the transition zone between the fresher groundwater at shallower depths and the underlying connate brines which are known to contain these substances derived from natural sources. In addition to being a common indicator of man-made waste sources, fluoride is a common minor groundwater constituent that originates from natural bedrock sources. Areas with natural fluoride concentrations greater than 4 mg/L are known to exist but are uncommon.

- The majority of the on-site exit pathway and off-site wells which have had drinking water standard exceedances in the past did not show continuing contamination at those levels during FY 2014. The ROD does not specify applicable or relevant and appropriate requirement (ARAR)-based performance goals for groundwater. MCLs are used for screening purposes only.

- The biological monitoring results indicate that Melton Branch and lower WOC stream communities are impaired relative to reference sites. Since introduction of new fish species in the watershed, fish communities have improved steadily in both species richness and abundance. However, there is no evidence of improving trends in the benthic macroinvertebrate communities over the last 5 – 10 years, with substantial year to year variation.

- LUCs were implemented in Melton Valley in FY 2014 in accordance with the approved Land Use Control Implementation Plan (LUCIP) for the watershed as certified in Appendix A of this document.

- Signs were maintained to control access and surveillance patrols were conducted. The EPP Program functioned according to established procedures and plans. Inspections of engineering controls were conducted at the Melton Valley hydrologic isolation areas and maintenance was performed as required. Items such as isolation caps, drainage features, monitoring weirs, and leachate collection equipment were inspected as applicable at each site. All caps were noted to have good vegetative coverage and were mowed a minimum of once during the year.

Bear Creek Valley

Following is a summary of the Bear Creek Valley (BCV) watershed assessment:

- Surface water monitoring at the integration point (Bear Creek kilometer [BCK] 9.2) showed that the *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) goal of ≤34 kg/yr of uranium was not attained. The measured uranium flux at the integration point in FY 2014 was about 96 kg which is nearly three times the ROD goal. An estimated one-quarter of the uranium flux is attributed to surface water discharged from the S-3 Ponds plume, about 75% of the uranium flux originated in the Bear Creek Burial Grounds (BCBGs), and approximately 2% originated from NT-3. The uranium mass balance estimate for the integration point monitoring at BCK 9.2 compared to the sum of upstream contributing stations was within 5% during FY 2014 which is considered a good mass balance considering the complex nature of surface water and shallow groundwater flow in the area. The annual uranium discharge flux is directly related to the total annual rainfall and during recent years Oak Ridge has experienced above average rainfall amounts. Rainfall in FY 2014 was slightly below average.

- NT-8 near the BCBGs continues to be the largest contributor of uranium to Bear Creek having accounted for 72.4 kg of uranium during FY 2014 . Implementation of an NT-8 Surface Water action is a potential project identified in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2). Investigations and projects during groundwater strategy implementation will be sequenced according to ORR-wide groundwater issues prioritization.

- Nitrate concentrations meet applicable ROD criteria at the watershed integration point (BCK 9.2). Cadmium concentrations exceeded AWQC requirements at NT-1 and at the BCK 12.34 monitoring location near the S-3 Ponds contaminant source.

- The average nitrate concentration measured at BCK 12.34 near the S-3 Pond source area was less than the industrial risk-based concentration.

- In Zone 1, the western half of BCV, groundwater contaminant concentrations continue to remain low. However, there are uncertainties about groundwater contaminant levels and flow paths that have been identified in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2). Evaluation of potential pathways and installation of additional wells will be included in investigations during groundwater strategy implementation and will be sequenced according to ORR-wide groundwater issues prioritization. Evaluation of uranium isotope ratios in the Zone 1 springs and wells shows that spring SS-6 is unique in the area in that its uranium appears to originate from upstream of NT-8 while all the other Zone 1 locations show uranium isotopic signatures that reflect the influence of NT-8 discharges.

- Mean mercury concentrations in rockbass in lower Bear Creek (BCK 3.3) remained elevated and are above EPA-recommended AWQC.

- Polychlorinated biphenyl (PCB) concentrations in stoneroller minnows continued the long-term trend of elevated levels but decreasing since a big spike in 2004.

- LUCs in BCV were maintained. Signs were maintained to control access and surveillance patrols were conducted as part of routine S&M inspections. Inspections conducted at the Boneyard/Burnyard (BYBY), Spoil Area 1, and SY-200 Yard sites included assessment of the vegetative cover and drainage. Maintenance activities and routine mowing were performed.

The Environmental Management Waste Management Facility (EMWMF) is an operating CERCLA waste disposal facility located in the BCV watershed. Operation of the EMWMF is an ongoing CERCLA action to dispose of waste from CERCLA response actions on the ORR and associated sites. The CERCLA action status of the EMWMF is not reported in this document but is evaluated in the EMWMF annual Phased Construction Completion Report (PCCR).

Chestnut Ridge

Following is a summary of the Chestnut Ridge assessment:

- **United Nuclear Corporation (UNC) –** Gross beta activity continues to be observed in downgradient well GW-205 although levels have decreased significantly since the well was re-developed in 2010. The gross beta activity is attributed predominantly to the presence of potassium containing a natural radioactive ^{40}K component. Strontium-90 has been detected intermittently in the well but was not detected in FY 2014. The downgradient spring (UNC SW-1) exhibits data consistent with results from downgradient monitoring wells at the site.

- **Kerr Hollow Quarry (KHQ) –** The July 2014 and subsequent verification and confirmation sampling/analysis results for Resource Conservation and Recovery Act of 1976 (RCRA) point-of-compliance (POC) well GW-144 show carbon tetrachloride concentrations similar to the levels sporadically detected in previous groundwater samples from the well. Although this continues to represent a long-term decreasing trend of carbon tetrachloride at the KHQ, the DOE and URS | CH2M Oak Ridge LLC (UCOR), Operator and Co-operator, respectively, of the unit have proposed to increase monitoring in GW-144 to semiannually for the same VOCs required by the RCRA post-closure permit and to add semiannual monitoring at the downgradient surface-water exit pathway (S17) for the watershed that includes KHQ. These changes in monitoring requirements will continue until four consecutive non-detect samples are obtained from well GW-144.

- **Filled Coal Ash Pond (FCAP) –** The monitoring results since the RA indicate that the remedy is minimizing the migration of contaminants into surface water as it exits the wetland. Although concentrations have decreased significantly since implementation of the RA, total arsenic concentrations generally exceed the screening criteria in both the upgradient and downgradient locations at the FCAP wetland. Based on the sampling for the FY 2011 through FY 2014 period, the passive wetland treatment area reduces total arsenic concentrations by about 93% with associated reductions of dissolved arsenic of about 19%. Arsenic levels in Rogers Quarry fish have been near background. However, selenium and mercury concentrations remain higher in fish relative to typical background concentrations for selenium and relative to federal AWQC guidelines for mercury, suggesting continuing low level inputs from the FCAP. Stream community measures show that McCoy Branch remains below, or at the lower end, of values observed in reference streams.

Inspections were performed at the UNC site, KHQ, and FCAP to assess items such as site security and access controls, proper signage, vegetative cover, drainage features, and condition of wells as applicable at each site. Routine mowing and other maintenance activities were performed in FY 2014.

Upper East Fork Poplar Creek

Following is a summary of the Upper East Fork Poplar Creek (UEFPC) watershed assessment:

- The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) goal for mercury in surface water at Station 17 is 200 ng/L. The average flow-paced composite mercury concentration during FY 2014 was 1,490 ng/L, down from 1,710 ng/L in FY 2013. Total mercury concentrations in several of the weekly composite samples collected at Station 17 during FY 2014 were less than the 200 ng/L ROD goal.

- The Big Spring Water Treatment System (BSWTS) was fully operational during FY 2014. Although no significant downtime or operational problems occurred, winter and early spring seasonal rainfall caused the influent to BSWTS groundwater collection system to exceed the treatment system's design capacity. This necessitated bypassing the system during 30 weeks. Approximately 98% of the bypass discharge occurred between late November 2013 and early March 2014 with a mercury discharge from the bypass of approximately 10 g during the year (less than 0.1% of measured flux at Station 17).

- The performance standard for uranium at Station 17 is to monitor the trend. The uranium flux at Station 17 in FY 2014 decreased relative to levels measured during the previous several years of above-average rainfall.

- The East End Volatile Organic Compound (EEVOC) plume removal action is measured through two metrics. The first metric is the effectiveness of the groundwater withdrawals at reducing VOC concentrations in the plume off DOE property to the northeast in Union Valley. The second metric is the performance of the air stripper at removing the signature VOCs from the water discharged to UEFPC. FY 2014 data indicate that the groundwater pump and treatment system has effectively withdrawn groundwater and has limited off-site plume migration. Evidence of that performance is the below drinking water limit concentrations of carbon tetrachloride in off-site monitoring wells in Union Valley. During FY 2014 the air stripper system performed well after a mechanical problem noted in October 2013 was corrected. The variable frequency drive on the well pump motor required replacement during September 2014. A brief (4-day) system outage occurred at that time.

- Aquatic biological monitoring shows that mercury concentrations in rock bass at Station 17 generally remain stable. However, at upstream locations EFK 23.4 and EFK 24.2, mercury concentrations in redbreast appear to have declined in response to the reduction in aqueous mercury concentrations in FY 2013. While redbreast mercury concentrations in water at upper reaches of the creek have declined, they have not responded to decreases in aqueous total mercury concentrations at downstream sites in East Fork Poplar Creek.

- LUCs in UEFPC were maintained, including signs to control access, surveillance patrols, and an ongoing EPP program. Institutional controls in Union Valley were maintained.

Off-Site Actions

Following is a summary of the off-site actions assessment:

- **Lower East Fork Poplar Creek (LEFPC)** – Monitoring at Station 17 is conducted to measure the concentration and mass flux of mercury that is discharged from the UEFPC watershed into LEFPC. During FY 2014, the flow-paced continuous monitoring detected an average concentration of 1,490 ng/L and a mass flux of 14.4 kg mercury. The levels of mercury in fish tissue in the LEFPC have remained elevated.

  A periodic survey to detect residential use of shallow groundwater was last performed in FY 2012. There were no new wells identified for residential use along LEFPC. Visual inspections in FY 2014 confirmed that land use of the property of the former Dean Stallings Ford automobile dealership has not changed. The area is now leased to Ole Ben Franklin Motors used car dealership which opened for business in January 2014.

- **Clinch River/Poplar Creek and Lower Watts Bar Reservoir (LWBR)** – Performance monitoring of the Clinch River and Poplar Creek continues to indicate an overall downward trend in fish PCB concentrations. The decreasing PCB trends in fish are some of the most dramatic observed by the long-running Oak Ridge biological monitoring programs. However, striped bass are routinely above PCB advisory limits, especially larger fish. Mercury concentrations in fish at monitored sites continue to indicate the influence of mercury sources from East Fork Poplar Creek, 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 LWBR obtained during FY 2014 continue to indicate that mercury and PCB levels in fish are decreasing from historical levels.

  Fish consumption advisories are maintained by TDEC and were in effect for Clinch River/Poplar Creek and LWBR in FY 2014. Sign postings about advisories are also maintained by TDEC. The Tennessee Wildlife Resources Agency (TWRA) posts these advisories on their website and includes the advisories in their Tennessee Fishing Guide that is available on-line and where fishing licenses are sold.

The Watts Bar Interagency Working Group (WBIWG) provided continued controls on sediment-disturbing activity in the deep water channel. In FY 2014, seven dredging permit applications were received and approved for Clinch River/Poplar Creek and LWBR.

ETTP

Following is a summary of the ETTP watershed assessment:

- During FY 2014, surface water and groundwater monitoring indicates that contaminant levels are generally stable to decreasing in most instances and are consistent with the data from previous years with the exception of the ^{99}Tc topic discussed below. All surface water radiological data were below the screening level of 4% of the Derived Concentration Standard. VOC concentrations at the Mitchell Branch K-1700 weir are well below the applicable AWQC and the benchmark values for potential surface water toxicity. Collection and treatment of groundwater containing hexavalent chromium is ongoing and is protective of water quality in Mitchell Branch.

- Performance monitoring at the K-1007-P1 Holding Pond began in 2010. The mean fillet concentration is below the target of 1 µg/g total PCBs in fish fillets in this pond. Whole body fish concentrations, however, remain above the 2.3 µg/g target. Clam studies continue to indicate that storm drains are a source of PCBs to the K-1007-P1 Holding Pond, but the magnitude of this PCB source appears to be diminishing over time. Resuspension of contaminated sediments in the pond are a more likely important source of PCBs to fish. The removal action at the K-1007-P1 Holding Pond was 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.

- In FY 2014 mercury continues periodically to exceed the AWQC in storm water outfalls and in surface water, and exceeds the EPA's recommended criterion in fish tissue. The long term trend at the K-1700 Mitchell Branch exit pathway location shows a continuing decline from peak levels in FY 2010. Over the last twelve quarters only one result was above the AWQC value of 51 ng/L. However, there are storm water locations such as Outfall 05A that continue to routinely exceed the AWQC value. Legacy sources of mercury contamination will be addressed under planned CERCLA response actions for decontamination and decommissioning (D&D) and soil remediation. In addition, the new National Pollutant Discharge Elimination System (NPDES) storm water permit for ETTP scheduled for issuance in FY 2015 will specifically require additional investigative monitoring for and emphasis on mercury. This additional monitoring will support these ongoing and future CERCLA actions. This closes an issue identified in the 2014 RER.

- VOCs are the most significant groundwater contaminant at ETTP. Trichloroethene (TCE) concentrations in wells BRW-003 and -017 in the K-1064 Peninsula area and from the PC-0 spring in the K-901-A Holding Pond area are continuing to decline. At the K-770 area the alpha and beta activity levels have reached relatively low levels although seasonal fluctuations are apparent in the data. Measured alpha and beta activity levels in K-770 area groundwater were below drinking water screening levels in FY 2014 except the beta activity level in well UNW-013 was greater than the 50 pCi/L screening level in the August sample.

- Following demolition of Building K-25, ^{99}Tc was found in storm water and underground utilities associated with Building K-25. Following an extensive investigation of storm water sewers, underground electrical duct banks, sanitary sewers, and groundwater, the conclusion was that the concentrations of ^{99}Tc were in compliance with applicable regulatory requirements and DOE Orders and did not pose a threat to human health and the environment. A *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1) was prepared that documented the findings. In FY 2015 the recommendations of the Removal Site Evaluation will be addressed, characterization of exposure units (EUs) Z2-20, -21, and -22 (Building K-25 footprint) will be completed, and increased monitoring for ^{99}Tc in groundwater and surface water will be completed.

- Aquatic biological monitoring of Mitchell Branch indicates mercury and PCBs are elevated in fish to concentrations above human health thresholds, and fish and benthic communities remain impaired relative to upstream and reference sites, especially in the lower sections.

- The following LTS issues identified in previous RERs have been resolved:

  - Maintenance and inspection requirements identified for the K-1070-A Burial Ground in 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) are no longer applicable. They have been superseded by a no further action (NFA) determination for the Zone 1 EU where the K-1070-A Burial Ground is located.

  - LTS requirements and frequencies for the K-1407-B and K-1407-C ponds site have been clarified in an erratum to the *Remedial Action Report for the K-1407-B Holding Pond and the K 1407-C Retention Basin* (DOE/OR/01-1371&D1).

  - LTS requirements and frequencies for the K-1070-C/D G-Pit and K-1071 Concrete Pad have been changed in an erratum to the *Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad* (DOE/OR/01-1964&D2).

- Interim LTS requirements for slabs following building demolition are the subject of an open issue. The ETTP D&D and RA Project Teams have reached agreement on the management of slabs and are in the process of documenting and implementing the agreement. The results of implementing this agreement will be reflected in the next RER.

- General LUCs remained in place at ETTP.

  - Signs were maintained to control access and surveillance patrols were conducted as part of routine S&M inspections. The EPP program functioned according to established procedures and plans for the site. Required mowing was performed. Signs and access controls at the K-1070-C/D Burial Ground were inspected.

  - The northern section of 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. However, the end use identified in the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2) is unrestricted industrial, i.e., recreational use was not designated. This is an issue that was identified in the 2010 RER and carried forward in subsequent RERs. The Zone 1 Final ROD will address this issue.

CERCLA Actions at Other Sites

Following is a summary of the other sites assessment:

- **White Wing Scrap Yard** – Inspections were performed at the White Wing Scrap Yard to assess items such as access roads and the condition of gates and perimeter fencing. Site maintenance in FY 2014 included removing fallen trees.

- **Oak Ridge Associated Universities South Campus Facility** – Concentrations of detected VOCs in wells GW-841 and GW-842 from FY 1994 through FY 2014 have exhibited a long-term decreasing concentration history with a slight increase during FY 2013 and FY 2014. The FY 2014 results show that TCE in well GW-841 increased slightly and is above the drinking water standard. TCE in well GW-842 increased slightly in FY 2014, but remains below the drinking water standard. No VOCs were detected in surface water at the site during FY 2014. Groundwater use restrictions at the site were maintained.

REFERENCES

DOE/OR/01-1371&D1. *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin*, 1995, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1750&D4. *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1826&D3. *Record of Decision for Interim Actions for the Melton Valley Watershed, Oak Ridge National Laboratory, Oak Ridge, Tennessee,* 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1951&D3. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1964&D2. *Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1997&D2. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2261&D2. *Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2628/V1&V2&D2. *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2663&D1. *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for the Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

This page intentionally left blank.

1. INTRODUCTION

1.1 PURPOSE

The purposes of the annual Remediation Effectiveness Report (RER) are to:

- evaluate the performance of completed and ongoing actions 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),

- evaluate the effectiveness of and compliance with the long-term stewardship (LTS) requirements for each of the completed actions, and

- summarize watershed monitoring results.

With the exception of some ecological sampling data, all data reported in this *2015 Remediation Effectiveness Report* was collected prior to or in fiscal year (FY) 2014.

1.2 REMEDIATION STRATEGY

In Oak Ridge, DOE and its predecessor agencies have had a mission over the past 60 years of uranium enrichment, weapons production, and energy research. As a result of this mission, there is a legacy of hundreds of contaminated sites on the ORR. The ORR was placed on the CERCLA National Priorities List (NPL) in 1989. The *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014), signed by DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) in 1991, describes how remediation under CERCLA will be performed.

The remediation strategy for the contaminated sites on the ORR is based on a watershed management approach. The Clinch River bounds the ORR on three sides, and there are active creeks that flow down the valleys to the Clinch River (Figure 1.1). These surface water systems are fed by runoff from rainfall and by the groundwater that continually discharges to the surface streams. As much as 90% of the water entering the ground flows rapidly through highly porous, shallow soil, which contains most of the contaminated sites, before discharging to nearby surface water. Consequently, the primary pathway for contaminant migration is through shallow groundwater to surface water which then flows off-site. Because of abundant rainfall (an average of 54 in./yr), contaminant transport by shallow subsurface flow to surface waters, and the presence of contaminated sites in defined watersheds, a watershed strategy became the basis for environmental restoration.

Watershed management is an integrated, holistic approach to restore and protect ecosystems and to protect human health by focusing on hydrologically defined drainage basins. Watershed management is applied to the environmental restoration of the ORR by grouping contaminated sites into the following five watersheds (Figure 1.1):

- Bethel Valley,

- Melton Valley,

- Bear Creek Valley (BCV),
- Upper East Fork Poplar Creek (UEFPC), and
- East Tennessee Technology Park (ETTP).

Additionally, decisions have been made and actions taken off-site (Lower East Fork Poplar Creek [LEFPC], Clinch River/Poplar Creek, and Lower Watts Bar Reservoir [LWBR]), on Chestnut Ridge, and at other sites (White Wing Scrap Yard and Oak Ridge Associated Universities South Campus Facility).

The watersheds are used to:

- identify, assess, and prioritize contaminant releases,
- make remedial decisions, and
- evaluate remedial effectiveness.

Contaminants released from the contaminated sites accumulate in floodplain soils and aquatic sediments. Contaminants not retained, or those remobilized, are released to the surface waters and subsequently off-site to the Clinch River. Therefore, the surface water acts as an integrator of contaminant flux, and integration points (Figure 1.1) are identified in each watershed at which contaminant releases can be measured, assessed, tracked, and prioritized. Once the baseline monitoring and characterization are completed and the cleanup objectives are defined, the contribution of each remedial action (RA) toward achieving the objectives can be estimated and assessed at the watershed integration point. Through surface water monitoring both the specific performance of each action and the cumulative progress toward achieving the cleanup objectives can be assessed. Additionally, implementation of an ORR-wide strategy is underway to prioritize and address groundwater contamination and includes a study of off-site groundwater (Section 1.2.1 and Appendix D).

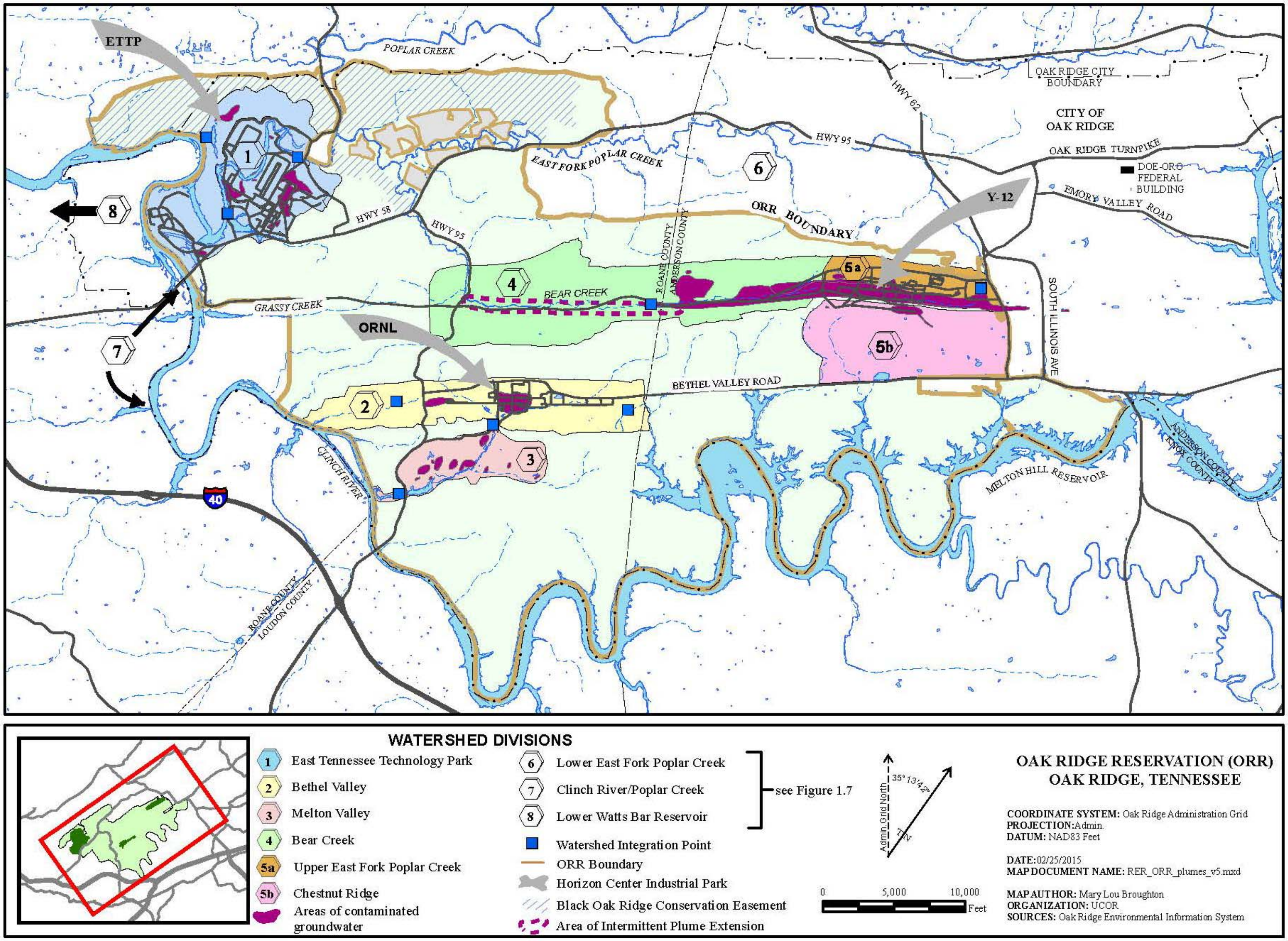


Figure 1.1. Watersheds on the ORR.

Since its inception in 1989, the following risk-based prioritization has been used for determining the sequence of remediation work:

- mitigate immediate on-site and off-site risks,
- reduce further migration of contaminants off-site,
- address sources of off-site surface water and groundwater contamination,
- address remaining on-site contamination, and
- address demolition of facilities.

Remedial decisions reflect tradeoffs among protection of human health and the environment, compliance with environmental standards, and implementation criteria, primarily cost and implementability. A preferred alternative is selected that represents the optimum solution among these factors. For the ORR the optimum solution needs to be determined at the watershed scale to ensure that the evaluation considers the cumulative resources needed for cleanup and the resource implications for alternate end uses. The optimum decision for a single contaminated site may not be the same as when other contaminated sites in the same watershed are considered as well. For this reason the optimum decision for each contaminated site is made in the context of the optimum solution for the entire watershed. By focusing on future end use, the appropriate level of cleanup for a watershed can be established. The watershed record of decisions (RODs) contain performance goals to be met and a series of RAs designed to achieve them.

While waiting for the watershed decisions to be made with the associated series of RAs, single-project actions were performed primarily to mitigate immediate risks and to reduce further migration of contaminants off-site. In addition, interim RODs have been signed at Bethel Valley (DOE/OR/01-1862&D4), Melton Valley (DOE/OR/01-1826&D3), UEFPC (DOE/OR/01-1951&D3 and DOE/OR/01-2229&D3), BCV (DOE/OR/01-1750&D4) and Zone 1 and Zone 2 at ETTP (DOE/OR/01-1997&D2 and DOE/OR/01-2161&D2, respectively) for sources and soil. This allowed decisions to be made and remediation performed on sources and soil and the more complex decisions on topics such as groundwater, surface water, sediment, ecological protection, and final land use controls (LUCs) to be deferred until the source terms are remediated and there is a better understanding of the contaminant pathways. These interim RODs also are interim for the sources and may be changed in the final ROD.

1.2.1 ORR Groundwater Strategy

Figure 1.1 shows areas of known groundwater contamination in each of the watersheds. No watershed-scale 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 because of the hydrogeologic complexity of fractured rock and karst systems. During the 1990s, several passive groundwater RAs were implemented using *in situ* media to capture or degrade contaminants. None of these RAs met with long-term success, and all were terminated. RAs 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 off-site plume migration at the Y-12 National Security Complex (Y-12) East End Volatile Organic Compound (EEVOC) plume in UEFPC and at the hexavalent chromium plume at the ETTP. Such systems do require periodic maintenance and potential modification, as is the case at the Core Hole 8 plume in Bethel Valley. In Melton Valley, 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.

Development of an interagency approach for addressing ORR groundwater contamination was completed in FY 2013 and resulted in an ORR Groundwater Strategy (*Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* [DOE/OR/01-2628/V1&V2&D2]) that was agreed to by DOE, EPA, and TDEC in FY 2014. The ORR Groundwater Strategy provides a comprehensive framework for early actions and long-term implementation to support CERCLA decision-making for ORR groundwater.

The ORR Groundwater Strategy identified and ranked plumes across the ORR using a modified EPA Hazard Ranking System approach and available data. The approach takes into account the inherent hazards of a plume, a plume's ability to migrate, and distance from the plume to potential receptors. Since groundwater contaminant migration may result in surface water discharges that exceed ecological protection standards, both human and ecological receptors were considered in plume ranking. Plume ranking results guide the prioritization of projects identified to address plumes and data uncertainties. The initial plume ranking and project prioritization results presented in the ORR Groundwater Strategy will be reevaluated as implementation of the strategy proceeds. Findings will be used to identify early groundwater actions that may be necessary for protection of human health and the environment prior to final site cleanup.

Implementation of ORR Groundwater Strategy recommendations began in FY 2014:

- DOE set up an ORR Groundwater Program to systematically prioritize and investigate groundwater plumes and data gaps. The ORR Groundwater Program investigations will be integrated with remedy effectiveness and trend monitoring conducted by the Water Resources Restoration Program (WRRP).

- Planning is underway for an Off-site Groundwater Assessment project to evaluate off-site groundwater quality and movement. The project is a cooperative DOE, EPA, and TDEC effort.

- Development of an ORR-wide regional flow model has been initiated.

A summary of ORR Groundwater Program activities for FY 2014 is provided in Appendix D.

1.3 LTS

Because most of the remediation decisions for ORR sites do not allow unlimited use/unlimited exposure (UU/UE), LTS will be required at these sites. LTS is the set of activities necessary to protect human health and the environment from physical hazards, residual contamination, and wastes remaining following remediation. The basic elements of LTS are:

- Stewards – Stewards are responsible for developing, implementing, and overseeing LTS activities.

- Operations – Operations are those activities necessary to ensure the integrity of the engineering controls and LUCs.

  - *Engineering controls* include actions to stabilize and/or physically contain or isolate waste, contamination, or other residual hazards. Engineering controls include in situ stabilization; capping of residual contamination; excavation of residual contamination; groundwater extraction and treatment systems; demolition of buildings; 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, excavation/penetration permit (EPP) programs and state advisories, as well as physical controls, such as contamination area postings, fences, signs, and surveillance patrols.

Operations include facility operations (e.g., routine operations of a groundwater treatment facility to maintain optimum performance), inspection, verification, surveillance, monitoring (e.g., monitoring of surface water, groundwater, sediment and biota as reported in RERs), enforcement, maintenance, modification, replacement, and evaluation.

- Information Systems – Information systems maintain records of residual contamination, associated risks, required LTS activities, and performance of the engineering controls and LUCs.

- Research – Research is needed in areas such as the long-term performance of stabilization and containment technologies and long-term migration of contaminants to reduce the cost of LTS and the risk of residual contamination.

- Public Participation – Public participation is required since the public is being protected and should be involved in selecting, implementing, and reviewing the performance of the remedy and LTS activities.

- Public Education – Public education is necessary to ensure that the nature and risk of residual contamination and the resultant types of LUCs are understood.

- Funding – Adequate and sustained funding is necessary to develop and maintain LTS activities.

LTS ensures that the engineering controls and LUCs remain effective for an extended, or possibly indefinite, period of time until residual hazards are reduced sufficiently to permit unrestricted use and unlimited access (McCracken 2004). LTS is designed to ensure that:

- engineering controls prevent the residual hazard from migrating to the receptor, and

- LUCs prevent the receptor from encountering the residual hazard.

Various CERCLA decision documents are used to make remediation decisions on the ORR. Typically, either a ROD for an RA or Action Memorandum (AM) for a removal action defines the selected remedy. These decision documents contain the statutory decision for the response actions and may also specify LTS requirements. However, because most decision documents generally lack specifics on LTS requirements, additional details typically are found in post-ROD documents, such as post-construction reports, remedial action reports (RARs), removal action reports (RmARs), phased construction completion reports (PCCRs), or monitoring plans. Final LTS requirements will be included in comprehensive RARs for each watershed ROD. This will allow source control actions to have been completed or at least identified, the interim RAs to be completed, evaluated, and changed, if necessary, and the end state of each watershed to be understood so that appropriate LTS requirements can be identified.

The RER evaluates the performance of LTS activities. The definitions encompassing LTS have evolved over time, and earlier decision documents used the term "institutional controls" instead of LUCs and engineering controls. This term "institutional controls" is used throughout this document when using citations directly from these earlier decision documents.

Figure 1.2 illustrates the Environmental Management (EM) lifecycle. As remediation projects are completed, areas with residual contamination transition to LTS. Performance and protectiveness of implemented remedies are reviewed and follow-up actions are taken to address any identified issues to ensure protectiveness. This review may lead to a reevaluation of the approved remedy.

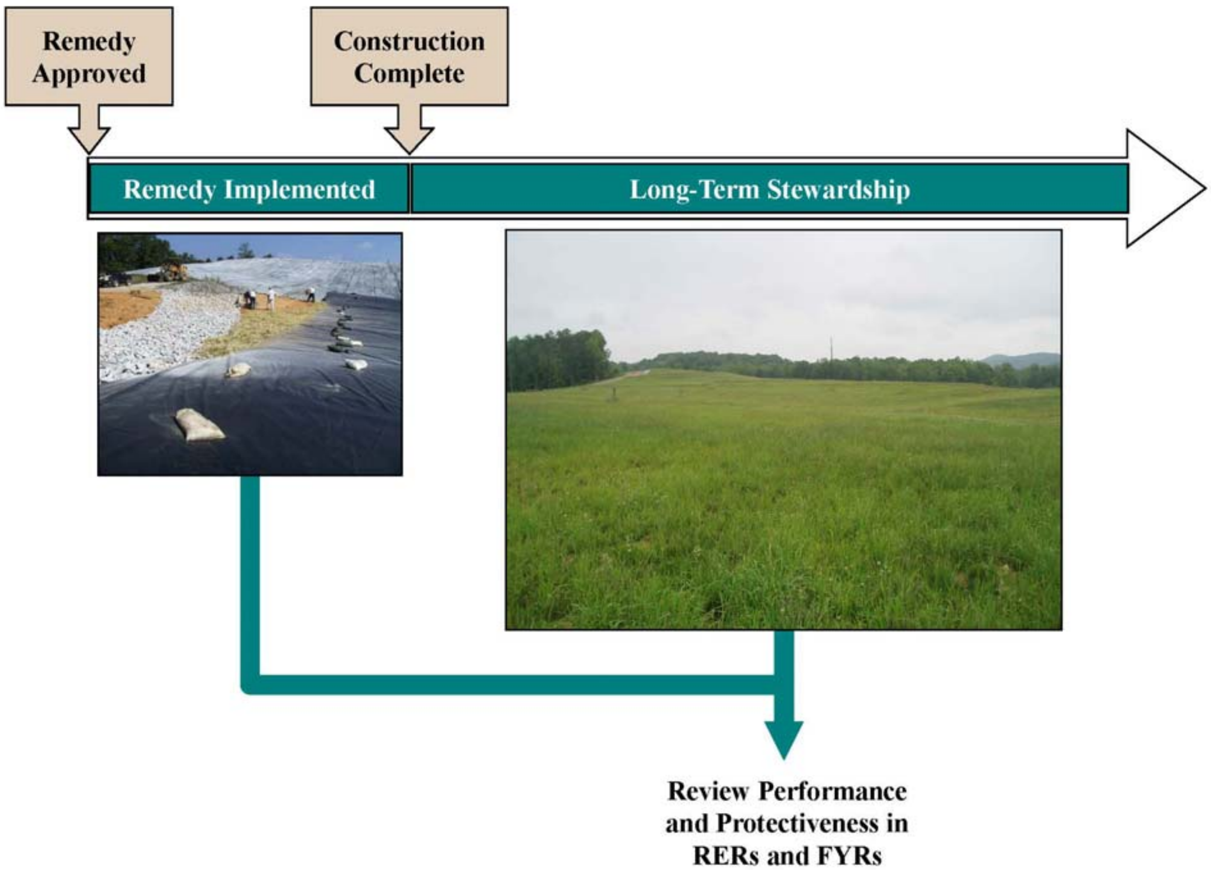


Figure 1.2. EM lifecycle.

The hierarchy of assessing the performance of implemented remedies is illustrated in Figure 1.3. The decision document describes the remedy in terms of engineering controls and LUCs. The completion document describes the completed action and may further define LTS requirements. Under LTS, engineering controls must be operated, maintained, and monitored, and LUCs must be inspected and verified so protectiveness and performance can be evaluated. On the ORR, DOE EM uses the WRRP to implement performance monitoring requirements (Section 1.3.1) and to track other LTS requirements (Section 1.3.2). Performance is assessed and reported in the RER and CERCLA Five-Year Review (FYR) which may cause a reevaluation of the remedy.

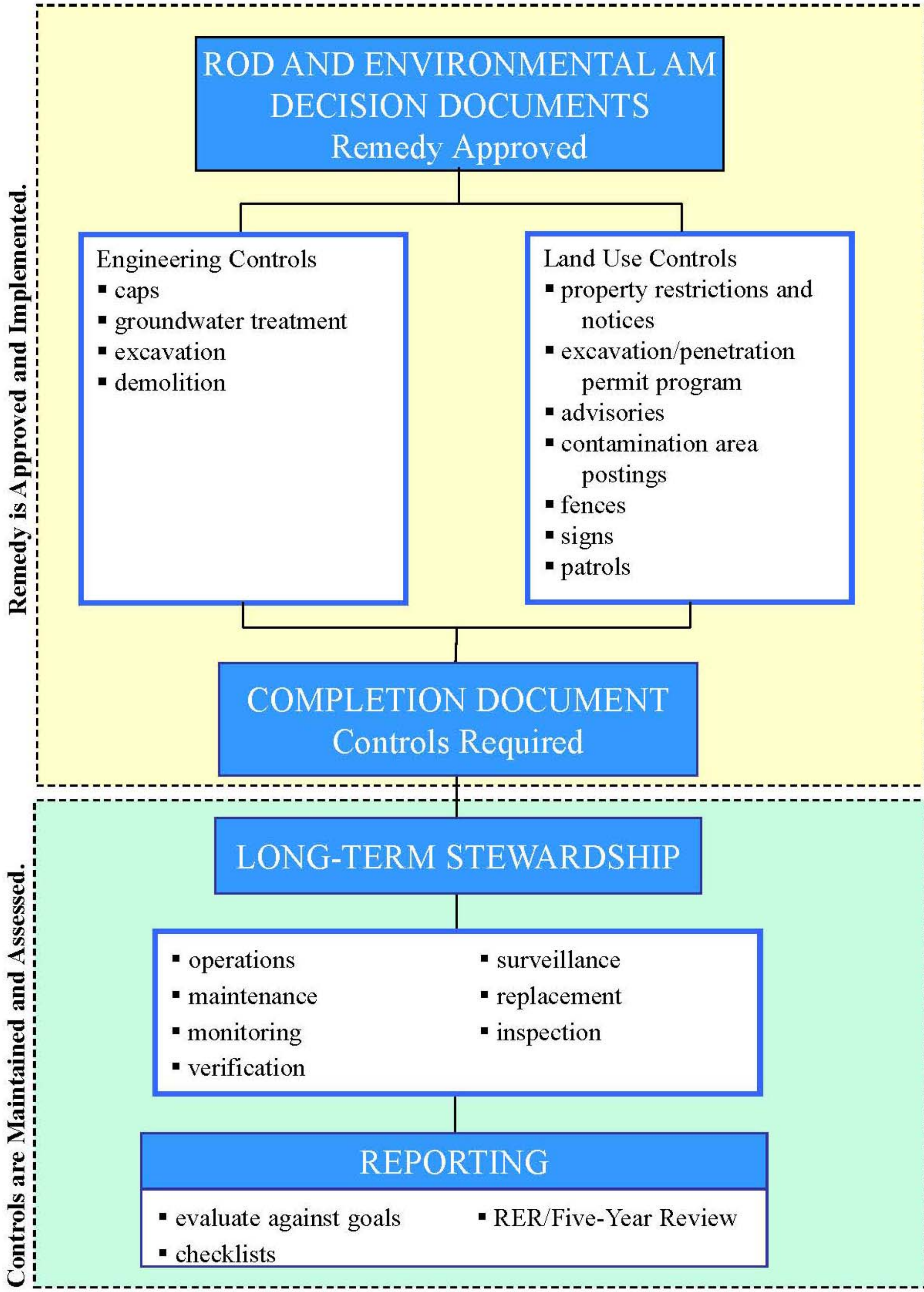


Figure 1.3. Hierarchy for assessing performance.

1.3.1 Performance Monitoring

Performance monitoring is an instrumental component of LTS. It is used to assess the performance of completed CERCLA actions where residual contamination is left that does not allow for UU/UE. On the

ORR for CERCLA sites this information is compiled by DOE EM through the WRRP. The WRRP was established to implement a comprehensive, integrated environmental monitoring and assessment program for the 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 performance assessment data, baseline data also is collected to gauge the effectiveness of future actions once implemented. All data used in the RER are collected in accordance with the watershed-specific monitoring plans and the *Quality Assurance Project Plan for the Water Resources Restoration Program* (UCOR-4049), or, for data collected by other programs, in accordance with a quality assurance project plan (QAPP) that meets equivalent standards and requirements. The QAPP has been developed to identify and implement quality assurance requirements for use in sample collection, laboratory analysis, and data management of groundwater, surface water, sediment, and biota activities performed under the WRRP. The QAPP identifies the procedures that will be followed in the collection, custody, and handling of samples, as well as verification and validation of environmental/laboratory data, used in the WRRP. Appendix F of the QAPP also contains specific sampling and analysis plan (SAP)/QAPP checklists approved by the EPA. The QAPP meets the requirements of the EPA (EPA/240/B-01/003), *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5),* and integrates with the current *Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge, Tennessee* (UCOR-4160).

Performance levels (goals) for CERCLA actions are identified in decision documents and are used for performance monitoring. Some performance levels are risk-based and dependent upon future end uses for environmental media designated in the decision document (e.g., industrial land use). Additionally, ambient water quality criteria (AWQC) and Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) are identified as applicable or relevant and appropriate requirements (ARARs) for many CERCLA actions and are therefore also used for comparative purposes but are not performance goals unless explicitly stated in the decision document.

Tennessee has surface water use classifications listed in Rules of the TDEC, Chap. 0400-40-04, and assigns one or more of those uses to each surface water body in the state. Numeric and narrative AWQC are listed in Chap. 0400-40-03-.03 for each of these designated uses. For the designated uses set for streams on the ORR, only Fish and Aquatic Life and Recreational Use have specific numeric AWQC set for particular compounds. Unless stated otherwise, the most stringent of the applicable AWQC for the assigned designated uses for ORR surface waters were used in the RER for comparison to the surface water data.

Cleanup goals for groundwater on the ORR have yet to be determined and will be set under future CERCLA decisions for ORR watershed actions. Tennessee is authorized by EPA to administer the federal Clean Water Act of 1972 (CWA) in the state, and has a classification scheme for groundwater that includes use classifications and specific numeric criteria and risk standards for each use. However, as described in Section 5.3.4 of the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2), the state groundwater rules are not EPA-approved. Absent that approval, the rules are not considered by EPA to be *legally applicable* at EPA CERCLA sites, as that term is applied under the CERCLA ARAR process, so they do not apply to ORR groundwater cleanup. The CERCLA National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires that federal SDWA MCLs and non-zero maximum contaminant level goals (MCLGs) be attained for all RAs for groundwaters that are current or potential sources of drinking water, where the MCLs/non-zero MCLGs are relevant and appropriate under the circumstances of the release [40 CFR 300.430(e)(2)(i)(B)-(C)]. Unless stated otherwise, the most stringent of the state or federal MCLs or non-zero MCLGs for ORR groundwater were used in the RER for comparison to groundwater data. The use of MCLs/non-zero MCLGs is not intended to imply any conclusions regarding the use classification or cleanup goals for ORR groundwaters at this time.

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

1.3.1.1 Watershed-scale Monitoring Plans

A meeting was held in FY 2013 in which the Federal Facility Agreement (FFA) Project Managers determined that watershed-scale sampling and analysis plans for the Oak Ridge, Tennessee sites would be classified as primary documents tied to an existing type of primary document (i.e., an RAR) under the current FFA. With this decision, the status of the watershed-scale monitoring plans was clarified, providing approval authority to the TDEC, as well as the EPA. Table 1.1 provides the previous title of each of the watershed-scale monitoring plans with its document number and the associated primary document title.

1.3.2 Tracking Other LTS Requirements

Information about other LTS requirements used in this document was collected and/or compiled by DOE EM through the WRRP in conjunction with Surveillance and Maintenance (S&M) Programs at ETTP, Oak Ridge National Laboratory (ORNL), and Y-12. 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 the S&M Program in accordance with site-specific S&M plans. Inspection checklists are completed electronically for each location and linked to any needed maintenance request forms in the Land Use Manager (LUM) web-based application. This documentation is maintained electronically in LUM and hard copies are ultimately filed in the Document Management Center. The WRRP routinely reviews the status of these checklists in LUM to monitor effectiveness and to summarize compliance with the LTS requirements annually in the RER.

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

The *Memorandum of Understanding for Implementation of a Land Use Control Assurance Plan (LUCAP) for the United States Department of Energy Oak Ridge Reservation* (DOE/OR/01-1824&D1/A2) requires that the Manager, DOE Oak Ridge Operations (ORO), annually verify in the RER that Land Use Control Implementation Plans (LUCIPs) are being implemented on the ORR. Only select LUCs for Melton Valley require an annual certification, and this annual certification for Melton Valley is in Appendix A.

1.3.2.1 LUM Tracking System

In 2013, a new electronic data entry and tracking system was implemented in the field to help consolidate the more than 200 data and progress tracking spreadsheets that were being generated each year for LTS. The LUM software streamlines the stewardship tracking process for more than 90 ORR CERCLA and Resource Conservation and Recovery Act of 1976 (RCRA) sites and generates consistent, real-time information. LUM went live in 2014 and serves as the administrative record for site inspection checklists.

Advantages of LUM include centralized data storage; standardized content and reports; easy access in field/paperless or standard inspection template; accountable record of CERCLA/RCRA required inspections; efficient tracking of LTS requirements and compliance (ensures nothing is missed); query function; and automatic e-mail reminders and notifications regarding upcoming inspections, outstanding issues, site maintenance requests, and corrective actions. This new tracking process facilitates the monitoring and implementation of LTS activities across the ORR.

Table 1.1. Revised watershed-scale monitoring plan titles

Document Number	Previous Title	Primary Document Title
DOE/OR/01-1982&D3	Water Resources Restoration Program Sampling and Analysis Plan for the Melton Valley Watershed, Oak Ridge Reservation, Oak Ridge, Tennessee	Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan
DOE/OR/01-2457&D2/A1	Water Resources Restoration Program Sampling and Analysis Plan for the Bear Creek Valley Watershed, Oak Ridge Reservation, Oak Ridge, Tennessee	Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee
DOE/OR/01-2466&D2	Water Resources Restoration Program Sampling and Analysis Plan for the Upper East Fork Poplar Creek and Chestnut Ridge Administrative Watersheds, Oak Ridge Reservation, Oak Ridge, Tennessee	East Fork Poplar Creek and Chestnut Ridge Administrative Watersheds Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee
DOE/OR/01-1820&D3	Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River/Poplar Creek Operable Units at the Oak Ridge Reservation, Oak Ridge, Tennessee	Lower Watts Bar Reservoir and Clinch River/ Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee
DOE/OR/01-2477&D1	NA	East Tennessee Technology Park Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee
DOE/OR/01-2478&D1	NA	Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee

NA = not applicable

1.4 NPL BOUNDARY DEFINITION

The DOE ORR (land bounded acreage 33,223), which includes the former K-25 gaseous diffusion plant (ETTP), the Y-12/BCV waste management areas, and ORNL/Melton Valley waste management areas, is surrounded by approximately 20,100 acres of mostly wooded parcels. These buffer parcels have little to no federal process-related history and most have now been determined to never have been on the Oak Ridge NPL Site. However, the use of the Site title *Oak Ridge Reservation* made it appear that the entire Reservation was contaminated and placed on the NPL in 1989.

The FFA Appendix C list of remediation areas has been modified to better represent only the known contaminated areas on and off the ORR constituting the NPL site. The FFA Appendix B Oak Ridge Site Description now contains a new map that only reflects the contamination areas on and off the reservation.

As part of the NPL boundary definition effort, a total of 19,393 acres have been approved for either no further investigation under CERCLA or a CERCLA Clean Parcel Determination. Figure 1.4 reflects areas within the ORR that have been approved as clean. Known contamination areas, sediment contamination areas, DOE operational areas, and areas addressed by CERCLA watershed decision documents are also shown on the figure. DOE operational areas are operating areas like the Spallation Neutron Source (SNS) facility that are outside the watersheds and not listed in the FFA.

1.5 ORR 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 2014 are summarized to provide a general context for the remainder of this document.

Details of rainfall distribution for FY 2014 are illustrated in Figure 1.5. Mean monthly rainfall values for FY 2014 vary from ~0.6 in./mo. to approximately 8 in./mo. During FY 2014, the greatest monthly rainfall occurred in December 2013 when several large winter storm systems crossed the region dropping approximately 8 in. of rainfall. The lowest monthly rainfall occurred during October 2013 with only approximately 0.6 in. of rain. During FY 2014, rainfall distribution was uneven with the months of October, January, March, May, and September experiencing below average monthly average levels while December and August experienced above average rainfall. The remainder of months experienced about average or greater than average rainfall levels.

Total average rainfall on the ORR during FY 2014 was approximately 48.8 in. based on a composite of six rain-gauge stations located throughout the ORR (Figure 1.6). Two of the rain gauges are located at ETTP (K-1208RG and K-1209RG), two of the rain gauges are located at Y-12 (Y-12W and TOWY; TOWE data was used prior to 2006 when TOWY was constructed), one rain gauge is located at ORNL (formerly TOWC which was replaced by newly constructed TOWD at essentially the same location), and the Oak Ridge Townsite raingage (KOQT) located at the Federal Office Building. The total rainfall during FY 2014 was approximately 6 in. less than the long-term mean of 54 in./yr. The lower than average annual rainfall is reflected in somewhat reduced contaminant flux values at several monitoring locations.

1.6 DOCUMENT ORGANIZATION

The RER contains the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Bethel Valley Watershed
- Chapter 3 – Melton Valley Watershed
- Chapter 4 – Bear Creek Valley Watershed
- Chapter 5 – Chestnut Ridge
- Chapter 6 – Upper East Fork Poplar Creek Watershed
- Chapter 7 – Off-Site Actions
- Chapter 8 – East Tennessee Technology Park
- Chapter 9 – CERCLA Actions at Other Sites
- Appendix A – Certification of Land Use Control Implementation Fiscal Year 2014
- Appendix B – Selected Oak Ridge National Laboratory Groundwater Data
- Appendix C – Action Plans Identified from 2011 Third Reservation-Wide CERCLA Five-Year Review (DOE/OR/01-2516&D2)
- Appendix D – Oak Ridge Reservation Groundwater Program

Figure 1.1 shows the watersheds on the ORR and Figure 1.7 shows the off-site CERCLA areas downstream of the ORR. Implementation of the watershed RODs can take many years to complete. Therefore, watershed maps in each chapter use different symbols to identify completed actions and actions in progress.

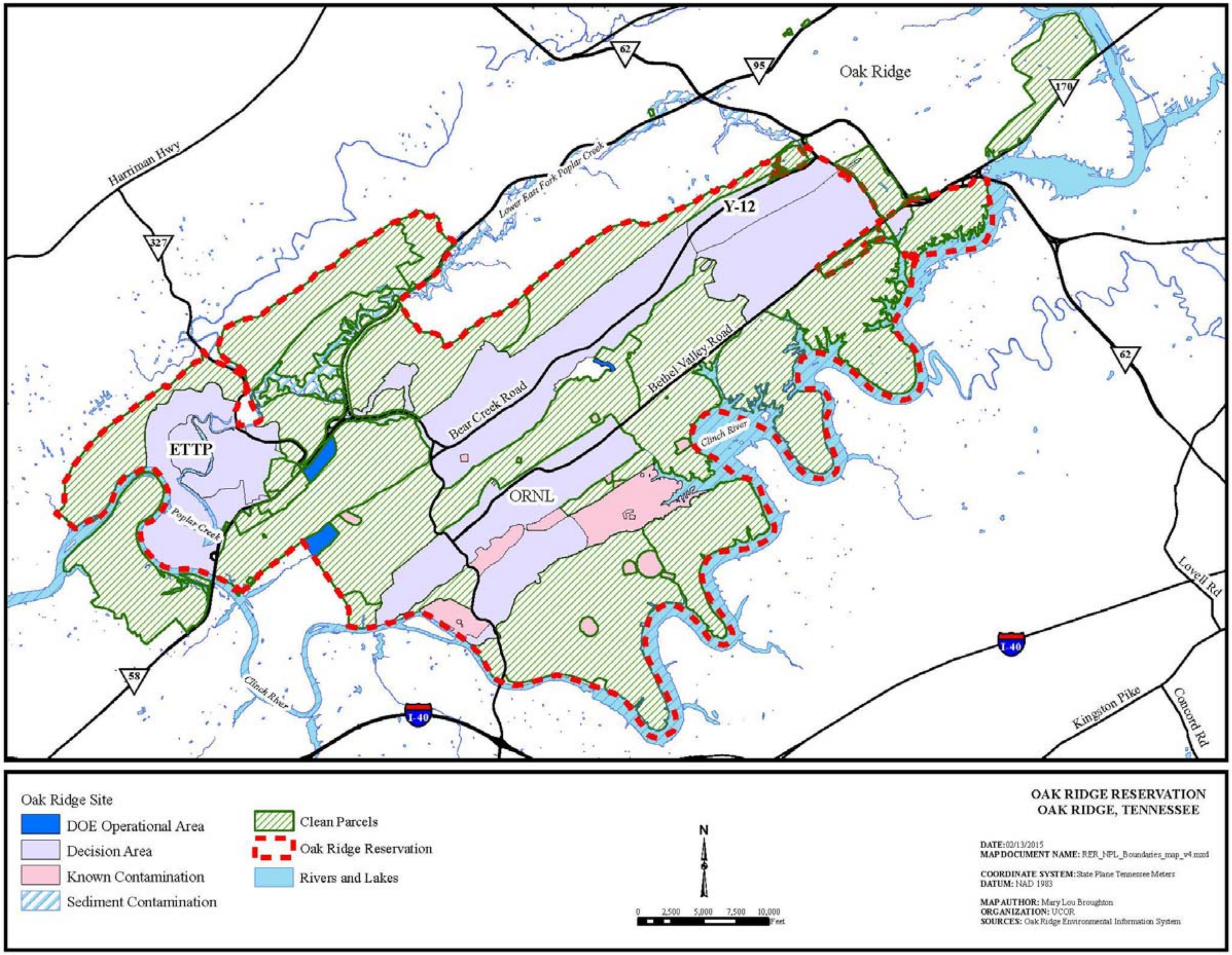


Figure 1.4. Oak Ridge NPL site – decision, known contamination, and sediment contamination areas.

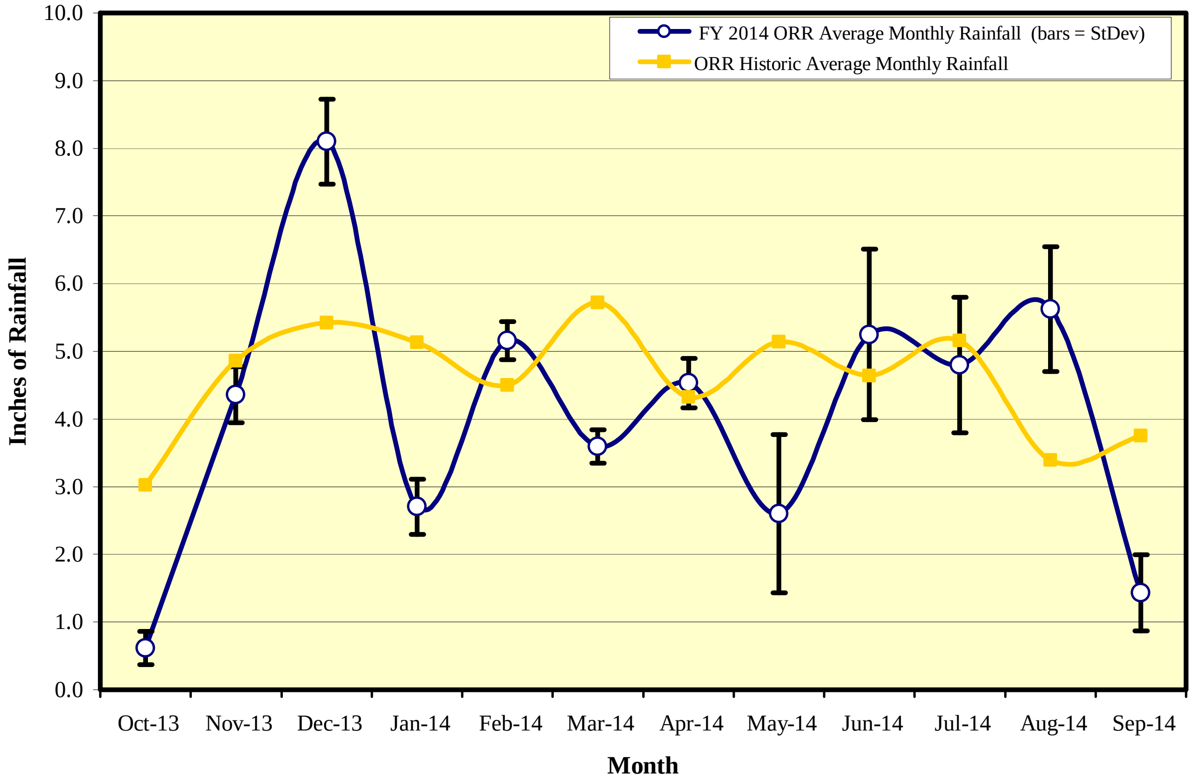


Figure 1.5. FY 2014 monthly average rainfall from six rain gauges on the ORR.

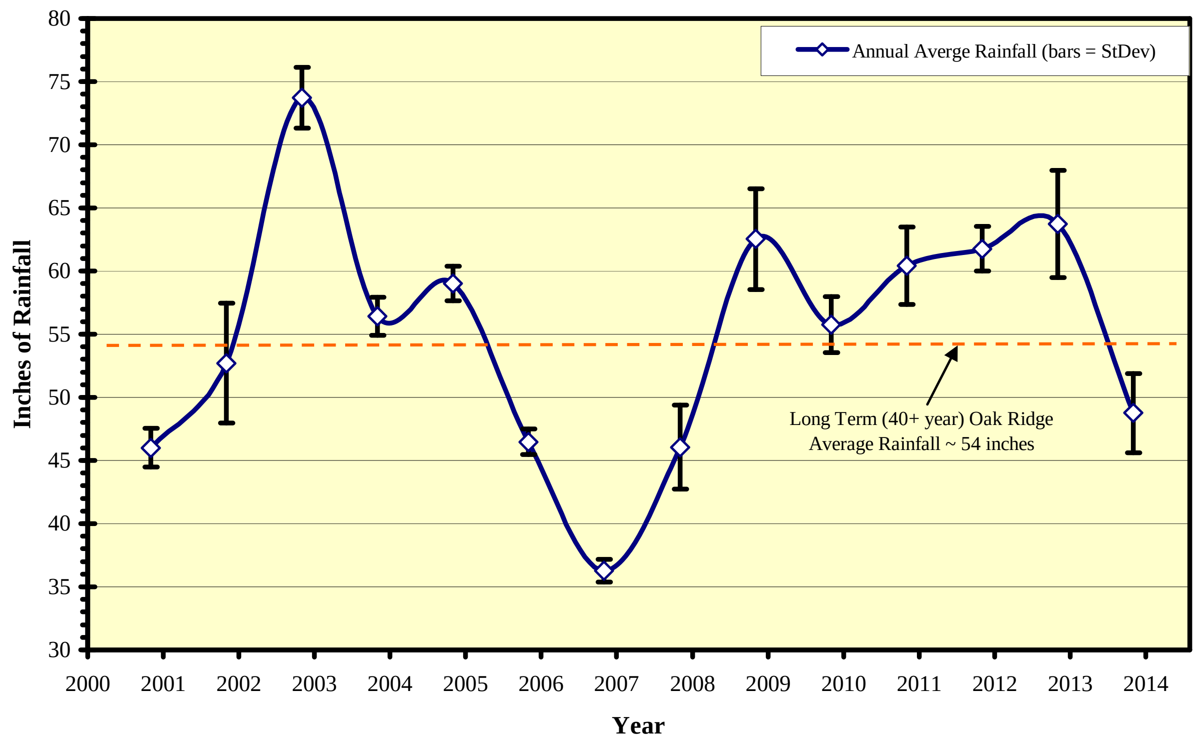


Figure 1.6. Mean annual rainfall from six rain gauges on the ORR, FY 2001 – 2014.

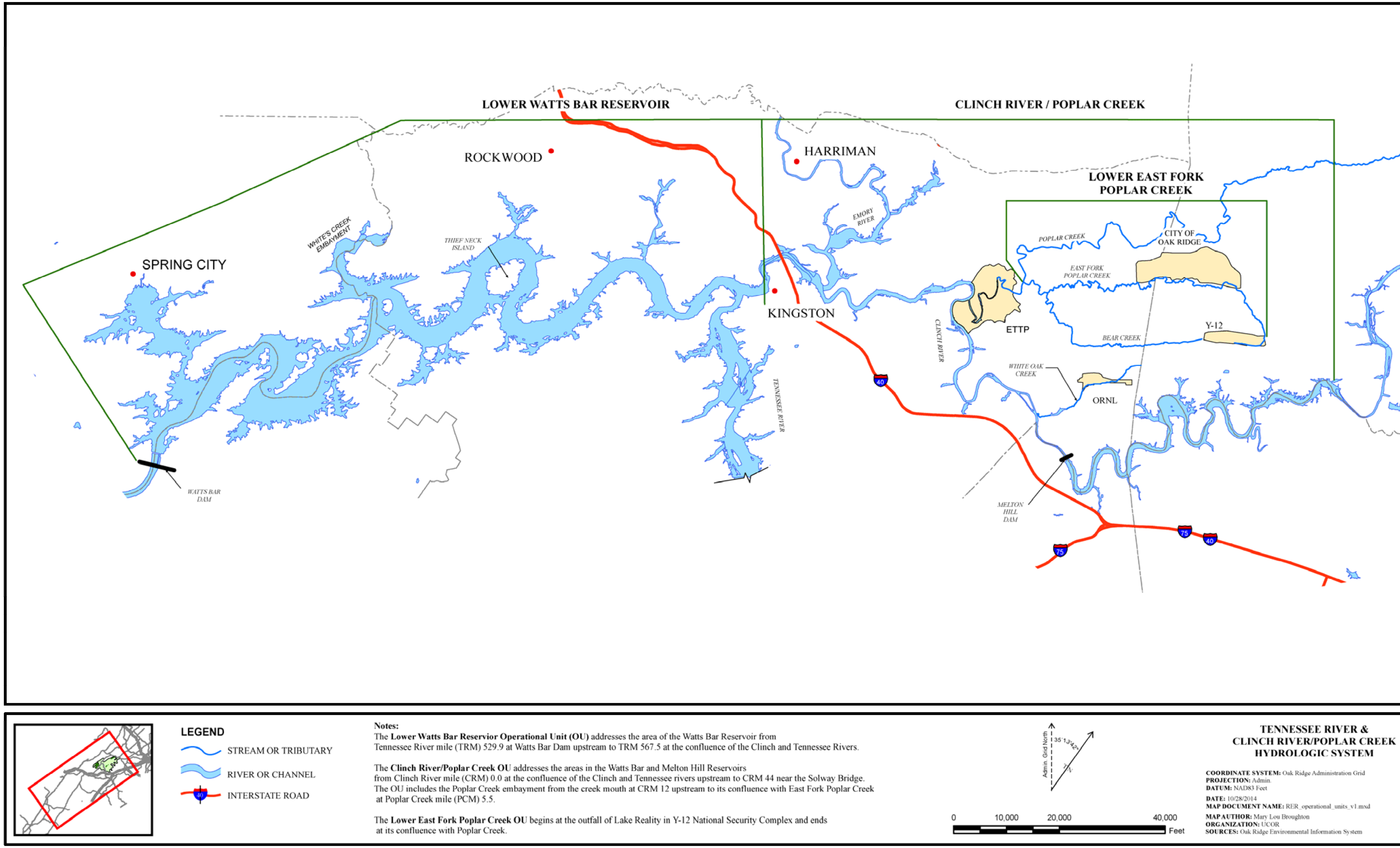


Figure 1.7. Off-site CERCLA areas (Lower Watts Bar, Clinch River/Poplar Creek, and Lower East Fork Operational Units).

This page intentionally left blank.

A chapter is devoted to each of the watersheds (Figure 1.1), to Chestnut Ridge, to off-site actions, and to other sites. Rather than forming a single defined hydrologic watershed, Chestnut Ridge and ETTP comprise several individual sub-watersheds but are treated as a single unit for decision-making and performance assessment purposes. Each chapter identifies completed watershed-scale actions, completed single-project actions, and completed demolition projects (if applicable) with LTS requirements. For each chapter, the following information is provided:

- Description of the completed actions, including engineering controls and LUCs;
- Description of monitoring and other LTS requirements (e.g., inspection and verification of LUCs, facility operations, and site inspection and maintenance) for completed actions;
- Evaluation of compliance with LTS requirements. When insufficient data exist to assess the impact of the completed actions, e.g., when the action was only recently completed or not all actions prescribed by the watershed ROD have been implemented, a preliminary evaluation is made of early indicators of effectiveness at the watershed scale, such as contaminant trends at surface water integration points; and
- Summary, issues and recommendations.

Actions that do not have LTS requirements or have been terminated or superseded by watershed-scale actions are not discussed. The *2011 Third Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2516&D2) includes an up-to-date compendium of all CERCLA decisions.

1.7 ISSUES AND RECOMMENDATIONS

To track issues through their resolution, Table 1.2 is a compilation of the issues and recommendations identified in subsequent chapters of this RER and unresolved issues carried forward from a previous RER. Beginning with the 2015 RER, a trackable RER issue is defined as an item identified in the effectiveness evaluation that:

- is for a completed CERCLA action.
- does not meet a performance standard or goal specified in a ROD or completion document (e.g., ROD, PCCR, etc.). For example, monitoring results exceed a performance level over a period of time or an engineering control or LUC was not performed as specified and a timely repair was not able to be made.
- does not already have an identified path forward through planned remedy maintenance actions or designated future CERCLA actions.

Other factors may be considered when determining if an item is a trackable RER issue (e.g., unusual climatic conditions, intermittent nature of exceedance, etc.). Observations from monitoring data (e.g., trends) and stewardship tracking are highlighted in the Executive Summary of the RER.

Table 1.3 identifies those issues that are closed out in this RER and will no longer be tracked in future RERs or FYRs. Table 1.4 is a summary of issues, recommendations, and follow-up actions from the *2011 Third Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2516&D2) updated through September 2014. Table 1.5 is reserved at this time in this document.

An issue that is carried forward from a previous year's RER is only discussed in the respective chapter of the text if FY 2014 assessment clarifies, modifies, or otherwise impacts the issue in any way. For example, because issues in Table 1.2 may require completion of future actions, 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 1.2. 2015 RER issues and recommendations
(New issues identified in this RER are in blue text.)

Issue[a]	Recommendation/Resolution	Responsible parties	Target response date
Melton Valley			
1. Several wells in Melton Valley have chronically not attained the ROD goal for groundwater level within hydrologically isolated areas.	1. Two wells in SWSA 6 and 3 wells in SWSA 4 have not attained the ROD goal for groundwater level control inside hydrologically isolated areas. A review of conditions, including potential modifications to monitoring and applicable CERCLA documentation, is planned.	DOE	FY 2016
ETTP			
1. An asphalt cover has been placed over the K-29 slab since approval of the CERCLA completion document for building demolition. (2014 RER)	1. An addendum to the *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) will be prepared to reflect the new slab end state and changes in slab monitoring. A meeting is planned among the FFA parties to determine an approach for managing contaminated footprints and the outcome will be reported in the next RER as appropriate.	DOE/EPA & TDEC	FY 2015
2. There are several issues associated with the interim management of potentially contaminated slabs at ETTP. Monitoring requirements identified in demolition completion documents have been changed or eliminated following a remedial action decision for the area without appropriate interaction. The frequency of radiological monitoring by the Radiation Protection Program has changed without notification to the Regulators. Fixatives placed over radiological contamination do not have specified inspection and maintenance requirements. (2013 RER)	2. Discussions are ongoing among the FFA parties to develop an approach for managing potentially contaminated slabs at ETTP, and the outcome will be documented in the next RER.	DOE/EPA & TDEC	FY 2015

Table 1.2. 2015 RER issues and recommendations (cont.)
(New issues identified in this RER are in blue text.)

Issue[a]	Recommendation/Resolution	Responsible parties	Target response date
3. 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)	3. DOE acknowledges the land use differences that exist between the BORCE and that which is designated in the Zone 1 ROD. The *Final Proposed Plan for Soils in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2648&D1) addresses anticipated future industrial and recreational land use in Zone 1. The determination in the Proposed Plan that industrial use goals for Zone 1 are also protective of recreational uses is planned to be included in the Zone 1 Final Soils ROD.	DOE/EPA & TDEC	FY 2015 with Zone 1 Final Soils ROD

[a]The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2013 RER).

BORCE = Black Oak Ridge Conservation Easement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ETTP = East Tennessee Technology Park
FFA = Federal Facility Agreement
FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation

Table 1.3. Closed-out RER issues in 2014

Issue[a]	Recommendation/Resolution	Responsible parties Primary/Support	Target response date
Melton Valley			
1. Increasing trend for ^{90}Sr has been observed during FY 2012 and FY 2013 in HRE tributary monitoring data. (2014 RER)	1. DOE conducted additional sampling in the HRE tributary that identified the abandoned LLLW pipeline along the north side of Melton Valley Drive as the probable source of ^{90}Sr that causes the increasing concentration trend observed at the HRT-3 monitoring location. Strontium-90 levels measured in surface water near the source area were less than the Melton Valley ROD remediation level for surface water. Monitoring in the HRE Tributary will continue consistent with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1982&D3).	DOE	FY 2015
ETTP			
1. The *Remedial Action Report for the K-1070-A Burial Ground, Oak Ridge, Tennessee* (DOE/OR/01-2090&D1) specifies the frequency of inspections for subsidence and erosion and the frequency of mowing. These specified frequencies are no longer required, and the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) recommended the frequencies be changed. (2014 RER)	1. The K-1070-A Burial Ground is in EU Z1-59 in the Interim Zone 1 ROD. 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) documents evaluation of EU Z1-59 and concludes that "…the approximately 50 acres of the K-1070-A EU Group composed of EU 57, EU 58, EU 59, and EU 60 meet the RAO established in the Zone 1 ROD and NFA is appropriate." Therefore, the LTS requirements in the *Remedial Action Report for the K-1070-A Burial Ground, Oak Ridge, Tennessee* (DOE/OR/01-2090&D1) have been superseded.	DOE/EPA & TDEC	FY 2014
2. A recommendation was made in the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) site visit to clarify the requirements and frequencies in the *Remedial Action Report for the K-1407-B Holding Pond and the K 1407-C Retention Basin* (DOE/OR/01-1371&D1). (2014 RER)	2. The requirements and frequencies in the *Remedial Action Report for the K-1407-B Holding Pond and the K 1407-C Retention Basin* (DOE/OR/01-1371&D1) were clarified in an erratum.	DOE/EPA & TDEC	FY 2015

Table 1.3. Closed-out RER issues in 2014 (cont.)

Issue[a]	Recommendation/Resolution	Responsible parties Primary/Support	Target response date
3. The frequency of soil cover inspections, mowing, radiological surveys, and fence inspections for the K-1071 pad are excessive. (2013 RER)	3. These requirements in the RAR for the K-1070-C/D G-Pit and K-1071 Concrete Pad (DOE/OR/01-1964&D2) were changed in an erratum.	DOE/EPA & TDEC	FY 2014
4. Mercury monitoring results in the Mitchell Branch area and STP Outfall 05A area routinely exceed the mercury AWQC level. (2014 RER)	4. The sources of mercury contamination will be addressed under the planned CERCLA response actions. Demolition of the inactive STP (K-1203) and support facilities will be performed under the *Action Memorandum for the Remaining Facilities Demolition Project at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2049&D2). Soil will be remediated in the Mitchell Branch and STP Outfall 05A areas under the *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) and the future Sitewide ROD. In addition, the new NPDES storm water permit for ETTP scheduled for issuance in FY 2015 will specifically require additional investigative monitoring for and emphasis on mercury. This additional monitoring will support these ongoing and future CERCLA actions.	DOE/EPA & TDEC	As determined by FFA Appendix E and J

[a]The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2013 RER). Only issues that are closed out in this RER (2015) are included. Similarly, prior RERs have identified issues which were closed out in that year.

AWQC = ambient water quality criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ETTP = East Tennessee Technology Park
EU = exposure unit
FFA = Federal Facility Agreement
FY = fiscal year
FYR = Five-Year Review
HRE = Homogeneous Reactor Experiment
LLLW = liquid low-level waste
LTS = long-term stewardship
NFA = no further action
NPDES = National Pollutant Discharge Elimination System
RAO = remedial action objective
RAR = Remedial Action Report
RER = Remediation Effectiveness Report
ROD = Record of Decision
STP = Sewage Treatment Plant
TDEC = Tennessee Department of Environment and Conservation

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a]

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Future
General Issue – All Watershed ROD Actions with pending long-term actions							
Closed G-1 [OUs 30, 32, 28, 15]	Risk methods, toxicity factors, and COCs have changed over time for actions under watershed RODs that are in progress.	During planning for additional actions not yet started under the BV, BCV, UEFPC, Zone 1, and Zone 2 RODs, remediation levels will be updated prior to implementing additional actions and documented in approved CERCLA work plans. The remediation levels will be included in post-ROD documentation.	DOE	EPA/TDEC	Status: Risk and COC information are being updated as needed in planning and documenting watershed actions. For example: • In recent ETTP Zone 2 PCCRs (e.g., *Phased Construction Completion Report for Exposure Units Z2-04 and Z2-05 in Zone 2, at the East Tennessee Technology Park, Oak Ridge, Tennessee* [DOE/OR/01-2590&D1] approved 02/11/13), characterization data is compared against Zone 2 ROD RLs for ROD-identified COCs; risk screening levels (current chemical RSLs and radionuclide PRGs) for an aggregate risk evaluation; and the Zone 2 ROD soil screening levels for protection of groundwater. • Technetium-99 was not a COC in the ETTP Zone 2 ROD but when increased levels were detected following demolition of the K-25 building, a soil remediation level for ^{99}Tc was developed and incorporated in a revision to the Zone 2 RDR/RAWP. As part of the protectiveness evaluation, a comparison of updated risk and COC information as compared to the ROD-specified criteria will be performed for completed actions as part of the FYR to determine potential impacts to the RAOs established by the applicable ROD.	N	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Future
Off-ORR Actions							
Closed OF-1 [OU 10]	There is mercury underlying the parking lot corner at the Former Dean Stallings Ford property along LEFPC. This property is for sale and the sale could result in a change in land use.	DOE will monitor any future changes to land use. If changes occur DOE will evaluate the need for additional ICs and other response actions.	DOE	EPA/TDEC	Annually via RER. (note: annual review OK because remedy is protective) Monitoring of the former Dean Stallings Ford property is completed annually and reported on in the RER. Checking on the former Dean Stallings property is a requirement as stated in the RAR on the LEFPC Project (DOE/OR/01-1680&D5). "An annual survey to verify land use in the area of the Dean Stallings Ford automobile dealership parking lot shall be performed to verify that the land use has not changed since the issuance of the *East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report* (DOE/OR/02-1119&V1&D2)," therefore this issue is closed.	N	Y
OF-2 [OUs 28]	New information suggests mobilization of mercury from the UEFPC and LEFPC streambed and stream banks is the primary source of mercury export during high-flow conditions. The current ROD did not address the entire hydrologic system (e.g., upstream sources within Y-12) and did not address creek bank or creek bed sediments.	Assessment of the entire EFPC system from its headwaters within Y-12 (OU 28) to its downstream confluence with Poplar Creek will be documented in the RER. Any potential action on this issue will be addressed as part of the sequencing approach for mercury remediation throughout the system (see Issue UEF-1).	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: Action Plan #1 with a status update is included in this RER in Appendix C. Studies in FY 2014 included field studies of bank soil erosion and bank mercury concentrations, shallow groundwater studies, and geospatial and modeling analyses. The studies have focused on obtaining a better understanding of the role of major source compartments of the watershed. Field studies of bank soils and groundwater were initiated in FY 2013 and will be conducted through the first half of FY 2015. Laboratory studies, focused on source media mercury leachability,	Y	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Future
					methylation, and bioaccumulation, were performed in FY 2013 and were completed in FY 2014. Geospatial analysis and modeling efforts were initiated in FY 2013 but will be a major emphasis in FY 2015, the last year of the three year study.		
OF-3 [OU 10]	New mercury bioaccumulation studies show mercury uptake in spiders along EFPC.	Continue studies to complete the conceptual model for mercury bioaccumulation in measurement points (e.g., spiders) and subsequent ecological endpoint receptors in the EFPC RI prior to the Final ROD.	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 03/30/13. Status: Action Plan #2 with a status update is included in this RER in Appendix C. In FY 2014, soil surveys and an invertebrate reconnaissance study was conducted prior to invertebrate sampling scheduled in FY 2015. The overall objectives of the FY 2014 studies were to identify plots of land that would have appropriate habitat for the target invertebrate taxa and that would be representative of high, medium, and low mercury exposure to invertebrates. The study was designed such that there would be a range of exposure conditions to calculate bioconcentration factors for invertebrates that could then be used in risk calculations.	Deferred	Deferred
Closed OF-4 [OU 24]	The ^{137}Cs action level used by the WBIWG should be reviewed in light of the various changes in the risk assessment process and cancer slope factors.	The WBIWG will review the ^{137}Cs action level used for dredging permit decisions.	WBIWG	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: The Action Plan identified that the ^{137}Cs action level continues to be protective in the Watts Bar Reservoir and Clinch River/Poplar Creek for reviewing typical residential dredge permit requests. Larger commercial dredge requests will be evaluated to assure protectiveness. This Action Plan	N	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Future
					is closed out. The closed out Action Plan (#3) is included in this RER, Appendix C.		
		MV Actions					
Closed MV-1 [OU 29]	During FY 2009 and FY 2010, the groundwater level control in the SWSA 4 downgradient trench in MV showed short-term problems following significant rainfall events. This indicates the possibility that contaminated groundwater may be discharged to the IHP for periods of time when water level control in the trench is inadequate.	DOE will evaluate the performance of the downgradient trench extraction wells and will recommend an action to improve system performance.	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: A project to redevelop extraction wells in the SWSA 4 downgradient trench and to replace failed pumps is now complete and therefore this Action Plan is closed out. The closed out Action Plan (#4) is included in this RER, Appendix C.	N	N
		BV Actions					
Closed BV-1 [OU 30]	The BV ROD goal for surface water of "achieve at least 45% risk reduction at 7500 Bridge" is difficult to use as a quantitative measure of performance due to (1) uncertainty related to the exact baseline risk values against which to measure this reduction, and (2) lack of clarity in the ROD on sampling and statistical approach for measuring changes.	Modify Interim ROD to clarify criteria.	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: The Action Plan clarifies baseline conditions and recommends that the 45% risk reduction goal continue to be evaluated using the current approach; therefore this Action Plan is closed out. The closed out Action Plan (#5) is included in this RER, Appendix C.	N	N
Closed BV-2 [OU 35]	Corehole 8 Plume collection system operation and maintenance issues are preventing it from currently meeting the RmAR performance goals.	Corehole Plume collection system is currently being upgraded. System is scheduled to be back online in FY 2012.	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: The Action Plan identified the large scale upgrade of the Corehole 8 plume collection system, i.e., installation of two bedrock plume extraction wells and replacement of all	N	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Affects Protectiveness? (Y/N)[b] Future
					of the system's electrical, mechanical and control components. This upgrade is now complete and therefore this Action Plan is closed out. The closed out Action Plan (#6) with a description of the activities is included in this RER, Appendix C.		
		UEFPC Actions					
UEF-1 [OU 28]	Mercury concentrations at Station 17 are above the 200 ppt performance goal. Mercury concentrations in fish in LEFPC have yet to respond to commensurate reductions of mercury from historical response actions.	Remedial measures have not been completed under the UEFPC Phase I ROD. Implementation of Mercury Mitigation Strategy, including the Mercury Action Strategy Document and a Mercury Water Treatment System (Outfall 163), are initial phased response actions.	DOE	EPA/TDEC	Submit action plan(s) per FFA Section XXXI in the Mercury Mitigation Strategy 3/31/13, including: - RDWP and Conceptual Design (Outfall 200) 6/30/13. Status: A revised *Strategic Plan for Mercury Remediation at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2605&D2) and a revised *Remedial Design Work Plan for the Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2599&D2), which includes a conceptual design report for the Outfall 200 MTF were submitted to the regulators in FY 2014. Also submitted in FY 2014 were the *Focused Feasibility Study for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-2600&D1), and *Proposed Plan for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-2601&D1). These documents support a planned modification of the UEFPC Phase I	Y	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b]	
						Current	Future
					ROD to include the Outfall 200 MTF and other supplemental mercury abatement actions.		
Closed UEF-2 [OU 42]	The POC for the AWQC (organisms only) for the EEVOC Plume needs to be revised to an in-stream POC.	DOE will issue a NSC to the EEVOC Plume AM to clarify the POC for monitoring compliance.	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: DOE has issued an NSC to the EEVOC Plume AM and an erratum to the RmAR and therefore this Action Plan is closed out. The closed out Action Plan (#7) is included in this RER, Appendix C.	Y	Y
			BCV				
Closed BCV-1 [OU 32]	The BCV ROD does not provide a comprehensive list of COCs and related RLs to evaluate compliance with ROD goals. This was the first “watershed” ROD and did not include these levels.	Identify specific COCs and related RLs to assess remedy performance prior to the BCV final ROD.	DOE	EPA/TDEC	Submit action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: Action Plan #8 clarifies criteria and provides a recommended approach to assess remedy performance; therefore, this Action Plan is closed out. The closed out Action Plan #8 is included in this RER, Appendix C.	N	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Future
Closed BCV-2 [OU 32]	NT-1 currently exceeds AWQC ARAR for cadmium (0.25 µg/L) and the OU is not protective of aquatic life. The S-3 Ponds removal action to address S-3 Ponds Pathways 1 and 2 was ineffective and, therefore, terminated. The S-3 Pond RA for Pathway 3 has not been implemented. Uranium activity at BCK 9.2 remains above acceptable levels for residential and industrial human receptors; however, there is no current unacceptable human exposure. Approximately 51% appears to come from NT-8, which drains the BCV Burial Grounds that are not under an existing ROD. A second significant amount of flux passing BCK 9.2 is measured at BCK 12.34, which drains the S-3 Ponds.	FFA Appendix E milestones for response actions at NT-8 and S-3 Ponds Pathways 1-3 deferred to FFA Appendix J in 2022 per agreement at the April 30, 2012 Supervisory Management Team meeting. Remaining actions for elevated flux passing BCK 9.2 and not meeting the Phase I ROD objectives will be evaluated in subsequent decision documents (e.g., NT-8 early action and BCBGs Final Action) and prioritized/scheduled in accordance with FFA Appendix E and J.	DOE	EPA/TDEC	Submit S-3 Ponds Pathways 1–3 action plan per FFA Section XXXI in 2012 D2 RER 7/30/12; report on action plan completion/status in 2013 RER 3/30/13. Status: Monitoring for uranium and cadmium at BCK 12.34 will continue. Action Plan #9 describes the FFA schedule for response actions at S-3 Ponds Pathways 1-3, NT-8, and BCBGs. This Action Plan is closed out. The closed out Action Plan #9 is included in this RER, Appendix C.	Y	Y
		Chestnut Ridge					
Closed CR-1 [OU 26]	Monitoring at FCAP indicates arsenic concentrations in surface water downstream of the FCAP dam are occasionally greater than revised AWQC for "recreation, organisms only." However, arsenic concentrations are less than the AWQC for "fish and aquatic life." The ROD does not specify compliance with either of these numeric criteria; however, they are used as comparative criteria to track reduction in "contaminant migration to surface water" and "risk to ecological receptors."	Continue to monitor water quality downstream of the dam at MCK 2.0 as currently planned per WRRP monitoring.	DOE	EPA/TDEC	Report data and provide AWQC comparison in the annual RER. In the 2013 RER, report specifically on the status of this FYR issue. Status: AWQC comparison is included in the 2013 RER. The use of AWQC as comparative criteria was written into the text of the FCAP performance monitoring goals and objectives section in the 2013 RER (Section 5.4.1.1), therefore this issue is closed.	N	N
		ETTP					
ETTP-1 [OU 15]	Land use in the northern portion of Zone 1 (Black Oak Ridge) has been changed to a conservation easement (BORCE) and used for recreational use: hiking, bicycling, and select deer hunts. The end use identified in the Zone 1 ROD is unrestricted industrial (i.e., recreational use was not designated).	Designate use as recreational. Address through appropriate documentation agreed upon with the ETTP Core Team. Determine if industrial use goals are protective of recreational uses. The *Final Proposed Plan for Soils in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee*	DOE	EPA/TDEC	Zone 1 Final Proposed Plan – 8/9/14. Zone 1 Final ROD – 5/8/15. Status: The *Final Proposed Plan for Soils in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2648&D1) was submitted to the regulators on 4/29/14. The Zone 1 Final Soils ROD is scheduled for	N	Y

Table 1.4. 2011 FYR summary of issues and recommendations and follow-up actions[a] (cont.)

DOE FYR Issue # [CERCLIS OU #]	Issue	Recommendation and follow-up action	Party responsible	Oversight agency	Milestone date	Affects Protectiveness? (Y/N)[b] Current	Affects Protectiveness? (Y/N)[b] Future
		(DOE/OR/01-2648&D1) addresses anticipated future industrial and recreational land use in Zone 1. The determination in the Proposed Plan that industrial use goals for Zone 1 are also protective of recreational uses is planned to be included in the Zone 1 Final Soils ROD.			submittal in FY 2015.		
Closed ETTP-2 [OU 15]	The DVS process was not designed to address all sources of contamination to groundwater, and although PCCRs have released land for industrial use, some sources remain, e.g., K-1070-F, Contractor's Spoil Area, and others.	Address ongoing sources.	DOE	EPA/TDEC	Status: The DVS process has been approved and implemented in accordance with the Zone 1 Interim ROD as documented in approved PCCRs. Selection of remedies for remaining sources of groundwater contamination has been deferred to the future ETTP Sitewide ROD.	N	Y

[a]Issues and actions are from the 2011 FYR D2, (DOE/OR/01-2516&D2), status as of September 30, 2014.
[b]Assumes that the proposed recommendation has not been implemented.

AM = Action Memorandum
ARAR = applicable or relevant and appropriate requirement
AWQC = Ambient Water Quality Criteria
BCBG = Bear Creek Burial Ground
BCK = Bear Creek kilometer
BCV = Bear Creek Valley
BORCE = Black Oak Ridge Conservation Easement
BV = Bethel Valley
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System
COC = contaminant of concern
CR = Clinch River
DOE = U.S. Department of Energy
DVS = Dynamic Verification Strategy
EEVOC = East End Volatile Organic Compound
EFPC = East Fork Poplar Creek
EPA = U.S. Environmental Protection Agency
ETTP = East Tennessee Technology Park
FCAP = Filled Coal Ash Pond
FFA = Federal Facility Agreement
FY = fiscal year
FYR = Five-Year Review
IC = institutional control
IHP = Intermediate Holding Pond
LEFPC = Lower East Fork Poplar Creek
MCK = McCoy Branch kilometer
MTF = Mercury Treatment Facility
MV = Melton Valley
N = No
NSC = Non-Significant Change
NT = North Tributary
ORR = Oak Ridge Reservation
OU = operable unit
PCCR = Phased Construction Completion Report
POC = point of compliance
PRG = Preliminary Remediation Goal
RA = remedial action
RAO = remedial action objective
RAR = Remedial Action Report
RAWP = Remedial Action Work Plan
RDR = Remedial Design Report
RDWP = Remedial Design Work Plan
RER = Remediation Effectiveness Report
RI = Remedial Investigation
RL = remediation level
RmAR = Removal Action Report
ROD = Record of Decision
RSL = Regional Screening Level
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
UEF = Upper East Fork
UEFPC = Upper East Fork Poplar Creek
WBIWG = Watts Bar Interagency Working Group
WRRP = Water Resources Restoration Program
Y = Yes
Y-12 = Y-12 National Security Complex

Table 1.5. Summary of completed technical issues and recommendations from the FYR (Reserved)

1.8 REFERENCES

DOE/OR/01-1750&D4. *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1824&D1/A2. *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, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1826&D3. *Record of Decision for Interim Actions in the Melton Valley Watershed, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1862&D4. *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1951&D3. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1997&D2. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2161&D2. *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2229&D3. *Record of Decision for Phase II Interim Remedial Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek, Oak Ridge, Tennessee*, 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2628/V1&V2&D2. *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)*, 2001, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D. C.

McCracken, Stephen H., March 18, 2004, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee, Memorandum to Gerald G. Boyd, U.S. Department of Energy Oak Ridge Operations Office Manager, Oak Ridge, Tennessee on the subject Oak Ridge Long-term Stewardship Strategic Plan.

UCOR-4049. *Quality Assurance Project Plan for the Water Resources Restoration Program, U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, URS | CH2M Oak Ridge LLC, Oak Ridge, TN.

UCOR-4160. *Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge, Tennessee*, URS | CH2M Oak Ridge LLC, Oak Ridge, TN.

This page intentionally left blank.

2. BETHEL VALLEY WATERSHED

2.1 INTRODUCTION AND STATUS

2.1.1 Introduction

The Bethel Valley watershed contains most of the 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 identifies those with monitoring or other LTS requirements. Figure 2.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Only sites that have LTS requirements (Table 2.1) are included in these performance evaluations. End uses of a site form the basis of Remedial Action Objectives (RAOs) and determine access restrictions and allowable activities at the site. Figure 2.2 shows ROD-designated end uses within the watershed and interim controls requiring LTS.

Completed CERCLA actions in the Bethel Valley 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 a complete discussion of background information and performance metrics for each remedy, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chapter 6 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

2.1.2 Status

<u>Watershed-Scale Actions</u>

The *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE/OR/01-1862&D4) includes a combination of RAs and decontamination and decommissioning (D&D) projects.

- The *Remedial Design Report/Remedial Action Work Plan for Soils, Sediments and Dynamic Characterization Strategy for Bethel Valley* (DOE/OR/01-2378&D5) presents a statistically-based soil characterization strategy to verify that the RAOs (DOE/OR/01-1862&D4) are met following RA. Remediation of the Building 3550 slab was recently completed under this Remedial Design Report/Remedial Action Work Plan (RDR/RAWP).
    - **Building 3550 Slab**. Building 3550 is one of 34 buildings recently demolished in the Central Campus area of ORNL. In FY 2013 the concrete slab was excavated, along with contaminated soil beneath the slab to a depth of up to two ft, and the area was graded and seeded with grass (Figure 2.3). The *Phased Construction Completion Report for Bethel Valley Building 3550 Slab Remediation at the Oak Ridge National Laboratory* (DOE/OR/01-2627&D1) was approved in November 2013. No monitoring or other LTS requirements are specified in the report.

Table 2.1. CERCLA actions in Bethel Valley watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
Watershed-scale actions			
		Actions complete	
Bethel Valley Interim Actions	ROD (DOE/OR/01-1862&D4): 05/02/02	PCCR for Hot Storage Garden (DOE/OR/01-2265&D1) approved 01/10/06	No/No
	NSC (DOE/OR/01-2152&D1), addition of Hot Storage Garden (3597): 06/25/04	PCCR for the Tanks T-1, T-2, and HFIR (DOE/OR/01-2238&D1) approved 11/16/05	No/No[c]
	NSC, delineates area of land transferred for multi-program research facility: 12/03/04	PCCR for the Bethel Valley Mercury Sumps Groundwater Action (DOE/OR/01-2472&D1) approved 08/27/10	Yes/Yes
	NSC, addition of IFDP facilities: 09/10/09	PCCR for Corehole 8 Extraction System (DOE/OR/01-2534&D1/A1) approved 04/23/12	Yes/Yes
	NSC, errata to NSC submitted 09/10/09; no approval required: 10/26/09	PCCR for Northwest Quadrant Slabs and Soils (DOE/OR/01-2579&D1) approved 11/05/12	No/TBD[f]
	ESD (DOE/OR/01-2446&D2), changes to SWSA 3 remedy: 10/05/10	PCCR for D&D of General Maintenance Facilities (DOE/OR/01-2552&D2) approved 10/09/12	No/TBD[f]
	NSC, clarification of risk reduction goals at 7500 bridge: 11/16/13	PCCR for D&D of Small Facilities and Southeast Contaminated Lab Facilities (DOE/OR/01-2573&D2) approved 10/09/12	No/TBD[f]
		PCCR for Isotopes Row Facilities Legacy Material Removal (DOE/OR/01-2557&D2) approved 09/21/12	No/Yes
		PCCR for BVBGs (DOE/OR/01-2533&D2) approved 05/11/12	Yes/Yes
		PCCR for 4500 Gaseous Waste Reconfiguration and Stabilization (DOE/OR/01-2614&D1) approved on 11/20/13	No/No
		PCCR for Building 3026 C Hot Cell Demolition (DOE/OR/01-2629&D1) approved on 11/21/13	No/TBD[f]
		PCCR for Building 3038 Legacy Material Removal (DOE/OR/01-2617&D2) approved on 01/27/14	No/No
		PCCR for 3550 Slab (DOE/OR/01-2627&D1) approved on 11/04/13	No/No

Table 2.1. CERCLA actions in Bethel Valley watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
Single-project actions			
		Actions complete	
WAG 1 Corehole 8 (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	Superseded by PCCR for Corehole 8 Extraction System (DOE/OR/01-2534&D1/A1)[g]
		Phase I Operations Report (DOE/OR/01-1832&D2) submitted on 11/02/99	
		Phase II Operations Report (DOE/OR/01-1882&D1) approved 06/21/00	
Building 3001 Canal	AM (DOE/OR/02-1533&D2): 11/18/96	RmAR (DOE/OR/01-1599&D2) approved 08/22/97	No/No[d]
Surface Impoundments Operable Unit	ROD (DOE/OR/02-1630&D2): 09/25/97	RAR for Impoundments A and B (DOE/OR/01-2086&D2) approved 05/17/04	No/Yes
		RAR for Impoundments C and D (DOE/OR/01-1784&D2) approved 04/19/99	No/No
Metal Recovery Facility	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
WAG 1 Tank WC-14 (1) Liquid removal	AM (DOE/OR/02-1322&D2): 02/16/95	RmAR (DOE/OR/01-1397&D1) approved 08/21/95	Discontinued/No
WAG 1 Tank WC-14 (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	AM (DOE/OR/02-1381&D2): 07/28/95	RmAR (DOE/OR/01-1460&D1) approved 12/12/96	No/No
GAAT Operable Unit	ROD (DOE/OR/02-1591&D3): 09/2/97	RAR (DOE/OR-01-1955&D1) approved 10/2/01	No/No
Inactive Liquid LLW Tanks	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
		RmAR II Addendum (DOE/OR/01-1953&D2/A2) submitted 09/26/01	No/No
GAAT Shells/Risers	AM (DOE/OR/01-1957&D2): 07/13/01	RmAR (DOE/OR/01-2010&D1) approved 08/21/02	No/No

Table 2.1. CERCLA actions in Bethel Valley watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
Corehole 8 Plume Source (Tank W-1A)	AM (DOE/OR/01-1749&D1): 09/17/98 Amended in 1999	RmAR (DOE/OR/01-1969&D3) approved 08/30/12	No/Yes
2000 Complex D&D	AM (DOE/OR/01-2412&D1): 09/03/09	RmAR for 2000 Complex (DOE/OR/01-2501&D1) approved 08/25/11	No/No
3026 C&D D&D Wooden Superstructure	AM (DOE/OR/01-2402&D2) 03/24/09	RmAR (Wooden Superstructure) (DOE/OR/01-2470&D1) submitted 03/22/11 (approval not required)	No/TBD[f]
		Actions in progress	
Buildings 3074, 3136 and 3020 Stack D&D	AM (DOE/OR/01-2407&D1): 04/09/09	RmAR (DOE/OR/01-2641&D1) submitted on 06/27/14	TBD[e]

[a]Information on the enforceable agreement milestones for ongoing actions is in Appendix E of the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014) and is available at <http://www.ucor.com/ettp_ffa_appendices.html >.

[b]"No/No" indicates no monitoring/other LTS requirements are identified in the CERCLA action completion document beyond those identified in the watershed ROD. Refer to Table 2.4 for watershed-scale monitoring requirements and Figure 2.2 and Table 2.15 for watershed-scale LUCs and other LTS requirements.

[c]The *Phased Construction Completion Report for the Remediation of Tanks T-1, T-2, and HFIR* (DOE/OR/01-2238&D1) states that the above-ground areas of these sites are subject to routine maintenance and radiological surveys. However, this requirement was superseded by the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1/A1) which omits any LTS requirements for these sites. The LTS of these sites is no longer reported in the RER. The T-1 and T-2 Tanks are located on the Bethel Valley watershed map (Figure 2.1) and HFIR Tank is located on the Melton Valley watershed map (Figure 3.1).

[d]The *Removal Action Report on the Building 3001 Canal* (DOE/OR/01-1599&D2) 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 annual RER.

[e]The completion document was not approved during the FY 2014 reporting period.

[f]This completion document includes "Other LTS" requirements for potentially contaminated slabs, e.g., slab monitoring, access controls, inspection, etc. Interim LTS requirements for potentially contaminated slabs following building demolition are the subject of an informal dispute. Until the informal dispute is resolved, the "Other LTS" requirements for potentially contaminated slabs are not known and are TBD.

[g]The "Monitoring/Other LTS" requirements in a completion document have been superseded, or replaced, by the requirements in the subsequent, referenced completion document.

AM = Action Memorandum
BVBGs = Bethel Valley Burial Grounds
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D = decontamination and decommissioning
ESD = Explanation of Significant Difference
FY = fiscal year
GAAT = Gunite and Associated Tanks
HFIR = High Flux Isotope Reactor
IFDP = Integrated Facility Disposition Project
LLW = low-level waste
LTS = long-term stewardship
LUC = land use control
NSC = Non-Significant Change
PCCR = Phased Construction Completion Report
RAR = Remedial Action Report
RER = Remediation Effectiveness Report
RmAR = Removal Action Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TBD = to be determined
WAG = Waste Area Grouping

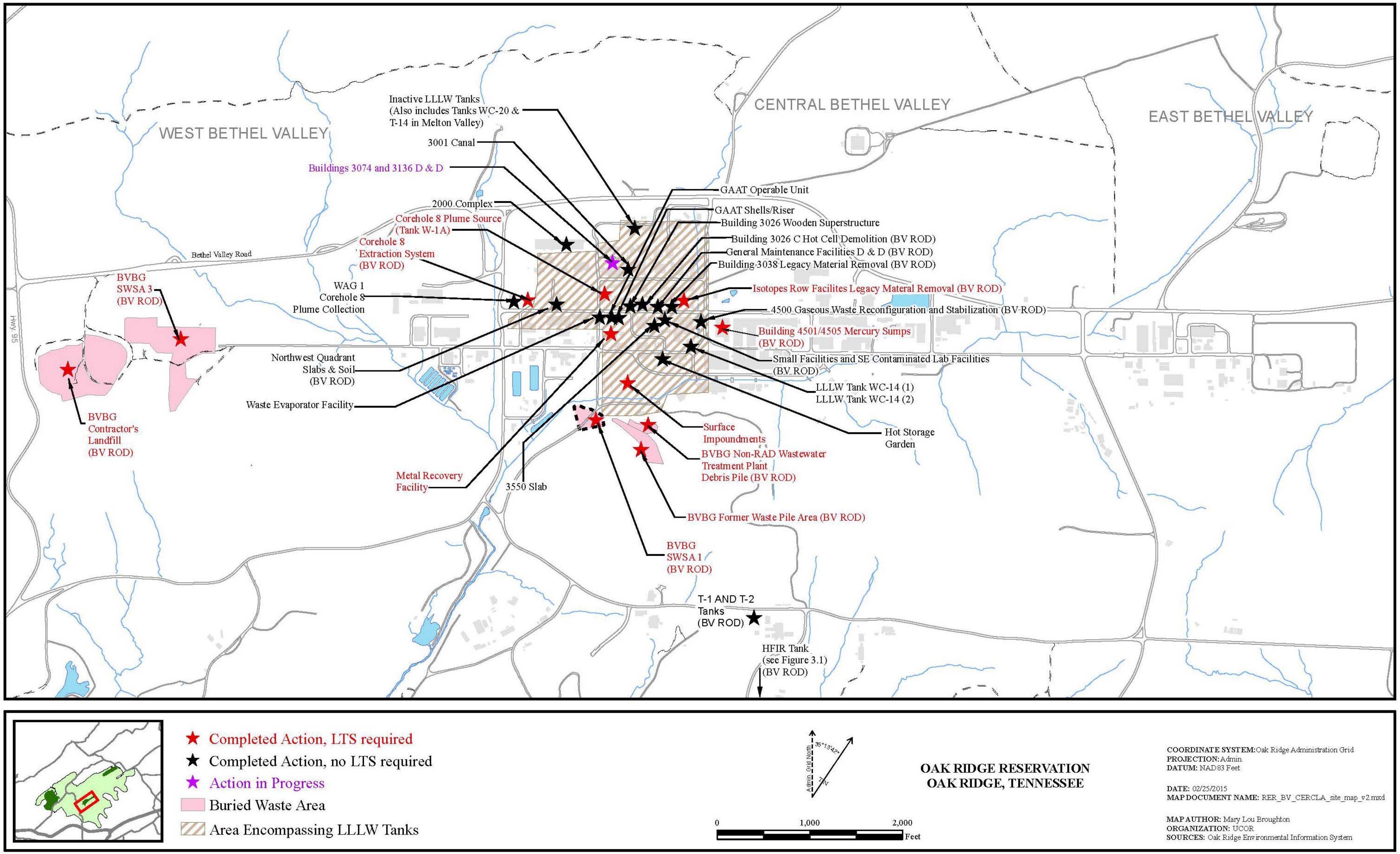


Figure 2.1. Bethel Valley watershed.

This page intentionally left blank.

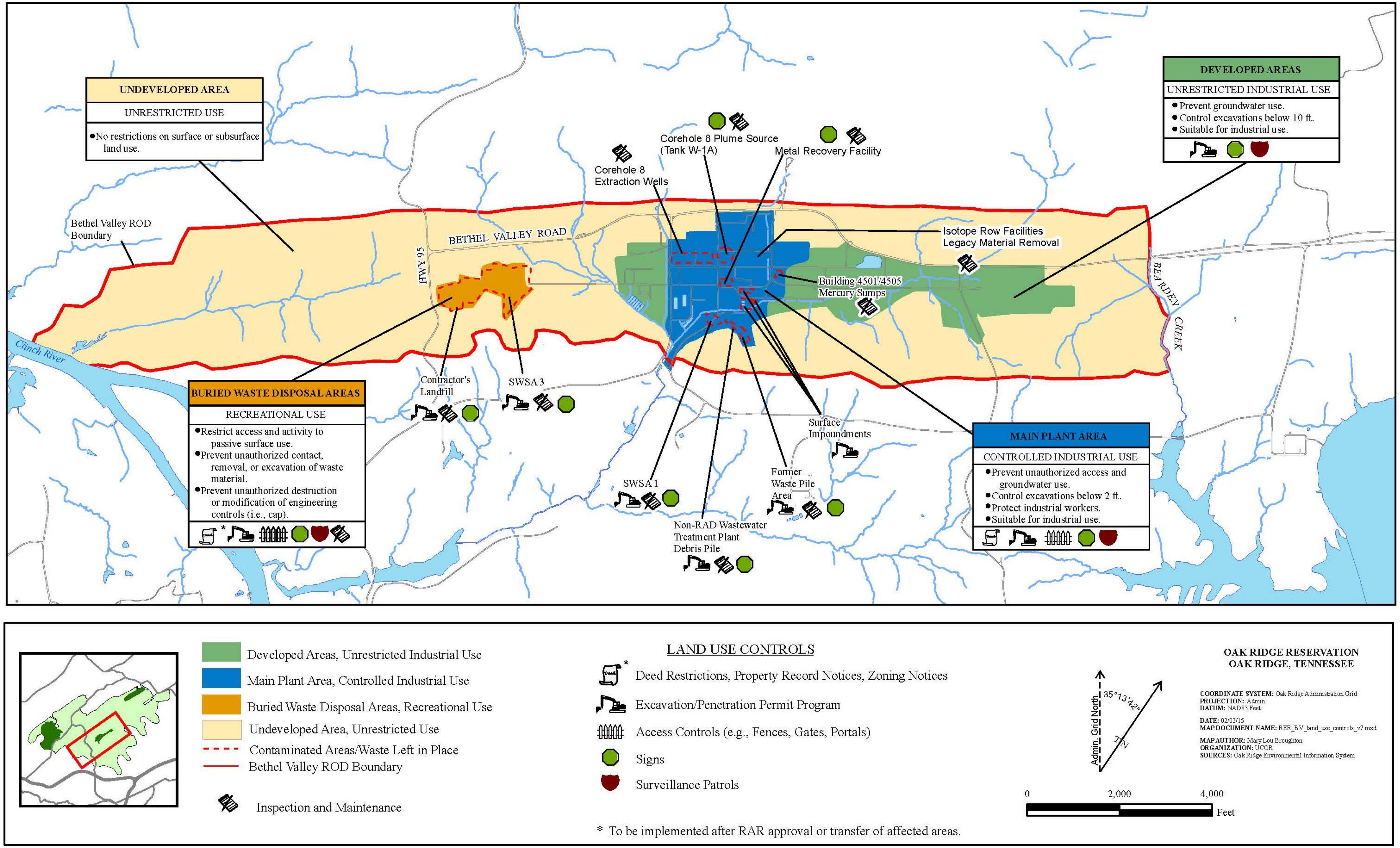


Figure 2.2. Bethel Valley ROD-designated end uses and interim controls requiring LTS.

This page intentionally left blank.

Figure 2.3. Building 3550 area after being cleared.

- The *Remedial Design Report/Remedial Action Work Plan for the Decontamination and Decommissioning of Non-Reactor Facilities in Bethel Valley* and addenda (DOE/OR/01-2428&D2, DOE/OR/01-2428&D2/A2, DOE/OR/01-2428&D2/A3) addresses demolition of approximately 180 facilities and the removal of legacy material planned for implementation over a period of more than 20 years. Recent D&D activities completed under this RDR/RAWP are as follows:

  – **Building 3026 Hot Cells D&D.** Building 3026 C&D, one of the original buildings constructed in the 1940s to support the war effort, has been inactive since the 1990s. Entries into the highly contaminated hot cells have been minimal. A *Waste Handling Plan for Facility 3026 C&D Hot Cells Demolition at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2490&D2) was approved in FY 2011. Also in FY 2011 the 3026-C "Counting Room" and "Tritium Lab" were decontaminated. In FY 2012 3026-C "Cell Bank 1" and "Cell Bank 2" and 3026-D "Storage/Sorting Cell" were decontaminated, and 3026-C was demolished. In FY 2013, preparation for demolition of 3026-D was halted because higher levels of contamination than anticipated were found. The available funding allowed 3026-D to be left in a safe configuration for surveillance and maintenance but did not allow demolition. The *Phased Construction Completion Report for Facility 3026 C Hot Cell Demolition at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2629&D1) was approved in November 2013. No monitoring or other LTS requirements are specified in the report.

  – **Building 3038 Legacy Material Removal.** Building 3038 is a 7,773 ft^2 nuclear facility located in the ORNL Central Campus. Building 3038 was used for packaging, inspecting, and shipping activities for radioisotopes. In 1994 all operations ceased. In FY 2013, in order to prepare the building for future demolition, all waste was removed from the building and disposed; stabilization activities were completed; the local ventilation system was re-started; and the air-monitoring equipment was placed on-line. The *Phased Construction Completion Report for Building 3038 Legacy Material Removal and Preparation for D&D at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2617&D2) documenting completion was approved in January 2014. No monitoring or other LTS requirements are specified in the report.

– **4500 Area Gaseous Waste Reconfiguration and Stabilization.** The objective of the 4500 Area Gaseous Waste Reconfiguration and Stabilization Project was to deactivate one of the five Cell Ventilation System branches and remove several facilities from the central Hot Off-Gas system. The ventilation system branches and off-gas system are part of the Central Gaseous Waste System that vent through the 3039 Central Stack. The project provided localized ventilation systems to the 4501, 4505, 4500N, and 4507 facilities; stabilized the hot cells in Building 4507; cleaned out filter pits 3106 and 4556; and stabilized hundreds of ft of deactivated underground ductwork. Demolition, removal of existing equipment, and fabrication and installation of the replacement ventilation system for the 4501, 4505, and 4500N facilities were completed in January 2013. In September 2013, characterization of the underground ductwork, stabilization of the underground ductwork, and cleanout of the 3106 and 4556 filter pits were completed. Design, fabrication, installation, and operation of the local ventilation system for Building 4507 had previously been completed in FY 2012, along with stabilization of the 4507 hot cells. The *Phased Construction Completion Report for the 4500 Gaseous Waste Reconfiguration and Stabilization Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2614&D1) for the CERCLA portion of this project was approved in November 2013. No monitoring or other LTS requirements are specified in the report.

Single-Project Actions

Buildings 3074 and 3136 and 3020 Stack Dismantlement. The *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) was prepared in 2009 for the dismantlement of Buildings 3074 and 3136 and the 3020 Stack. Buildings 3074 and 3136 were dismantled in FY 2009 (Figure 2.4), and the waste was disposed in FY 2012. The 3020 Stack was not dismantled. If it is dismantled in the future, the scope will be performed as a separate CERCLA response action. In June 2014 the *Removal Action Report for Buildings 3074 and 3136 and the 3020 Stack at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2641&D1) documenting dismantlement of Buildings 3074 and 3136 was submitted to EPA and TDEC.

Figure 2.4. Demolition of Building 3074 (top) and Building 3136 (bottom)

2.2 ROD FOR INTERIM ACTIONS FOR THE BETHEL VALLEY WATERSHED

2.2.1 Performance Monitoring

2.2.1.1 Performance Monitoring Goals and Objectives

The remedy in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) includes actions to address contaminated buildings and other facilities designated for demolition, 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., Building 4500N) and infrastructure that have ongoing missions, contaminated media and sources that are inaccessible due to the presence of the active facilities and infrastructure. The final groundwater decision will be made after source control actions are complete, their effectiveness is monitored, and limited additional characterization data is collected.

The *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) stipulated RAOs for Bethel Valley based on future end 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 Bethel Valley/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 2.2). Figure 2.2 illustrates the future end use areas.

Table 2.2. RAOs for Bethel Valley[a]

Issue	*Protection goals*
Future end 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*

[a]*Record of Decision for Interim Actions at Bethel Valley* (DOE/OR/01-1862&D4).

AWQC = ambient water quality criteria
ORNL = Oak Ridge National Laboratory
RAO = remedial action objective
SWSA = Solid Waste Storage Area

RAOs for surface water include attainment of a 45% risk reduction from baseline levels of 1994 at the 7500 Bridge and attainment of AWQC for designated stream uses. Principal contaminants of concern identified for risk reduction at the 7500 Bridge include ^{90}Sr and ^{137}Cs. In addition, the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) specifies the attainment and maintenance of water quality and sediment contaminant levels of 1 x 10^{-4} for a hypothetical recreational end use scenario. The RAOs for groundwater are to prevent further degradation of water quality by remediation of soils that contribute to groundwater contamination above a 1 x 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 *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) 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. The ROD did not specify ARAR-based groundwater remediation levels and meeting such ARAR-based levels is not a performance objective of the ROD. The ROD 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 other LTS requirements will be developed in the PCCR for each element of the remedy. Table 2.3 lists the performance objectives and performance measures for the defined RAs. Figure 2.5 shows watershed scale monitoring locations and Table 2.4 lists CERCLA action performance monitoring in Bethel Valley.

Table 2.3. Performance measures for major actions in Bethel Valley[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*

Table 2.3. Performance measures for major actions in Bethel Valley[a] (cont.)

Waste type	*Unit*	*Remedial actions*	*Performance objective (protection goals)*	*Performance measure (demonstration of effectiveness)*
				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 m (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)*
	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-based 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[b]*

Table 2.3. Performance measures for major actions in Bethel Valley[a] (cont.)

Waste type	***Unit***	***Remedial actions***	***Performance objective (protection goals)***	***Performance measure (demonstration of effectiveness)***
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[b]); 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(16)[c]]*

[a]Table 2.37 of *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4).

[b]A *Notification of Non-Significant Change to the Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4/R2) clarified the target concentration levels and compliance sampling techniques for measuring the 45% risk reduction.

[c]Previous ARAR citations have referenced TDEC 1200-4-6-.09. Current ARAR citations and current well P&A practice is consistent with substantive requirements of TDEC 0400-45-06-.09.

AWQC = ambient water quality criteria
HFIR = high flux isotope reactor
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
TDEC = Tennessee Department of Environment and Conservation
VOC = volatile organic compound

This page intentionally left blank.

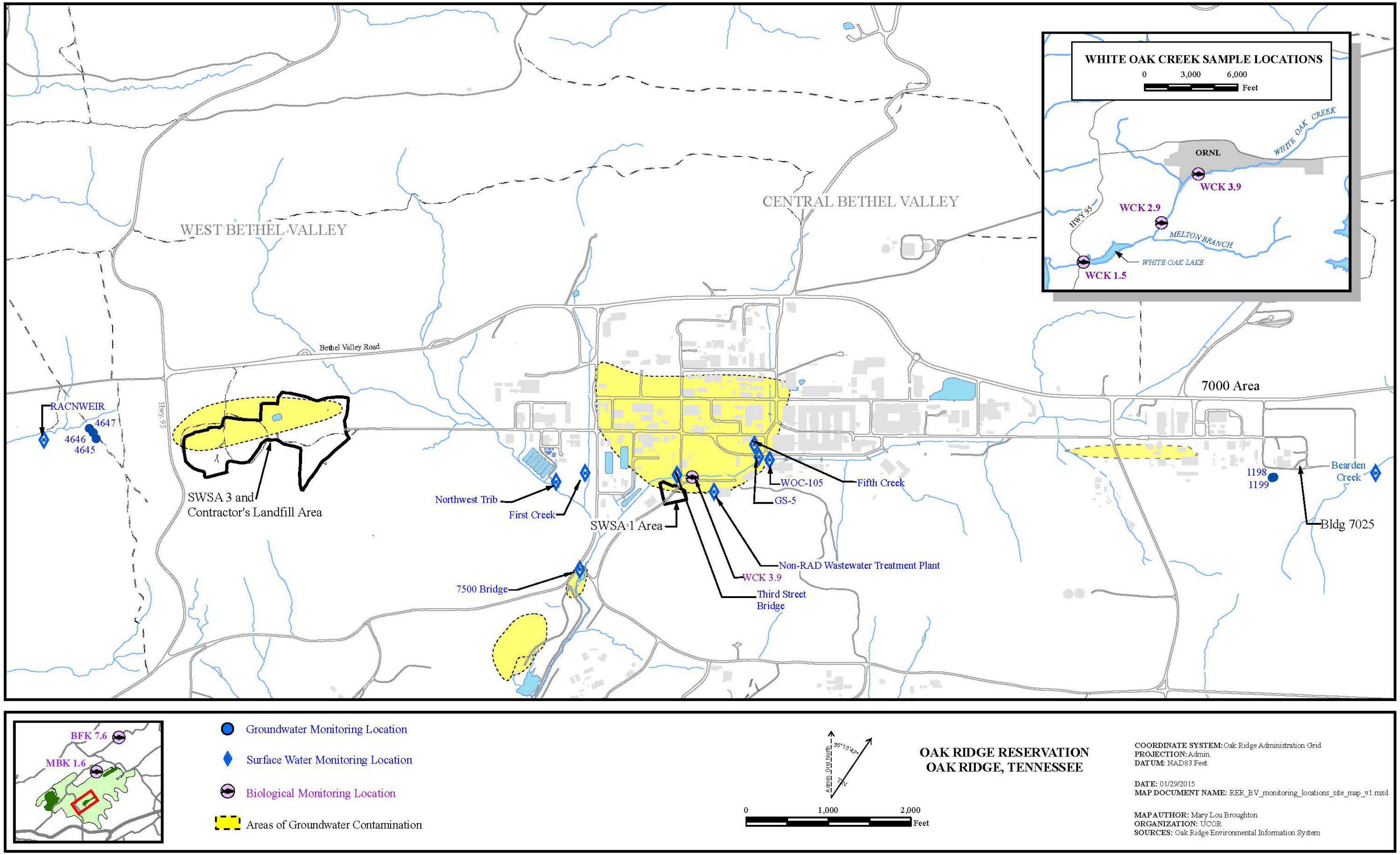


Figure 2.5. Watershed scale monitoring locations in Bethel Valley.

This page intentionally left blank.

Table 2.4. CERCLA action performance monitoring in Bethel Valley*[a]

Media	Monitoring Location	Schedule and Type of Sample	Parameters	Performance Standard
		PERFORMANCE MONITORING		
Surface water	7500 Bridge Weir	Continuous flow-proportionate monthly composite sample	^{90}Sr, gamma activity[b]	Achieve (BV Interim Actions ROD): • 45% risk reduction from 1994 levels at 7500 Bridge for ^{90}Sr and ^{137}Cs (i.e., 37 pCi/L of ^{90}Sr and 33 pCi/L of ^{137}Cs) • AWQC for all designated stream uses in all waters of the state (FYR)
	First Creek Weir	Continuous flow-proportionate monthly composite sample	COCs (^{90}Sr, gross alpha, gamma activity [b])	None specified
	NWT Weir	Continuous flow-proportionate monthly composite sample	COCs (^{90}Sr)	
	Raccoon Creek Weir	Continuous flow-proportionate monthly composite sample	COCs (^{90}Sr)	
	7500 Bridge Weir	Monthly grab sample Semiannual grab sample (Hg snapshot) Annual grab sample (prior to FYR)	Total mercury Total mercury AWQC	51 ppt (ng/L) Hg (BV Mercury Sumps) 51 ppt (ng/L) Hg (BV Mercury Sumps) AWQC (BV Mercury Sumps)
	WOC-105	Semiannual grab sample (Hg snapshot)	Total mercury	51 ppt (ng/L) Hg (BV Mercury Sumps)
	First Creek	Continuous flow-proportionate monthly composite monitoring	^{90}Sr	Document quantity of ^{90}Sr discharging from Corehole 8 plume to First Creek as it contributes to WOC (PCCR for Corehole 8 Extraction System)
	SWSA 3 Sediment Basin (BVBGs BASIN OUT)	Semiannual grab monitoring	Metals, VOCs, ^{90}Sr, and tritium	Basin will access upgradient trench as a potential source of contaminants and can be compared to the recreational goal of 1 x 10^{-4} risk for swimmers (BVBGs action).

Table 2.4. CERCLA action performance monitoring in Bethel Valley*[a] (cont.)

Media	Monitoring Location	Schedule and Type of Sample	Parameters	Performance Standard
Biota	WCK 6.8 WCK 3.9 FCK 0.1 FCK 0.8 FFK 0.2 FFK 1.0	Fish and benthic macroinvertebrate species surveys	Richness and density survey	Comparison to reference location to evaluate whether aquatic populations are being protected (BV Interim Actions ROD)
Groundwater	4579-01 4579-02 4579-03	Semiannual grab samples[c]	Gross alpha and gross beta activity, ^{90}Sr	Exit pathway (West BV/Raccoon Creek area) monitoring trend to determine if contaminants are leaving known contaminated areas (BVGWES)
	Well 4411	Quarterly grab sample	^{90}Sr	To monitor contaminant concentration trends (PCCR for Corehole 8 Extraction System)
	Well 4570	Semiannual grab sample	^{90}Sr	Sample groundwater down-dip to the southwest of the Corehole 8 Plume source (PCCR for Corehole 8 Extraction System)
	Wells 4571 and 4572	Semiannual grab sample	^{90}Sr	Installed west along geologic strike to detect potential underflow of First Creek (PCCR for Corehole 8 Extraction System)
	Wells:[d] **0482**, **0483**, **0484**, **0491**, **0492**, **0493**, 0692, 0693, **0694**, 0698, 0699, 0700, 0702, 0706, 0790, 0985, 0986, 0987, 0988, 0990, 0991, 0992, 0993, 0994, 0995, **0996**, **0997**, 0998, 1247, 1248, 4579-01, 4579-02, 4579-03, 4645, 4646, 4647, 4670, 4671, 4672, 4673, 4674, 4675	Quarterly synoptic monitoring	Water levels	Intent of the SWSA 3—CSMA cap is to limit the amount of water that encounters buried wastes by reducing or eliminating percolation of precipitation and through-flow of shallow groundwater. Therefore, water table elevations are expected to decline under the cap over time (See Table 7-2 of BVBGs PCCR [DOE/OR/01-2533&D2] for long-term water table elevation goals for SWSA 3).
	Wells 0706, 0995 Well 0985 Wells 4645, 4646, 4647 Wells 0992, 0993, 0994, 0997, 4579-01, 4579-02 , 4579-03	Semiannual grab samples	^{90}Sr, tritium VOCs, ^{90}Sr, tritium Metals, ^{90}Sr, tritium Metals, VOCs, ^{90}Sr, tritium, gross alpha, and gross beta	Downward trend in ^{90}Sr concentration towards 8 pCi/L (BVBGs PCCR)

Table 2.4. CERCLA action performance monitoring in Bethel Valley*[a] (cont.)

*Source: *Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-2478&D1).

[a]Table presents current requirements for monitoring included in the Interim Actions ROD for the BV, post-decision primary documents, or any subsequent errata that have received concurrence/approval from the EPA and TDEC. Additional monitoring requirements will be developed and approved during the remedial design process for actions yet to be implemented.

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

[c]Per the BVGWES report (DOE/OR/01-2219&D2), 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 (though 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 trend is clearly demonstrated. Note that monitoring has not been reduced due to the presence of contamination.

[d]**Bolded** values represent wells included in Table 7-2 of the PCCR for BVBGs (DOE/OR/01-2533&D2) and listed in Table 2.13 of this report which specifies long-term water table elevation goals for nine wells.

AWQC = ambient water quality criteria
BV = Bethel Valley
BVBGs = Bethel Valley Burial Grounds
BVGWES = Bethel Valley Groundwater Engineering Study
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC = contaminant(s) of concern
CSMA = Closed Scrap Metal Area
EPA = Environmental Protection Agency
FCK = First Creek kilometer
FFK = Fifth Creek kilometer
FY = fiscal year
FYR = Five-Year Review
NWT = Northwest tributary
PCCR = Phased Construction Completion Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
VOC = volatile organic compound
WCK = White Oak Creek kilometer
WOC = White Oak Creek

2.2.1.2 Evaluation of Performance Monitoring Data

2.2.1.2.1 Surface Water

2.2.1.2.1.1 Surface Water Quality Goals and Monitoring Requirements

The following excerpts (italicized) from Section 2.12.7.3 of the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) include the specific concentration goals for the principal surface water contaminants of concern.

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 of 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 2.5 *(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.*

***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 x 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 2.5 *(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.*

A *Notification of Non-Significant Change to the Record of Decision for Interim Actions in Bethel Valley (DOE/OR/01-1862&D4/R2)* clarified the target concentration levels and compliance sampling techniques for measuring the 45% risk reduction as follows:

> *. . .DOE is therefore adding to the BV ROD the specific target concentration levels for ^{90}Sr and ^{137}Cs of 37 pCi/L and 33 pCi/L, respectively, to meet the 45% risk reduction goal. . .DOE is issuing this non-significant change to clarify that sampling is done in the following manner based on the following approach:*
>
> *A monthly flow-paced composite sample at the 7500 Bridge will be taken and used for the average concentration parameter in the risk calculation to demonstrate compliance with the 45% risk reduction goal. This sampling approach produces an average (arithmetic mean) annual constituent concentration result that inherently accounts for impacts of flow rate on concentrations over time. This sampling approach is also conservatively reflective of how a surface water intake system for a public water supply would be sampled.*

Surface water remediation levels are outlined in Table 2.5.

Table 2.5. Surface water remediation levels in Bethel Valley[*]

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 2.5)	*See Fig. 2.36* (Figure 2.5) *(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 x 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*

[*]Table 2.38 of the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4).

[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

2.2.1.2.1.2 Surface Water Monitoring Results

This section presents the surface water monitoring results of watershed-scale contaminant discharge monitoring and single-project action monitoring results related to completed or ongoing CERCLA projects. Watershed-scale surface water and groundwater monitoring provides an ongoing data record against which to determine the effectiveness of RAs as well as verifying reduction of off-site releases of contaminants.

The Bethel Valley administrative watershed (Figure 2.2) lies in portions of three topographic basins. The White Oak Creek (WOC) basin encompasses all of the ORNL main campus area as well as most of the Solid Waste Storage Area (SWSA) 3 and Contractor's Landfill area, and all but the easternmost portion of facilities at the 7000 Services area. The western portion of SWSA 3 and all of the Contractor's Landfill lie in the headwater of the Raccoon Creek basin which is wholly included in the Bethel Valley administrative watershed which drains directly to the Clinch River. The easternmost portion of the 7000 Services Area lies in the Bearden Creek topographic basin which drains directly into Melton Hill Reservoir.

Surface water monitoring in Bethel Valley includes both continuous, flow-paced monitoring by the EM Program at key instream locations and routine collection of grab samples, as well as ORNL facility discharge monitoring conducted by University of Tennessee-Battelle, LLC (UT-B) for the DOE Office of Science.

The *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) stipulates that AWQC be met in surface water. DOE evaluates the status of AWQC attainment in each CERCLA FYR. The most recent review conducted in the *2011 Third Reservation-Wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) indicated that for 10 sampled locations including WOC mainstem and tributary locations criterion exceedances were detected for chlordane at two locations, for heptachlor at two locations, and for mercury at one location.

2.6.1.2.1.2.1 Watershed-Scale Surface Water Monitoring Results

Radiological Discharges to WOC

Historic and ongoing discharges of ^{90}Sr and ^{137}Cs in surface water in the central part of Bethel Valley are principal contaminants of concern that directly impact the condition of the watershed and are performance metrics for the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4). Tritium discharges in WOC originate primarily from sources outside of Bethel Valley:

- groundwater collected in Melton Valley and transferred to the Process Water Treatment Complex (PWTC) via the groundwater collection and treatment system.
- wastewaters generated by Office of Science operating facilities such as the High Flux Isotope Reactor and SNS that are discharged via the PWTC and sanitary sewage systems.

Figure 2.6 shows locations in the ORNL main plant area in Bethel Valley where contaminant concentrations and flows are measured to estimate the discharge fluxes from various contributing areas or outfalls. Strontium-90 is the principal radiological contaminant of concern (COC) in surface water in Bethel Valley because it is a fairly widely distributed contaminant in buried waste, in contaminated soils related to LLLW pipeline leaks, and in groundwater. Three CERCLA actions included in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) were completed during FY 2012 that are reducing ^{90}Sr discharges to surface water – the Bethel Valley Burial Grounds (BVBGs) RA at SWSAs 1 and 3, installation of additional groundwater extraction wells in the Corehole 8 plume, and completion of the excavation of Tank W-1A and associated contaminated soils.

Cesium-137 is a significant surface water contaminant in WOC, and its sources include discharges from the PWTC and soils on the WOC floodplain contaminated from the former Surface Impoundments Operable Unit area downstream to 7500 Bridge Weir. While 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.

Fieldwork to upgrade the 4500 Area Gaseous Waste System was initiated in FY 2012 and completed in FY 2013. Monitoring data for metals, mercury, and radiological constituents at Fifth Creek and other locations downstream of the work area indicate no significant surface water impacts due to the 4500 Area Gaseous Waste System Upgrades project. Radiological monitoring at Fifth Creek was conducted at an increased frequency (monthly) in FY 2014 for performance assessment of the project. After FY 2014 (one year after project completion), no project-specific performance assessment monitoring is required.

The 7500 Bridge is the primary exit pathway for surface water to discharge from the upper portion of the WOC watershed in Bethel Valley into the lower WOC watershed area in Melton Valley. Table 2.6 lists the average annual ^{90}Sr and ^{137}Cs activities calculated from the flow-paced monthly composite samples collected at the 7500 Bridge for the baseline year (FY 1994) and for the period FY 2001 through FY 2014. The Bethel Valley ROD goals for ^{90}Sr and ^{137}Cs based on the 45% risk-reduction requirement are included in the table column headers. As shown in Table 2.6 and on Figure 2.7, ^{90}Sr and ^{137}Cs activities were less than the ROD goal levels during FY 2014. The annual average radionuclide activities shown on Figure 2.7 summarize the variable levels measured in the monthly composite samples. To reflect the variability in parameter levels, the graphs include both the annual average activity and the average plus one standard deviation of the mean. For years when the mean plus one standard deviation shows a wider range there was more measured variation than for years when these results show a narrower range.

During FY 2014, the ungauged ^{90}Sr sources contributed about 70% of the total 0.22 Ci measured at the 7500 Bridge Weir. The principal source of this ungauged flux is attributed to discharges that occurred through storm drain Outfalls 207 and 304 (Figure 2.6). The EM Program was notified by UT-B Environmental Compliance personnel that a sample collected from Outfall 207 in January 2014 contained elevated ^{90}Sr activity. It was also found that ^{90}Sr discharges from Outfall 304 had increased. DOE EM initiated an investigation to locate the source of contamination to the outfalls. The investigation identified a failed sump pump at one of the closed and remediated LLLW tank farms as the problem. The sump pump collects contaminated groundwater from the vicinity of the tank farm and sends it to treatment at the on-site PWTC. When the pump failed, the groundwater capture ceased and contaminated groundwater seeped into the nearby storm drains and was discharged to WOC. DOE EM repaired the pump and monitored the decline in contaminant concentrations and discharge fluxes to the stream. Approximately 6% of the ^{90}Sr discharge at the 7500 Bridge Weir originated from First Creek, which receives low levels of contamination from the Corehole 8 plume.

Tritium concentrations in surface water in the Bethel Valley portion of WOC increased in 2006 as a result of collection and transfer for treatment of former groundwater discharges in Melton Valley and remain at elevated levels. This activity is conducted as a condition of the RA taken in Melton Valley. However, tritium concentrations in surface water throughout WOC are still below the DOE-Derived Concentration Standard (DCS) level for tritium (1.9×10^6 pCi/L; DOE-STD-1196-2011).

Table 2.6. 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
2011	**54**	< 16
2012	33	< 15
2013	33	< 24
2014	33	< 15

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

[a]*Record of Decision for Interim Actions in Bethel Valley Watershed* (DOE/OR/01-1862&D4) baseline year.
[b]Goal = 45% reduction in average concentrations compared to concentrations during baseline year.

ROD = Record of Decision

This page intentionally left blank.

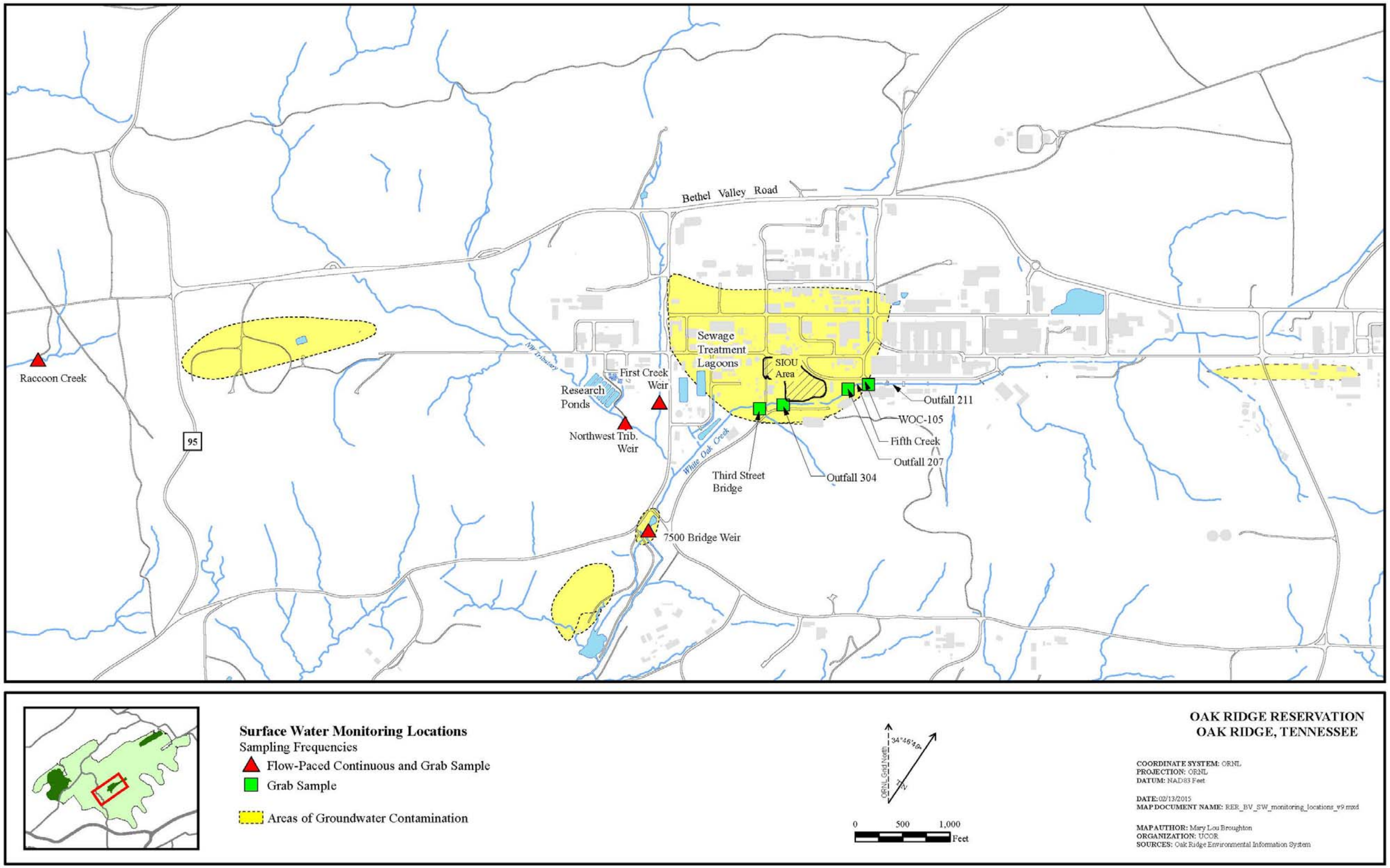


Figure 2.6. CERCLA surface water monitoring locations in ORNL main plant area.

This page intentionally left blank.

Radiological Discharges to Raccoon Creek and Bearden Creek

Raccoon Creek and Northwest Tributary (SWSA 3 Area). Surface water in the western end of Bethel Valley is monitored to measure contaminant discharges to Raccoon Creek and the Clinch River via a western exit pathway. Figure 2.5 shows locations where Bethel Valley 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 estimating flux.

Table 2.7 summarizes annual ^{90}Sr detection frequency and maximum value; total annual flow volume for months having detectable ^{90}Sr; average ^{90}Sr activity from continuous flow-paced samples containing detectable levels at the Raccoon Creek Weir; and estimated flux for periods when reliable station flow data were available. The average detected ^{90}Sr activity, the calculated ^{90}Sr flux, and the flow volumes include data only for months in which ^{90}Sr was detected. Since completion of the SWSA 3 hydrologic isolation in 2011, the ^{90}Sr activity levels in the Raccoon Creek headwaters have decreased by 50 – 60% from values measured during the previous several years. This decrease is attributed to the effect of hydrologic isolation of buried waste in SWSA 3 and the Contractor's Landfill.

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 BVBGs SWSA 3 action. Northwest Tributary data is discussed in a later section. 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 COC in surface water in the area. Continuous flow sampling has been conducted at the Northwest Tributary Weir and the Raccoon Creek Weir for many years.

The long-term surface water flux monitoring (Figure 2.8) of Raccoon Creek shows that the Raccoon Creek ^{90}Sr flux is less than 5% of the combined flux of Raccoon Creek and Northwest Tributary, which are the streams affected by SWSA 3 surface water discharges. During FY 2014, the ^{90}Sr activity levels in Raccoon Creek were below reliable quantitation limits in three of the 12 monthly composite samples. During September 2014 the ^{90}Sr activity was 12.9 pCi/L which is greater than the 8 pCi/L drinking water maximum contaminant level derived concentration (MCL-DC)[1].

[1]This maximum contamination level derived concentration (MCL-DC) is listed in 40 *Code of Federal Regulations* (CFR) 141.66(d)(2), Table A, as the "Average Annual Concentration Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr," which is the maximum contaminant level (MCL) for beta particle and photon radioactivity.

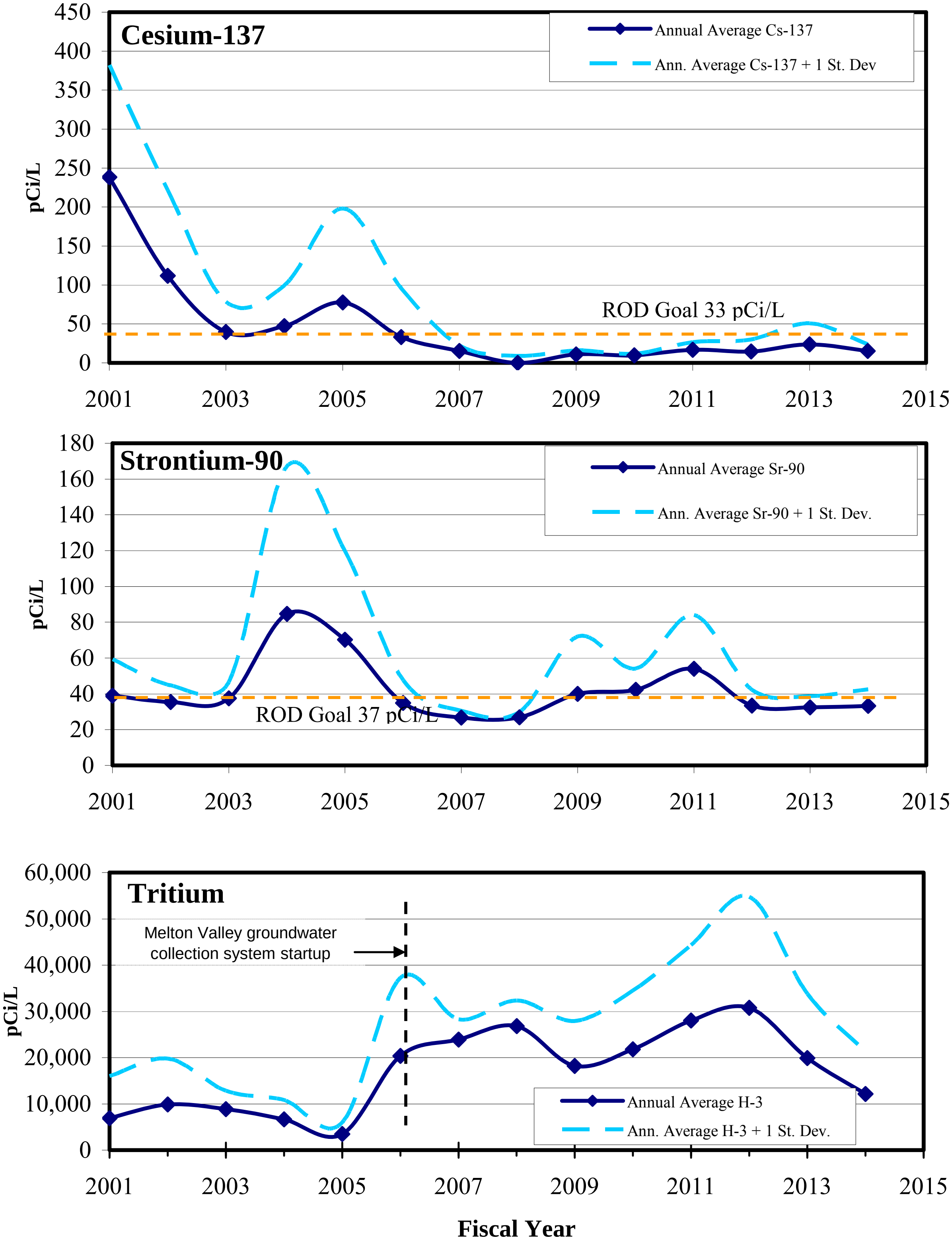


Figure 2.7. Annual average activities of ^{137}Cs, ^{90}Sr, and tritium at 7500 Bridge.

Table 2.7. ^{90}Sr data from Raccoon Creek Weir

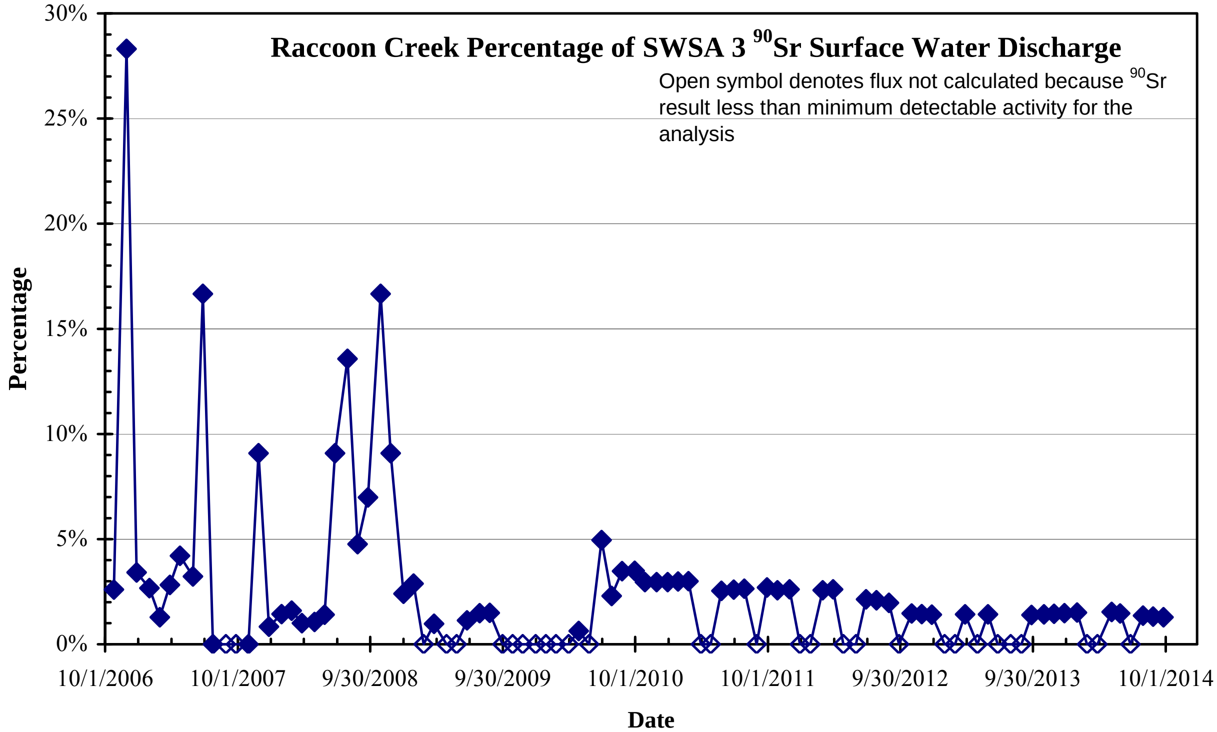
Year	Detection frequency and maximum value (No. detects/No. samples) (Maximum pCi/L)	Flow volume for months with detected ^{90}Sr (L)	Average detected ^{90}Sr (pCi/L)	^{90}Sr Flux (Ci)
FY 1999 Total	8 / 12 55.9	84,336,484	20.9[a]	3.7E-04
FY 2001 (11 months)	7 / 11 8.15	6,6011,324	5.2[a]	3.10E-04
FY 2002	7 / 12 25.1	3,0153,673	13.2[a]	9.35E-04
FY 2003 (11 months)	10 / 12 17.9	241,405,801	6.4[a]	9.8E-04
FY 2004	12 / 12 26.9	254,130,320	9.6[a]	1.68E-03
FY 2005	12 / 12 64.8	--[b]	16.8[a]	--
FY 2006	12 / 12 77.2	--[b]	29.3[a]	--
FY 2007 (February – September)	6 / 8 32.4	86,992,200[c]	12.7[a]	1.1E-03
FY 2008	12 / 12 59.6	117,209,419	15.5[a]	6.4E-04
FY 2009	8 / 12 35.6	150,003,288	10.7[a]	6.2E-04
FY 2010	5 / 12 18.4	20,509,344	11.5[a]	1.9E-04
FY 2011[d]	11 / 12 18.3	277,034,731	5.2	6.4E-04
FY 2012	8 / 12 9.05	146,306,405	4.0	4.3E-04
FY 2013	6 / 12 12.0	383,686,704	5.5	5.9E-04
FY 2014	9 / 12 12.9	182,522,116	4.9	3.7E-4

[a]Activity value represents average activity for all monthly flow composite samples with detected ^{90}Sr.
[b]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.
[c]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.
[d]The SWSA 3 hydrologic isolation was completed during FY 2011.

FY = fiscal year
SWSA = Solid Waste Storage Area

Northwest Tributary (SWSA 3 RA)

The Northwest Tributary of WOC surface water basin receives surface runoff from the area generally west of First Creek and east of the WOC/Raccoon Creek watershed divide and from the northern slope of Haw Ridge to the south and the southern slope of Chestnut Ridge to the north. Dry season baseflow discharge in the Northwest Tributary comes from groundwater and from discharges from the constructed ponds associated with the ORNL 1500 complex. The eastern karst discharge pathway from beneath SWSA 3 contributes flow to the Northwest Tributary and is a groundwater transport pathway for ^{90}Sr from SWSA 3 to the stream. Surface water monitoring has been conducted for many years at the Northwest Tributary Weir. The principal COC in surface water related to SWSA 3 is ^{90}Sr. Continuous flow-paced surface water composite sampling is conducted with a monthly composite period to measure average ^{90}Sr activity level and discharge flux. Figure 2.9 shows the monthly ^{90}Sr activity levels and discharge fluxes for FYs 2005 through 2014. The period during which SWSA 3 remediation occurred is also shown.



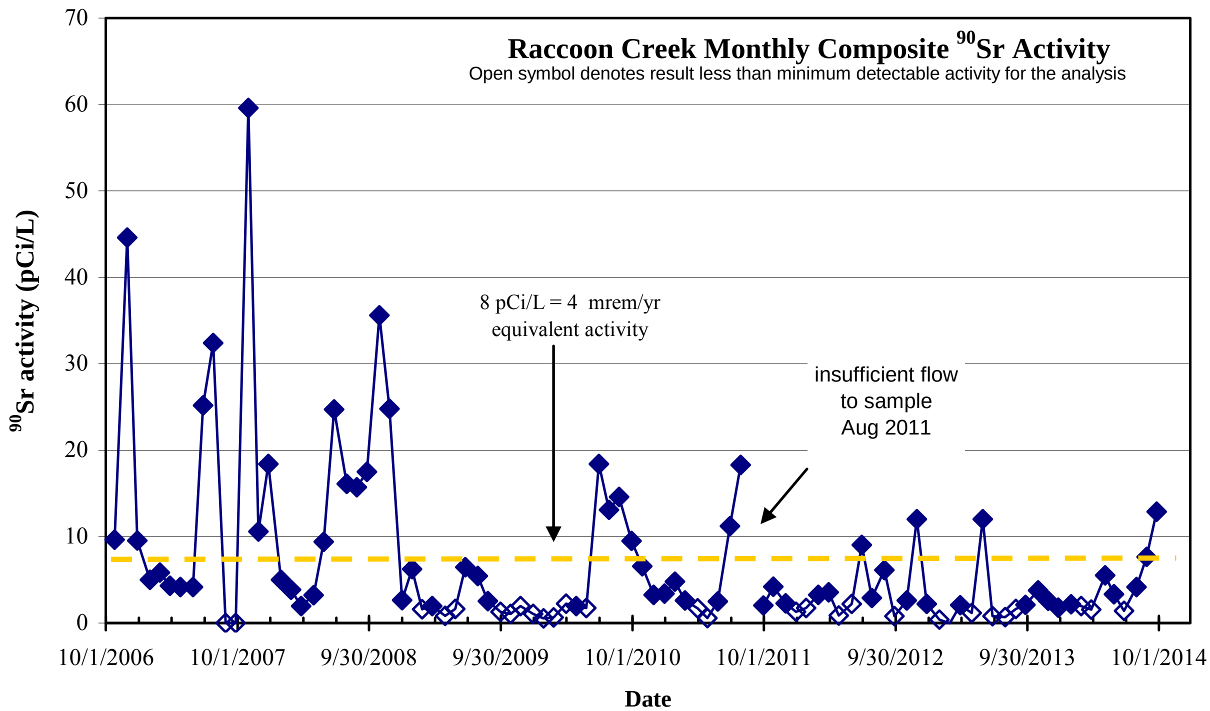


Figure 2.8. Raccoon Creek percentage of combined SWSA 3 surface water ^{90}Sr discharge.

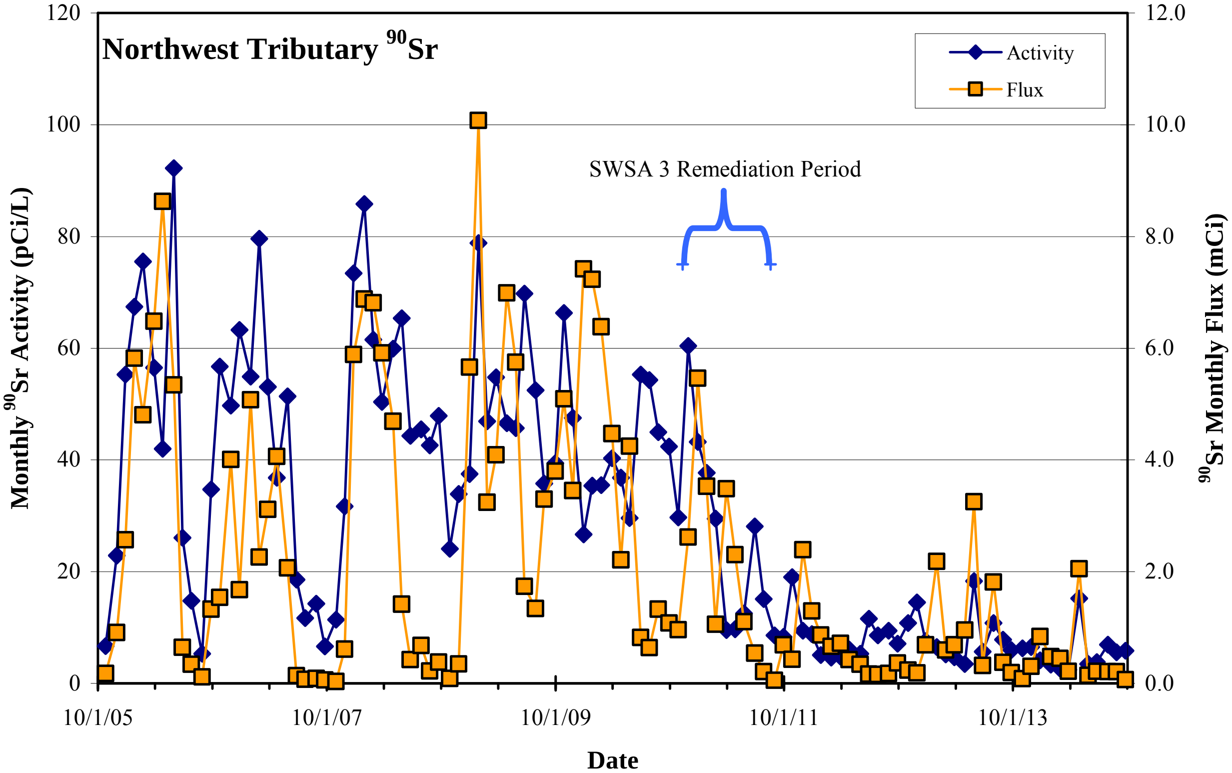


Figure 2.9. Northwest Tributary ^{90}Sr monitoring results FY 2005 – FY 2014.

Activity levels and discharge fluxes of ^{90}Sr decreased during the construction period and appear to have reached a new, lower level with an associated lower fluctuation range subsequent to completion of the RA. Comparison of Northwest Tributary average ^{90}Sr activity levels and fluxes between the pre-remediation period December 2008 through December 2010 and the remediation and post-remediation period January 2011 through September 2014 shows a 75% reduction. Average ^{90}Sr activity before remediation was 46 pCi/L (standard deviation 13 pCi/L) while the during- and post-remediation average ^{90}Sr activity has been 9.5 pCi/L (standard deviation 7.2 pCi/L). The pre-remediation average monthly ^{90}Sr discharge flux was 3.98 mCi/mo. (standard deviation 2.48 mCi/mo.) while the during- and post-remediation average monthly flux has been 0.84 mCi/mo. (standard deviation 0.9 mCi/mo.). The post-remediation long term average monthly ^{90}Sr activities and fluxes and their respective standard deviations are decreasing with time which reflects progressive water quality improvement since the primary contaminant source was hydrologically isolated.

An interesting measure of the effectiveness of hydrologic isolation of burial grounds is the rate of contaminant discharge per inch of rainfall through time. When contaminant mass per inch of rainfall is plotted through time, changes in the role of recharge water percolation into shallow waste units with consequent evolution of leachate formation and discharge to adjacent streams is shown. Figure 2.10 shows the monthly mCi of ^{90}Sr discharged per inch of rainfall for the Northwest Tributary weir for FY 2005 – FY 2014. Historically, the months of December through April fall within the period of maximum groundwater recharge and leachate formation/discharge to surface water in the Northwest Tributary. As shown in Section 1.5, annual rainfall totals at the ORR have varied from much below average during the drought of 2006 – 2008 to above average during the 2009 – 2013 period, and were less than the long term average in FY 2014. Interestingly, Figure 2.10 shows that regardless of the annual rainfall totals, the pre-remediation December – April period showed nearly constant average ^{90}Sr mCi/in. rainfall levels while the summer months showed much greater fluctuation in the rainfall driver of contaminant discharge from SWSA 3. This is expected since evapotranspiration caused by warmer temperatures and vegetation growth and moisture transpiration creates soil moisture deficit conditions during summer which reduces the groundwater recharge effectiveness of summer rainfall compared to winter months. The dates of contour fill placement and membrane cap construction at SWSA 3 are shown on Figure 2.10. It is apparent that placement of contour fill over the burial ground reduced the effective percolation and leachate discharge and that following full cap construction the winter season evolution of ^{90}Sr out of SWSA 3 to the Northwest Tributary has been reduced by 90% compared to levels measured during several pre-construction years. Although the PCCR did not stipulate specific surface water performance goals for the SWSA 3 closure action, the monitoring results at SWSA 3 indicate that the action has significantly reduced ^{90}Sr discharges from the site. Groundwater performance metrics for the SWSA 3 closure action are discussed in a later section.

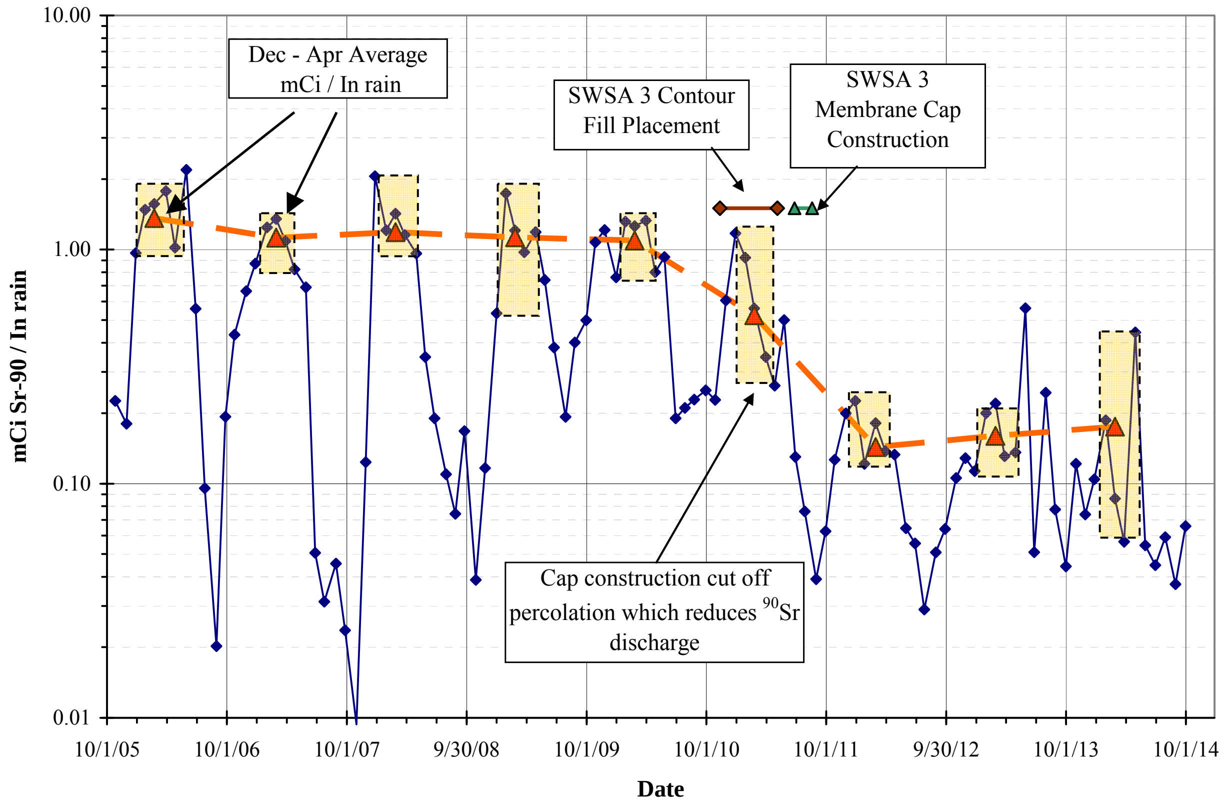


Figure 2.10. Northwest Tributary ^{90}Sr monthly mCi/in. of rainfall.

Bearden Creek (7000 area). The eastern surface water exit pathway near the ORNL site is in Bearden Creek which lies to the east of the ORNL 7000 Services Area (Figure 2.5). Surface water is sampled in a tributary of Bearden Creek at the eastern end of the ORNL area in Bethel Valley to evaluate contaminant discharges to surface water east of the 7000 Services Area. The principal contaminant source that affects this area is the former tritium handling facility at Building 7025 (Figure 2.5). 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 volatile organic compound (VOC) plume in groundwater that migrates westward from its source toward WOC.

Surface water monitoring has been conducted in the Bearden Creek tributary near the 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 MCL-DC (20,000 pCi/L)[2]; however these results are considered suspect because of possible laboratory problems. During the period 2000 through 2005, seven of 10 samples contained detectable tritium at activities ranging from 417 pCi/L to 949 pCi/L. A hiatus in sampling at the Bearden Creek location occurred between 2005 and 2009. Of nine semiannual samples collected since 2009, only one detection of tritium has occurred at an activity of 511 pCi/L in July 2010. The Bethel Valley ROD is an interim decision for groundwater and groundwater cleanup levels have not yet been established. Drinking water MCLs are sometimes used as reference levels in discussing detected groundwater contaminants. All of the sample results, excluding the suspect 1998 – 1999 results, have been either non-detect values or were less than 10% of the drinking water tritium MCL-DC.

Surface Water Mercury Monitoring

Mercury is a COC in surface water because of its strong bioaccumulation tendency in fish. Mercury sampling has been conducted for many years at the 7500 Bridge. Since the winter of 2008 semiannual sampling of mercury has been conducted at First Creek, Northwest Tributary, Raccoon Creek and Fifth Creek, in WOC at the Third Street Bridge, and at WOC-105 upstream of the Fifth Creek Confluence. Monitoring results for Raccoon Creek, Northwest Tributary, and First Creek indicate that they are not significant contributors of mercury, as each of these sites has routinely contained less than 5 ng/L of total mercury. Mercury discharges to WOC in Bethel Valley originate predominantly from discharges directly to WOC upstream of Fifth Creek, from sources to Fifth Creek, and from treated wastewater effluent discharged from the ORNL PWTC. The current most stringent applicable AWQC concentration for mercury is TDEC's Recreational Organism Only criterion of 51 ng/L.

Fifth Creek contains mercury at concentrations that have ranged from < 10 ng/L to > 100 ng/L. During the past several years there have been several mercury detections at levels several times the 51 ng/L AWQC value. ORNL and EM staff have worked collaboratively to locate the sources of mercury discharge into Fifth Creek. During FY 2014, the CERCLA monitoring program collected two samples from Fifth Creek for mercury analysis. The sample collected in November 2013 contained 103 ng/L total mercury while the sample collected in June contained 18.8 ng/L total mercury. There are two known sources of mercury discharge to Fifth Creek – releases from Building 4501 where mercury lithium isotope process pilot operations occurred in the 1950's, and an unknown source or sources that discharge from an outfall from the Isotopes Area into Fifth Creek north of Central Avenue. The UT-B National Pollutant Discharge Elimination System (NPDES) Water Quality Protection Program identified high concentrations of mercury discharging from storm drain Outfall 265. Utility line leaks of chlorinated water near the eastern end of Building 3026 or in the 3039 stack area were thought to be causing subsurface mercury mobility and infiltration into the storm drain. In September 2014 a portion of the ORNL Process Water piping system located to the west of this mercury source area was taken out of service because of a leak unrelated to this mercury issue. When the piping was removed from service and pressurization discontinued, the leak that caused the mercury migration ceased. Dry-weather flow from the Outfall 265 storm drain pipe also stopped at the same time, indicating that the leak west of the area being investigated was the sole dry-weather contributor to Outfall 265 flow. Monitoring of the outfall will continue by UT-B, as will monitoring of mercury in Fifth Creek by the EM Program.

The ORNL PWTC treats both radiologically and chemically contaminated wastewater that originates from numerous sources from the Office of Science activities at ORNL and a wide range of EM related

[2]This MCL-DC is listed in 40 CFR 141.66(d)(2), Table A, as the "Average Annual Concentration Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr," which is the MCL for beta particle and photon radioactivity.

sources including collected groundwater from the ORNL site and leachate from the Environmental Management Waste Management Facility (EMWMF). Effluent from the facility is regulated and monitored under the facility NPDES permit and there is an associated radiological monitoring plan. Effluent monitoring and permit reporting is the responsibility of the Office of Science and is implemented by UT-B. NPDES effluent monitoring over the past few years has shown mercury concentrations in the facility effluent several times greater than the AWQC level. The treatment process includes several stages of processing including clarification, ion exchange and chemical processes before the final step which is passage through two columns containing granular activated carbon (GAC) to remove organic compounds and mercury. During FY 2014 DOE proactively conducted sampling and analyses to evaluate the effectiveness the GAC columns for mercury removal. Those tests indicated that mercury removal efficiency was less than optimal. During the summer of 2014, DOE replaced the conventional GAC in one column with a sulfur impregnated GAC to provide a treatment media that may be more effective at mercury removal prior to discharge. Evaluation of the effectiveness of that upgraded treatment process is ongoing. Early results look promising and monitoring will continue by both the EM program and by the Office of Science under the NPDES requirement.

Additional mercury monitoring results related to the RA for mercury discharges from Building 4501 are discussed below. DOE has completed actions stipulated by the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) for treatment of basement sump groundwater at Building 4501. Other sources of mercury contamination in soil throughout the site will be addressed in future actions under the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4). Monitoring of mercury in surface water in Fifth Creek and other locations in Bethel Valley will continue.

Building 4501 Mercury Contaminated Sump Discharges

In December 2007, the first RA specified in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) was partially completed by re-routing mercury-contaminated basement sump water at Building 4501 to treatment at the PWTC. Prior to the action, some 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 final treatment and discharge at the PWTC. This system installation includes a pre-filter and ion exchange located in the basement of Building 4501 that serves to pre-treat the sump water which is then routed to the PWTC.

Mercury monitoring is conducted at several surface water sampling locations in Bethel Valley, and two locations are key to measuring the effectiveness of the Building 4501 sump water re-route. These locations include the watershed integration point surface water sampling location at the 7500 Bridge and an in-stream sampling location (WOC-105) that is located approximately 250 ft downstream of the Outfall 211 storm drain (Figure 2.6). Prior to the 2007 RA in the Building 4501 basement, some of the mercury contaminated basement sump discharges were routed to the storm drain that discharges at Outfall 211. Residual mercury contamination, including elemental mercury, remains in sediment accumulations in the upper portion of the storm drain. This residual mercury contamination is the source of ongoing mercury discharges to WOC at Outfall 211.

Figure 2.11 shows the mercury concentration history for the WOC-105 and 7500 Bridge locations. As shown on Figure 2.11, after 4501 basement sump water was routed to the PWTC the frequency of AWQC exceedances for total mercury at 7500 Bridge decreased, with infrequent spikes that exceed the AWQC level. At the WOC-105 location a similar dramatic decrease in mercury concentrations followed the removal of Building 4501 basement sump water discharges from Outfall 211.

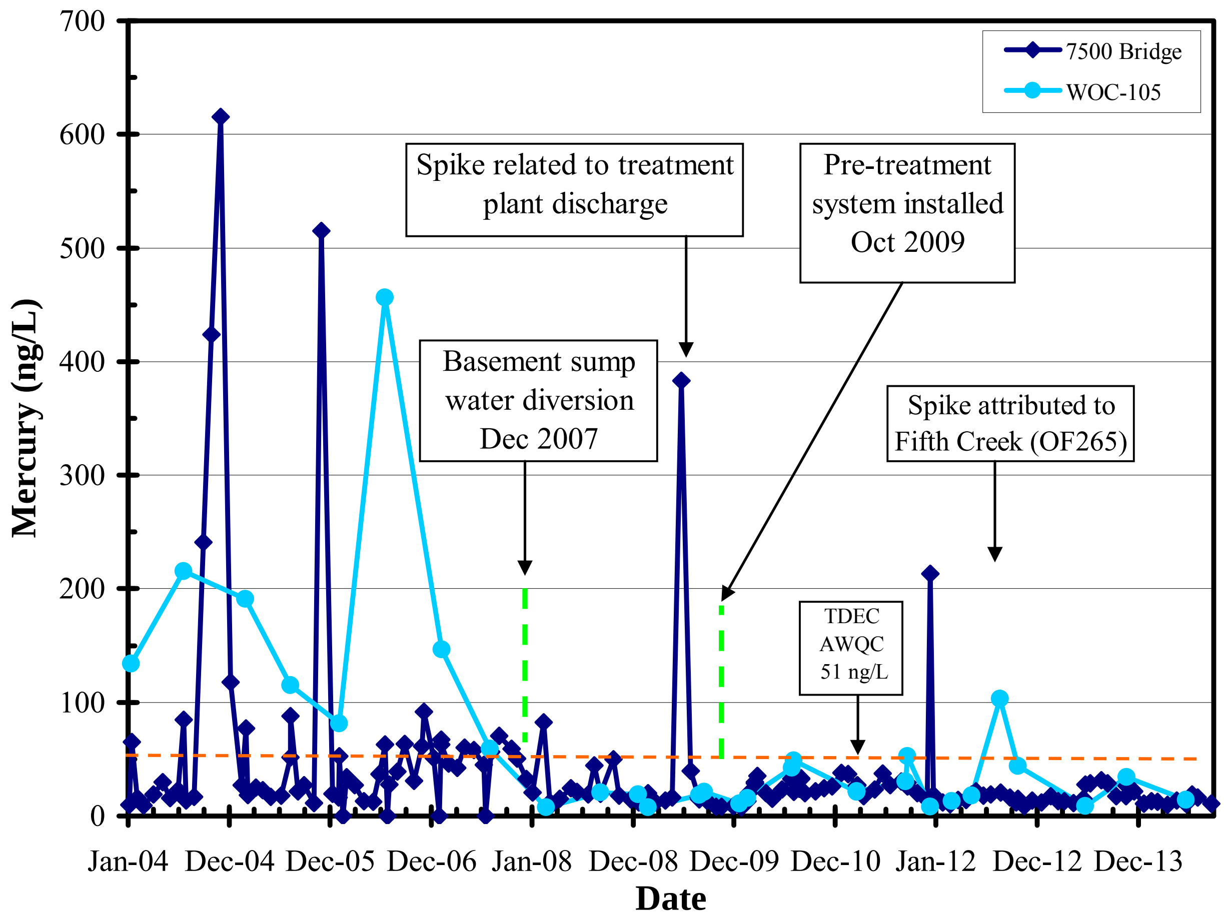


Figure 2.11. Mercury concentration history at 7500 Bridge and WOC-105 monitoring locations.

During FY 2014 mercury concentrations were less than the AWQC limit in both of the semiannual samples. During FY 2014, all of the mercury sample concentrations at 7500 Bridge were below the AWQC value of 51 ng/L.

Corehole 8 Extraction System

In 1991, CERCLA characterization efforts identified a plume of ^{90}Sr contaminated groundwater in the western portion of the ORNL Main Plant Area, referred to as the Corehole 8 plume (Figure 2.12). Note that the Corehole 8 plume source (Tank W-1A) is addressed as a separate action and is included in Section 2.3.1. A removal site evaluation performed in 1994 concluded that contaminated groundwater seeping into the storm drain system was being discharged into First Creek. 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 the ORNL.

Since the time that seepage into First Creek was discovered, the Corehole 8 Plume has been addressed through a series of actions beginning with the initial Corehole 8 (Plume Collection) removal action completed in 1994. Performance monitoring and other LTS requirements for that removal action have been superseded by the *Phased Construction Completion Report for the Bethel Valley (Corehole 8) Extraction System* (DOE/OR/01-2534&D1) approved April 23, 2012. This action was completed under the Bethel Valley ROD.

Figure 2.13 is a simplified 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 in the vicinity of Tank W-1A. Groundwater seepage within the dipping bed carries contamination downward and westward, as shown by the flowlines in Figure 2.13. A portion of 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 full vertical and lateral extent of the Corehole 8 Plume has not been confirmed but will be determined by investigations leading to a final groundwater decision for Bethel Valley.

Evaluation of Plume Collection Performance Monitoring Data

During FY 2014, the Corehole 8 plume interceptor system did achieve the performance goal for reduction of ^{90}Sr discharge to First Creek as discussed below. During FY 2009 – FY 2011 the electrical control systems on the original groundwater collection sumps became increasingly unreliable and numerous operational outages occurred. In 2010 DOE issued 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/OR/01-2469&D2) that included design details for extraction system expansion including the addition of bedrock plume extraction wells, testing and repair of existing delivery piping, and replacement of the existing pumps and the entire system controls. In mid-March of FY 2012 the refurbished collection system was placed in operation. Upon completion of the refurbishment, the *Phased Construction Completion Report for the Bethel Valley Corehole 8 Extraction System at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2534&D1) was approved that documents the work performed and the system configuration upon completion.

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 2.8 includes the FY 2014 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 2014 was approximately 10% of the flux measured during calendar year 1994 prior to startup of the Corehole 8 groundwater collection system. Table 2.9 shows the history of ^{90}Sr fluxes and flux reduction factors in First Creek from calendar year 1993 through FY 2014.

Performance evaluation data summarized in Table 2.9 show that the Corehole 8 plume collection system effectively reduced contaminant discharge to First Creek through FY 2008, but that performance deteriorated in FY 2009 and remained poor through FY 2011. The system performance goal was not met during FY 2009 through FY 2011. Despite the system being out of service for half the FY 2012 due to construction, the remedy goal of ^{90}Sr reduction in First Creek was met during FY 2012. During FY 2014 the Corehole 8 plume collection system experienced some operational problems related to malfunction of an anti-siphon component as well as a failure of the main Lift Station pump. Both of these problems were corrected as part of normal operation and the system was returned to service. Despite operational challenges the ^{90}Sr reduction factor in First Creek was on par with previous years of good performance, probably because of the below-average annual rainfall.

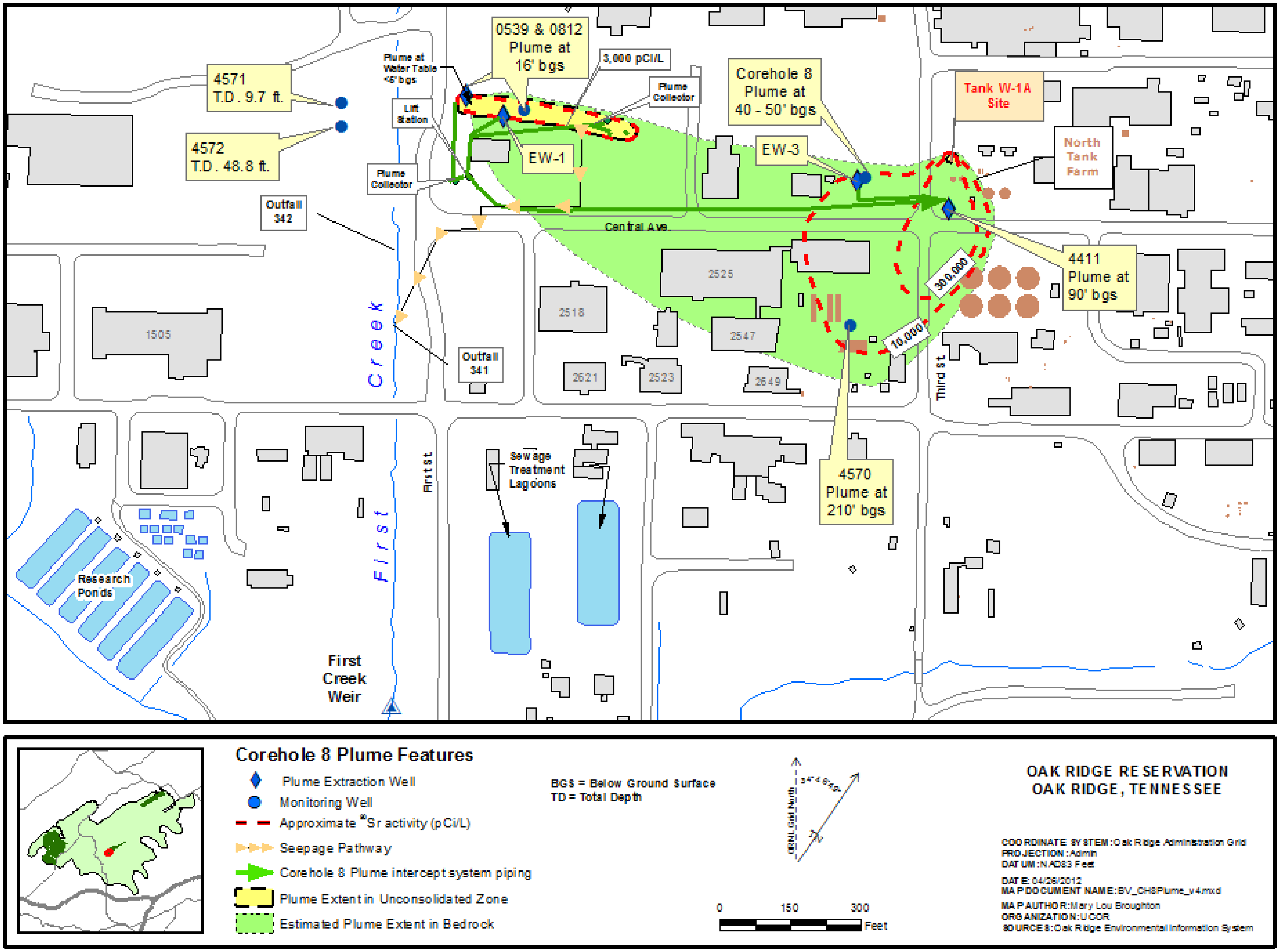


Figure 2.12. Location and features of the Corehole 8 Plume.

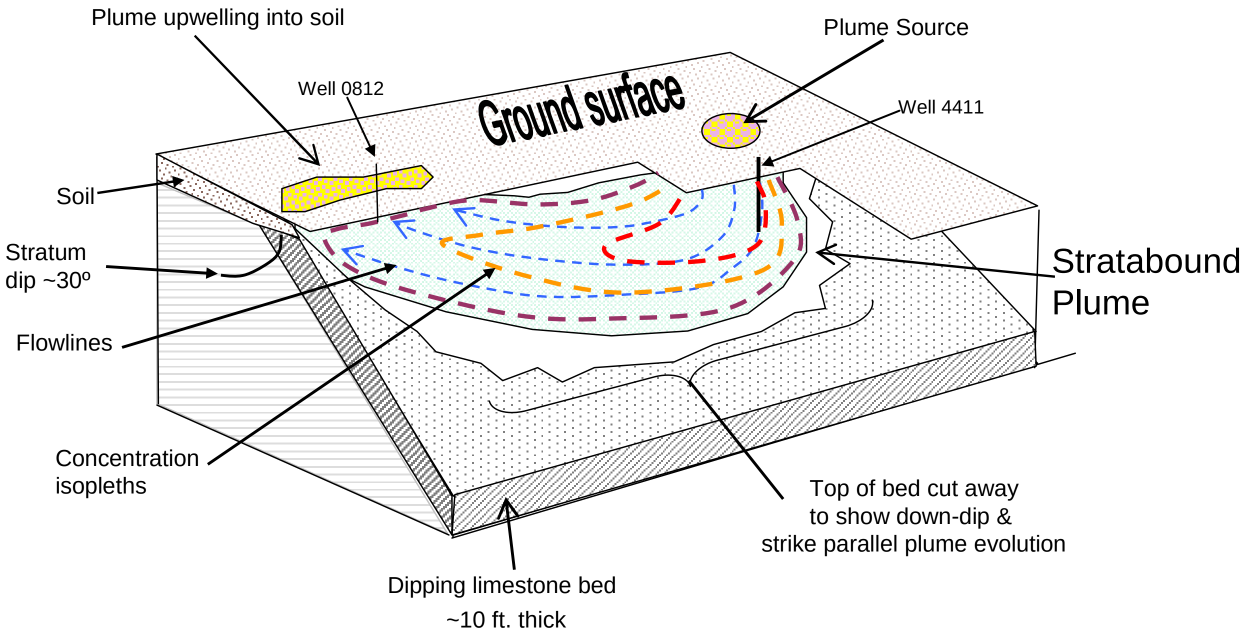


Figure 2.13. Conceptual block diagram of the Corehole 8 Plume.

Table 2.8. First Creek ^{90}Sr fluxes pre-action and in FY 2014

Month	CY 1994 (pre-action)			Month	FY 2014		
	^{90}Sr (pCi/L)	Flow volume (L)	^{90}Sr flux (Ci)		^{90}Sr (pCi/L)	Flow volume (L)	^{90}Sr flux (Ci)
January 1994	124.4	102,893,891	0.0128	October 2013	22.6	22,992,373	0.0005
February 1994	95.6	126,569,038	0.0121	November 2013	26.4	45,914,371	0.0012
March 1994	89.2	228,699,552	0.0204	December 2013	34.8	152,576,309	0.2048
April 1994	105.4	166,982,922	0.0176	January 2014	11.5	122,771,203	0.0014
May 1994	236.5	41,437,632	0.0098	February 2014	8.85	119,520,115	0.0011
June 1994	297.3	32,963,337	0.0098	March 2014	4.32	69,983,899	0.0003
July 1994	324.4	25,585,697	0.0083	April 2014	12.6	101,937,326	0.0013
August 1994	378.4	30,919,662	0.0117	May 2014	4.05	38,117,146	0.0002
September 1994	364.9	26,586,673	0.0097	June 2014	13.1	48,677,486	0.0006
October 1994	133.6	24,700,599	0.0033	July 2014	7.87	33,933,902	0.0003
November 1994	260.9	37,178,996	0.0097	August 2014	8.89	40,478,040	0.0004
December 1994	179.8	66,740,823	0.012	September 2014	3.57	18,035,597	0.0001
	Total	911,258,822	0.137	Total		814,937,768	0.013

CY = calendar year
FY = fiscal year

Table 2.9. ^{90}Sr flux changes at First Creek Weir, 1993 – 2014

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
FY 2011	**0.116**	8.5
FY 2012	0.059	43.1
FY 2013	0.042	69.5
FY 2014	0.013	90.8

[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.

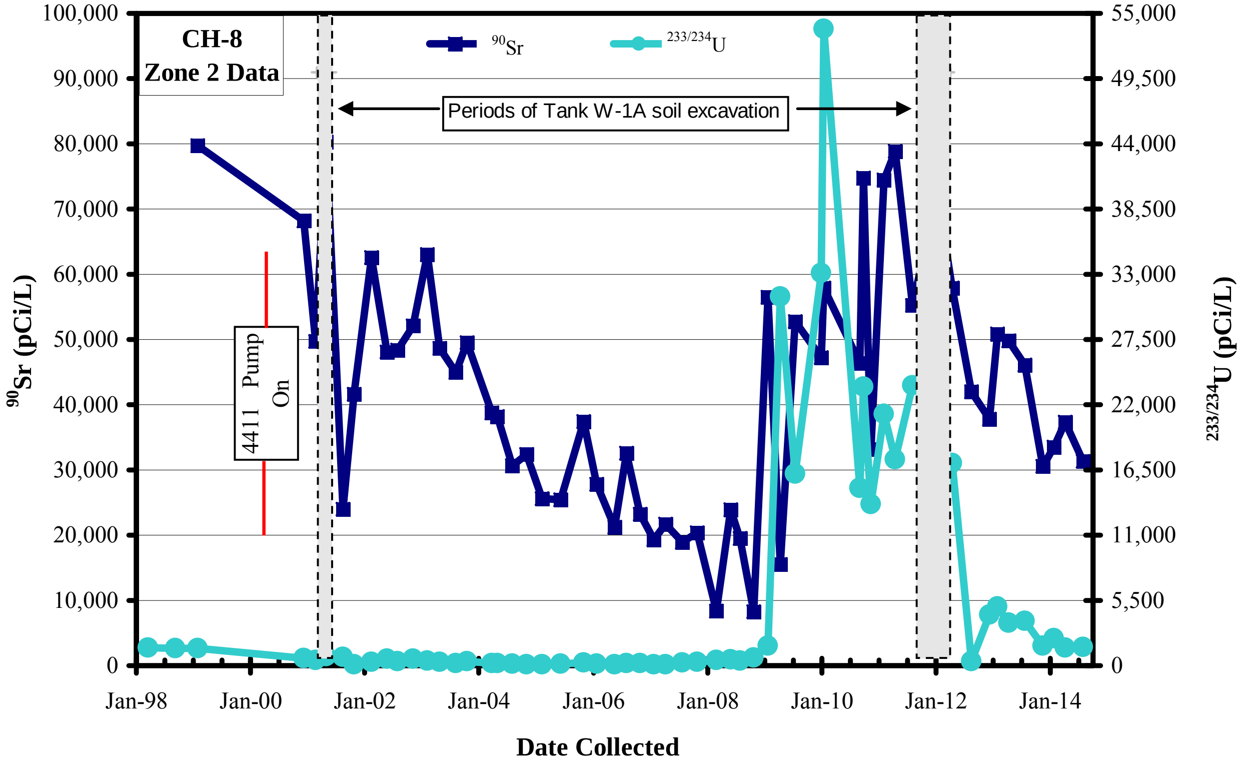
CY = calendar year
FY = fiscal year
NA = not applicable

Figure 2.14 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 below ground surface (bgs) in a location approximately 120 ft south of the former Tank W-1A location, 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 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 2.14 show that during FY 2014 at Corehole 8, ^{90}Sr and $^{233/234}U$ activities decreased from levels measured during the preceding several years perhaps in response to completion of the Tank W-1A removal in 2012. Similar to Corehole 8, ^{90}Sr and $^{233/234}U$ activities in well 4411 continued to gradually decline during FY 2014.

Figure 2.15 shows the Corehole 8 groundwater collection sump ^{90}Sr and alpha activity data from system startup in 1995 through FY 2014. 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 North Tank Farm. 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 2.10 includes Corehole 8 collection system monthly and year-end total flow volumes collected and strontium flux captured and sent to the PWTC for FY 1997 and FY 2014. Figure 2.16 shows the annual flux of ^{90}Sr collected by the Corehole 8 groundwater collection system along with total annual rainfall. The long-term average annual rainfall for Oak Ridge is approximately 54 in./yr. As shown on Figure 2.16, FY 2003 – FY 2005, and FY 2009 – 2013 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.

Figure 2.17 shows ^{90}Sr and $^{233/234}U$ activities measured at well 4570 (Figure 2.12) since its installation as recommended in the *Engineering Study Report for Groundwater Actions in Bethel Valley* (DOE/OR/01-2219&D2). Contaminant activities have declined overall since the beginning of monitoring this well although both contaminants exhibited increasing behavior during FY 2014. The cause of the increase is uncertain, however, reduced rainfall and its associated groundwater recharge may reduce dilution in this groundwater flow system. Wells 4571 and 4572 (Figure 2.12) are monitored semiannually to evaluate the potential extension of the plume west of First Creek. Well 4571 samples groundwater from the top of bedrock at a depth of 9.7 ft, while well 4572 samples shallow bedrock groundwater at a depth of 48.8 ft bgs. Strontium-90 was not detected in either sampling event in these two wells during FY 2014 at minimum detectable activity levels less than 2.08 pCi/L.

Plume Collection Performance Summary. The Corehole 8 plume collection system met its performance goal during FY 2014 based on ^{90}Sr flux reduction in First Creek (Table 2.9) which contributed to the average measured ^{90}Sr activity at 7500 Bridge meeting its ROD goal (Table 2.6). Contaminant activity levels in the plume rose to high levels in the 2009 – 2010 period and have decreased significantly as shown on graphs for well 4411, Corehole 8 Zone 2, and in the collected groundwater in the Corehole 8 collection system. This decrease in plume contaminant levels is an indication that the plume mass is gradually decreasing. The total flux of ^{90}Sr captured during FY 2014 is lower than during previous periods when the collection system was performing optimally, and the decrease in plume contaminant activity is the reason. The total captured plume volume (~ 8.7 million L as shown in Table 2.10) was relatively low and reflects the combined effects of below-average annual rainfall and operational outages.



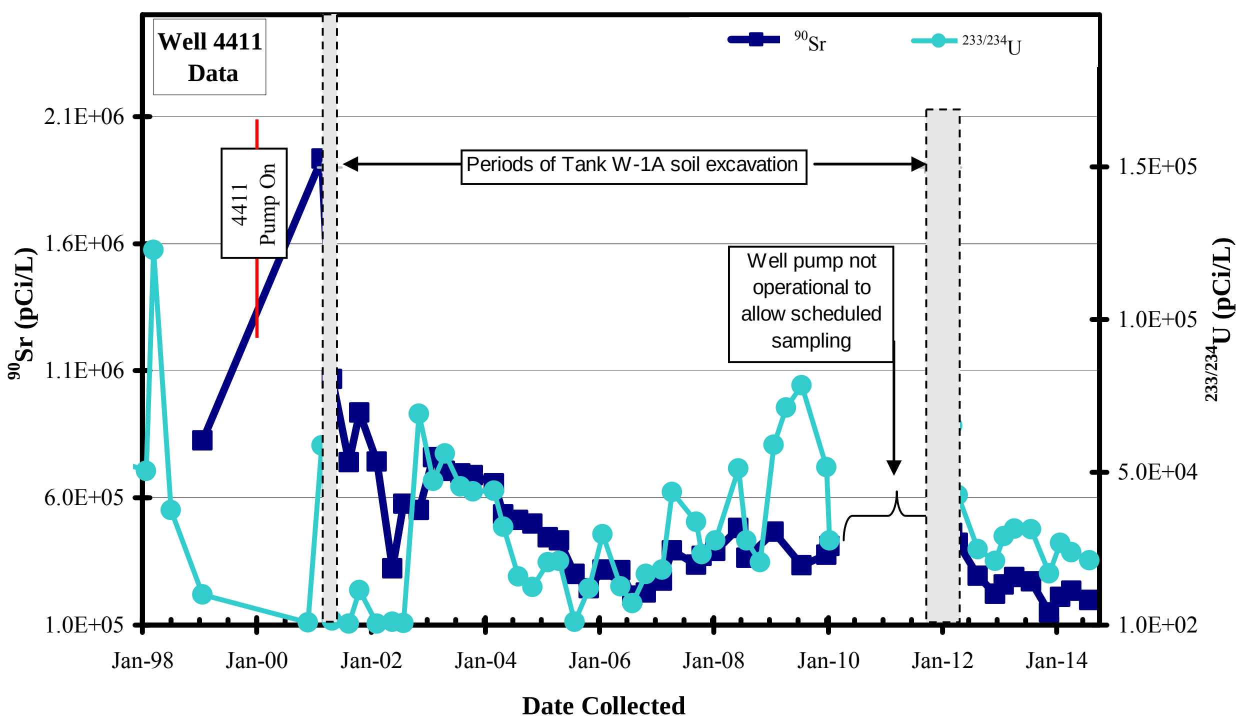


Figure 2.14. Contaminant activities in well 4411 and Corehole 8 Zone 2.

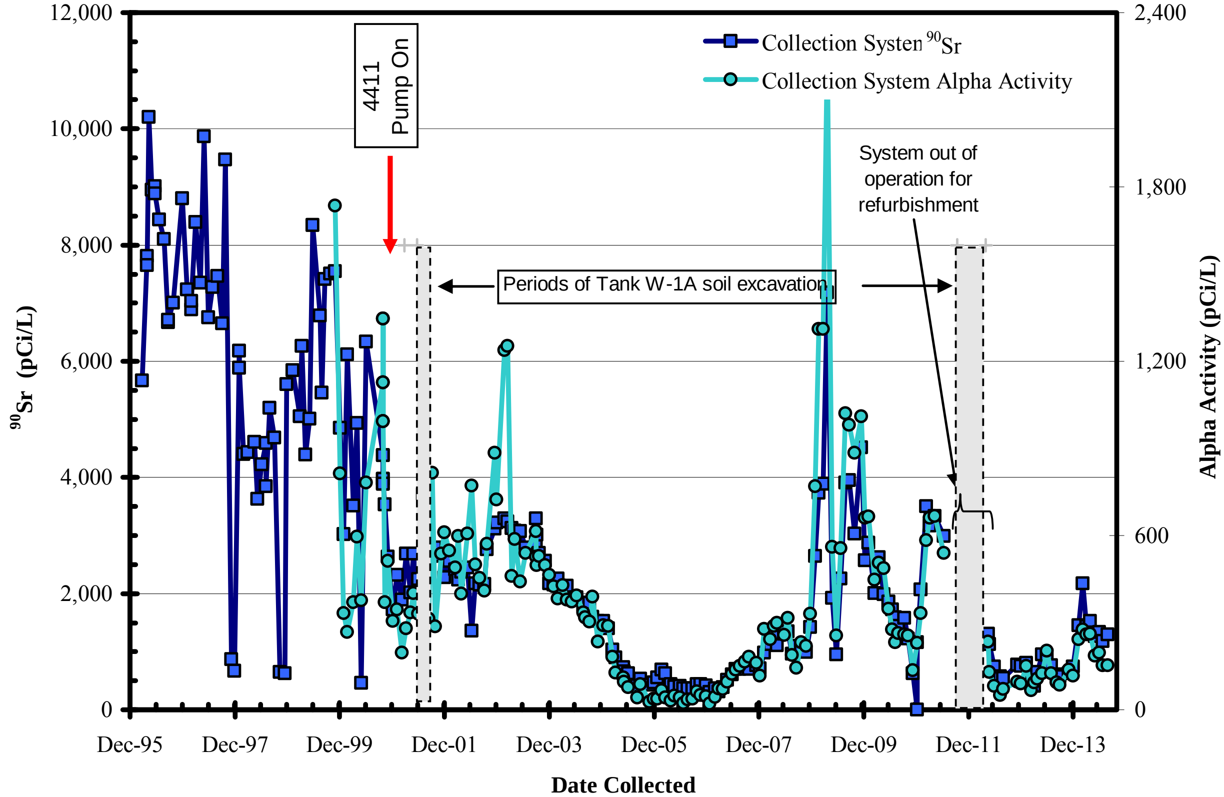


Figure 2.15. ^{90}Sr and alpha activity in collected Corehole 8 Plume groundwater.

Table 2.10. Corehole 8 groundwater collection system ^{90}Sr flux

Month	FY 1997			Month	FY 2014		
	^{90}Sr (pCi/L)	Flow volume (L)	^{90}Sr flux (Ci)		^{90}Sr (pCi/L)	Flow volume (L)	^{90}Sr flux (Ci)
October 1996	8700	933,000	0.0081	October 2013	623	352,041	0.0002
November 1996	8800	1,845,000	0.0162	November 2013	741	309,816	0.0002
December 1996	7230	2,595,000	0.0188	December 2013	1,450	1,129,018	0.0016
January 1997	6890	1,711,000	0.0118	January 2014	3,560	1,506,499	0.0054
February 1997	8390	1,858,000	0.0156	February 2014	1,430	1,200,658	0.0017
March 1997	7350	2,162,000	0.0159	March 2014	1,530	956,635	0.0015
April 1997	9870	1,946,000	0.0192	April 2014	1,260	795,874	0.0010
May 1997	6750	1,697,000	0.0115	May 2014	1,340	830,045	0.0011
June 1997	7280	2,631,000	0.0192	June 2014	1,180	431,078	0.0005
July 1997	7463	1,705,000	0.0127	July 2014	1,300	552,629	0.0007
August 1997	6647	1,131,000	0.0075	August 2014	1,300	428,746	0.0006
September 1997	9465	953,000	0.009	September 2014	1,190	200,909	0.0002
	Total	21,167,000	0.1655		Total	8,693,946	0.015

FY = fiscal year

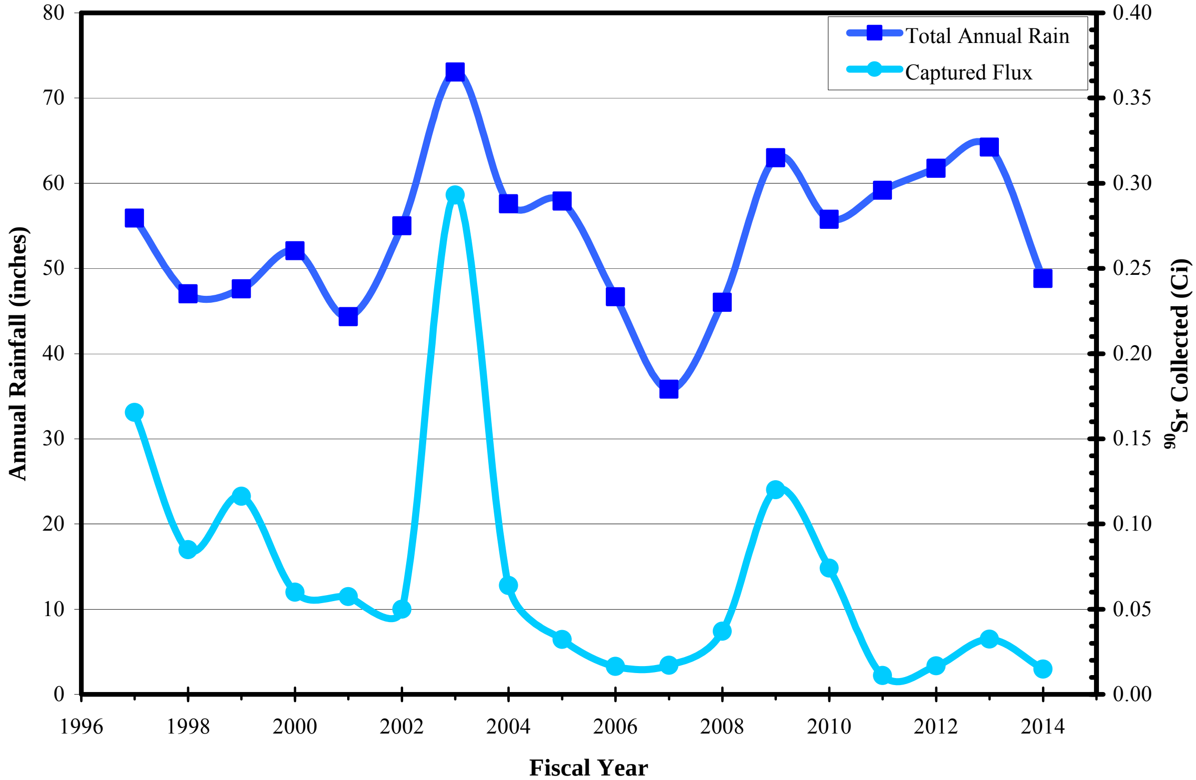


Figure 2.16. Corehole 8 Plume groundwater collector annual intercepted ^{90}Sr flux and rainfall.

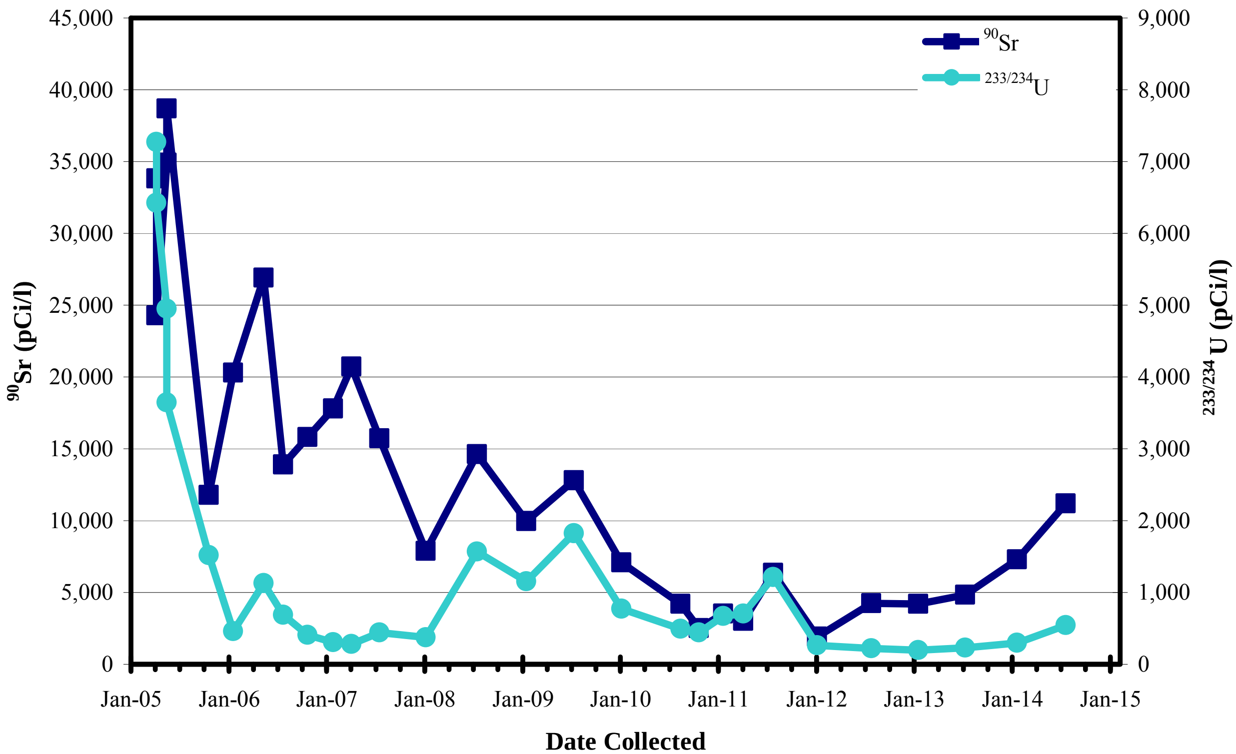


Figure 2.17. ^{90}Sr and $^{233/234}$U activities in well 4570.

2.2.1.2.2 Groundwater

CERCLA groundwater monitoring in Bethel Valley for actions under the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) includes exit pathway well monitoring, ongoing monitoring related to the 7000 Area VOC Plume Treatability Study that was conducted in 2011, and monitoring related to the SWSA 3 RA. Exit pathway wells in the western and eastern ends of the ORNL area in Bethel Valley are monitored to determine if contaminants discharge to Raccoon Creek and Bearden Creek, respectively. Results of surface water monitoring in these two watersheds were discussed in Section 2.2.1.2.1.2. Figure 2.5 shows locations where Bethel Valley exit pathway sampling is conducted. Bearden Creek Exit Pathway groundwater monitoring well results (wells 1198 and 1199) are discussed later in this section. Wells 4579, 4645, 4646, and 4647 in the Raccoon Creek headwaters are discussed along with the SWSA 3 monitoring results.

ORNL 7000 Area VOC Plume Treatability Study

The 7000 area VOC plume is predominantly a trichloroethene (TCE) plume, with several transformation products that are formed by microbial degradation of the TCE. Principal degradation products include cis-1,2-dichloroethene (DCE), 1,1-DCE, and vinyl chloride (VC). The plume occurs essentially totally in fractured, karst bedrock of the Ordovician age Witten formation. The Witten formation is comprised of interbedded argillaceous limestone (containing a high clay/silt fraction) and relatively pure limestone beds. In the 7000 area the lower half of the Witten formation contains two relatively distinct pure limestone members locally referred to as the "Little Lime" and the "Big Lime" (which is not correlative with the Mississipian age Big Lime that is a prominent petroleum producing formation beneath the Cumberland Plateau and Mountains). The core portion of the plume occurs in the "Little Lime" which is also suspected to be a key groundwater contaminant pathway for radionuclides at SWSA 3. The source of the TCE is suspected to have been releases from a small parts cleaning facility that was dismantled prior to CERCLA site investigations. The principal known discharge location for groundwater affected by the plume is at a small spring that forms the head water of a small tributary of WOC.

The report for the *Treatability Study for the Bethel Valley 7000 Area Groundwater Plume, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2566&D1) was issued in May 2012. The report presented the results of field and laboratory tests that were used to design a field scale biostimulation pilot test. The report also summarized monitoring results for a one year period following the injection of materials that allowed native dehalogenating microbes and other native microbes to increase their population numbers with resulting degradation of TCE and its transformation products.

Sampling and analysis is ongoing at seven monitoring wells (752, 1201, 4576, 4577, 4581, 4582, and 4583) and one spring (SP-200) in the study area to document the sustainability of the treatment and measure ongoing trends in VOC concentrations and microbial populations. In addition, sampling is periodically conducted for VOCs at additional wells in the vicinity of the study area. These include three zones in the multi-port well 4575 and at well 754.

Table 2.11 summarizes the observed biostimulation response of the treated portion of the aquifer, as represented by trends of field parameters indicative of suitable conditions for biodegradation, VOC concentrations, and microbial indicators for all post-biostimulation monitoring results at eight selected wells. Time history graphs of VOC concentrations and several microbial indicators of response to the biostimulation test are included in Appendix B.2. The data presented in the time history graphs span the period from December 2010, just prior to the injection, to July 2014, more than 42 months post-injection. The results over this time period indicate significant contaminant degradation has occurred, with pre-injection concentrations of TCE that were on the order of 1,000 to 10,000 µg/L having fallen now to the range of 10 to 100 µg/L or lower. The TCE half-life values ranged from 50 to 140 days for the first two years after amendment injection for six of the seven wells in and downgradient of the treated area (Table 2.12), whereas after this time period, half-life values became two or more times longer than this, presumably as the electron donor amendment was exhausted. There have also been increases and then similar declines in the daughter products cis-1,2-DCE and VC, as expected for the sequential degradation nature of the reductive dechlorination of TCE. Positive contaminant degradation effects from the amendment injection were observed in monitoring wells approximately 120 and 320 ft (wells 4581 and 4576, respectively) downgradient of the injection wells. Most of the wells (0752, 1201, 4576, 4581, and 4582) also indicate a rebound or increase in contaminant levels at the same points in time (April to July 2013; July 2014), and these increases appear to correlate with periods of heavy precipitation in the local area (Appendix B.2). Contaminant increases associated with precipitation fluctuations suggest that packets of contamination are periodically released from the vadose zone into the aquifer at times of higher infiltration.

In the case of most wells, the carbon source data depict concentrations (measured as total organic carbon [TOC]) that have fallen, although the TOC is still present at levels from 100 to 1,000 mg/L at the injection wells. These carbon levels typically are high enough to maintain the anaerobic conditions necessary for contaminant reductive dechlorination. However, recent field parameter data indicate the groundwater at the shallower or more upgradient wells (0752, 1201, 4581) is reverting back toward aerobic conditions. Since the plume occurs in a karst limestone unit, there is potential for rapid recharge of groundwater through the upgradient and shallower portions of the plume during and after rainfall events. These rapid influxes of fresh, oxygenated groundwater appear to be cutting short the lifespan of the injected biostimulation amendments. The post-injection data indicate the longevity of the carbon amendment appears to be 12 to 18 mo. for shallow or upgradient wells, and at least 30 mo. for deeper and downgradient wells. The change from anaerobic to aerobic conditions in groundwater also resulted in a decrease in the dechlorinating bacteria (*Dehalococcoides* sp. [DHC]), which is not surprising given that these bacteria are strict anaerobes.

In summary, the monitoring data collected to date indicate significant TCE degradation has occurred at six of the seven wells as a result of the in situ treatment pilot study, and daughter product appearance and degradation has also occurred at the same six wells. Additionally, the molar sum of chlorinated ethenes indicates a strong decline at three of the seven wells, and a minimal to moderate decline at the four remaining wells. A molar sum analysis is helpful in assessing overall contaminant destruction for a contaminant that is degraded through sequential daughter products. Finally, the low detected concentrations of TCE and cis-1,2-DCE at the SP-200 spring (located approximately 1200 ft downgradient of the injection wells) do not appear to have been affected whatsoever by the pilot study amendment injections.

Figure 2.18 provides the plume map, projected to the surface, prior to injection of the biostimulant materials, and includes a cross-section showing the TCE plume (with VC concentrations also indicated on the cross-section) based on the December 2010 groundwater data. Figure 2.19 represents the plume, in both plan view and cross-sections, as depicted based on the July 2014 groundwater data.

General conclusions can be made from the ongoing monitoring results:

- After 3.5 years of TCE biodegradation from the single biostimulant injection, VOC concentrations within and downgradient of the treatment zone remain significantly lower than pre-injection concentrations.

- Positive contaminant degradation effects from the amendment injection were observed in monitoring wells approximately 120 and 350 ft downgradient of the injection wells.

- Increases in contaminant levels at the same points in time appear to correlate with periods of heavy precipitation suggesting that a slug of contaminants is periodically pulsed through the aquifer at times of higher infiltration.

- Rapid influxes of fresh, oxygenated groundwater appeared to reduce the lifespan of the injected carbon amendment and decrease the anaerobic dechlorinating bacteria (DHC) population.

- The post-injection data suggest that carbon donor material has persisted in the injection wells for up to 3.5 years; however, anaerobic conditions abated at three of the four injection wells at roughly 18 mo. after the amendment injection.

The post-injection monitoring results of the field-scale amendment injections in the 7000 Area of ORNL have indicated that anaerobic reductive dechlorination can be successfully implemented at full scale for treating TCE in groundwater in the 7000 Area.

The *Treatability Study Work Plan for 7000 Area in Bethel Valley, Oak Ridge, Tennessee* (DOE/OR/01-2475&D2) stipulated monitoring of VOCs, field parameters, biodegradation parameters, and genetic indicators for one year post-injection of the biostimulants. Thus, the treatability study ended in January of 2012 which was one full year post-injection. The report (*Treatability Study for the Bethel Valley 7000 Area Groundwater Plume Oak Ridge National Laboratory Oak Ridge, Tennessee* [DOE/OR/01-2566&D1]) issued in 2012 recommended continued monitoring without stipulating a duration. DOE continued that full scale monitoring through FY 2014 to obtain a more robust dataset to document the microbial processes. In FY 2015 DOE discontinued analysis of phospholipid fatty acids (PLFA) and hydrogen gas because those analyses are rather expensive and numbers of DHC had shown significant declines. DOE continues to monitor field parameters, VOCs (including ethane, ethylene, and methane), total and ferrous iron, anions (including alkalinity, chloride, fluoride, sulfate, nitrate-nitrite, and sulfide), total organic carbon, and abundance of DHC which is the functional microbial genera responsible for degradation of TCE and its transformation compounds. Starting in FY 2016 DOE will analyze groundwater at the ORNL 7000 Area for VOCs including chlorinated organics and their transformation products as well as methane/ethylene/ethane to track ongoing degradation and rebound in the plume. Additional remedial actions on the ORNL 7000 TCE plume will be conducted as a matter of prioritization in the ORR Groundwater Program and in accordance with the agreed FFA schedule.

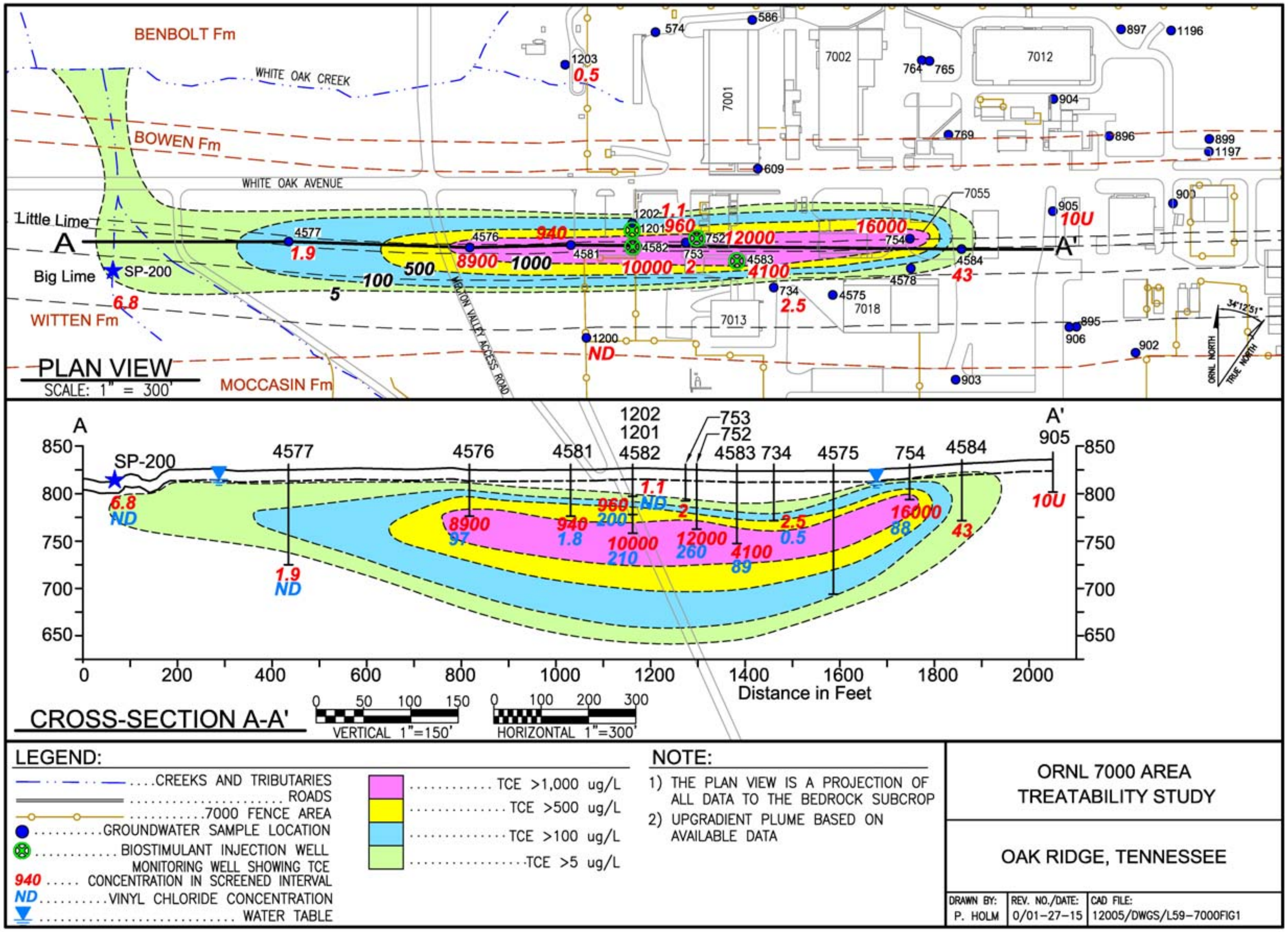


Figure 2.18. ORNL 7000 Area pre-treatability study VOC plume plan and section views.

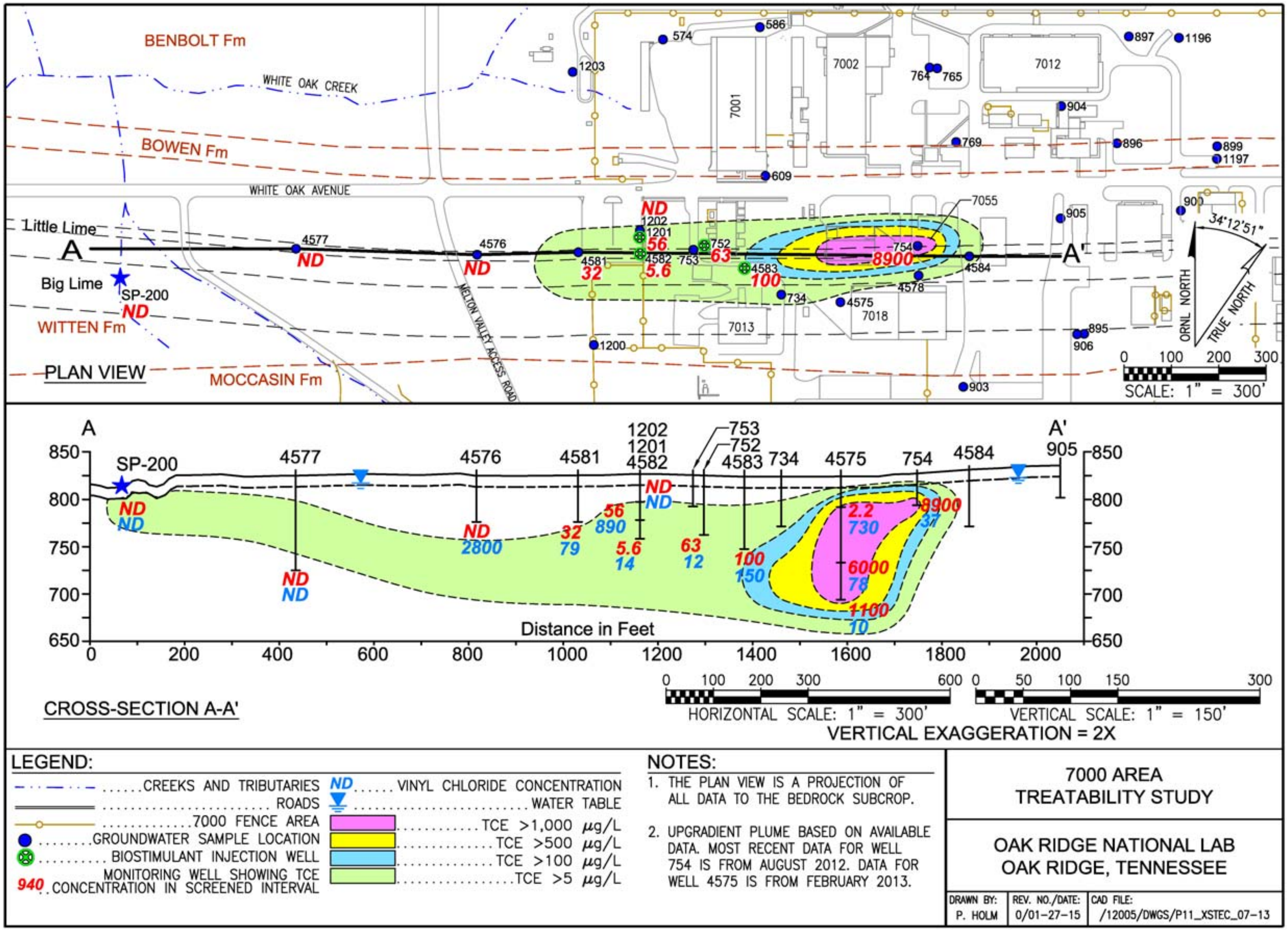


Figure 2.19. ORNL 7000 Area treatability test VOC plume plan and section views 3.5 years after biostimulation in July 2014.

Table 2.11. Summary of qualitative observations from pilot study post-injection monitoring, January 2011 – October 2014

Relative well location	Well ID	Contaminant trends	TOC and VFAs	DHC and gene copies	Field parameters	MEE and H_2 gasses	Overall conclusion
Not Injected	1202	Mostly non-detect VOC	TOC at background levels	Very low DHC	Aerobic, ORP pos	Very low levels	Low VOCs, no discernible ARD activity
Injection Wells	1201	TCE ↓ 1 OM; DCE ↓ 1 OM; VC ↑ > 1 OM	1000 mg/L	Strong DHC ↑, genes follow DHC	Anaerobic DO; ORP initially neg ↑ above 0, slight pH ↓	Strong methane; H2↑and then ↓; ethene ↑	Moderate ARD activity, CAH rebound 1 OM mid-2013 and mid-2014; GW conditions abating but TOC still high
	4582	TCE ↓ 3 OM; DCE ↓ 2 OM; VC↑,↓ 1 OM	100s mg/L	DHC fluctuating at moderate levels; genes follow DHC	Anaerobic DO; ORP moderately neg; pH ↑	H2 ↑ and ↓; Strong methane ↑; ethene ↑ and fluctuates	Strong ARD activity: GW conditions abating but TOC present at moderate levels
	0752	TCE ↓ 2 OM; DCE ↓ 1 OM; VC ↓ 2 OM	1000 mg/L	moderate DHC, declining to < 10 cells/mL	Aerobic DO; ORP ↑ to > 0 mV; Strong pH ↓	Low methane, slow ↑	Moderate ARD activity, CAH rebound 1 OM mid-2013; GW conditions returned to aerobic but TOC still high; possible up gradient O_2 influence
	4583	TCE ↓ 1½ OM; DCE ↓ ½ OM; VC steady	~ 10,000 mg/L	Low DHC	Anaerobic DO; ORP neg but ↑ to 0; steady pH	Moderate methane ↑; low ethene	Low-level ARD activity; GW conditions abating but TOC still high
Downgradient Wells	4581	TCE ↓ 1½ OM; DCE fluctuates; VC ↑ 2 OM	1 – 10 mg/L initially and ↓ to 1 mg/L (background)	Strong DHC and gene ↑	Anaerobic; ORP fluctuates mostly below 0; pH fluctuates	Strong methane and ethene ↑	Moderate ARD at location downgradient of injection; connection with upgradient injection source may be restricted, based on TOC levels, CAH rebound mid-2013
	4576	TCE ↓ 4 OM: DCE ↓ ½ OM; VC ↑,↓ 1 OM	100 mg/L and ↓ to 1 mg/L	Strong DHC and gene ↑; SRBs ↑	Anaerobic; ORP neg with slow ↑; steady pH	Strong methane and ethene ↑; minor H2 ↑	Very strong evidence of ARD activity, some CAH rebound mid-2013
	4577	Low VOC near non-detect, minor TCE and DCE ↓	TOC at background levels; spike in organic acids 3rd quarter 2011	Very low DHC, slight ↑ and ↓	Aerobic, ORP pos	Generally low levels, spike of H2, methane and ethene at 3rd qtr 2011	Low VOCs, very minor ARD activity, distance from injection location is likely reason for lack of ARD

ARD = anaerobic reductive dechlorination
CAH = chlorinated aliphatic hydrocarbon
DCE = dichloroethene
DHC = *Dehalococcoides*
DO = dissolved oxygen
GW = groundwater
ID = identification
MEE = methane, ethane, and ethene
OM = order of magnitude
ORP = oxidation-reduction potential
SRB = sulfate reducing bacteria
TCE = trichloroethene
TOC = total organic carbon
VC = vinyl chloride
VFA = volatile fatty acid
VOC = volatile organic compound

Table 2.12. Summary of qualitative observations from pilot study

Well ID	First 2 years Data after Injection		All data after injection	
	Half-life (day)	Attenuation rate (day^{-1})	Half-life (day)	Attenuation rate (day^{-1})
Injection Wells				
752	70.4	0.0098	197.5	0.0035
1201	140.9	0.0049	235	0.0029
4582	69.3	0.0100	121.4	0.0057
4583	100.5	0.0069	1490.6	0.0005
Average	**95.3**	**0.0073**	**511.1**	**0.0014**
Downgradient Wells				
4581	55	0.0126	829.1	0.0008
4576	47.2	0.0147	217.3	0.0032
4577	686.3	0.0010	1694.7	0.0004
Average	**121.2**	**0.0057**	**673.4**	**0.00103**

ID = identification

SWSA 3 and Raccoon Creek Exit Pathway

SWSA 3 was the third area used for mixed radioactive and hazardous waste disposal at ORNL. The site also received waste materials from Y-12, ETTP (the former K-25 Gaseous Diffusion Plant), and off-site sources since it was designated as a regional disposal site for radioactive waste by the Atomic Energy Commission. The 6.1 acre mixed waste disposal area received wastes for below-grade disposal between 1946 and 1951; however, the area was used as an above ground contaminated equipment storage area until 1979. Other waste management units in the vicinity of SWSA 3 included a 4 acre scrap metal disposal area and a 7 acre Contractor's Landfill. The BVBGs RA conducted between 2010 and 2012 constructed upgradient shallow groundwater/stormflow diversion trenches along the upslope (southern) edge of the scrap metal storage area and SWSA 3 with a multi-layer hydrologic isolation cap over both units. A soil cover was constructed over the Contractor's Landfill. The SWSA 3 and scrap metal area cap and the Contractor's Landfill soil cover are contiguous features and the two areas are demarcated by a narrow gravel roadway corridor.

The three disposal units were constructed in clay-rich residual soils derived from weathering of the underlying Witten formation argillaceous (containing significant amount of clay and silt) limestone. Waste disposal trenches in SWSA 3 were excavated into the clay-rich soil and it is not known how much soil buffer was left between the base of disposed waste and the top of the limestone bedrock. Emplacement of contaminated waste on a fractured or karst bedrock surface creates an immediate pathway for contamination to enter the groundwater. Local areas consist of colluvial soils derived from residuum of the Rome and Moccassin formations that underlie the northern slope of Haw Ridge to the south of the disposal units. Bedrock to the north of the disposal units is the Bowen formation—a thin (~ 30 ft thick) siliceous shale with a thin limestone zone in its mid-section and the Benbolt formation which is another mixed argillaceous and pure limestone formation. Because of its siliceous nature, the Bowen formation is somewhat less susceptible to chemical weathering and thus may act as an aquitard between the overlying and underlying limestone-rich bedrock formations. The bedrock beneath the disposal areas is the Witten formation which contains interbeds of argillaceous limestone and relatively pure limestone. Site investigations at SWSA 3 conducted in the late 1970s and early 1980s documented the existence of karst conditions at SWSA 3 as evidenced by cavities encountered in bedrock boreholes and rapid movement of groundwater. Three groundwater tracing activities were conducted at SWSA 3 and groundwater seepage velocities in karst pathways were documented to range from about 120 ft/d to over 43,000 ft/d. The tracer tests documented shallow groundwater movement at rapid velocities emerging at springs and seeps in the headwaters of both the Northwest Tributary to the east and Raccoon Creek to the west. A tracer injected in well 0493 in the western portion of SWSA 3 was observed in both streams with a migration velocity of about 240 ft/d to the east into the Northwest Tributary and a velocity of about 120 ft/d to the west into the Raccoon Creek headwater. Tracer migration both east and west from the injection point suggests the existence of the groundwater divide for shallow groundwater in the vicinity of the injection point location. The strength of the shallow groundwater divide at greater depths beneath the SWSA 3 area has not been verified.

The *Phased Construction Completion Report for the Bethel Valley Burial Grounds at the Oak Ridge National Laboratory, Oak Ridge Tennessee* (DOE/OR/01-2533&D2) specifies groundwater level measurement locations and frequencies as well as sampling locations for analysis of site related contaminants. Figure 2.20 shows the monitoring locations and indicates the types and frequencies of monitoring required. The synoptic groundwater level measurements are useful to prepare piezometric surface maps and to evaluate local vertical head gradients between shallow wells constructed in the soil or near top of bedrock zone compared to deeper wells constructed in bedrock. Groundwater elevations measured in the synoptic surveys are tabulated in Table 2.13. Figure 2.21 shows a piezometric surface map drawn based on average 2014 groundwater elevation data from water table wells. The map shows the major groundwater elevation contours as well as locations where groundwater tracing studies were conducted in the early 1980s. The inferred tracer trajectories (Figure 2.21) for the tracer injected at well 0493 to the points of emergence in the adjacent stream heads suggests that the "Little Lime" member of the Witten Formation may be a conductive pathway for both the tracer and the co-located ^{90}Sr discharges. There is an apparent area of low groundwater level beneath the northeastern portion of the SWSA 3 cap. This area appears to be co-located with the inferred subcrop of the "Little Lime" member of the Witten formation. Groundwater elevations in the wells within the closed 810 ft piezometric contour are the lowest in the area but are slightly higher than the elevation in Northwest Tributary where the ^{90}Sr and tracer entered the stream. The piezometric contours show gradients from both the north side (Bowen/Benbolt formations) and south (upper Witten and Moccasin formations) toward a low water level trend in the lowermost Witten formation. This is a result of the karst drainage network in that area. A groundwater divide having an elevation between 810 and 820 ft above Mean Sea Level (aMSL) is shown on Figure 2.21 beneath the western end of the SWSA 3 cap based on the combination of groundwater elevation data obtained during 2014 and the historic tracer behavior.

The *Phased Construction Completion Report for the Bethel Valley Burial Grounds at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2533&D2) states *"…the goal for SWSA 3 is a declining trend in the average water elevations to approximately the elevation of bedrock…"* Table 7-2 (of the PCCR) specified average groundwater elevation goals for nine wells at SWSA 3. The long term water table elevation goals and progress toward their attainment are included in Table 2.13. Since installation of the cap and upgradient stormflow diversion trench in 2011, three of the nine wells assigned target groundwater elevations have not attained the elevation goal to date. The three wells are located in the eastern portion of SWSA 3. Hydrographs for the wells with continuous groundwater level monitoring are included in Appendix B.1. The hydrographs show that there are gradual groundwater elevation declines in progress in the three wells that have not yet met the PCCR goals.

Table 2.13. SWSA 3 groundwater target elevation attainment summary

Well	Elevation Goal (ft aMSL)	FY 2014 Average Groundwater Elevation (ft aMSL)
0482	823	**826.97**
0483	835	827.68
0484	824	816.29
0491	816	**824.94**
0492	818.5	**824.70**
0493	829	820.98
0694	838.33	831.81
0996	814.31	807.98
0997	818.64	811.85

Bold table entries indicate wells that have not attained their groundwater elevation goal.

aMSL = above mean sea level
FY = fiscal year
SWSA = Solid Waste Storage Area

As indicated in Figure 2.20 sampling and analysis for contaminants of interest is required for groundwater wells and surface water at the SWSA 3 sediment basin. The sediment basin surface water is sampled because discharges from the upgradient shallow groundwater/stormflow diversion trench drain into the basin. Contaminants specified for analysis in the *Phased Construction Completion Report for the Bethel Valley Burial Grounds* (DOE/OR/01-2533&D2) include ^{90}Sr and tritium, VOCs, and metals.

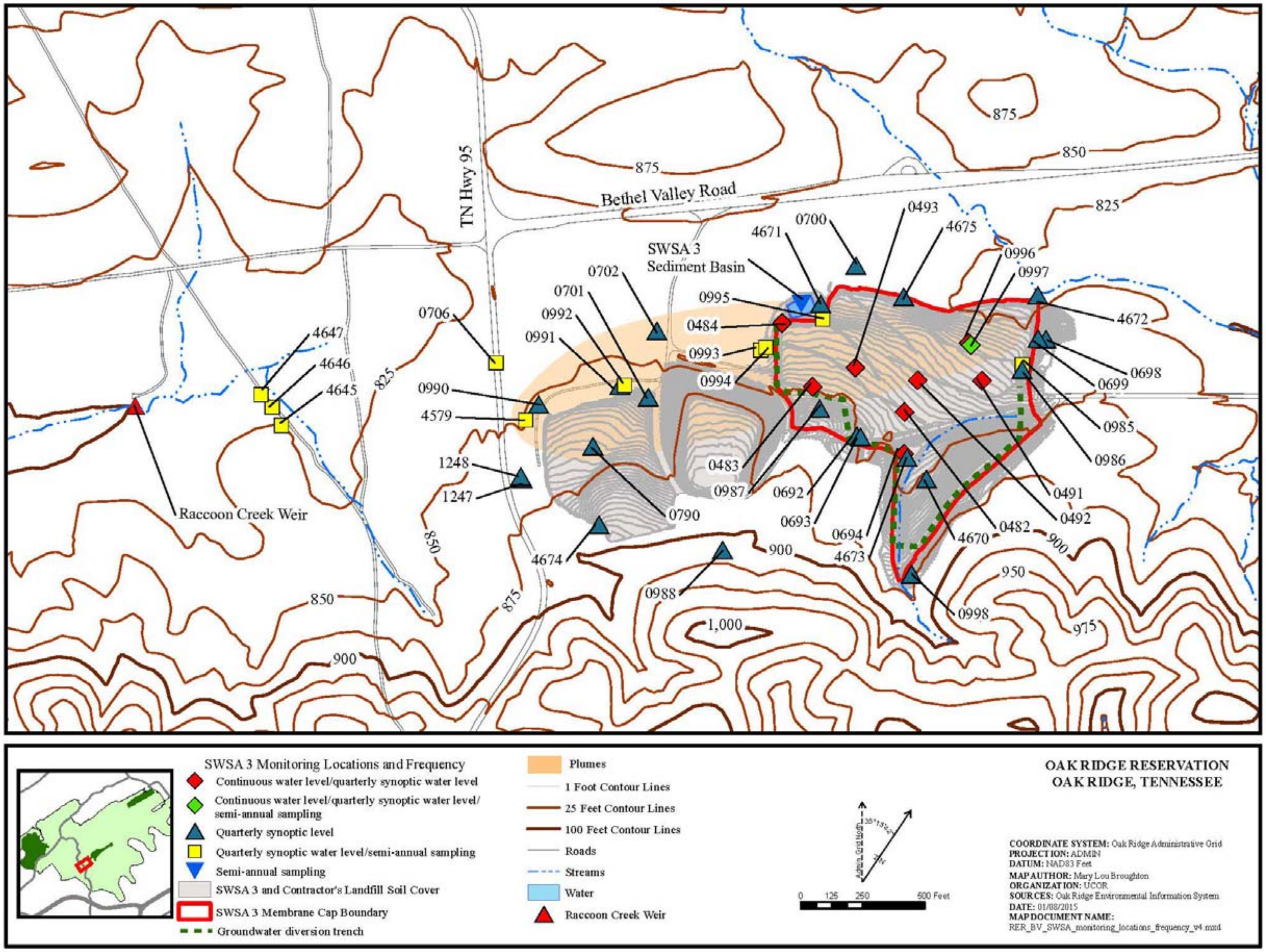


Figure 2.20. SWSA 3 monitoring locations.

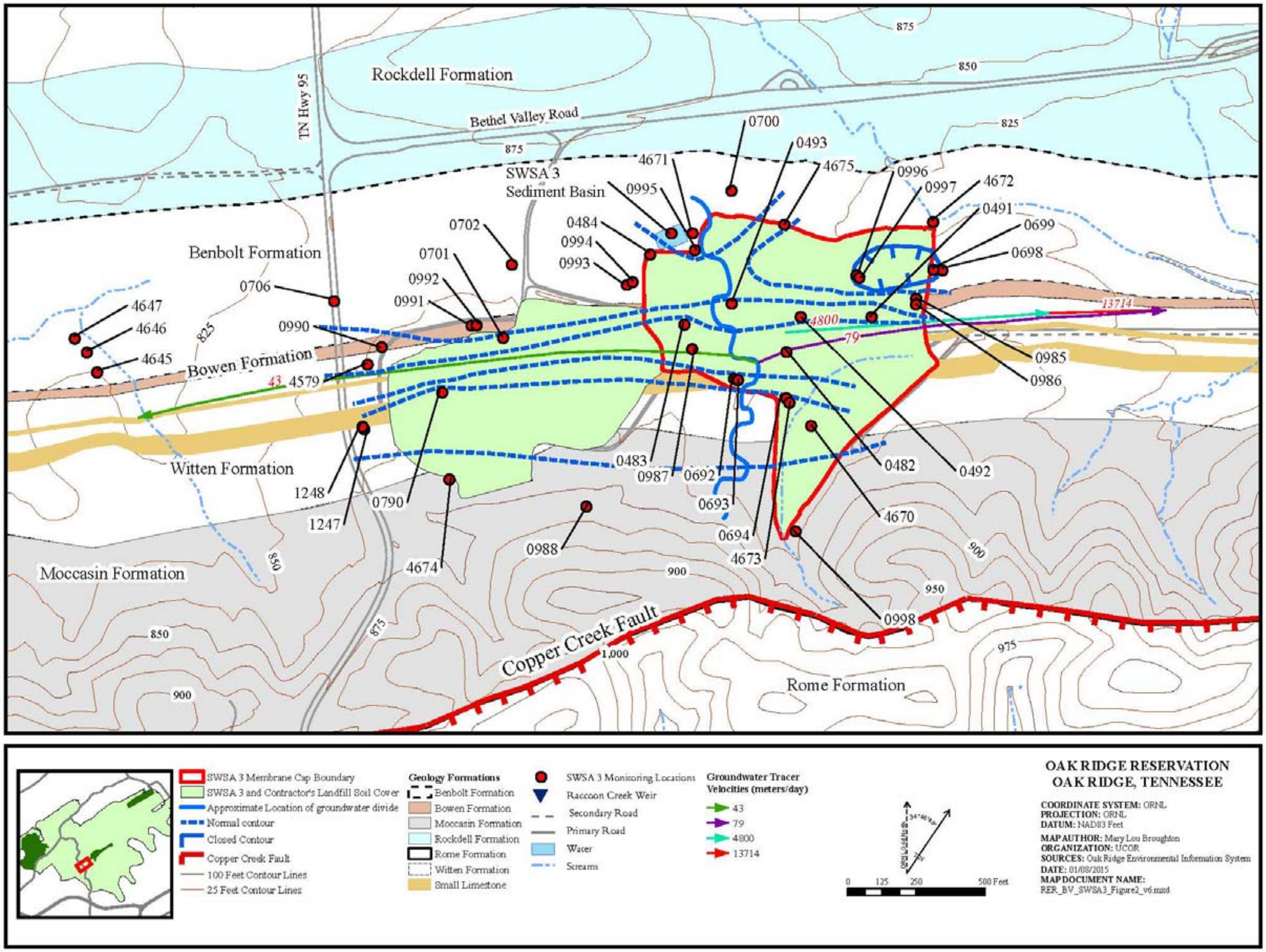


Figure 2.21. SWSA 3 area geology and piezometric surface map.

Groundwater analytical results from sampling rounds conducted during FY 2014 were screened against Primary Drinking Water Standards to determine locations where the criteria are exceeded. Figure 2.20 shows the approximate extent of groundwater contamination above MCLs in the vicinity of SWSA 3 and the Contractors Landfill based on FY 2014 groundwater sampling and analysis. Table 2.14 lists contaminants detected in groundwater during FY 2014 at levels greater than drinking water standards. The table also includes trend evaluations for the contaminants based on the Mann-Kendall trend evaluation method. Based on the available data ^{90}Sr, which is the principal groundwater contaminant at SWSA 3, shows decreasing to stable or no trend activity behavior where it is detected at levels greater than the MCL-DC. The data show that an area of groundwater contaminated with ^{90}Sr occurs near the western edge of the SWSA 3 cap at well 0994. During FY 2014 the ^{90}Sr activity in well 0994 was about 150 – 160 pCi/L which is about 100 pCi/L lower than FY 2013 levels. Well 0994 is an 80.5 ft deep bedrock well with open-hole construction in the 59.1 – 80.5 ft interval below original ground surface. The open hole portion of this well intersects the lowermost Witten formation and the upper half of the Bowen Formation. This interval was found to be prone to conduit formation along the bedding contacts between the contrasting limestone and siliceous siltstones during investigations conducted in the 1980's (Steuber, et. al. 1981). These conduits provide preferential groundwater flow pathways predominantly along geologic strike. Well 0993 which is a shallower (45 ft deep) well adjacent to well 0994 had ^{90}Sr activities of about 14 and 21 pCi/L in samples collected in November 2013 and May 2014, respectively which shows a slight increase compared to FY 2013 although the overall trend in this well remains decreasing.

Wells 4645, 4646, and 4647 that were installed in 2010 to monitor groundwater in the Raccoon Creek headwater did not contain contaminants above drinking water criteria in 2014. In past years ^{90}Sr has been consistently detected in well 4647, the shallowest of those wells, at levels less than the 8 pCi/L drinking water MCL-DC. That well samples groundwater water near the known contaminated seep that discharges into Raccoon Creek. During FY 2014 ^{90}Sr was not detected in either sample collected in November 2014 or June 2014. During June FY 2014 ^{90}Sr was detected in wells 4645 and 4646 at 2.15 and 2.84 pCi/L, respectively. These are the first detections of ^{90}Sr in these two wells.

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 2.5). Both wells monitor groundwater in bedrock, with well 1198 being a shallower well, screened from about 28 – 43 ft bgs, and well 1199 being 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 2014, tritium was not detected in well 1198 in samples collected in January and September. In well 1199, tritium activity was measured at 1,080 pCi/L in January and 872 pCi/L in September. Both of these detected tritium results are lower than the respective seasonal samples collected during FY 2013. Analyses for VOCs have been conducted throughout the monitoring history at both wells. VOCs have occasionally been detected in well 1199. No VOC compounds were detected in either well in the two FY 2014 sampling events.

Table 2.14. Summary of FY 2014 SWSA 3 groundwater MCL exceedances and related contaminant trends

Well	Anal. Type	Analyte	All Data			MCL	Units	Pre-Remediation FY 09 – 11		Post-remediation FY 12 – 14		M-K Trend Analysis	Notes
			No. of analyses	No. of detects	Results >MCL			No. of detects	Average	No. of detects	Average		
0992	RAD	Beta Activity[a]	15	15	11	50	pCi/L	10	142	5	59.9	Stable	Decreasing FY12
0992	RAD	^{90}Sr[b]	15	15	15	8	pCi/L	10	66.9	5	29.2	Stable	Decreasing FY12
0993	RAD	^{90}Sr	15	15	15	8	pCi/L	10	167	5	18.8	Decreasing	
0994	RAD	Beta Activity	20	20	19	50	pCi/L	15	1,330	5	428	Stable	
0994	RAD	^{90}Sr	18	18	18	8	pCi/L	13	655	5	205	Decreasing	
0997	RAD	^{90}Sr	16	16	13	8	pCi/L	11	40.1	5	8.2	Decreasing	
4579-01	VOA	Benzene	14	14	14	5	µg/L	7	9.49	7	8.1	Decreasing	
4579-01	RAD	Beta Activity	23	10	3	50	pCi/L	9	60.7	1	58.7	Stable	Sus. Outlier FY12
4579-01	RAD	^{90}Sr	24	8	3	8	pCi/L	6	34.3	2	12.7	Stable	Sus. Outlier FY12
4579-02	VOA	Benzene	14	13	8	5	µg/L	6	5.5	7	5.9	Stable	
4579-02	RAD	^{90}Sr	24	8	2	8	pCi/L	6	14.7	2	16.5	No Trend	Sus. Outlier FY12
4579-03	RAD	^{90}Sr	24	23	9	8	pCi/L	16	8.7	7	8.5	Stable	

[a] 50 pCi/L is the value used to trigger analyses to determine beta emitting radionuclides present in public water supplies (65 FR 76708 – 76753).

[b] 8 pCi/L is the MCL-DC listed in 40 CFR 141.66(d)(2), Table A, as the "Average Annual Concentration Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr," which is the MCL for beta particle and photon radioactivity.

Notes: Average concentration calculated using only detected results.

Quantitative trend analysis based on M-K Test of time-series sampling/analysis results for a maximum of ten sampling events (counting backward from the most recent sampling date). Based on the methodology described in Gilbert (1987) and Wiedemeier et al. (1999), non-detect analytical results, which were reported for wells 4579-01 (beta and ^{90}Sr) and 4579-02 (benzene and ^{90}Sr), were replaced with the appropriate detection limit or MDA as surrogate values for M-K Test purposes. The M-K Test statistic (S) for each time series trend is calculated and plotted on a 90% confidence level chart. When the calculated S statistic (positive or negative) plots above the equivalent 90% confidence interval for the applicable number of sampling events, the time-series data define an *Increasing* trend if S > 0, or a *Decreasing* trend if S < 0. The time series data define a *Stable* trend if the S statistic plots below the equivalent 90% confidence interval and the associated CV is < 1, whereas *No Trend* is evident if the CV is > 1.

CFR = *Code of Federal Regulations*
CV = coefficient of variation
FR = Federal Register
FY = fiscal year
MCL = maximum contaminant level
MCL-DC = maximum contaminant level derived concentration
MDA = minimum detectable activity
M-K = Mann-Kendall
RAD = radionuclide
SWSA = Solid Waste Storage Area
VOA = volatile organic analyses

2.2.1.2.3 Aquatic Biological Monitoring in WOC

Biological monitoring data are available for several locations in Bethel Valley, including a location in WOC near the watershed's exit point (Figure 2.22). This information is useful in evaluating watershed trends and the effectiveness of watershed-scale decisions defined in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4). Biological monitoring data for the WOC watershed includes contaminant accumulation in fish, fish community surveys, and benthic macroinvertebrate surveys.

Mercury concentrations in fish collected from the stream sections of WOC decreased from 2008 – 2012, falling below the EPA recommended fish-based mercury AWQC of 0.3 µg/g (Figure 2.23), likely due to the decreases in aqueous mercury concentrations seen as a result of the *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion at the Oak Ridge National Laboratory* in 2008 (DOE/OR/01-2472&D1). Since 2012, however, concentrations in fish from the stream sections of WOC have been increasing slightly, averaging 0.24 µg/g at White Oak Creek kilometer (WCK) 3.9 and 0.28 µg/g at WCK 2.9 in 2014. While these concentrations are slightly higher than those seen in 2013, they are not significantly so, and remain below the AWQC.

During the same time period, mercury concentrations in fish collected from White Oak Lake (WOL) appear to be following opposite trends. From 2008 – 2012, average concentrations in both bluegill and largemouth bass increased, reaching their highest mean concentrations on record in 2012. Since 2012, however, while concentrations in fish in the stream sections of WOC increased slightly, concentrations in bass and bluegill collected in WOL have been decreasing, averaging 0.42 µg/g and 0.07 µg/g, respectively, in 2014 (Figure 2.23).

The ORNL's Water Quality Protection Program continues to investigate the sources of polychlorinated biphenyls (PCBs) to WOC. Studies conducted in 2009 – 2010 identified First Creek as a major source of PCBs to WOC, and follow up work from 2011 – 2014 has pinpointed specific pipes and outfalls leading to First Creek (e.g., Outfall 341, Outfall 250) as significant contributors of PCBs to the WOC watershed. Mean total PCB concentrations (defined as the sum of Aroclors 1248, 1254, and 1260) in redbreast sunfish from the WOC watershed remained within historical ranges (Figure 2.24). PCB concentrations in redbreast collected in WOC in 2014 were comparable to those seen in recent years, with mean concentrations of 0.34 $\pm$ 0.01 µg/g at WCK 3.9, and 0.57 $\pm$ 0.01 µg/g at WCK 2.9 (compared to 0.46 µg/g at WCK 3.9 and 0.19 µg/g at WCK 2.9 in 2013). Mean PCB concentrations in largemouth bass collected from WCK 1.5 in 2014 (1.13 µg/g) were comparable to those seen in 2013 (1.18 µg/g; Figure 2.24), and mean concentrations in bluegill remained comparable to those seen in previous years (0.64 µg/g; Figure 2.24).

How do the current PCB results in fish compare to the latest fish consumption guidelines? Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criterion for total PCBs is 0.00064 µg/L under the recreation designated use classification and is the target for PCB-focused Total Maximum Daily Loads (TMDLs), including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon; TDEC 2010a,b,c). In the state of Tennessee, assessments of impairment for water body segments as well as public fishing advisories are based on fish tissue concentrations. Historically, the Food and Drug Administration (FDA) threshold limit of 2 µg/g in fish fillet was used for advisories, and then for many years an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. Most recently, the water quality criterion (0.00064 µg/L for total PCBs) has been used by TDEC to calculate the fish tissue concentration triggering impairment and a TMDL (TDEC 2007) under its TMDL Program, and this concentration is 0.02 mg/kg in fish fillet (TDEC 2010a,b,c). TMDLs are used to develop controls for reducing pollution from both point and non-point sources in order to restore or maintain the quality of a water body and ensure it meets the applicable water quality standards. The fish PCB concentrations in the WOC watershed are still well above the calculated TMDL concentration.

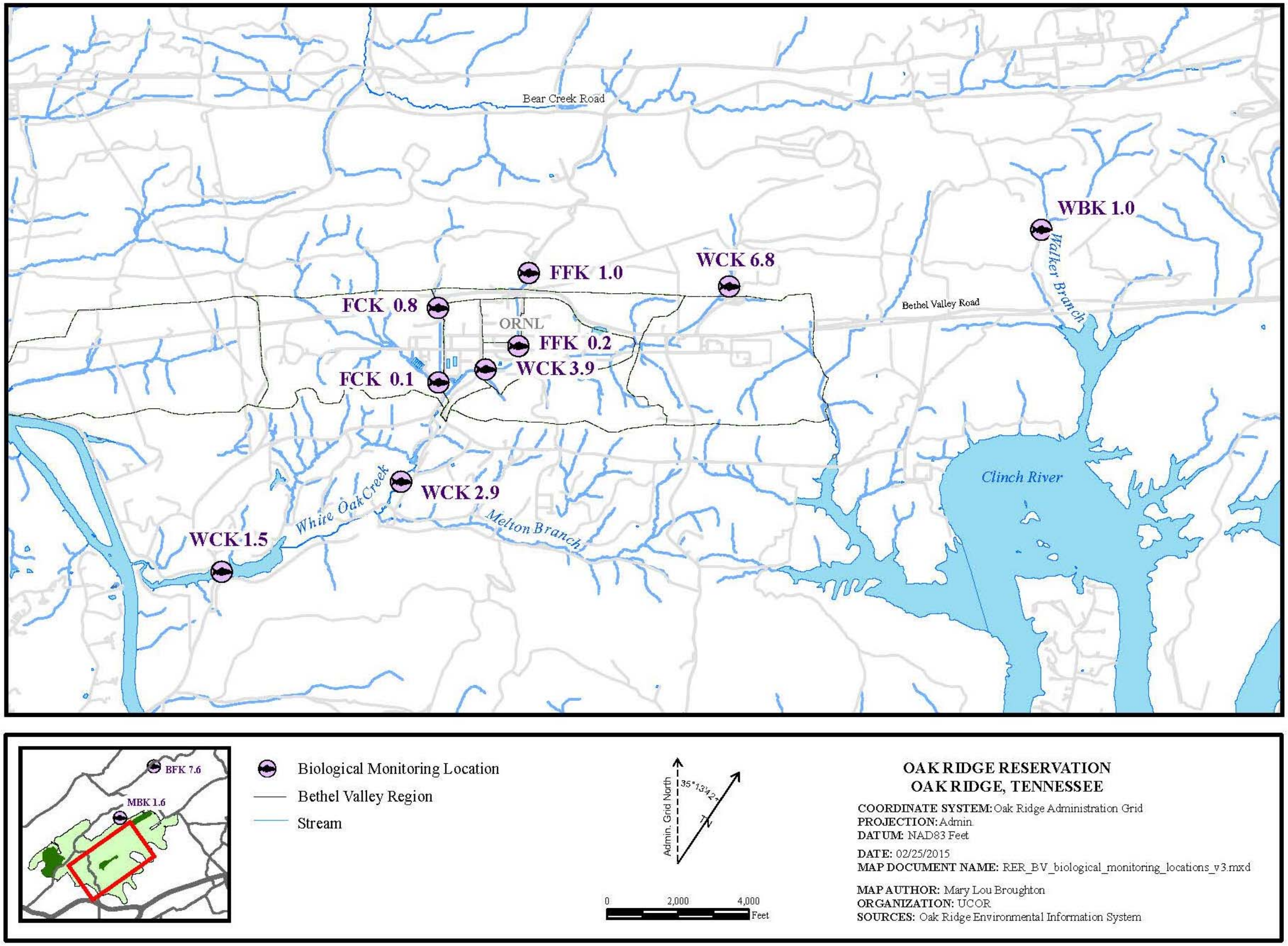


Figure 2.22. Biological monitoring locations at the ORNL.

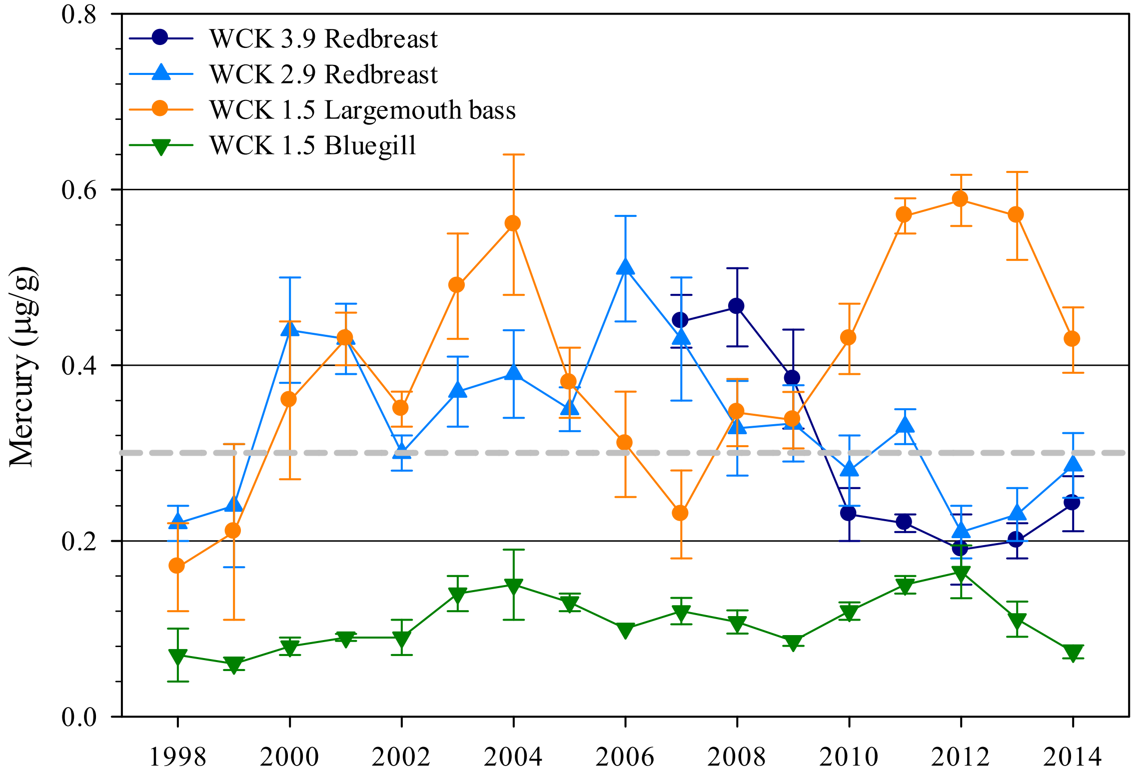


Figure 2.23. Mean concentrations of mercury (µg/g, ± SE, N = 6) in muscle tissue of sunfish and bass from WOC (WCK 2.9 and WCK 3.9) and WOL (WCK 1.5), 1998 – 2014.

Dashed gray line indicates EPA's recommended AWQC (0.3 µg/g mercury in fish fillet).

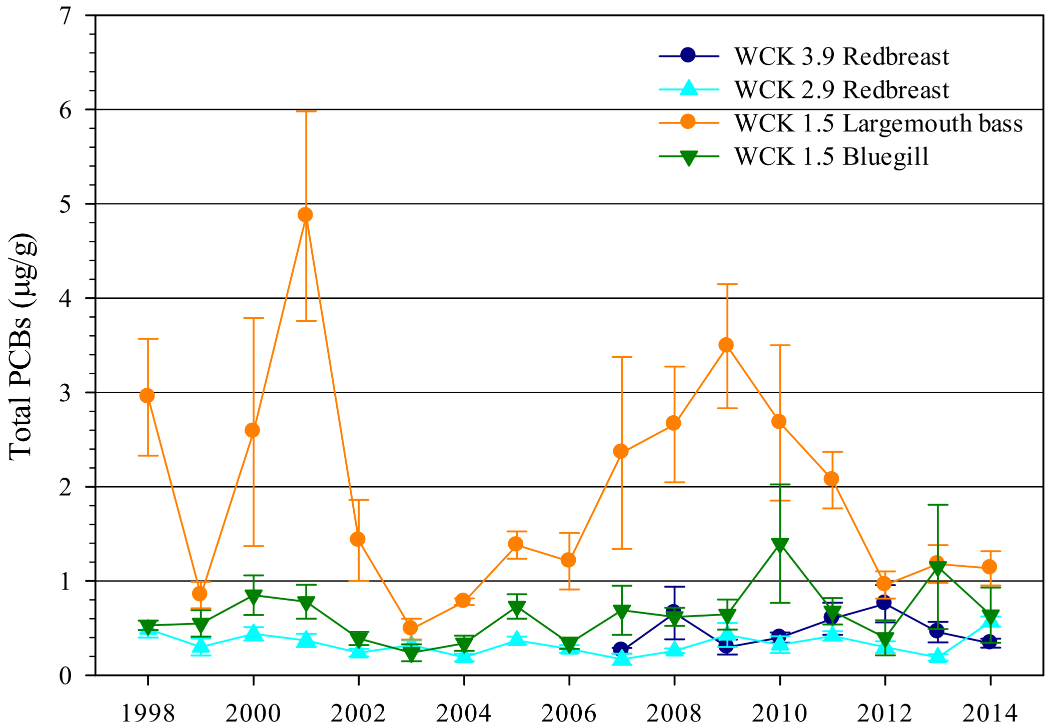


Figure 2.24. PCB concentrations (µg/g, ± SE, N = 6) in fish fillet collected from the WOC watershed, 1998 – 2014.

Fish and benthic communities in WOC are negatively impacted relative to local reference sites, although improvements have occurred since the mid-1980s. The fish communities in WOC have been fairly stable in terms of overall numbers of species in recent samples, with numbers of fish species being well below the larger Brushy Fork reference site (Brushy Fork kilometer [BFK] 7.6). The number of species at WCK 3.9 tends to be similar to or greater than the number of fish species found at the smaller Mill Branch reference site (Mill Branch kilometer [MBK] 1.6), while species numbers at the most upstream WOC site (WCK 6.8) remain fairly low (Figure 2.25). Nutrient availability in smaller headwater systems can be a limiting factor for both species richness and even density. Additionally, these sites have had developmental and industrial impacts which are likely causes contributing to low diversity. Recent introductions of native fish species into WOC watershed have been successful with continuing reproduction observed in five of the six introduced species and expanded distributions for three species, even into lower tributaries sites such as First Creek. The introduced species fill in missing groups of fish, including sensitive species such as darters and suckers, and are helping the overall richness of the fish fauna in WOC become more comparable with area reference streams. Samples collected in 2014 at WCK 3.9 included two darter species and high densities of striped shiners, all introduced species. 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, with fish being placed in the WOC watershed beginning in 2008 – 2012, and 2014.

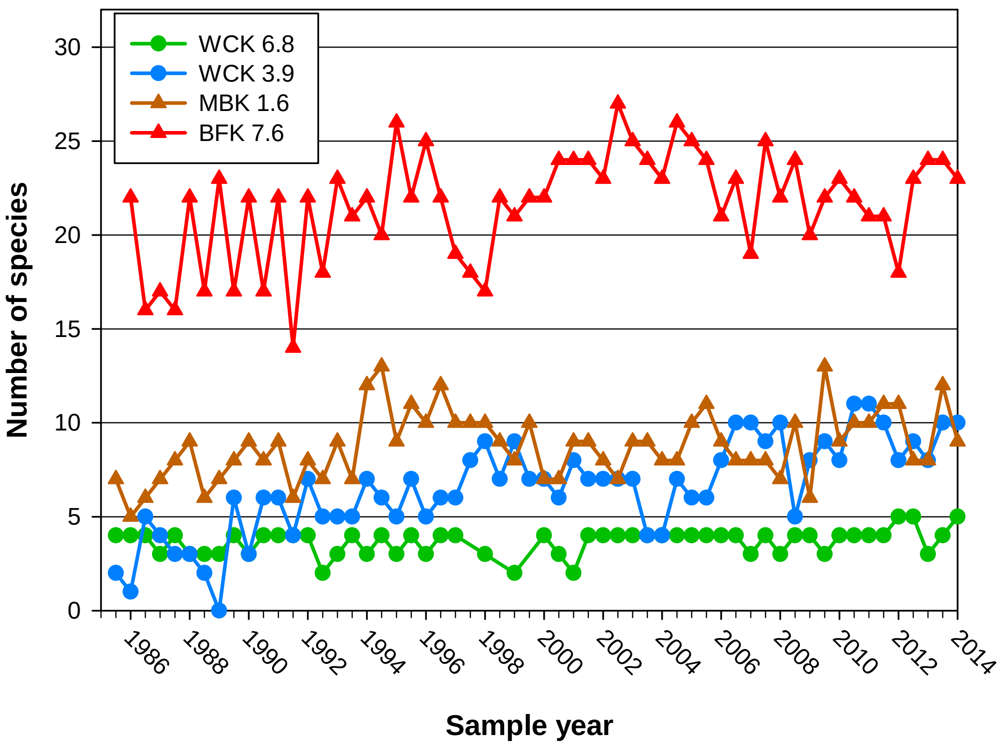


Figure 2.25. Species richness (number of species) in samples of the fish community in upper WOC and reference streams, BFK and MBK, 1985 – 2014.

Fish density is often a better indicator of stream impacts in small tributaries which generally lack species diversity. The two small second order tributaries that flow through the main ORNL facility into WOC (First Creek and Fifth Creek) have improved since 1985. First Creek has had historical impacts associated with development activities but has stabilized in recent years (Figure 2.26). Moderate increases in density at the lower site since 2011 are correlated with increased diversity associated with fish introduction efforts mentioned above. Fish densities in Fifth Creek are much more variable and reflect a stream that is likely stressed by chronic chlorine inputs which exacerbate seasonal impacts such as drought or flooding (Figure 2.27).

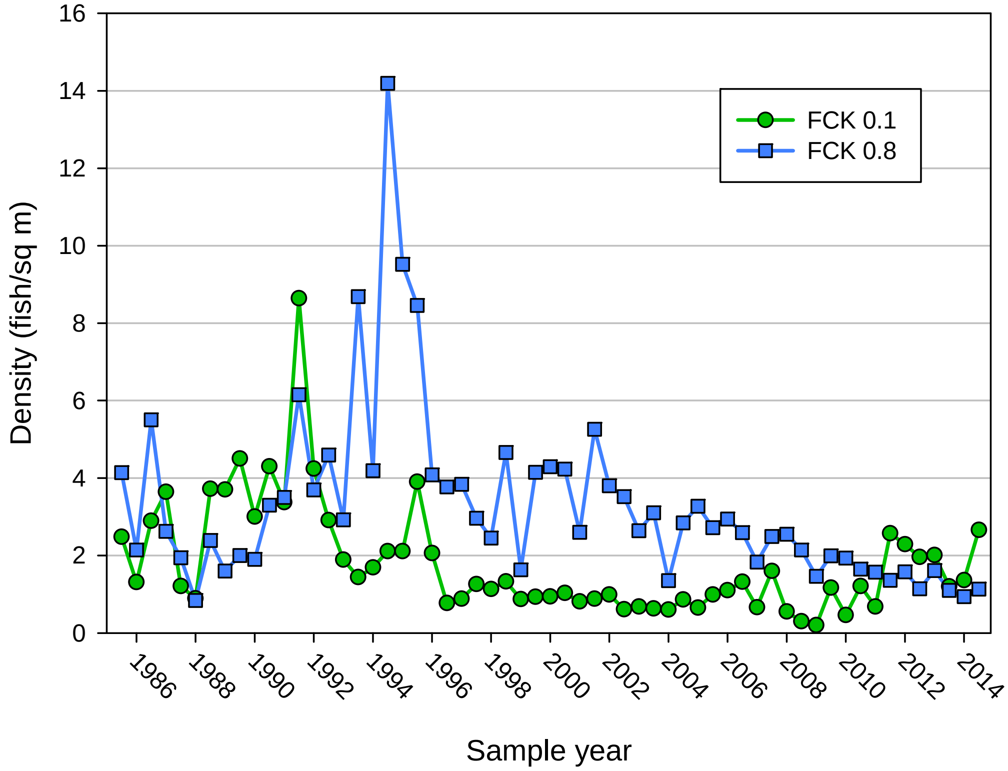


Figure 2.26. Fish density (fish/m^2) in samples of the fish community in First Creek, 1985 – 2014.

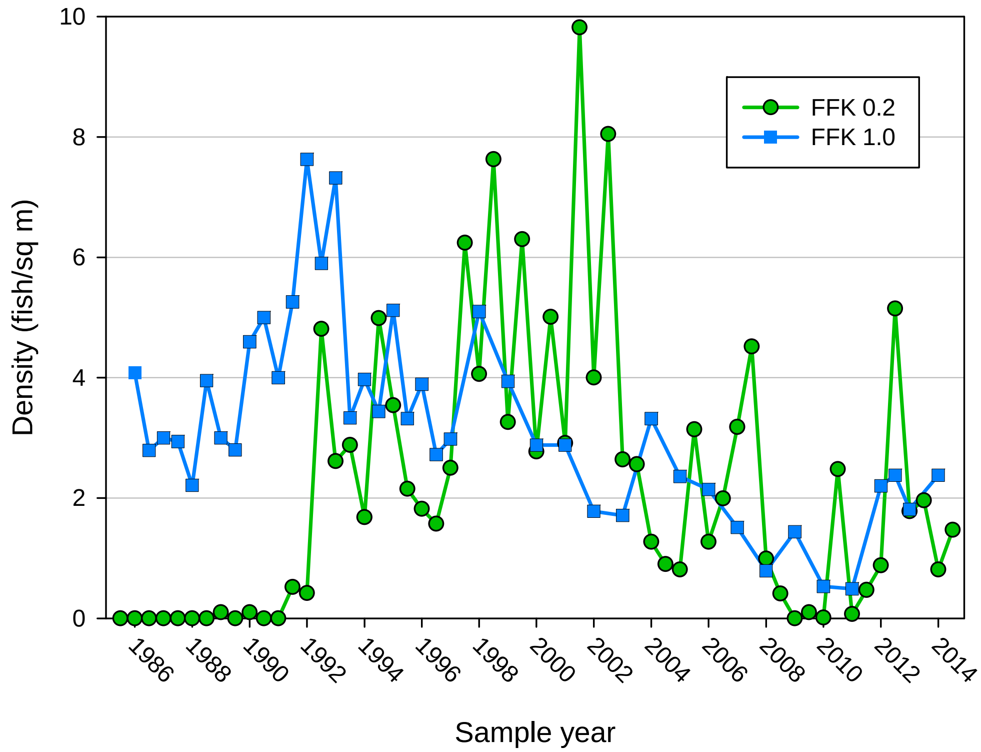


Figure 2.27. Fish density (fish/m^2) in samples of the fish community in Fifth Creek, 1985 – 2014.

The species richness of the pollution intolerant benthic macroinvertebrate taxa (Ephemeroptera, Plecoptera, and Trichoptera [EPT] taxa) at WCK 3.9 in WOC has improved substantially since 1987 (Figure 2.28). However, the overall trend in EPT taxa richness since 2002 suggests that that community has stabilized and no further recovery has occurred. Results for WCK 6.8 in 2013, downstream of most SNS outfalls to WOC, continued to indicate that conditions at that site are comparable to those at the Walker Branch kilometer 1.0 reference site (Figure 2.28). As for WCK 3.9, the condition of the benthic macroinvertebrate communities in lower First Creek and Fifth Creek at FCK 0.1 and FCK 0.2, respectively, has improved considerably since 1987, but the number of pollution intolerant EPT taxa at each site remains much lower than at their respective reference sites (Figures 2.29 and 2.30).

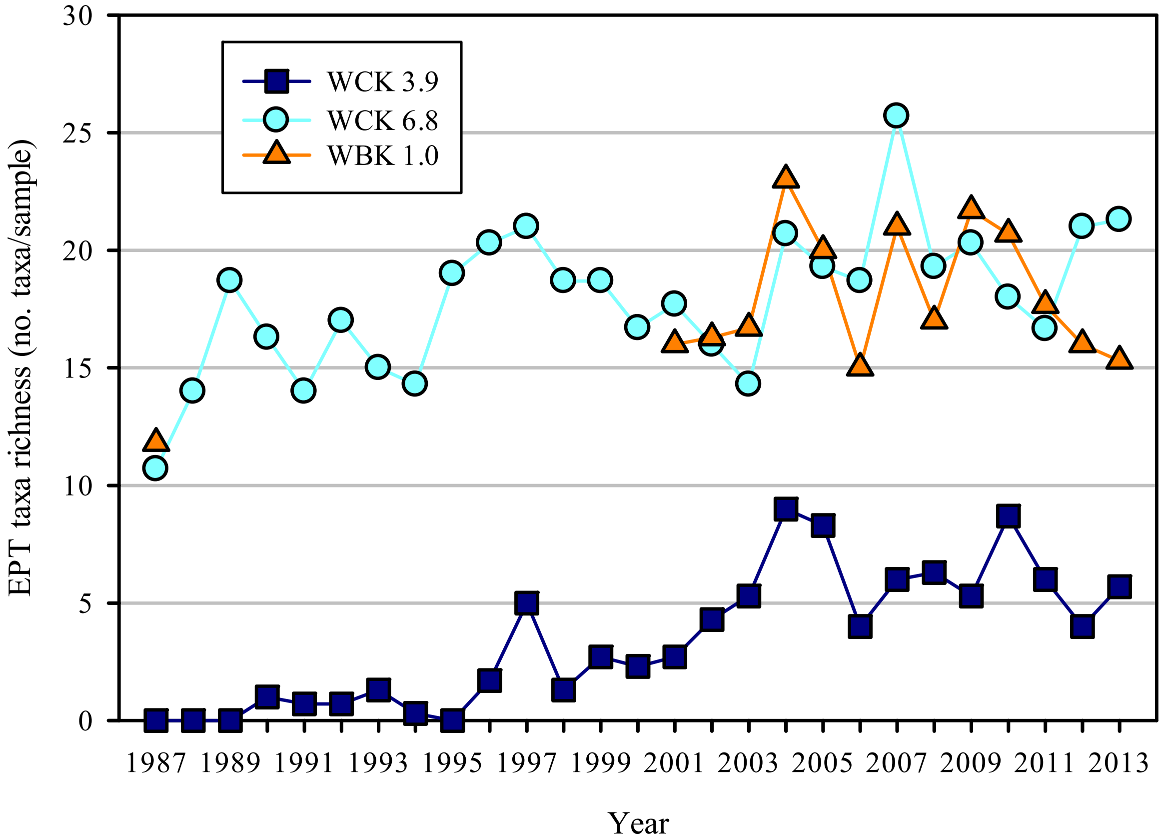


Figure 2.28. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in upper WOC and Walker Branch, April sampling periods, 1987 – 2013.[a,b]

[a]WBK = Walker Branch kilometer. EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies and caddisflies.
[b]Samples collected in 2014 have not yet been processed. Data were not available for Walker Branch from 1988 – 2000**.**

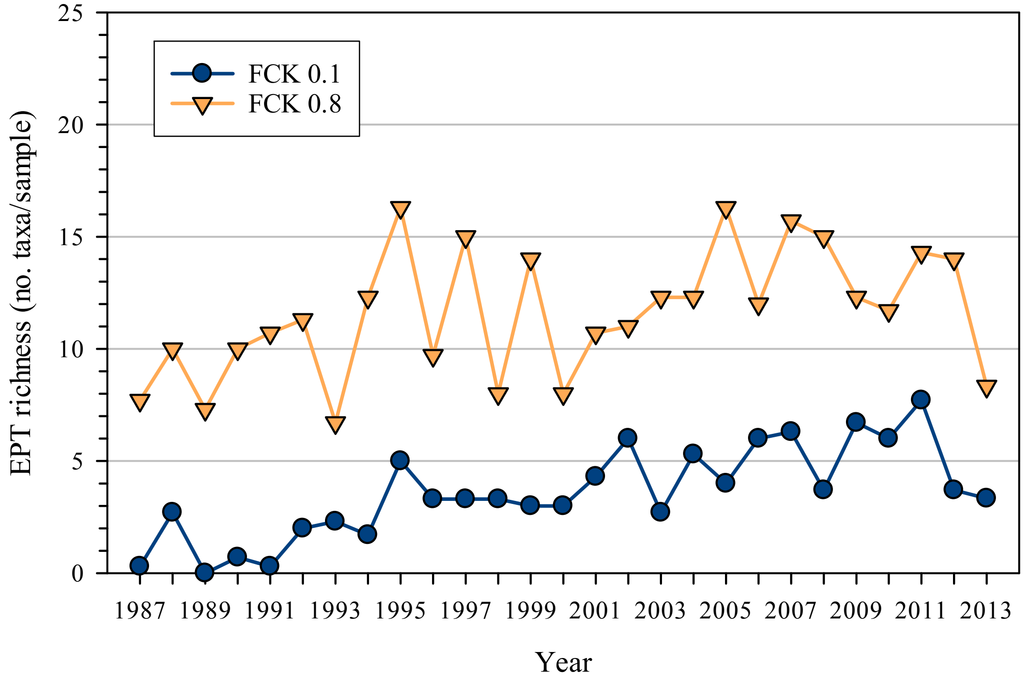


Figure 2.29. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in First Creek, April sampling periods, 1987 – 2013.[a,b]

[a]FCK = First Creek kilometer. EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies and caddisflies.
[b]Samples collected in 2014 have not yet been processed.

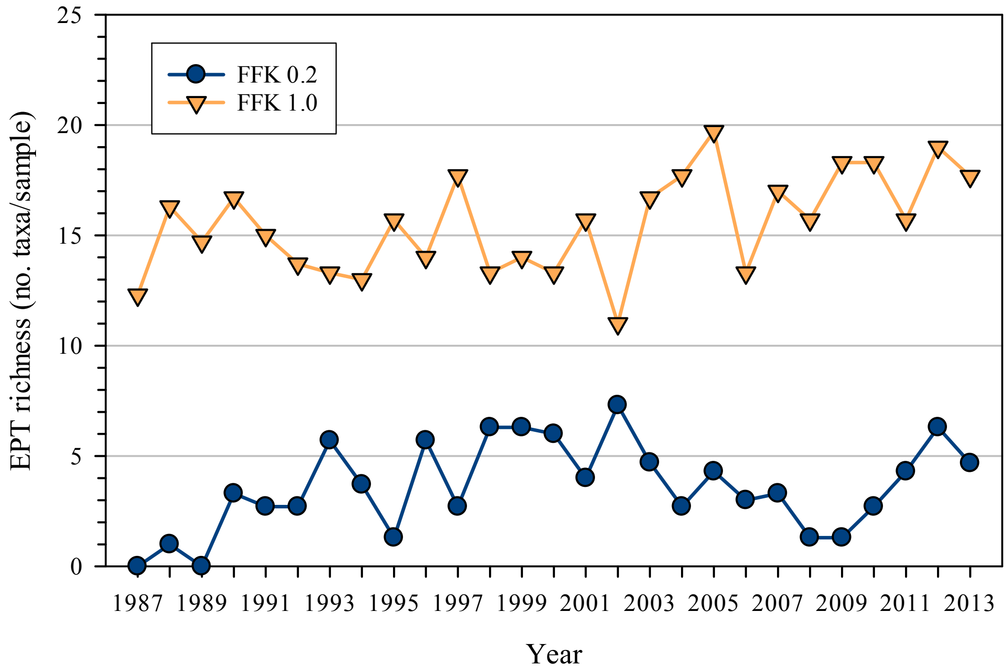


Figure 2.30. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in Fifth Creek, April sampling periods, 1987 – 2013.[a,b]

[a]FFK = Fifth Creek kilometer. EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies and caddisflies.
[b]Samples collected in 2014 have not yet been processed.

2.2.1.3 Performance Summary

Following is a summary of the FY 2014 Bethel Valley watershed performance monitoring;

- Strontium-90 and ^{137}Cs concentrations at the Bethel Valley watershed integration point (7500 Bridge) met their risk reduction goals. The Corehole 8 Extraction System met its performance goal based on ^{90}Sr flux reduction at First Creek during FY 2014, which contributed to the risk reduction goal for ^{90}Sr being met downstream at the 7500 Bridge.

- Surface water discharges of ^{90}Sr in Northwest Tributary and Raccoon Creek have decreased significantly as a result of hydrologic isolation of shallow buried waste at SWSA 3 and the Contractor's Landfill. Comparison of pre-remediation to FY 2014 groundwater contaminant concentrations shows that levels are decreasing or stable. Although three of nine wells have not yet attained design target groundwater levels, the groundwater level fluctuations within the waste depth zone in the hydrologic isolation area show that direct infiltration of rainwater into buried waste has been controlled.

- Mercury concentrations at the Bethel Valley watershed integration point (7500 Bridge) continue to meet the AWQC of 51 ng/L. CERCLA actions at Building 4501 to re-route and pre-treat mercury contaminated building sump water are shown to be effective at reducing mercury concentrations in the receiving reach of WOC. Mercury concentrations measured at WOC-105, located a short distance downstream from the former storm drain discharge from Building 4501, were less than the AWQC level in FY 2014 samples.

- Low levels of ^{90}Sr were detected in wells 4645 and 4646 in the headwaters of Raccoon Creek for the first time since the wells were installed in 2010. Detected levels were approximately 25% of the MCL-DC of 8 pCi/L.

- The observed improvement in fish mercury concentrations to levels below the EPA-recommended fish-based AWQC for mercury continued in WOC. Biological monitoring of the Bethel Valley watershed indicates moderate ecological recovery since 1987. Invertebrate community monitoring shows there is little evidence of improvement since 2002. Recent introductions of new fish species, however, have been partially successful.

2.2.2 Other LTS Requirements

Other LTS requirements for Bethel Valley watershed actions are listed in Table 2.15 and described below.

2.2.2.1 Requirements

Watershed-scale Requirements

The *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) includes interim LUCs to protect against unacceptable exposures to contamination during and after remediation. These interim LUCs will remain in effect until permanent LUCs are established in a future, final remedial decision. Objectives of the interim LUCs are below and shown in Figure 2.2:

- Groundwater use. Until a final groundwater decision is made, groundwater use restrictions are required in contaminated areas.

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

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

- Unrestricted areas: None required.

Building 4501 Mercury Treatment System Requirements

The LTS requirement specified in the *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion* (DOE/OR/01-2472&D1) is maintenance of the mercury pretreatment system in Building 4501, which began operation on October 23, 2009. Specifically, this requires maintenance of the pump, replacement of the cartridge prefilter, as needed, replacement of the ion exchange resin annually, and collection of system performance and operational data.

Corehole 8 Plume Extraction System Requirements

The *Phased Construction Completion Report for the Bethel Valley (Corehole 8) Extraction System* (DOE/OR/01-2534&D1) includes the following LTS requirements−operations and maintenance of the extraction system, routine walkdowns of the system to determine if the indicator lights are in the correct position, annual pressure testing of the line, and visual inspections of the indicator lights on the arrestors following severe thunderstorms. Operational reliability is tracked through monthly status reporting by the facility manager. Significant system outages will be reported to DOE for concurrence on implementation of actions deemed necessary to restore reliable operation.

LUC requirements at the Corehole 8 plume extraction system site are consistent with the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) designated land use of "Controlled Industrial." The LUC objective for this area is to prevent unauthorized access to restricted areas or any use of groundwater (except for the purpose of monitoring, testing, or treatment of groundwater); control excavation or penetrations below 2 ft or depths below the groundwater table; prevent unauthorized access; protect industrial workers; and preclude uses of the area that are inconsistent with the current industrial uses.

Table 2.15. Other LTS requirements for the Bethel Valley watershed

Other LTS requirements for LUCs[a]					
Type of control	**Affected areas**	**Purposes of control**	**Duration**	**Implementation**	**Frequency/ Implementation**
1. Property Record Restrictions[b] *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*	*Restrict use of property by imposing limitations* *Prohibit uses of groundwater*	*Indefinitely*	*Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office*	*DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s)*
2. Property Record Notices[c]	*All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions*	*Provide notice to anyone searching records about the existence and location of contaminated areas*	*Indefinitely*	*Notice recorded by DOE in accordance with state law at County Register of Deeds office: 1) as soon as practicable after signing of the ROD; 2) upon transfer of affected areas; 3) upon completion of all remedial actions*	*DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s)*
3. Zoning Notices[d]	*All waste management areas and other areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions*	*Provide notice to city about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes*	*Indefinitely*	*Initial Zoning Notice (same as Property Record Notice) filed with City Planning Commission as soon as practicable after signing of the ROD; final Zoning Notice and survey plat filed with City Planning Commission upon completion of all remedial actions*	*DOE official (or its contractors) will verify no less than annually that information is properly maintained with the City Planning Commission*
4. Excavation/Penetration Permit Program[e]	*Remediation systems, all waste management areas, and areas where hazardous substances are left in place at levels requiring land use and/or groundwater restrictions*	*Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity*	*As long as property remains under DOE control*	• *Implemented by DOE and its contractors* • *Initiated by permit request*	*DOE official (or its contractors) will verify no less than annually the functioning of permit program against existing procedures*

Table 2.15. Other LTS requirements for the Bethel Valley watershed (cont.)

Other LTS requirements for LUCs[a]					
Type of control	**Affected areas**	**Purposes of control**	**Duration**	**Implementation**	**Frequency/ Implementation**
5. Access Controls[f] (e.g., fences, gates, and portals)	*Specific locations will, if necessary, be determined by each remediation project*	*Control and restrict access to workers and the public to prevent unauthorized uses*	*Indefinitely*	*Controls maintained by DOE*	*DOE official (or its contractors) will conduct field survey no less than annually of all controls to assess condition (i.e., remain erect, intact, and functioning)*
6. Signs[g]	*At select locations throughout Bethel Valley*	*Provide notice or warning to prevent unauthorized access*	*Indefinitely*	*Signage maintained by DOE*	*DOE official (or its contractors) will conduct field survey no less than annually of all signs to assess condition (i.e., remain erect, intact, and legible)*
7. Surveillance Patrols	*Patrol of selected areas throughout Bethel Valley, as necessary*	*Control and monitor access by workers/public*	*Indefinitely*	• *Established and maintained by DOE* • *Necessity of patrols evaluated upon completion of remedial actions*	*DOE official (or its contractors) will verify no less than annually against procedures/plans that routine patrols conducted*

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/ Implementation**
Bethel Valley Mercury Sumps	Bethel Valley Mercury Sumps PCCR (DOE/OR/01-2472&D1)	• The ORNL Building 4501 Facility Manager will be responsible for operation and maintenance of the system, including pump maintenance and replacement of the cartridge prefilter as needed • Anticipated that the ion exchange resin will require annual replacement	Monitor annually to ensure it is functioning properly

Table 2.15. Other LTS requirements for the Bethel Valley watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/ Implementation**
Corehole 8 Extraction System	Corehole 8 Extraction Wells PCCR (DOE/OR/01-2534&D1)	• DOE and its contractor will maintain continual operation of the Corehole 8 extraction system • When a warning light that a pump has stopped functioning is illuminated in the Waste Operations Control Center, maintenance workers will go to the source of the problem/failure and evaluate the nature of the problem • Mandatory that annual pressure tests be conducted on each pipeline in this plume collection system • In the event a line fails its annual pressure test, that portion of the collection system will be taken out of service pending leak diagnostics and repair • A second routine service requirement is the servicing of lightning arrestors at electrical power poles 7 and 18. Following severe thunderstorm activities the indicator lights on the arrestors require visual inspection to determine when replacement becomes necessary. • Additionally, the maintenance subcontractor will perform routine walkdowns of the system to determine if the indicator lights are in the correct position in the field. If there is a failure of a component in the system, the operator will contact the UCOR facility manager to report the problem. • The LUC objectives for Corehole 8 designated "controlled industrial" established by Bethel Valley ROD are: - prevent unauthorized access to restricted areas or any use of groundwater (except for the purpose of monitoring, testing, or treatment of groundwater); - control excavation or penetrations below 2 ft or depths below the groundwater table; - protect industrial workers; and - preclude uses of the area that are inconsistent with the current industrial uses	Annual monitoring for each LUC following implementation Annual verification that each LUC continues to be effectively implemented

Table 2.15. Other LTS requirements for the Bethel Valley watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/ Implementation**
BVBGs: • SWSA 1 • Former Waste Pile Area • Nonradioactive Wastewater Treatment Plant Debris Pile • SWSA 3 • Contractor's Landfill	BVBGs PCCR (DOE/OR/01-2533&D2)	Long-term S&M actions will be conducted to control erosion, cap or cover settlement, run-on and run-off control system, trench drains, prevent rodent infestation, and control vegetative covers to prevent tree growth • Long-term S&M will also include maintenance of monitoring wells and survey benchmarks • If cap or cover damage is observed, the RDR/RAWP Appendix D should be consulted for detailed methods of determining the extent of damage to geosynthetic layers in the cap, and should be used to plan and implement repairs or maintenance at these sites • Vegetation is to be mowed (e.g., with a bush-hog) once per year to prevent growth of deep-rooted woody species • Semiannual inspections of: - Erosion damage and run-on/run-off drainage systems (and inspect following any rainfall of 25-yr, 24-hr intensity or equivalent) - Vegetative cover - Cover settlement, subsidence (and inspect after seismic events greater than 4.0 on the Richter scale) - Rodent control - Gas vents - Exterior condition of monitoring wells and piezometers - Survey benchmarks • Annual inspections of: - Interior condition of monitoring wells and piezometers - Cap and soil cover maintenance, road and signs maintenance • Inspection of weirs at surface water monitoring locations for clogging at each sampling event LUC objectives for the BVBGs are to prevent unauthorized access to restricted areas or use of groundwater; prevent unauthorized contact, removal, or excavation of waste left in place; protect maintenance workers; and preclude unauthorized uses of the area • Precluded uses include any additional material storage or waste disposal within the closed burial areas and any development or use of the property for residential, uncontrolled commercial/industrial, elementary and secondary schools, child care facilities and playgrounds • All seven Bethel Valley controls listed at the beginning of this table apply to the burial grounds	Site visits for inspections and physical controls will be no less than annually Annual RER to describe any necessary maintenance performed during the year, identify any breaches of the LUC objectives, and evaluate the status of the LUC objectives and describe how any deficiencies have been addressed Every fifth year, reporting of information necessary to satisfy the requirements of the CERCLA FYR for the Reservation

Table 2.15. Other LTS requirements for the Bethel Valley watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/ Implementation**
Surface Impoundments Operable Units A and B	RAR for Impoundments A and B (DOE/OR/01-2086&D2)	• Excavation institutional controls will remain in place for potential residual subsurface contamination around the site	Monitor annually to ensure the permit program is functioning properly
Metal Recovery Facility, Building 3505	RmAR for Metal Recovery Facility, Building 3505 (DOE/OR/01-2000&D2/R1)	• Though the surface areas have no radiological restrictions, the area is posted as an underground contamination area • The gravel area has no special maintenance needs beyond ensuring that the gravel cover is not grossly disturbed. In the event that the gravel cover is disturbed in a manner that might expose subsurface contamination, it will be repaired so as to restore the minimum 2 in. gravel protective cover over the epoxy barrier coating. • The site footprint has been included in the site database for periodic inspection to ensure that the residual subsurface contamination is not disturbed without proper evaluation	Verify annually that controls are being implemented
Corehole 8 Plume Source (Tank W-1A)	RmAR for Corehole 8 Plume Source (Tank W-1A) (DOE/OR/01-1969&D3)	• No excavation can be performed at the site unless an EPP is obtained.	Verify annually that controls are being implemented
Isotopes Row Area: Buildings 3030, 3031, 3032, 3033 Boneyard west of Building 3028	PCCR for Isotopes Row Facilities Legacy Material Removal (DOE/OR/01-2557&D2)	• The buildings are subject to routine maintenance under the DOE-EM S&M Program • No interim LUCs beyond those already established for ORNL are required (Note controls at start of table)	Verify annually that controls are being implemented

[a] Source for LUCs # 1-7: *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee* (DOE/OR/01-1862&D4).

[b] *Property Record Restrictions—Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with original property acquisition records of DOE and its predecessor agencies.*

[c] *Property Record Notices—Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination/waste disposal areas on the property.*

[d] *Zoning Notices—Includes information on the location of waste disposal areas and residual contamination depicted on a survey plat, which is provided to a zoning authority (i.e., City Planning Commission) for consideration in appropriate zoning decisions for non-DOE property.*

[e] *Excavation/Penetration Permit Program—Refers to the internal DOE/DOE contractor administrative program(s) that requires permit requester to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case of contaminated soil or groundwater, will not disturb the affected area without the appropriate precautions and safeguards.*

[f] *Access Controls—Physical barriers or restrictions to entry.*

[g] *Signs—Posted command, warning, or direction.*

BVBGs = Bethel Valley Burial Grounds
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy

Table 2.15. Other LTS requirements for the Bethel Valley watershed (cont.)

DOE-EM = U.S. Department of Energy Office of Environmental Management
EPP = excavation/penetration permit
FYR = Five-Year Review
LTS = long-term stewardship
LUC = land use control
ORNL = Oak Ridge National Laboratory
PCCR = Phased Construction Completion Report
RAR = Remedial Action Report
RAWP = Remedial Action Work Plan
RDR = Remedial Design Report
RER = Remediation Effectiveness Report
RmAR = Removal Action Report
ROD = Record of Decision
S&M = surveillance and maintenance
SWSA = Solid Waste Storage Area
UCOR = URS | CH2M Oak Ridge LLC

BVBGs Requirements

Under the *Explanation of Significant Differences from the Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-2446&D2) the SWSA 3 cap was extended to cover Contaminated Soil Area Number 2 and Contaminated Soil Area Number 3, as well as buried waste in the Closed Scrap Metal Area. These areas were designated as unrestricted end use in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) (after excavation). Now that they are under the SWSA 3 cap, the end use for these areas is recreational. This project was completed in FY 2011, and the PCCR was approved by the regulators on May 11, 2012 (DOE/OR/01-2533&D2).

The LTS requirements for the BVBGs areas (SWSA 1, Former Waste Pile Area, Nonradioactive Wastewater Treatment Plant Debris Pile, SWSA 3, and Contractor's Landfill) are specified in the *Phased Construction Completion Report for the Bethel Valley Burial Grounds* (DOE/OR/01-2533&D2) and include long-term S&M of the caps and covers. Specifically, S&M actions are to control erosion, to cap or cover settlement, to maintain run-on and run-off control system, to maintain trench drains, to prevent rodent infestation, to control vegetative covers to prevent tree growth, and to maintain monitoring wells and survey benchmarks. The *Phased Construction Completion Report for the Bethel Valley Burial Grounds* (DOE/OR/01-2533&D2) provides details on the inspection schedules, procedures, and corrective actions. LUCs for the BVBGs are the same as those specified in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4), with the exception of SWSA 3 expanding the area classified for recreational use (see discussion in section above). LUCs required by the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4) include property record restrictions; property record notices; zoning notices; internal permits programs (including excavation permit requirements); access controls; signs; and surveillance patrols. The primary controls used to limit unauthorized activities in the remediated areas include appropriate signage and administration of an EPP program.

Isotopes Row Facilities Requirements

The removal of legacy material from Isotopes Row Facilities is documented in the *Phased Construction Completion Report for the Oak Ridge National Laboratory Isotopes Row Facilities Legacy Material Removal* (DOE/OR/01-2557&D2). The building structures and associated facilities will be addressed as part of a separate future CERCLA action under the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4). The facilities are subject to routine maintenance under the S&M Program.

2.2.2.2 Status of Requirements

LUCs were maintained for the specified end use areas identified in the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4). Signs were maintained to control access and surveillance patrols were conducted as part of routine S&M inspections. The EPP Program functioned according to established procedures and plans.

Inspections of the Building 4501 pretreatment system were conducted weekly in FY 2014 by the UT-B 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. In FY 2014 routine maintenance included inlet filter changes and backwashing the ion exchange resin to remove sediment. Routine inspections were conducted in FY 2014 of the Corehole 8 plume extraction system and documented on monthly status reports. Maintenance of the system included replacing defective solenoid valve on Extraction Well #1 that was preventing flow from well. Operational issues noted on inspection sheets included continued low value readings on Lift

Station #1 flow meter compared to actual pump outflow; Extraction Well #1 sandy water valve failed in March; issues with Extraction Well #1 pump cavitating during low rainfall; and Lift Station #2 pump inoperable. See Section 2.2.1.2.1.2.1 for performance of the extraction system in FY 2014. The primary controls used to limit unauthorized activities at the Corehole 8 plume extraction system site include appropriate signage and administration of an EPP program. Access by the general public is restricted by the portal guard stations at the east and west ends of Bethel Valley Road. The Corehole 8 extraction system is not individually fenced and gated. While there are no physical controls to preclude access to the Corehole 8 extraction system by ORNL workers and visitors, appropriate signage and procedural controls are in place to warn of potential hazards.

Inspections of the BVBGs were conducted semiannually in FY 2014 in accordance with the *Phased Construction Completion Report for the Bethel Valley Burial Grounds* (DOE/OR/01-2533&D2). Inspection items included cover system, gas vents, access roads and culverts, survey benchmarks, drainage system, facility signs, and presence of unauthorized materials. It was noted that there was good grass coverage on SWSA 1 and SWSA 3 burial grounds. No maintenance was required in FY 2014 beyond routine mowing.

Per the *Phased Construction Completion Report for the Bethel Valley Burial Grounds* (DOE/OR/01-2533&D2), a survey plat documenting use restrictions and information about residual contamination and waste management areas was prepared. It will be submitted by DOE to the County Register of Deeds office upon completion of RAs (i.e., approval of the Bethel Valley RAR). Access by the general public is restricted by portal guard stations at the east and west ends of Bethel Valley Road. The BVBGs sites are not individually fenced and gated. While there are no physical controls to preclude access to the BVBGs sites by ORNL workers and visitors, appropriate signage and procedural controls are in place to warn of potential hazards.

Like other facilities at ORNL that are pending future D&D, Isotope Row facilities undergo routine S&M.

2.3 SINGLE-PROJECT ACTIONS IN BETHEL VALLEY WATERSHED

2.3.1 Tank W-1A

The location of the former Tank W-1A site (the Corehole 8 plume source) is on Figure 2.1. The *Removal Action Report for the Core Hole 8 Plume Source (Tank W-1A) at the Oak Ridge National Laboratory* (DOE/OR/01-1969&D3), approved in November 2012, documents completion of the non-critical removal action to address the source of contaminants being released to groundwater. This action removed Tank W-1A, contaminated soils surrounding the tank, tank saddles along with associated piping, valve pits and appurtenances in the area of the excavation. This report documents the actions taken toward removal of the Core Hole 8 plume source (Tank W-1A) as prescribed in the *Action Memorandum for the Core Hole 8 Plume Source (Tank W-1A)* (DOE/OR/01-1749&D1). The removal action objective of reducing off-site releases of contaminants at White Oak Dam by addressing the source area was met.

2.3.1.1 Other LTS Requirements

The Tank W-1A (Corehole 8 plume source) site has only LUC requirements. 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.

LUC requirements specified in the *Removal Action Report for the Core Hole 8 Plume Source (Tank W-1A) at the Oak Ridge National Laboratory* (DOE/OR/01-1969&D3) include no excavation can be performed at the site unless an EPP is obtained.

2.3.1.2 Status of Requirements

Excavation at all areas at ORNL, including the former Tank W-1A site, remained controlled in FY 2014 through the EPP Program.

2.3.2 Surface Impoundments

The location of the Surface Impoundments is on Figure 2.1. This action removed contaminated water, sediment, and the upper 0.1 to 0.2 ft of subimpoundment soil (clay). The action was implemented in two phases. The first phase removed contaminated water and sediment and backfilled impoundments C and D, which were small, lined impoundments. The second phase removed and treated discrete batches of contaminated sediment and backfilled impoundments A and B, which were larger, unlined impoundments. Upon completion, all four impoundments were covered with gravel and asphalt and are currently used as parking areas.

2.3.2.1 Other LTS Requirements

The *Remedial Action Report on the Surface Impoundments Operable Unit* (DOE/OR/01-2086&D2) states that no institutional controls are needed at the site; however, the report requires that institutional controls that limit excavation remain in place for potential residual subsurface contamination around the site.

2.3.2.2 Status of Requirements

The site underwent an annual inspection in FY 2014 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, an EPP Program with procedures is in place that does not allow unauthorized excavations/penetrations in this area.

2.3.3 Metal Recovery Facility

2.3.3.1 Other LTS Requirements

The location of the Metal Recovery Facility is on Figure 2.1. This action removed surface structures to slab, leaving in place the concrete floor slab, foundation, and other subsurface structures. The floor slab was sealed, and the slab and surrounding yard were covered with a minimum two in. of gravel. Final disposition of the slab and subsurface structures has been deferred to the *Record of Decision for Interim Actions in Bethel Valley* (DOE/OR/01-1862&D4).

The *Removal Action Report for the Metal Recovery Facility, Building 3505* (DOE/OR/01-2000&D2/R1) requires S&M and posting as an underground contamination area. S&M is required 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 2 in. gravel protective cover over the epoxy barrier coating must be restored.

2.3.3.2 Status of Requirements

The site underwent an annual inspection in FY 2014 performed by the ORNL S&M Program to monitor the condition of the gravel cover and ensure that the signs denoting underground contamination are visible and firmly in place. No maintenance was required.

2.4 BETHEL VALLEY WATERSHED ISSUES AND RECOMMENDATIONS

The issues and recommendations for the Bethel Valley watershed are in Table 2.16.

Table 2.16. Bethel Valley watershed issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issue Carried Forward			
None			
Completed/Resolved Issues[b]			
None			

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the 2015 RER. An "Issue Carried Forward" is an issue identified in a previous year's RER for FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.
[b]The year in which the issue originated is in parentheses, e.g., (2013 RER).

FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report

2.5 REFERENCES

65 FR 76708 – 76753, *National Primary Drinking Water Regulations; Radionuclides; Final Rule*, December 7, 2000, Environmental Protection Agency.

DOE/OR/01-1599&D2. *Removal Action Report on the Building 3001 Canal at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 1997, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1749&D1. *Action Memorandum for the Core Hole 8 Plume Source (Tank W-1A) Removal Action at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 1998, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1862&D4. *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee,* 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1862&D4/R2. *Notification of Non-Significant Change to the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee,* 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1969&D3. *Removal Action Report for the Core Hole 8 Plume Source (Tank W-1A) at the Oak Ridge National Laboratory, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2000&D2/R1. *Removal Action Report for the Metal Recovery Facility, Building 3505, at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2003, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2086&D2. *Remedial Action Report on the Surface Impoundments Operable Unit at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2004, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2219&D2. *Engineering Study Report for Groundwater Actions in Bethel Valley, Oak Ridge Tennessee*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2238&D1. *Phased Construction Completion Report for the Remediation of Tanks T-1, T-2, and HFIR*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2343&D1/A1. *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2378&D5. *Remedial Design Report/Remedial Action Work Plan for Soils, Sediments and Dynamic Characterization Strategy for Bethel Valley, Oak Ridge National Laboratory, Oak Ridge, Tennessee,* 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2407&D1. *Time-Critical Removal Action Memorandum for Buildings 3074 and 3136, and the 3020 Stack at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2428&D2. *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*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2428&D2/A2. *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*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2428&D2/A3. *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*, 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2446&D2. *Explanation of Significant Differences from the Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee, Bethel Valley Burial Grounds*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2469&D2. *Remedial Design Report/Remedial Action Work Plan for the Bethel Valley (Corehole 8) Extraction System at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2472&D1. *Phased Construction Completion Report for the Bethel Valley Mercury Sumps Groundwater Action Completion at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2475&D2. *Treatability Study Work Plan for 7000 Area in Bethel Valley, Oak Ridge, Tennessee*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2478&D1. *Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee*, 2015, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2490&D2. *Waste Handling Plan for Facility 3026 C&D Hot Cells Demolition at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2533&D2. *Phased Construction Completion Report for the Bethel Valley Burial Grounds at the Oak Ridge National Laboratory*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2534&D1. *Phased Construction Completion Report for the Bethel Valley (Corehole 8) Extraction System at Oak Ridge National Laboratory*, 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2557&D2. *Phased Construction Completion Report for the Oak Ridge National Laboratory Isotopes Row Facilities Legacy Material Removal*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2566&D1. *Treatability Study for the Bethel Valley 7000 Area Groundwater Plume, Oak Ridge National Laboratory*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2614&D1. *Phased Construction Completion Report for the 4500 Gaseous Waste Reconfiguration and Stabilization Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2617&D2. *Phased Construction Completion Report for Building 3038 Legacy Material Removal and Preparation for D&D at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2627&D1. *Phased Construction Completion Report for Bethel Valley Building 3550 Slab Remediation at the Oak Ridge National Laboratory*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2629&D1. *Phased Construction Completion Report for Facility 3026 C Hot Cell Demolition at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2641&D1. *Removal Action Report for Buildings 3074 and 3136 and the 3020 Stack at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for the Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE-STD-1196-2011. *Derived Concentration Technical Standard*, 2011, U.S. Department of Energy, Washington, D.C.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring, Chapter 16.4 Mann-Kendall Test, pp 208-217, and Appendix A, Table A.18 Probabilities for Mann-Kendall Non-Parametric Test for Trend, p. 272, John Wiley & Sons, Inc., New York, NY.

Steuber, A.M., et. al. 1981. An Investigation of Radionuclide Release from Solid Waste Disposal Area 3, Oak Ridge National Laboratory. ORNL/TM-7323.

TDEC 2007. State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October 2007. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Approved March 2008.

TDEC 2010a. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Melton Hill Reservoir: Lower Clinch River Watershed (HUC 06010207), Anderson, Knox, Loudon, and Roane Counties, Tennessee.

TDEC 2010b. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Watts Bar Reservoir: Watts Bar Lake Watershed (HUC 06010201), Lower Clinch River Watershed (HUC 06010207), and Emory River Watershed (HUC 06010208), Loudon, Meigs, Morgan, Rhea, and Roane Counties, Tennessee.

TDEC 2010c. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Fort Loudon Reservoir: Fort Loudon Lake Watershed (HUC 06010201), Blount, Knox, and Loudon Counties, Tennessee.

Wiedemeier, T.H., H.S. Rifai, G.J. Newell, and J.T. Wilson. 1999. Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface. John Wiley & Sons, Inc., New York, NY.

3. MELTON VALLEY WATERSHED

3.1 INTRODUCTION AND STATUS

3.1.1 Introduction

The Melton Valley watershed contains former burial grounds, tanks, facilities, disposal pits and trenches, and underground injection wells. Table 3.1 lists CERCLA actions within the watershed and identifies those with monitoring or other LTS requirements. Figure 3.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Only sites that have LTS requirements (Table 3.1) are included in these performance evaluations. End uses of a site form the basis of RAOs and determine access restrictions and allowable activities at the site. Figure 3.2 shows ROD-designated end uses within the watershed and interim controls requiring LTS.

Completed CERCLA actions in the Melton Valley watershed are gauged against their respective action specific goals. The collected data provides an evaluation of the indicators of effectiveness at the watershed scale.

For a complete discussion of background information and performance metrics for each remedy, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chapter 5 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). The information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

3.1.2 Status Update

<u>Watershed-Scale Actions</u>

The interim RAs in the *Record of Decision for Interim Actions for the Melton Valley Watershed, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-1826&D3) (Melton Valley ROD) have been completed and documented in the *Remedial Action Report for the Melton Valley Watershed, Oak Ridge, Tennessee* (DOE/OR/01-2343&D1) and RAR errata and addendum (Table 3.1). These interim RAs included a wide range of activities to reduce contaminant releases from the site, demolish unneeded facilities, plug and abandon unneeded wells, and remediate contaminated soils to prescribed risk levels. Selected remedies for sediments, floodplain soil exhibiting radiation <2500 μR/hr, and groundwater are not included in the Melton Valley ROD. A future remedial decision will select the remedy for these areas and will finalize or modify the interim remedial actions addressed under the Melton Valley ROD. Currently, contaminated sediments prevent WOC from meeting its stream use classification (e.g., recreation). Performance monitoring of completed Melton Valley ROD actions continued in FY 2014.

The *Addendum to Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2343&D1/A3/R1) was approved in FY 2014 that removes all RCRA administrative requirements, e.g., reporting and record-keeping, from SWSA 6, and as a result, long-term care and monitoring of SWSA 6 will continue under CERCLA in compliance with RCRA as ARARs. Annual reporting for SWSA 6 has been discontinued under RCRA and is included in this RER (Section 3.2.1.2.2.3). Post-closure care and monitoring under the existing CERCLA remedial program will continue.

Sampling the off-site wells to evaluate potential groundwater communication beneath the Clinch River between the ORR and an area of off-site groundwater use continued in accordance with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1982&D3).

<u>Single-Project Actions</u>

Molten Salt Reactor

- Defueling of the salt in the three fuel and flush drain tanks was completed under 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/02-1671&D2) and *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) and documented in the *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) approved in 2008.

  The *Waste Handling Plan for the Molten Salt Reactor Experiment Remediation of Secondary Low-Level Waste under the Melton Valley Closure Project at Oak Ridge, National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2200&D1) provided the execution plan for managing and disposing of waste from the defueling activities, as well as previously generated CERCLA waste. According to the Waste Handling Plan (WHP), all radioactive low-level waste (LLW) was expected to go to the EMWMF. All mixed or hazardous waste (mainly due to lead) was to be shipped for off-site treatment and disposal. Approximately 120 yd^3 of LLW was sent to EMWMF under an approved profile, as documented in the PCCR.

  In 2013, EPA and TDEC (Crane, J. L. January 24, 2013 and Petrie, R. January 9, 2013, respectively) requested an inventory of waste remaining at Molten Salt Reactor Experiment (MSRE) and a schedule for disposal. DOE provided an inventory of waste items (McMillian, W. G. and Japp, J. M. March 27, 2013), and the disposition plan (McMillian, W. G. and Japp, J. M. July 24, 2013). The *Addendum to the Waste Handling Plan for the Molten Salt Reactor Experiment Remediation of Secondary Low-Level Waste under the Melton Valley Closure Project at Oak Ridge, National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2200&D1/A1) (WHP Addendum) was prepared and approved in FY 2014 to:

  - Update activities and agreements since the WHP was approved.
  - Provide a clear description of waste remaining to be disposed under the WHP and waste that is not included in the WHP.
  - Detail the plan for characterizing the waste that is expected to be eligible for disposal in EMWMF, including documentation to justify disposal of some waste items and containers without sampling.
  - Provide information concerning future submittals of PCCRs to document the disposal of MSRE waste included in the WHP.

  As required by the WHP Addendum, a draft PCCR was prepared in FY 2014 that documents the MSRE waste characterized and disposed in FY 2014 (Figure 3.3).

Table 3.1. CERCLA actions in Melton Valley watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
		Watershed-scale actions	
		Actions complete	
Melton Valley Interim Actions	ROD (DOE/OR/01-1826&D3): 09/21/00 ROD Amendment (DOE/OR/01-2170&D1): 09/07/04 Changes remediation approach for Trenches 5 & 7 to *in situ* grouting ESD (DOE/OR/01-2040&D2): 03/12/04 Adds Tumulus 1 and 2 and the Intermediate Waste Management Facility to the scope of the Interim ROD ESD (DOE/OR/01-2165&D1): 09/07/04 Modifies requirements for 11 waste units ESD (DOE/OR/01-2249&D1): 09/13/05 Removes seven facilities from MSRE D&D ESD (DOE/OR/01-2333&D1): 12/27/06 Removes five shielded transfer tanks from D&D scope LUCIP (DOE/OR/01-1977&D6): 05/24/06	RAR (DOE/OR/01-2343&D1) 09/05/07	Yes/Yes
		o (DOE/OR/01-2343&D1/A1) erratum approved 06/25/09	No/Yes
		o (DOE/OR/01-2343&D1/A2) erratum submitted 10/19/09 (no approval required)	No/Yes
		o (DOE/OR/01-2343&D1/A3/R1) addendum approved 08/22/14	No/No
		o Melton Valley Watershed RAR CMP (DOE/OR/01-1982&D3) approved 09/05/13	Yes/No
		• PCCR for Hydrofracture Well Plugging & Abandonment (DOE/OR/01-2138&D1) approved 07/14/06	Superseded by RAR (DOE/OR/01-2343&D1)
		• PCCR for New Hydrofracture Facility D&D (DOE/OR/01-2306&D1) approved 07/31/06	
		• PCCR for Trenches 5 and 7 and HRE Fuel Wells In Situ Grouting (DOE/OR/01-2302&D1) approved 08/14/06	
		• PCCR for Hydrologic Isolation at SWSA 6 (DOE/OR/01-2285&D1) approved 09/06/06	
		• PCCR for SWSA 4 and IHP (DOE/OR/01-2300&D1) approved 09/11/06	
		• PCCR for Old Hydrofracture Facility D&D (DOE/OR/01-2014&D2) approved 09/26/06	
		• PCCR for Hydrologic Isolation at Seepage Pits and Trenches (DOE/OR/01-2310&D1) approved 10/02/06	
		• PCCR for Soils and Sediments (DOE/OR/01-2315&D1) approved 10/02/06	
		• PCCR for HRE Ancillary Facilities D&D (DOE/OR/01-2307&D1) approved 10/04/06	
		• 7841 Equipment Storage Area and 7802F Storage Shed D&D (DOE/OR/01-2323&D1) approved 10/05/06	

Table 3.1. CERCLA actions in Melton Valley watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
		• Hydrologic Isolation at SWSA 5 (DOE/OR/01-2286&D1) approved 11/06/06	
Single-project actions			
		Actions complete	
WOCE	AM (Letter): 11/9/90	RmAR (ORNL/ER/Sub/91-KA931/4) approved 09/30/92	No/Yes
WAG 13 Cesium Plots	IROD (DOE/OR/01-1059&D4): 10/06/92	RAR Postconstruction report (DOE/OR/01-1218&D2) approved 08/25/94	No/Yes
WAG 5 Seep C	AM (DOE/OR/02-1235&D2): 03/30/94	RmAR Postconstruction Report (DOE/OR/01-1334&D2) approved 06/22/95 o System shutdown prior to capping	Superseded by Melton Valley ROD (DOE/OR/01-1826&D3)
WAG 5 Seep D	AM (DOE/OR/02-1283&D2): 07/26/94	RmAR Postconstruction Report (DOE/OR/01-1334&D2) approved 06/22/95 o Collection of contaminated groundwater ongoing	Superseded by Melton Valley ROD (DOE/OR/01-1826&D3)
WAG 4 Seep Control	AM (DOE/OR/02-1440&D2): 02/12//96	RmAR (DOE/OR/01-1544&D2) approved 03/05/98	Superseded by Melton Valley ROD (DOE/OR/01-1826&D3)
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
Old Hydrofracture Tank Sludges	AM (DOE/OR/02-1487&D2): 09/12/96	RmAR (DOE/OR/01-1759&D1) approved 12/15/98	No/No
Old Hydrofracture 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 05/11/01	Superseded by Melton Valley ROD (DOE/OR/01-1826&D3)

Table 3.1. CERCLA actions in Melton Valley watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
White Oak Dam	AM (Time Critical) for Corrective Actions at White Oak Dam (DOE/OR/01-2460&D1): 7/23/10	RmAR (DOE/OR/01-2509&D1) approved 11/08/11	Yes/Yes
		o (DOE/OR/01-2509&D1) erratum submitted 10/23/12 (no approval required)	No/Yes
		Actions in progress	
MSRE D&D Fuel Salt Removal	ROD (DOE/OR/02-1671&D2): 07/07/98 ESD (DOE/OR/01-2088&D2) approved: 01/19/07 Deletes requirement to convert ^{233}U to an oxide	PCCR (DOE/OR/01-2256&D1 [removal and transfer of uranium from the MSRE Facility]) approved 10/10/08	No/No
		PCCR for waste characterized and disposed in FY 2014 in progress	TBD[c]
TRU Waste Processing Complex Sludge Test Area Buildout	AM (DOE/OR/01-2621&D1) 08/02/13	RmAR in progress	TBD[c]

[a]Information on the enforceable agreement milestones for ongoing actions is in Appendix E of the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014) and is available at <http://www.ucor.com/ettp_ffa_appendices.html>.

[b]"No/No" indicates no monitoring/other LTS requirements are identified in the CERCLA action completion document beyond those identified in the watershed ROD. Refer to Table 3.3 watershed-scale monitoring requirements and Figure 3.2 and Table 3.10 for watershed-scale LUCs and other LTS requirements.

[c]The completion document was not approved during the FY 2014 reporting period.

AM = Action Memorandum
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMP = Combined Monitoring Plan
D&D = decontamination and decommissioning
ESD = Explanation of Significant Difference
FY = fiscal year
HRE = Homogeneous Reactor Experiment
IHP = Intermediate Holding Pond
IROD = Interim Record of Decision
LTS = long-term stewardship
LUC = land use control
LUCIP = Land Use Control Implementation Plan
MSRE = Molten Salt Reactor Experiment
PCCR = Phased Construction Completion Report
RAR = Remedial Action Report
RmAR = Removal Action Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TBD = to be determined
TRU = transuranic
WAG = Waste Area Grouping
WOCE = White Oak Creek Embayment

This page intentionally left blank.

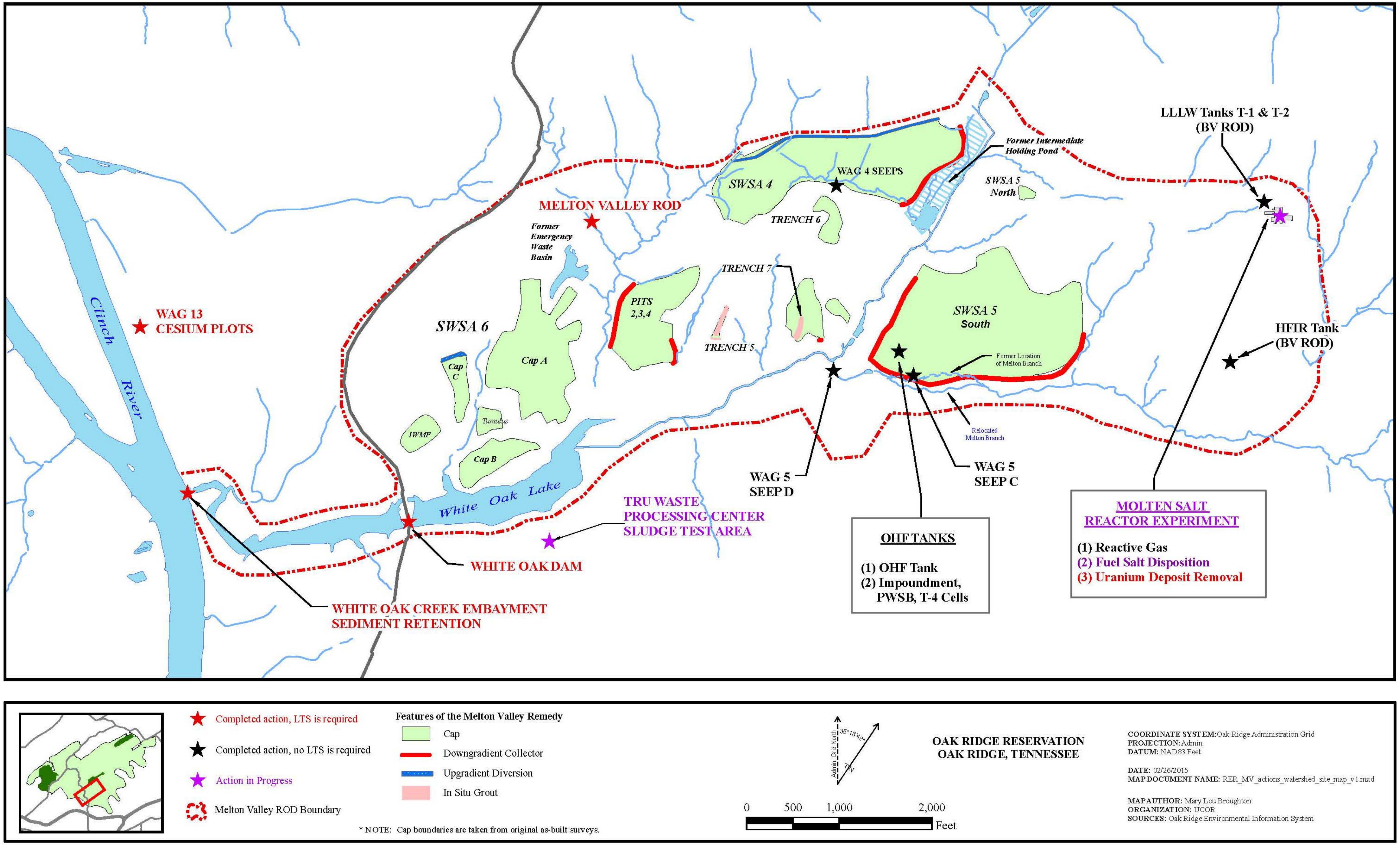


Figure 3.1. Melton Valley watershed.

This page intentionally left blank.

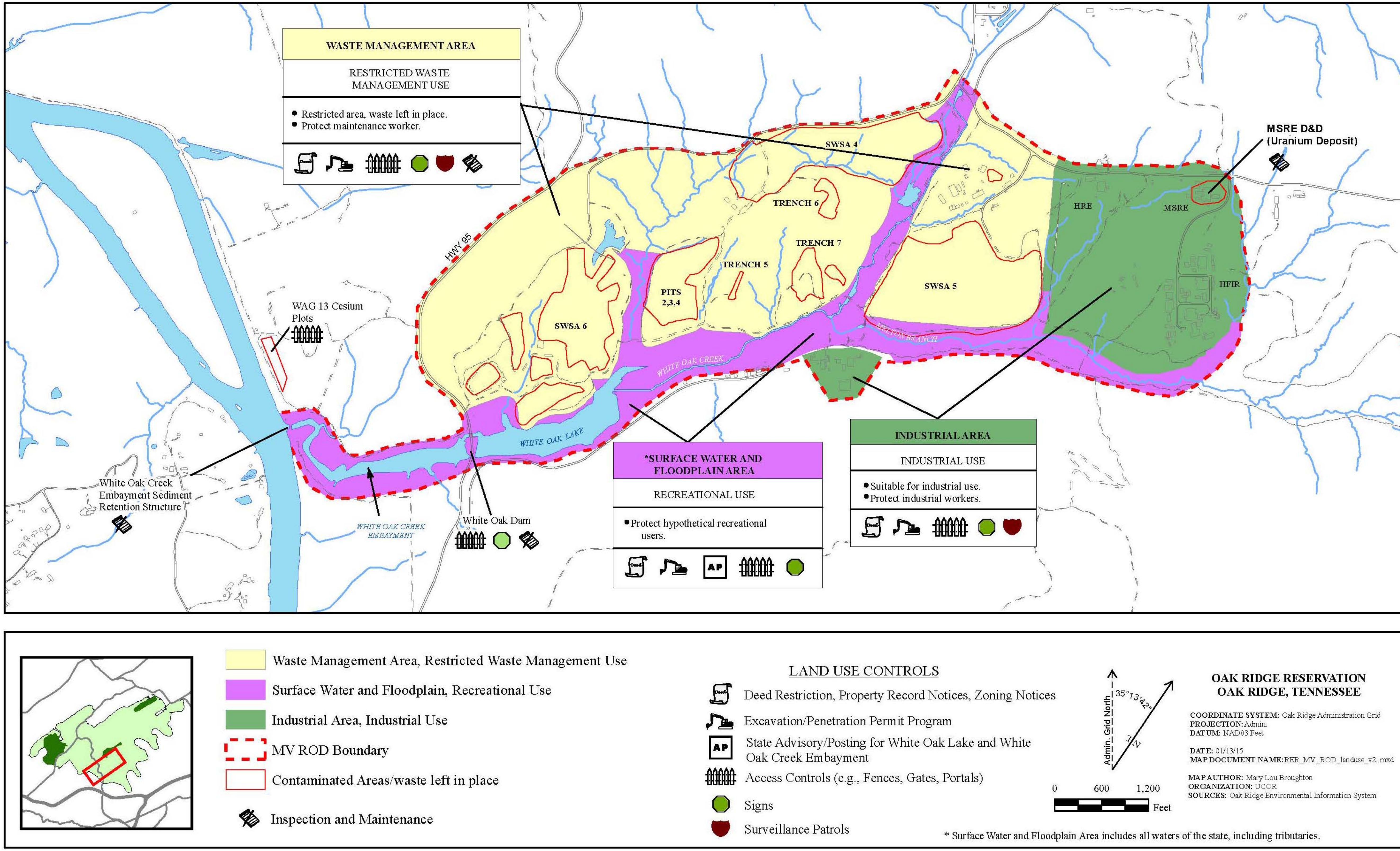


Figure 3.2. Melton Valley ROD-designated end use and interim controls requiring LTS.

This page intentionally left blank.

Figure 3.3. Waste from MSRE being packaged for transport.

Transuranic Waste Processing Center

- The Transuranic Waste Processing Center processes transuranic and alpha LLW that is stored at ORNL for permanent disposal. The Sludge Processing Facilities Buildout project includes the construction of a prototypical test facility to conduct technology maturation in support of the design and construction of the future sludge processing facilities. Site preparation activities began in April 2013, including clearing and grubbing of vegetation, removal of organic material and topsoil layers, and build-up and leveling of the site with suitable material followed by mechanical compaction supportive of future construction. During excavation of test pits in May 2013, various anomalous materials, including Tyvek, wood debris, trash, stainless steel and polyvinyl chloride (PVC) well casing materials, and concrete, were discovered. Some of this material was contaminated. Work was paused, and an *Action Memorandum for Time-Critical Removal Action for the Sludge Test Area Buildout at the Transuranic Waste Processing Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2621&D1) was prepared to remove and dispose of the contaminated soil and debris. The work under this time-critical removal action was completed in FY 2014 and preparation of a RmAR is in progress.

3.2 ROD FOR INTERIM ACTIONS FOR MELTON VALLEY WATERSHED

3.2.1 Performance Monitoring

3.2.1.1 Performance Goals and Monitoring Objectives

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) includes actions for the hydrologic isolation of burial grounds, removal of impoundments, grouting of Homogeneous Reactor Experiment (HRE) fuel wells, remediation of inactive waste pipelines, *in situ* grouting of Seepage Trenches 5 and 7, removal of contaminated soil and sediment, demolition of buildings, plugging and abandonment of wells, monitoring, and LUCs; stipulates RAOs for Melton Valley 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 3.2). Table 3.3 includes the performance objectives and performance measures in the ROD for those elements of the remedy that specified post-remediation 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 Melton Valley within two years after completion of remediation. Also included in Table 3.3 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 of Liquid Waste Seepage Trenches 5 and 7, a groundwater quality monitoring plan was prepared and implemented to monitor wells in the vicinity of those two units for water quality evaluation. Results of that sampling and analyses are included in Section 3.2.1.2.2.

Most of the laterally-flowing shallow groundwater (< 10 ft) 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 over 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 PWTC in Bethel Valley. Water at the equalization tank is sampled to verify that the wastewater meets the facility's waste acceptance criteria (WAC).

3.2.1.2 Evaluation of Performance Monitoring Data

This section evaluates the monitoring data in terms of meeting the goals of the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3). Performance monitoring includes surface water monitoring, groundwater monitoring, and biological monitoring. Figure 3.4 shows the watershed scale monitoring locations.

3.2.1.2.1 Surface Water

This section presents the results of remedy effectiveness evaluation of surface water monitoring in the Melton Valley watershed. Section 3.2.1.2.1.1 summarizes the remediation goals for surface water; Section 3.2.1.2.1.2 presents information concerning major radionuclide concentrations and fluxes at the surface water integration point monitoring stations; and Section 3.2.1.2.1.3 presents data obtained at the tributary sampling locations.

Table 3.2. RAOs for the Melton Valley watershed selected remedy[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 a HI of 1* • *Protect hypothetical recreational users of waters of the state*[c]
Ecological receptors	• *Protect ecological populations*[d]

[a]Source: *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3), Table 1.1.

[b]A future CERCLA decision will be prepared to determine whether additional actions are required for floodplain soil <2500 µR/h.

[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 RAs including LUCs. 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.

AWQC = ambient water quality criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
HI = hazard index
LUC = land use control
RA = remedial action
RAO = remedial action objective
SWSA = Solid Waste Storage Area

Table 3.3. Performance measures for major actions in the Melton Valley watershed[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 Road* *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 Section 3.2.1.2.1.3] *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 Section 3.2.1.2.1.3] *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 Section 3.2.1.2.2]
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 Section 3.2.1.2.1.3] *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 Section 3.2.1.2.1.3]* *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 Section 3.2.1.2.2]
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 Section 3.2.1.2.2.2]
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 Section 3.2.1.2.1.3] *Comply with RCRA postclosure requirements for designated RCRA areas (Ongoing).* [See Section 3.2.2] *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 Section 3.2.1.2.2]

Table 3.3. Performance measures for major actions in the Melton Valley watershed[a] (cont.)

Unit type/unit names project scope	*Performance objectives*	*Performance measure[b]* **(Attainment schedule) [RER section]**
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 Section 3.2.1.2.1.3] *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 Section 3.2.1.2.2]
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 Section 3.2.1.2.1.3] *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 Section 3.2.1.2.1.2] *Reduce contaminant releases to meet water quality conditions that would allow hypothetical residential use (risk level of 1 X 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 90Sr and tritium of 75-80% are required.* [See Section 3.2.1.2.1.3]

[a]Source: *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3), Table 2.17.

[b]*To meet a target post-remediation risk level of 1 X 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.

Note: Non-italicized text within table references sections in the current document.

AWQC = ambient water quality criteria
HRE = Homogeneous Reactor Experiment
ISV = *in situ* vitrification
OHF = Old Hydrofracture Facility
P&A = plugging and abandonment
RAO = remedial action objective
RCRA = Resource Conservation and Recovery Act
RER = Remedial Effectiveness Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation

This page intentionally left blank.

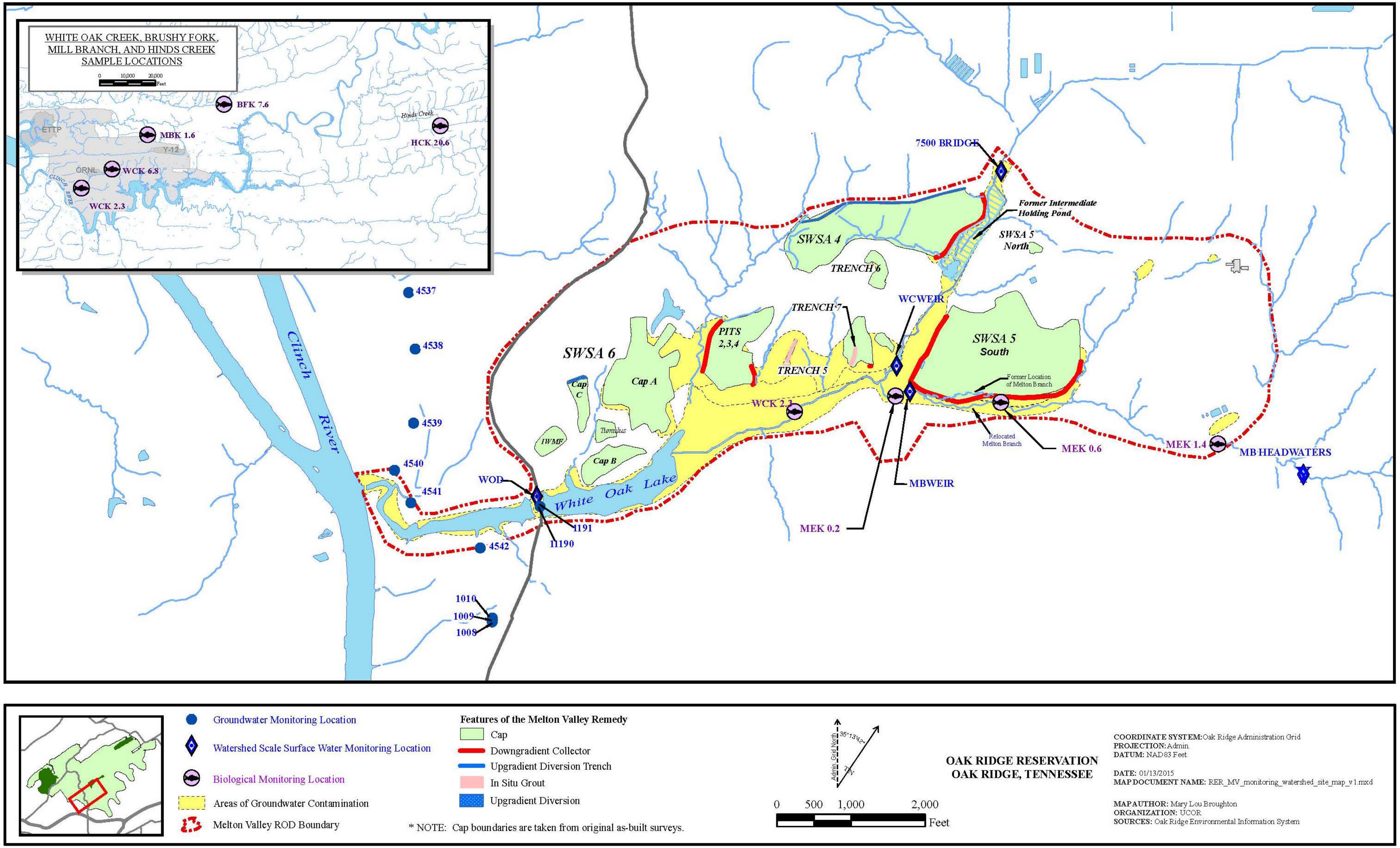


Figure 3.4. Melton Valley watershed scale monitoring locations.

This page intentionally left blank.

3.2.1.2.1.1 Surface Water Quality Goals and Monitoring Requirements

Surface water goals include protection of the Clinch River to meet its stream use classification (e.g., such as a domestic water supply) and to achieve AWQC in waters of the state. The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) includes specific surface water remediation levels (Table 3.4). Locations where surface water monitoring occurs to evaluate the remedy performance are shown on Figure 3.5. The following excerpts from the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) include the specific concentration goals for the principal surface water contaminants of concern in Melton Valley.

Table 3.4. Surface water remediation levels for the Melton Valley watershed[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 3.5 of RER	See Figure 3.5 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 3.6 of RER	See Table 3.5 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: *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3), Table 2.18.

Note: Non-italicized text within table is referencing figures and tables in the current document.

AWQC = ambient water quality criteria
N/A = not applicable
RER = Remediation Effectiveness Report
TDEC = Tennessee Department of Environment and Conservation

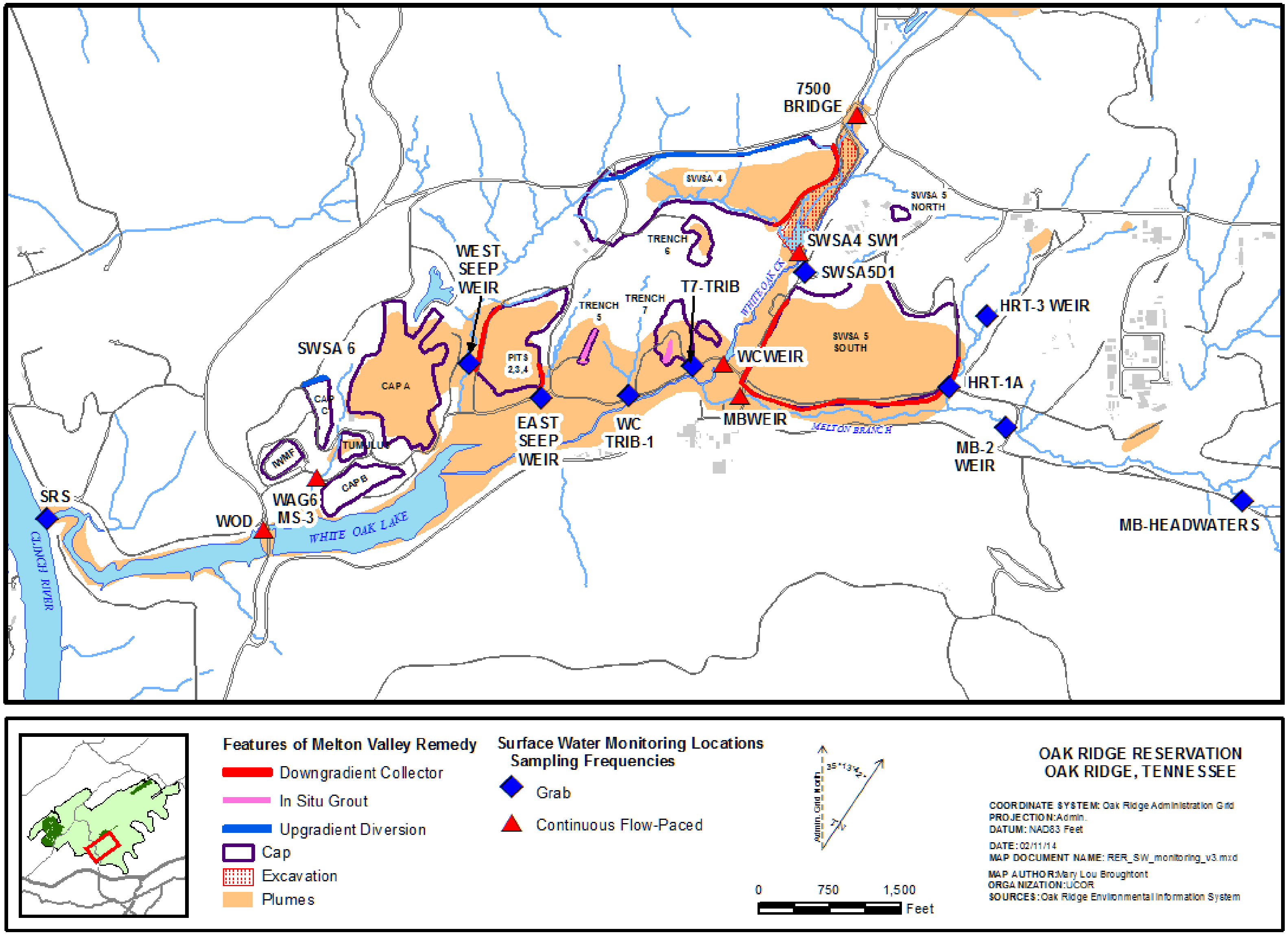


Figure 3.5. Melton Valley surface water monitoring locations.

Protect Clinch River to meet its stream use classification

This goal protects the Clinch River as a domestic water supply (e.g., meets SDWA MCLs), which is the most stringent of the use classifications assigned to the Clinch River, from contaminated surface water coming from Melton Valley. This goal provides residential risk-based limits for surface water at the confluence of WOC with the Clinch River. This goal will be met within 10 years from completion of actions in Melton Valley and Bethel Valley. 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 a hazard index (HI) less than one for a residential exposure scenario (i.e., general household use). Samples to demonstrate compliance with these remediation levels may be taken from the White Oak Creek Embayment (WOCE) and/or White Oak Dam. Table 3.5 lists the remediation levels for the contaminants contributing to residential risk at White Oak Dam.

Table 3.5. Residential risk-based surface water remediation concentrations for the Melton Valley watershed[a]

Contaminants at White Oak Dam[b]	*Units*	*Reference concentration[c]*	*Minimum detection limit[d]*	*Concentrations based on a residential scenario[e] (for WOCE 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} or excess lifetime cancer risk or hazard index 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*: Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3), Table 2.20.

[b]*Beryllium was identified as a contaminant of concern in the Feasibility Study but was not included here because the Environmental Protection Agency has since revised its position on the carcinogenicity of beryllium [see Record of Decision for Interim Actions for the Melton Valley Watershed (DOE/OR/01-1826&D3) Table 2.5]. Also, some of these contaminants have Safe Drinking Water Act maximum contaminant levels. The selected remedy will make progress toward protecting Clinch River as a drinking water source (i.e., meet Safe Drinking Water Act maximum contaminant levels).*

[c]*Reference concentrations equal twice the arithmetic mean of the background; these concentrations were used for surface water analyte screening in the Melton Valley 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
PCB = polychlorinated biphenyl
WOCE = White Oak Creek Embayment

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[1]*. 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}.

---

[1]The use classifications for White Oak Creek (WOC) and Mitchell Branch have changed since the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) was signed. These surface water bodies are currently classified for Fish and Aquatic Life, Recreation, and Irrigation uses and are no longer classified for Livestock Watering and Wildlife use. Under the new regulations, all other surface waters unnamed in the Clinch River Basin section of the regulations, with the exception of wet weather conveyances, are classified as Fish and Aquatic Life, Recreation, Irrigation, and Livestock Watering and Wildlife use.

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 3.6 *[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.*

3.2.1.2.1.2 Integration Point Monitoring Results

This section provides an evaluation of the surface water quality data collected at surface water integration points on WOC and Melton Branch during FY 2014 compared to the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) goals and performance metrics. Surface water monitoring locations are shown on Figure 3.5.

Table 3.6. Recreational risk-based surface water remediation concentrations for the Melton Valley watershed[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 WOCE)*	*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} excess lifetime cancer risk or hazard index 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: *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3), Table 2.19.

[b]*Beryllium was identified as a contaminant of concern in the Feasibility Study but was not included here because Environmental Protection Agency has since revised its position on the carcinogenicity of beryllium [see Record of Decision for Interim Actions for the Melton Valley Watershed (DOE/OR/01-1826&D3) 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 Melton Valley 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 contaminants of concern since numeric ambient water quality criteria exist for them.*

COC = contaminant on concern
D = daughter products
FS = feasibility study
NA = not applicable
ND = not detected or analyzed
WOCE = White Oak Creek Embayment

The principal surface water integration point monitoring station in Melton Valley is at White Oak Dam where WOC discharges from WOL. Continuous, flow-paced sampling is conducted at White Oak Dam 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 integration point surface water monitoring stations – the White Oak Creek Weir (WCWEIR), the Melton Branch Weir (MBWEIR), and the 7500 Bridge. Table 3.7 displays the activities of ^{137}Cs, ^{90}Sr, and tritium from the monthly flow-paced composite samples obtained at these main stem integration points.

Comparison of ^{137}Cs, ^{90}Sr, and tritium activities measured at White Oak Dam (Table 3.7) with the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) goal (Table 3.5) is the basis for remedy effectiveness evaluation for protection of the Clinch River.

Figure 3.6 shows the annual average and average-plus-one standard deviation activities of ^{137}Cs, ^{90}Sr, and tritium at White Oak Dam for FY 2001 through FY 2014. Total annual rainfall at the ORNL is provided to enable long-term comparison of contaminant response to rainfall. *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) 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 to ensure the best available measure of the time- and flow-weighted average contaminant activity.

Comparison of ^{137}Cs, ^{90}Sr, and tritium activities (Table 3.7) measured at 7500 Bridge, WCWEIR, and MBWEIR, which are upstream integration monitoring locations, with the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) goal for a recreational scenario (Table 3.6) indicates that all results for FY 2014 are well below the risk-based goals for these constituents. Comparison of the monitoring results from White Oak Dam (Table 3.7) with the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) goals for discharges to the Clinch River (Table 3.5) shows that the goals were met throughout FY 2014. Additional information concerning CERCLA contaminant monitoring at the 7500 Bridge is presented in Chapter 2, as applicable to goals of the *Record of Decision for Interim Actions at Bethel Valley Watershed* (DOE/OR/01-1862&D4).

Figure 3.7 shows the annual radionuclide flux for ^{137}Cs, ^{90}Sr, and tritium measured at White Oak Dam and the ORNL site total annual rainfall from FY 2001 through FY 2014. During FY 2014, rainfall was approximately 10% less than the long term average of 54 in. The total fluxes of ^{137}Cs, ^{90}Sr, and tritium measured during FY 2014 remained low and comparable to the FY 2007 through FY 2013 values.

The Melton Valley ROD stipulates that AWQC be met in surface water in a reasonable amount of time. The most recent review conducted in the *2011 Third Reservation-Wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) that included WOC mainstem and tributary sample locations indicated that for 13 sampled locations the only instance of a ROD COC exceeding the AWQC was a single mercury measurement at one location.

3.2.1.2.1.3 Tributary Surface Water Monitoring Results

Tributary monitoring locations (Figure 3.5) are sampled to evaluate the effect of remediation on water quality in tributaries to WOC and Melton Branch. Samples are obtained by the grab method, except at Waste Area Group (WAG) 6 MS-3 and SWSA 4 SW1 where flow-paced composite sampling is performed. Radiological remediation level goals for surface water in the Melton Valley tributaries are in Table 3.6. All results are well below the *Record of Decision for Interim Actions for the Melton Valley*

Watershed (DOE/OR/01-1826&D3) recreational goals for surface water. Graphs showing average annual concentrations of the major radionuclides over time at key tributary monitoring locations are in Figures 3.8 and 3.9. Examination of these figures indicates that in most areas radiological contaminant levels are either continuing to decrease compared to pre-2006 Melton Valley remedy completion data or have reached essentially stable levels. As shown in the middle panel of Figure 3.8, ^{90}Sr levels in the HRE Tributary downstream of the HRE facility (HRT-3 WEIR) showed an increasing trend for FY 2012 and FY 2013 and decreased somewhat during FY 2014. The cause of this increasing trend was investigated during FY 2014. Surface water grab samples were collected from the HRE tributary upstream and downstream of the HRE facility and from the small tributary on the east side of the facility. Elevated tritium activities were detected near two known former leak sites on the abandoned LLLW pipeline that parallels Melton Valley Drive to the north of the HRE facility. This contamination is thought to be mobilized by the prolonged above-average rainfall period between 2010 and 2013. The appearance of elevated ^{90}Sr in the stream near this area suggests that contamination may be moving through the remediated areas from locations further away along the pipeline. At no time did contaminant concentration levels in the HRE tributary approach the ROD risk-based goals for surface water upstream of White Oak Dam (Table 3.6), however DOE was proactive in following up on the apparent trend to determine source of contamination. Monitoring in the HRE tributary will continue consistent with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1982&D3). This closes an issue identified in Table 3.11.

Table 3.7. Summary of FY 2014 radiological contaminant levels at surface water integration points in Melton Valley

	7500 Bridge			WCWEIR			MBWEIR			White Oak Dam		
Monthly composite date	^{90}Sr	Tritium	^{137}Cs	^{90}Sr	Tritium	^{137}Cs	^{90}Sr	Tritium	^{137}Cs	^{90}Sr	Tritium	^{137}Cs
31-Oct-13	29.5	15,800	10.7	23	19,000	23	31	7,800	< 4.7	51	15,000	50
28-Nov-13	26.6	19,800	26.8	15	16,000	17	37	16,000	< 3	39	20,000	110
26-Dec-13	34.7	4,510	20.1	32	5,900	7.5	32	5,200	< 4.3	41	5,300	18
30-Jan-14	46.6	3,370	7.88	27	5,000	9.7	27	5,100	2.5	42	5,200	13
27-Feb-14	18.5	6,000	6.41	48	9,100	5.3	36	4,500	< 4.4	41	8,400	53
27-Mar-14	47	4,330	7.76	28	13,000	9.3	35	6,000	< 4.4	42	3,400	27
30-Apr-14	47	4,330	14.4	21	1,100	12	23	4,600	< 4.5	47	5,100	34
29-May-14	35	14,800	15	26	18,000	13	35	5,000	4.8	45	14,000	69
26-Jun-14	32.6	29,600	16.8	29	34,000	24	38	5,200	< 4.6	49	17,000	46
31-Jul-14	29.4	24,700	15.3	25	29,000	19	32	6,800	< 4.3	48	17,000	12
28-Aug-14	29.9	1,800	35.3	35	11,000	25	48	7,600	< 4.2	40	13,000	14
25-Sep-14	22.1	5,880	9.22	28	29,000	35	55	12,000	< 3	57	20,000	53
Average activity (pCi/L)	33.2	12,160	15.5	28.1	15,800	17	53.9	7,200	< 4.1	45.2	12,000	42
ROD Goal[a]	*1.33E+5*	*1.04E+8*	*2.37E+5*	*1.33E+5*	*1.04E+8*	*2.37E+5*	*1.33E+5*	*1.04E+8*	*2.37E+5*	85	58,000	150

[a]ROD goals per Tables 3.5 and 3.6.

Bold value indicates sample concentration exceeds *Melton Valley ROD goal.*
Activity values are pCi/L.

FY = fiscal year
MBWEIR = Melton Branch Weir
ROD = Record of Decision
WCWEIR = White Oak Creek Weir

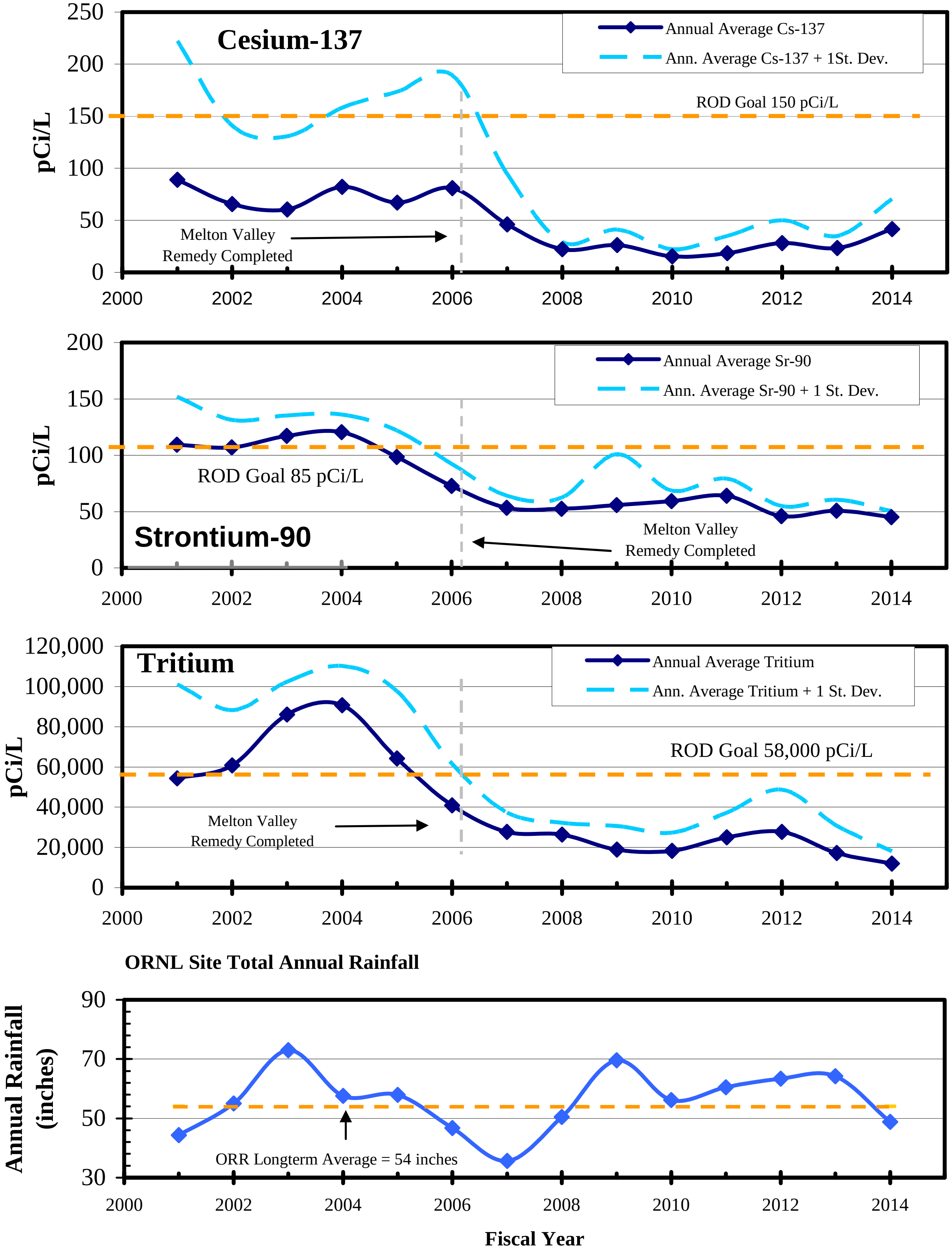


Figure 3.6. Annual average surface water activities of ^{137}Cs, ^{90}Sr, and tritium at White Oak Dam.

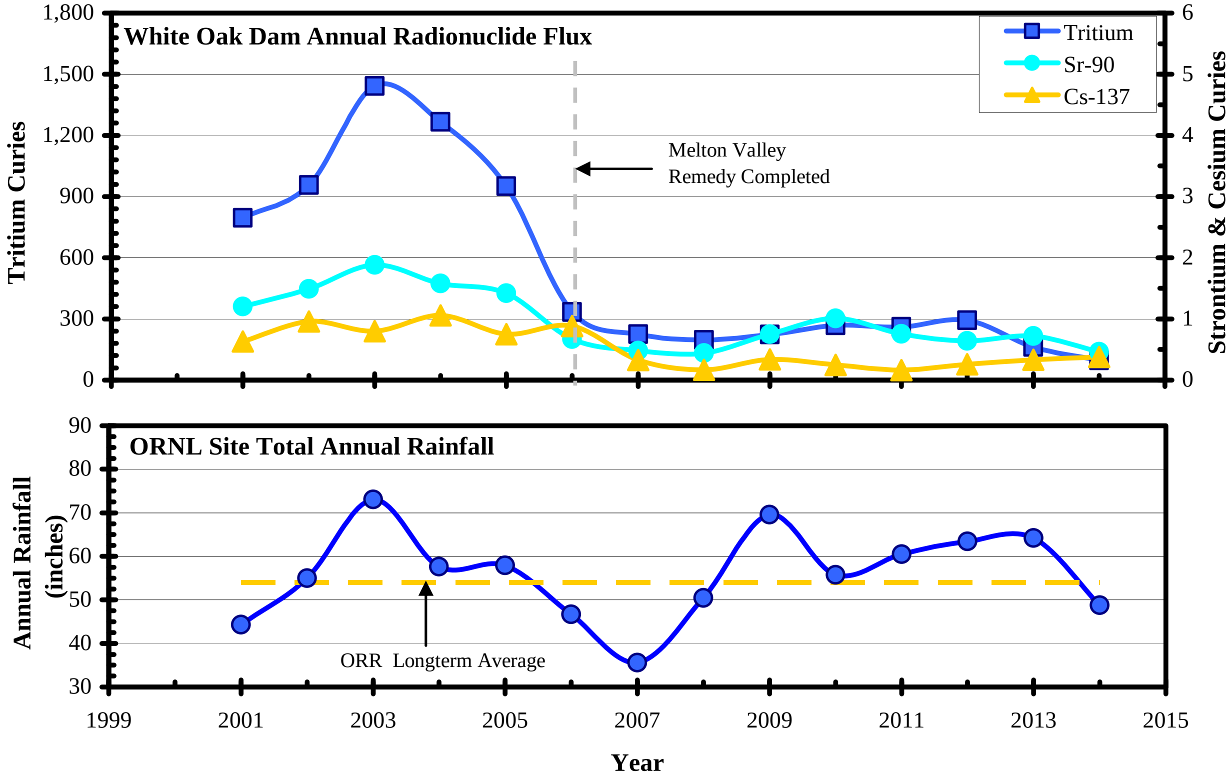


Figure 3.7. Annual radionuclide fluxes at White Oak Dam and annual rainfall at the ORNL.

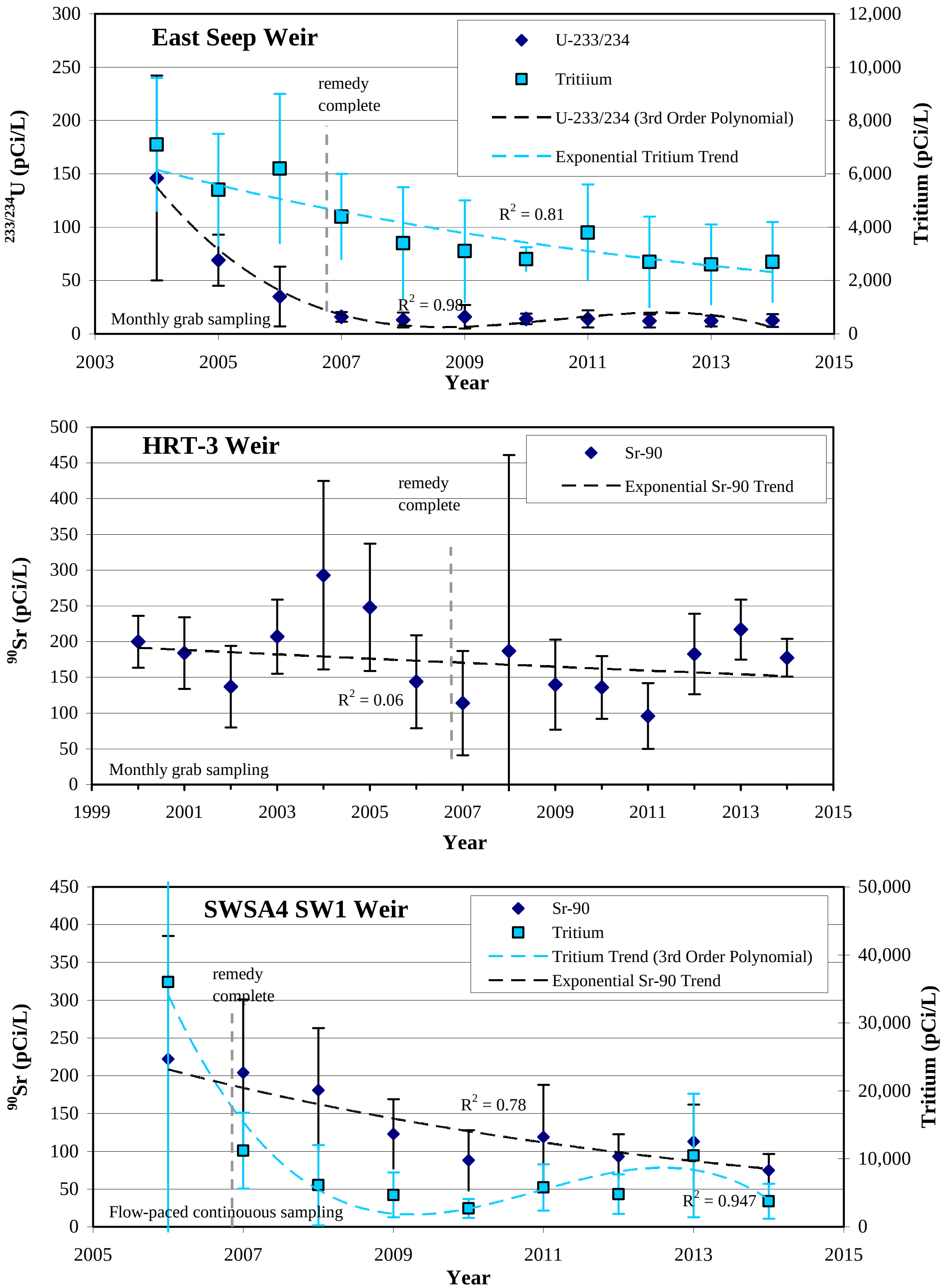


Figure 3.8. Tributary surface water average annual radionuclide activities at East Seep Weir, HRT-3 Weir, and SWSA 4 SW1 Weir.

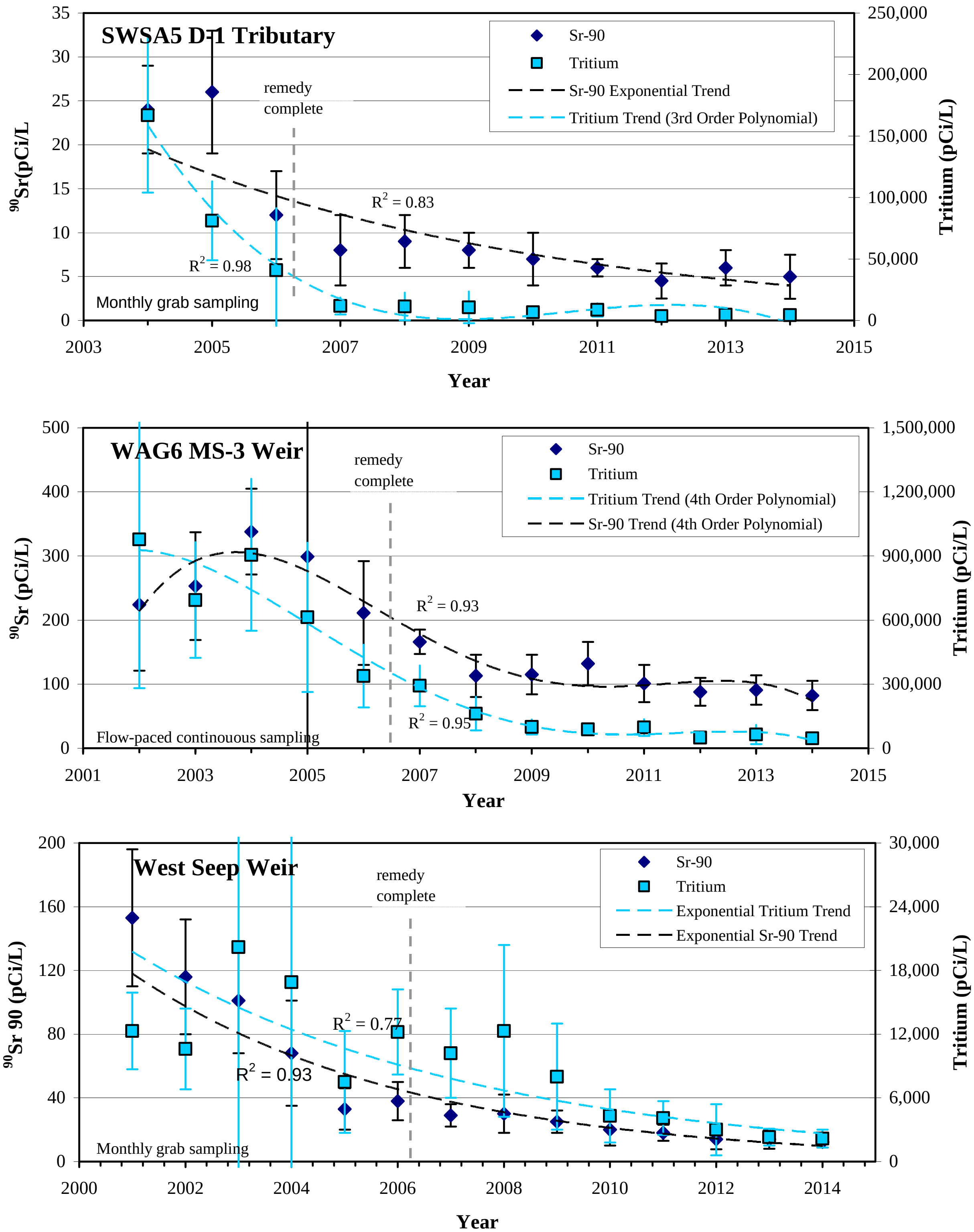


Figure 3.9. Tributary surface water average annual radionuclide activities at SWSA 5 D1-Tributary, WAG 6 MS-3 Weir, and West Seep Weir.

3.2.1.2.2 Groundwater Monitoring

3.2.1.2.2.1 Groundwater Quality Goals and Monitoring Requirements

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) RAO for groundwater is to mitigate further impact to groundwater in the waste management and industrial land use areas (Table 3.2). The ROD did not specify ARAR-based groundwater remediation levels and meeting such ARAR-based levels is not a performance objective of the ROD. Mitigation of further groundwater impacts from the Melton Valley CERCLA units was a goal of hydrologic isolation of buried waste, *in situ* grouting of Liquid Waste Seepage Trenches 5 and 7, and excavation of contaminated soils and pond sediment per the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3). 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 3.3). Groundwater level control in hydrologic isolation areas is discussed in Section 3.2.1.2.2.2.

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3). 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 results obtained to date in these areas, including SWSA 6, are discussed in Section 3.2.1.2.2.3.

3.2.1.2.2.2 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 Melton Valley. In some areas waste trenches were known to completely fill with water during winter months allowing contaminated water to run overland to adjacent streams. Contact of rainfall percolation water with buried waste materials was the source of contaminated leachate that subsequently seeped downward into the groundwater and laterally to adjacent seeps, springs, and streams.

The Melton Valley remedy utilizes multilayer caps to prevent vertical infiltration of rainwater into buried waste and 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 to WOC in Bethel Valley. Since an impermeable cutoff wall was not part of the design of the SWSA 4 downgradient trench, continuous pumping from the trench is required to maintain a groundwater capture gradient in the three-section trench to prevent contaminant discharge to the former Intermediate Holding Pond (IHP) area. At the other Melton Valley downgradient trench locations bentonite slurry walls were constructed adjacent to the groundwater capture trenches to eliminate inflows from outside the contained area.

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) includes the performance goal of reducing groundwater-level fluctuations within hydrologically isolated areas by > 75% from preconstruction fluctuation ranges (Table 3.3). 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 3.10 shows the locations where groundwater-level monitoring is conducted to evaluate hydrologic isolation performance. Wells shown within capped areas (52 wells) and along the northern edge of SWSA 4 where the upgradient stormflow diversion trench is located (three wells within or upgradient of the trench) are used to evaluate hydrologic isolation effectiveness. Six wells (in addition to the other 55 wells used to monitor caps) shown along the SWSA 4 downgradient groundwater collection trench are used to evaluate the performance of that element of the SWSA 4 remedy. 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 *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3). Fifty-two wells lie within hydrologic isolation areas and are used to evaluate groundwater fluctuations beneath caps.

During FY 2014, 90% (47 of the 52) of the wells located beneath caps and used to monitor hydrologic isolation effectiveness met their target groundwater elevations while five wells did not meet the goal – Wells 0850 and 4127 in SWSA 6, and wells 0955, 0958, and 1071 in SWSA 4. For the five locations that did not attain the ROD goal, an issue has been identified on Table 3.11 to review conditions, including potential modifications to monitoring and applicable CERCLA documentation. The reasons these wells did not attain 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. Some bedrock wells are observed to respond to head changes from areas outside hydrologic isolation structures such as caps and upgradient and downgradient seepage diversion or collection features. Elevated head conditions in bedrock beneath the buried waste areas may, or may not indicate that groundwater is upwelling beneath the caps depending on how the wells are constructed and the local bedrock and soil characteristics. This condition is observed at wells 4127 and 0850 in SWSA 6 (Figure 3.11) and at well 1071 in SWSA 4 (Figure 3.12). These three wells have exhibited periods of goal exceedance for several years. The reason wells 0955 and 0958 (Figure 3.13) at SWSA 4 did not meet target groundwater levels was because the wells are located adjacent to the SWSA 4 downgradient groundwater collection trench. During FY 2014, four of the 12 monthly groundwater level measurements at well 0955 (September through November 2013, and July 2014) met the target elevation for that location. During winter months the groundwater in well 0955 rose above the target level. During August and September 2014, rainfall amounts were extremely low (East Tennessee was reported to have had the driest September on record) and downgradient trench pumps had to be temporarily deactivated to prevent them from burning out the pump motors. During this brief pump outage groundwater levels rose and the September groundwater levels in both wells 0955 and 0958 rose above their target levels. Pumps were restored to normal operations in early October after a significant rainfall event replenished groundwater somewhat.

By design, the operation of the SWSA 4 downgradient trench relies upon maintaining lower groundwater levels within the trench compared to levels beneath the former IHP area to the east and beneath the hydrologic isolation cap to the west. If the groundwater extraction pumps installed in the gravel backfilled trench cannot pump enough water, some groundwater can escape into the surface water in the IHP area. Figure 3.14 shows hydrographs for wells constructed in the downgradient trench and in the IHP area. During the winter months, groundwater recharge is much greater than during the growing season and all the groundwater collection systems produce much more flow. Groundwater levels in the SWSA 4 downgradient trench rose to levels essentially the same as levels in the IHP area. Previous problems have occurred with the SWSA 4 downgradient trench and during FY 2013 a project was implemented to redevelop all the groundwater extraction wells in the SWSA 4 downgradient trench and replace failed pumps to improve the remedy performance. During the redevelopment process it was necessary to shut down multiple extraction pumps in the downgradient trench sections which allowed groundwater levels to rise surrounding the trench. The project was completed in February 2013.

A secondary measure of the SWSA 4 downgradient trench performance is the contaminant discharge from the IHP area as measured at SWSA 4 SW1 which is the location where surface water from the IHP area flows into WOC (data presented in previous section). During FY 2013 there was a slight increase in measured ^{90}Sr and tritium levels in the surface water at SWSA 4 SW1. During FY 2014 ^{90}Sr and tritium levels at SWSA 4 SW1 decreased compared to levels measured in FY 2013. Monitoring data from FY 2014 show that the groundwater level control in the downgradient collection trench remains challenged during winter months based both on the in-trench monitoring data and water levels measured in nearby well 0955 beneath the SWSA 4 cap.

Well 4544 in SWSA 4 has experienced two episodic groundwater level increases in response to intense rainfall events. The first event occurred in September 2012 and was reported in the 2013 RER. The second event occurred in December 2012. Well 4544 is instrumented with a continuous groundwater level monitor which captures groundwater level data at an hourly frequency. Following the December 2012 groundwater level spike, DOE conducted geophysical testing at the well location and in the surrounding area. That survey suggests that there may be a flaw in the high density polyethylene cap membrane near the well. However, in the design and construction of the Melton Valley hydrologic isolation caps, a bentonite-containing geosynthetic clay layer was installed immediately beneath the plastic membrane. The purpose of the geosynthetic clay layer is a safety feature that functions through swelling of the bentonite clay if water leaks through the plastic membrane. As the bentonite hydrates and swells, leak pathways are sealed. During FY 2014, DOE continued to monitor the data logger in well 4544 and water level fluctuations of less than 0.5 ft were observed. Based on the ongoing monitoring of well 4544 that shows no repeated groundwater incursions into the piezometer, DOE does not recommend undertaking any action at this time. DOE will continue to monitor the groundwater level continuously in well 4544 and, in the event that groundwater elevation spikes recur, the issue will be brought to the attention of FFA parties to determine a course of action.

Appendix B.3 contains a tabular summary of groundwater level monitoring results compared to target groundwater elevations. Well hydrographs showing groundwater level responses during FY 2007 through FY 2014 are also included in Appendix B.3.

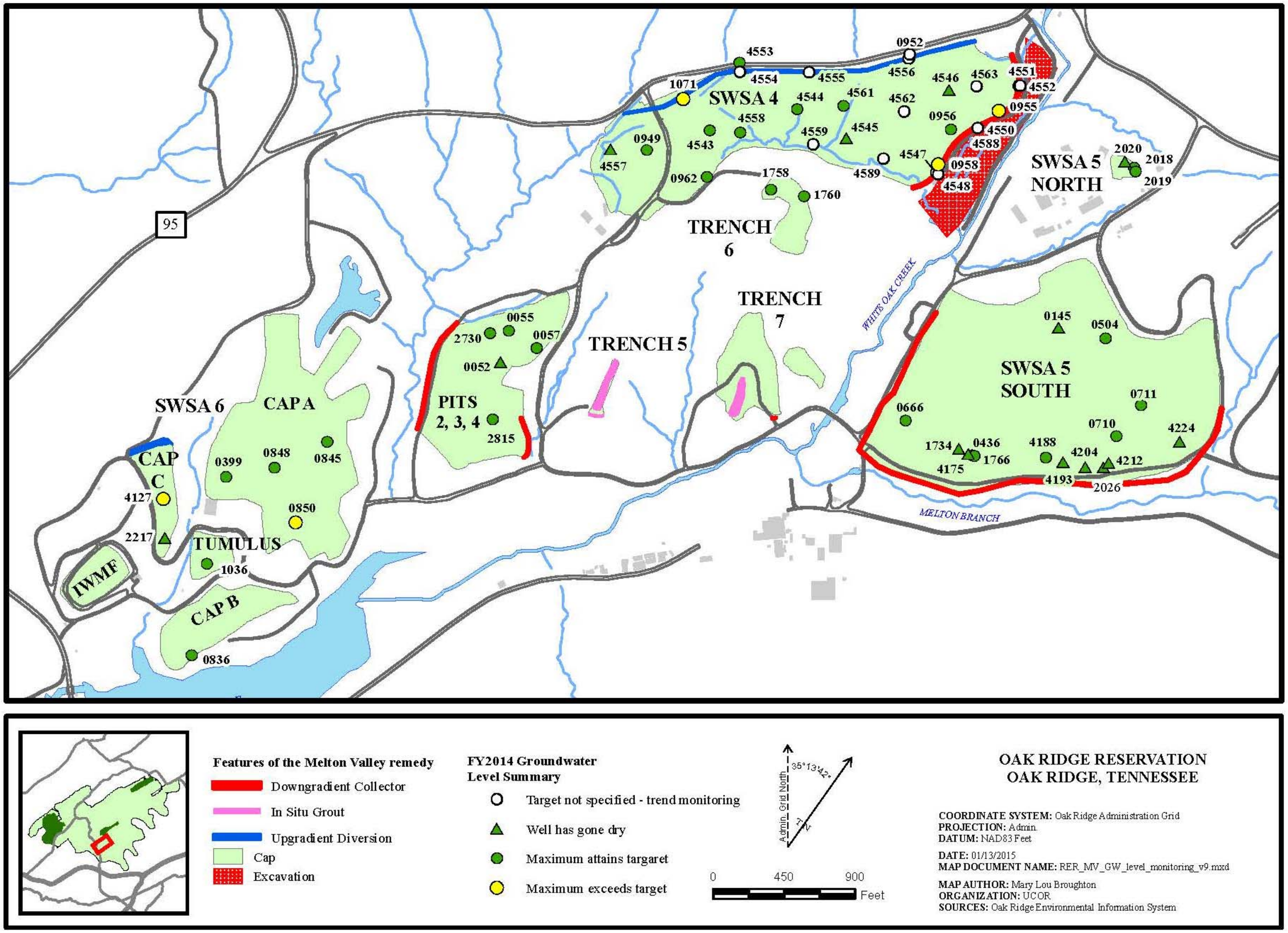


Figure 3.10. Summary of groundwater-level monitoring results for FY 2014.

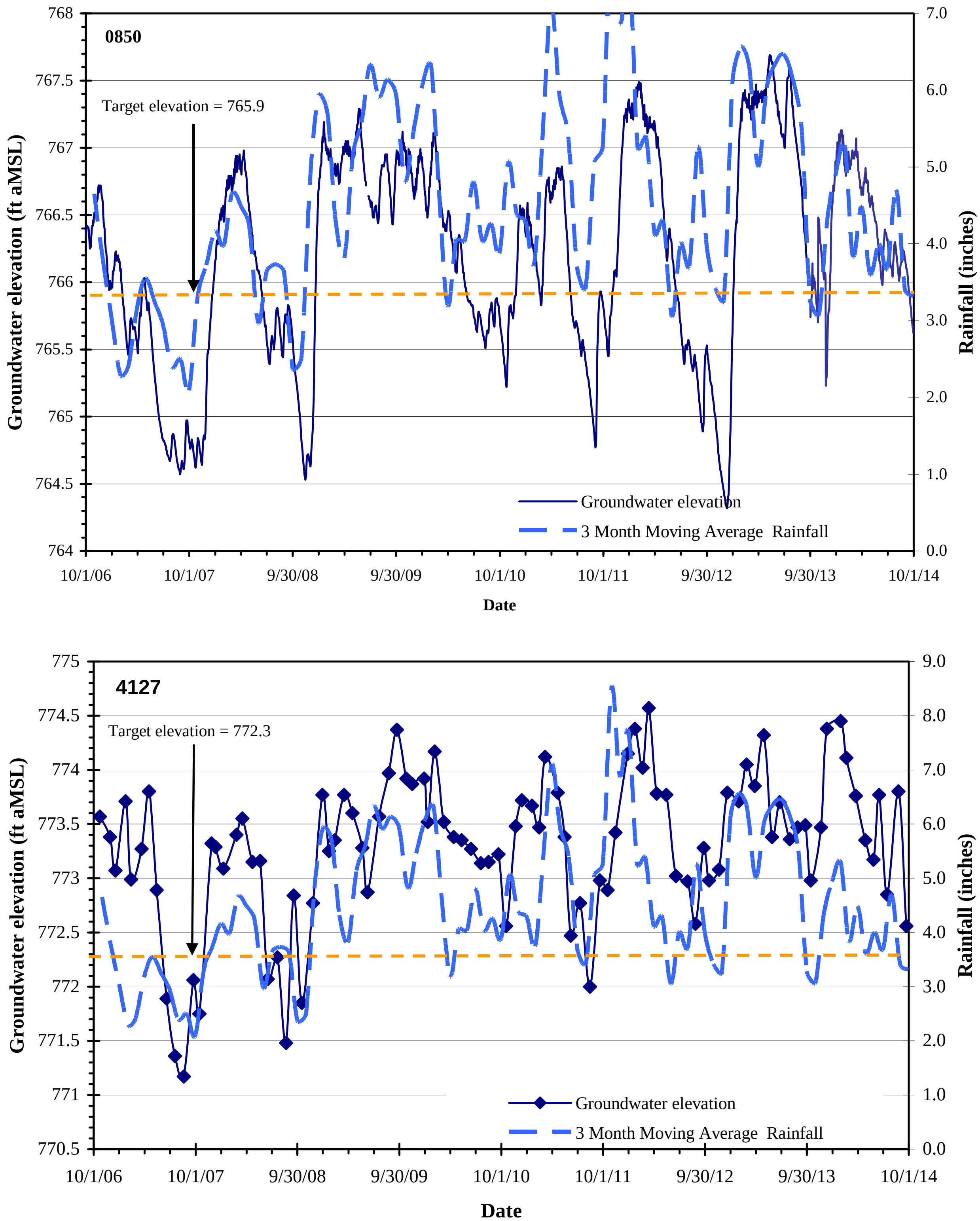


Figure 3.11. Hydrographs for wells 4127 and 0850 for FY 2007 – FY 2014.

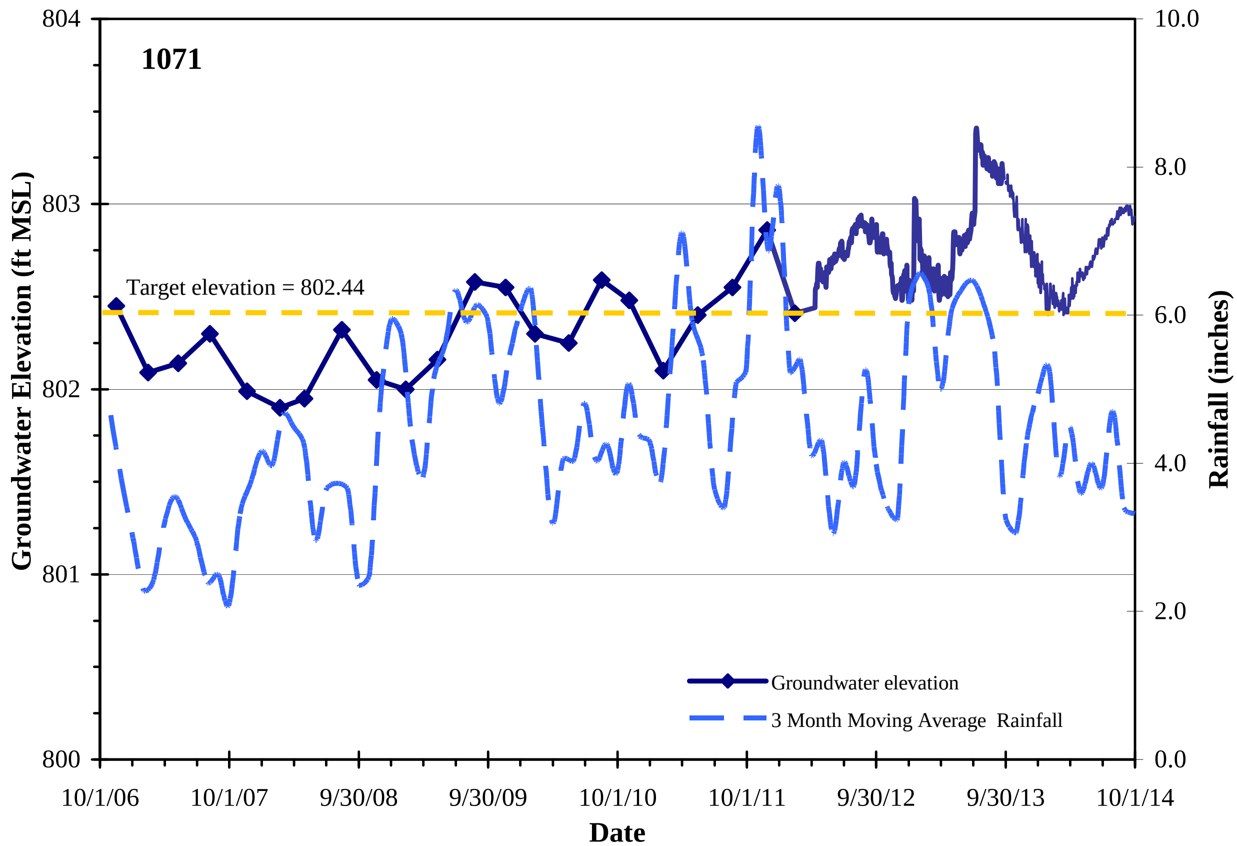
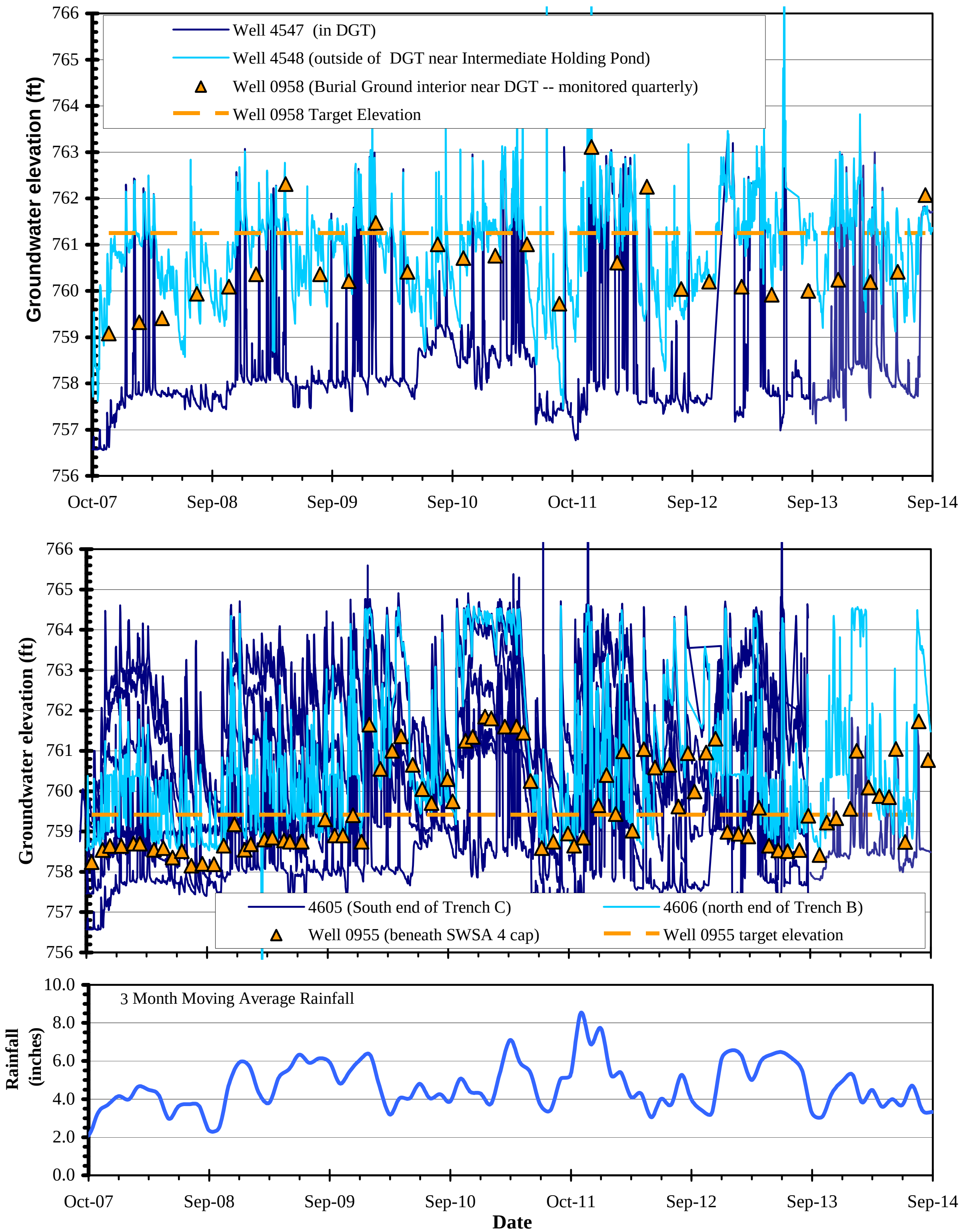


Figure 3.12. Hydrograph for well 1071.



DGT - downgradient trench IHP = Intermediate Holding Pond SWSA = solid waste storage area

Figure 3.13. Hydrographs of wells in SWSA 4, the downgradient trench, in the former IHP area.

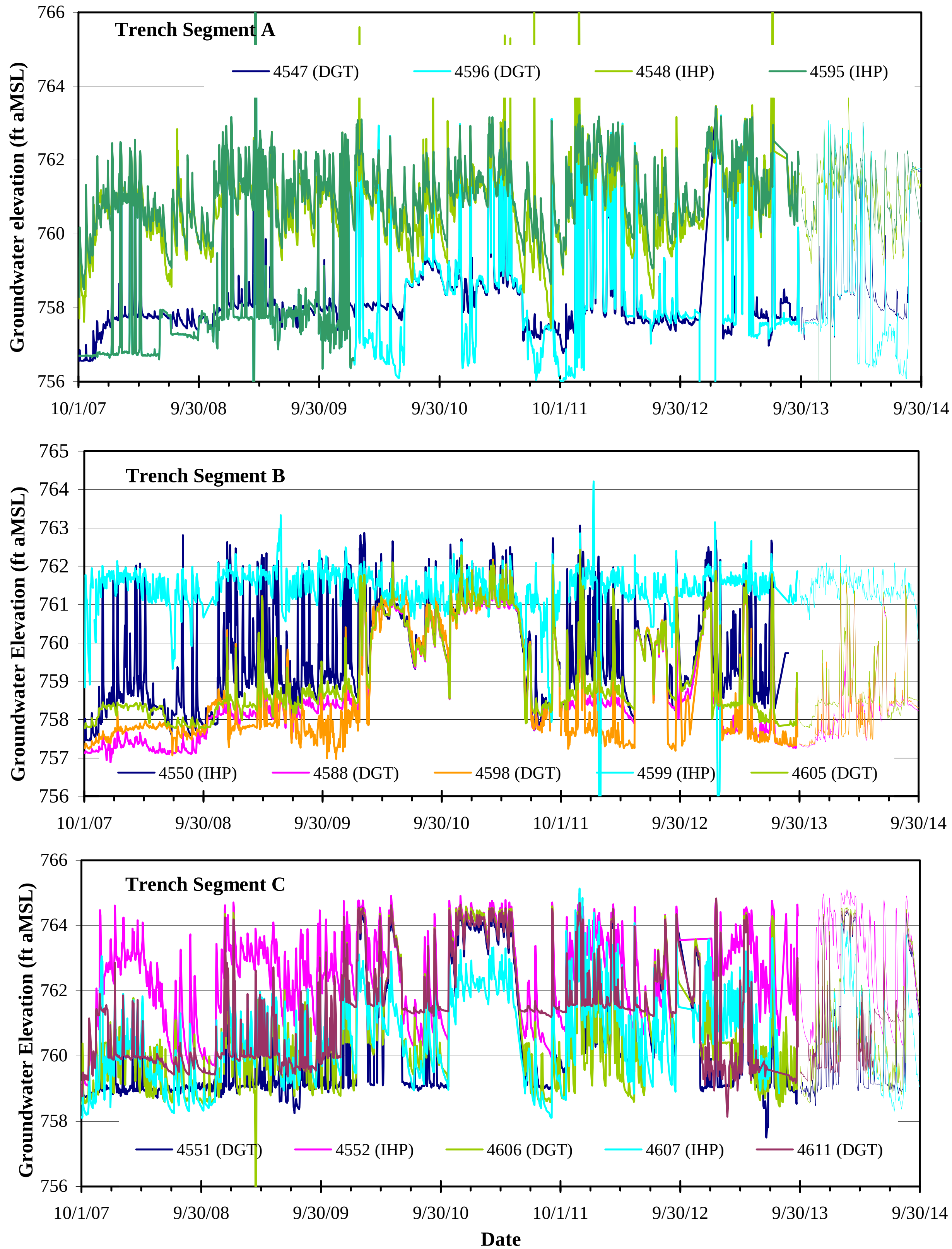


Figure 3.14. Hydrographs from piezometers monitoring the SWSA 4 downgradient trench performance.

3.2.1.2.2.3 Groundwater Quality

Groundwater monitoring is conducted for CERCLA remediation effectiveness evaluation in Melton Valley 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 under CERCLA. As discussed in Section 3.1.2, the CERCLA program provides RCRA-equivalent post-closure care of the unit through compliance with RCRA substantive requirements.

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 of LLLW Seepage Trenches 5 and 7.

Figure 3.15 shows the locations of wells that are monitored at the Pits and Trenches area. Monitoring of these wells was started prior to conducting the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) RAs. At Pits 2, 3, and 4, the remedy consisted of constructing a multi-layer hydraulic isolation cap over the three large seepage basins and constructing groundwater collection trenches along the western and eastern cap edges to collect contaminated groundwater. At Trenches 5 and 7 in situ grouting was used to fill voids in the gravel-filled trenches and reduce permeability of the surrounding soil. After grouting was complete, hydrologic isolation caps were constructed over the trench area at Trench 5 and over the trench and adjacent contaminated soil areas at Trench 7. A small groundwater seepage collections trench was constructed at the mouth of a valley on the east side of Trench 7 where a radiologically contaminated seep had previously existed.

Groundwater contaminants of concern at the Seepage Pits and Trenches are primarily radionuclides. Principal radionuclides detected at the Seepage Pits and Trenches include ^{14}C, ^{60}Co, ^{90}Sr, ^{99}Tc, tritium, ^{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 effect on carbon, this contaminant is detected in many wells near the Pits and Trenches. The highest levels of groundwater contamination in the Seepage Pits and Trenches area occur in the immediate vicinity of Trenches 5 and 7. Table 3.8 includes a summary of radiological contaminants for 14 wells in the Pits and Trenches area where radiological contaminants exceed risk-based screening criteria. Included in the table are the location of the well with respect to its contaminant source, the well number, principal radiological contaminants in the well, the average pre-remediation (February 2004 – September 2006) activity level, the average FY 2014 activity level, and the ratio of FY 2014 activity to pre-remediation activity (which indicates the factor by which contaminant levels have changed since remediation). Table 3.8 identifies the trend of radionuclide activity levels based on the 10 most recent analytical results per analyte per well during the post-remediation time period (January 2008 through September 2014) based on the Mann-Kendall non-parametric trend evaluation approach. This approach to trend evaluation analyzes the cumulative direction (increasing, decreasing, or stable) of concentration change of an analyte through time. The Mann-Kendall method requires at least four results for a parameter to conduct the trend evaluation. Sufficient data for trend analysis were available for all applicable contaminants. The method provides a 90% confidence level that the trend is significant. It is noted that the post-remediation trend is not related to the ratio of FY 2014/pre-remedy activity levels for the well. The trend is restricted to the post-remediation behavior of radiological contamination.

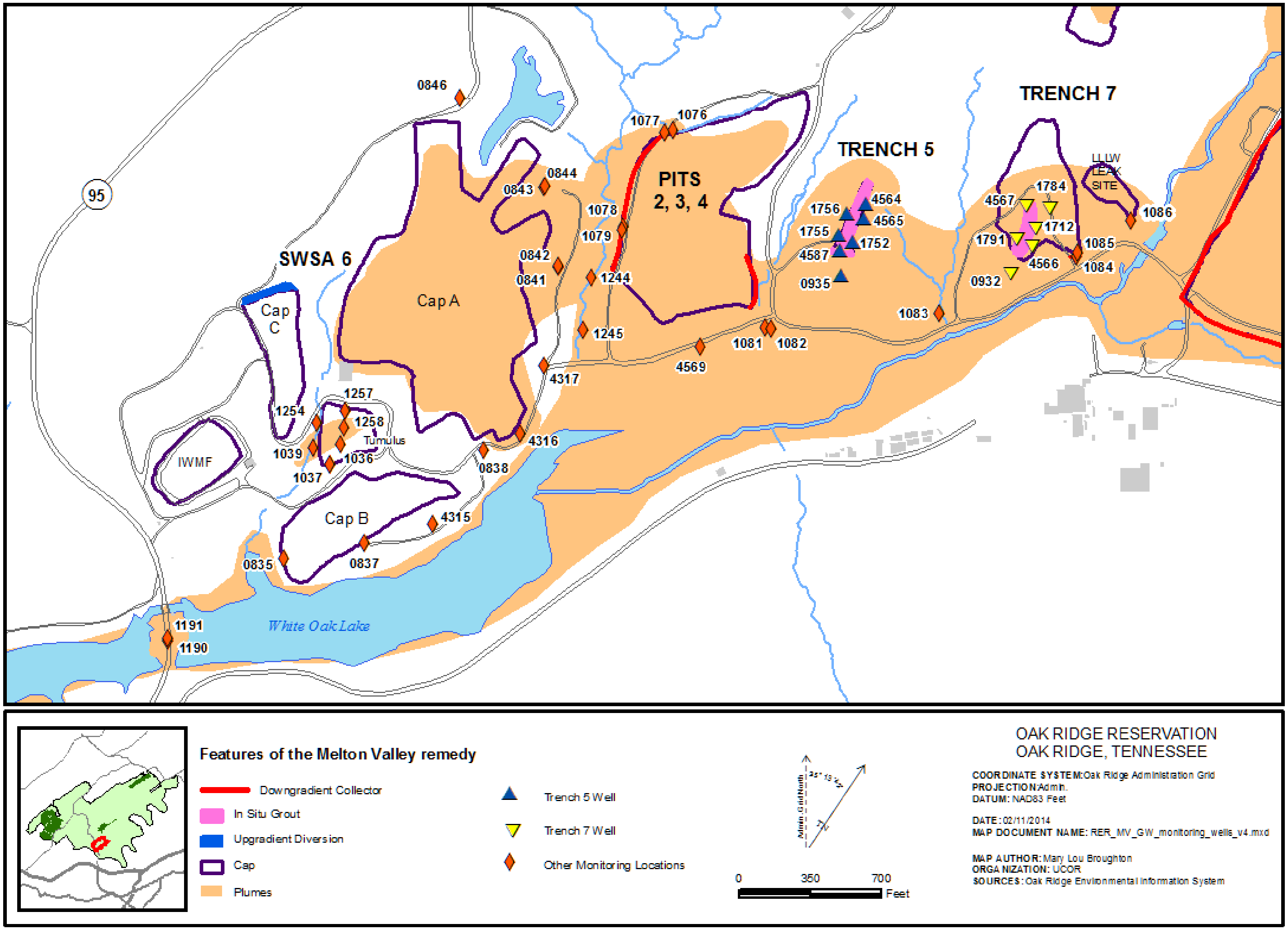


Figure 3.15. Locations of wells monitored in the vicinity of the Seepage Pits and Trenches and SWSA 6.

Table 3.8. Summary of radiological groundwater contaminants detected at Seepage Pits and Trenches

Area	Well	Contaminant	Average Activity (pCi/L)		Ratio (FY 2014/Pre.)	Exceeds SL	M-K Post-Remedy
			Pre-rem.	FY 2014			
Pits 2, 3, 4	1079	Alpha activity	478	208	0.4	MCL	Stable
Pits 2, 3, 4	1079	Tritium	130,333	79,300	0.6	MCL-DC	Decreasing
Pits 2, 3, 4	1079	$^{233/234}U$	264	205	0.8	Residential	Decreasing
Trench 5	0935	Tritium	38,000	24,475	0.6	MCL-DC	Decreasing
Trench 5	1752	Alpha activity	932	1,078	**1.2**	MCL	Increasing
Trench 5	1752	^{14}C	246,667	77,400	0.3	Industrial	Stable
Trench 5	1752	^{99}Tc	28,100	5,715	0.2	MCL-DC	Stable
Trench 5	1752	^{232}U	66.7	233	**3.5**	Industrial	Increasing
Trench 5	1752	$^{233/234}U$	593	946	**1.6**	Industrial	Increasing
Trench 5	1752	^{238}U	74.1	91.4	**1.2**	Residential	Increasing
Trench 5	1755	Alpha activity	1,687	1,284	0.8	MCL	Stable
Trench 5	1755	^{14}C	109,700	30,500	0.3	Industrial	Decreasing
Trench 5	1755	^{99}Tc	4,176.7	1,455	0.3	MCL-DC	Decreasing
Trench 5	1755	^{232}U	150	155	1	Industrial	Stable
Trench 5	1755	$^{233/234}U$	884	1,485	**1.7**	Industrial	Stable
Trench 5	1755	^{238}U	111	125	**1.1**	Residential	Stable
Trench 5	1756	Alpha activity	2,464	389	0.2	MCL	Stable
Trench 5	1756	^{14}C	59,700	12,095	0.2	Industrial	Stable
Trench 5	1756	^{99}Tc	4,403	1,217	0.3	MCL-DC	Stable
Trench 5	1756	^{232}U	189	57	0.3	Industrial	Stable
Trench 5	1756	$^{233/234}U$	1,416	361.0	0.3	Industrial	Stable
Trench 5	4564	Alpha activity	73.5	29.8	0.4	MCL	Decreasing
Trench 5	4564	^{14}C	33,467	8,725	0.3	Residential	Stable
Trench 5	4565	^{14}C	57,600	15,258	0.3	Industrial	Stable
Trench 5	4565	^{99}Tc	3,664	1,056	0.3	MCL-DC	Stable
Trench 5	4587	Alpha activity	55.4	121	**2.2**	MCL	Stable
Trench 5	4587	^{14}C	34,700	28,000	0.8	Industrial	Decreasing
Trench 5	4587	^{99}Tc	8,150	1,975	0.2	MCL-DC	Decreasing
Trench 5	4587	$^{233/234}U$	22.3	106.1	**4.8**	Residential	Stable
Trench 7	1084	^{14}C	38,400	6,258	0.2	Residential	Decreasing
Trench 7	1086	^{90}S	14.2	12.9	0.9	MCL-DC	Stable
Trench 7	1712	Alpha activity	290	314	**1.1**	MCL	Stable
Trench 7	1712	^{14}C	59,500	30,525	0.5	Industrial	Decreasing
Trench 7	1712	^{232}U	34.7	114.3	**3.3**	Industrial	Increasing
Trench 7	1712	$^{233/234}U$	215	240	**1.1**	Industrial	Stable
Trench 7	1784	Alpha activity	54	22	0.4	MCL	Increasing
Trench 7	1784	^{14}C	16,400.0	7,242.5	0.4	Residential	Stable

Table 3.8. Summary of radiological groundwater contaminants detected at Seepage Pits and Trenches (cont.)

Area	Well	Contaminant	Average Activity (pCi/L)		Ratio (FY 2014/Pre.)	Exceeds SL	M-K Post-Remedy
			Pre-rem.	FY 2014			
Trench 7	1791	Alpha activity	7	45	**6.8**	MCL	Stable
Trench 7	1791	^{14}C	27,300	14,025	0.5	Industrial	Decreasing
Trench 7	1791	^{99}Tc	898	14,950	**16.6**	MCL-DC	Stable
Trench 7	4566	Alpha activity	51.0	21.3	0.4	MCL	Stable
Trench 7	4566	^{14}C	148,467	43,450	0.3	Industrial	Stable
Trench 7	4566	^{60}Co	2,743	732	0.3	Residential	Decreasing
Trench 7	4566	^{99}Tc	1,250	1,470	**1.2**	MCL-DC	Stable

Notes: Bold type indicates a ratio that is > 1.

Quantitative trend analysis based on M-K Test of time-series sampling/analysis results for a maximum of ten sampling events (counting backward from the most recent sampling date) of post-remedy data (after January 2008). Based on the methodology described in Gilbert (1987) and Wiedemeier et al. (1999), a non-detect analytical result reported for well 4566 (alpha activity) was replaced with the MDA as a surrogate value for M-K Test purposes. The M-K Test statistic (S) for each time series trend is calculated and plotted on a 90% confidence level chart. When the calculated S statistic (positive or negative) plots within the equivalent 90% confidence interval for the applicable number of sampling events, the time-series data define an *Increasing* trend if S > 0, or a *Decreasing* trend if S < 0. The time series data define a *Stable* trend if the S statistic does not plot within the equivalent 90% confidence interval and the associated CV is < 1, whereas *No Trend* is evident if the CV is > 1.

CV = coefficient of variation
FY = fiscal year
Industrial = industrial scenario 1E-4 risk-based activity
M-K = Mann-Kendall
MCL = maximum contaminant level
MCL-DC = maximum contaminant level derived concentration
MDA = minimum detectable activity
Residential = residential scenario 1E-4 risk-based activity
SL = screening level

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) did not specify target groundwater contaminant levels or ARAR-based performance goals but stated that the remedy should “Mitigate further impact to groundwater” (Table 3.2). To provide a sense of risk levels associated with the detected radionuclides, FY 2014 contaminant levels are compared to four screening criteria: SDWA MCLs and MCL-DCs **(**8 pCi/L for ^{90}Sr, 900 pCi/L for ^{99}Tc[2], and 20,000 pCi/L for tritium), 1E-4 risk equivalent activities for industrial (based on Risk Assessment Information System [RAIS] risk calculator) or residential (based on EPA regional screening levels) water use scenarios. Risk-based criteria of the residential scenario are lower than for the industrial scenario, so if a radionuclide exceeds the industrial screen it also exceeds the residential screen. Conversely, in Table 3.8, those radionuclides that are identified as exceeding the residential screen do not exceed the corresponding industrial screen level. The analytical suite for all the wells at the Seepage Pits and Trenches is uniform. For wells and/or analytes not included in Table 3.8, analytical results may be either not detected or do not exceed any of the listed screening criteria.

Significant radionuclide reductions have occurred at most of the wells where screening criteria are exceeded. The median ratio of FY 2014 to pre-remediation levels was 0.5 which is consistent with previous levels since FY 2011, indicating an overall reduction of groundwater contaminant levels in the area of a factor of two. Forty-four combinations of locations and constituents are included in trend

[2]This MCL-DC is the average annual concentration assumed to produce a total body or organ dose of 4 mrem/yr (which is the MCL for beta particle and photon radioactivity), as calculated using the 168 hour data list in the National Bureau of Standards Handbook 69, as amended August, 1963, Department of Commerce, which is incorporated by reference into 40 CFR 141.66(d)(2).

evaluation at the end of FY 2014. Of those 44 trends, 26 are stable, 12 are decreasing, and six are increasing compared to 10 that were increasing as of the end of FY 2012, and five at the end of FY 2013. The reduction of increasing trends noted at the end of FY 2014 compared to the end of FY 2012 and the stable ratio of pre-remedy to current year contaminant ratios indicates that groundwater contaminant levels in the Seepage Pits and Trenches area are fairly stable. Of the six post-remediation trends that are increasing, two are for alpha activity in wells 1752 and 1784, three are for uranium isotopes in well 1752 (that cause the increasing alpha activity), and one is for ^{232}U in well 1712 at Trench 7. Although the cause of these increases is not known, possible factors may include changes in groundwater flow patterns beneath the capped areas covering Trenches 5 and 7 and/or effects of fluids displaced during the grouting process at those trenches. These wells are located on the eastern sides of Trench 5 (well 1752) and Trench 7 (wells 1712 and 1784). Groundwater levels in these wells that exhibit increasing contaminant trends are lower than groundwater elevations in wells along the western sides of the trenches which suggests that the affected groundwater seeps eastward. In the case of well 1752, the likely discharge area for the groundwater seepage would be into the surface water in the stream at WCTRIB-1. Contaminant concentrations in that stream have decreased since Trench 5 remediation. In the case of the two wells at Trench 7, the likely discharge area is beneath the extended Trench 7 cap to the east where a groundwater collection trench and sump was installed to capture contaminated groundwater and route it to treatment. No apparent impact is evident in adjacent monitoring areas. Monitoring of these wells will continue consistent with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1982&D3).

Three tributaries to WOC originate in, or receive water from the Seepage Pits and Trenches, as shown on Figure 3.5. Review of the surface water tributary monitoring (Section 3.2.1.2.1.3, Figures 3.8 and 3.9) shows that levels of radiological contamination have decreased at the West Seep Creek and East Seep sampling locations. The location shown as T7-TRIB on Figure 3.5 is the location of a former seep that formerly contained ^{60}Co and was the subject of investigations in the 1980s. During Melton Valley closure, a groundwater collection system was installed to capture residual groundwater seepage in the area, and the entire area was capped. Thus, no more seepage occurs to WOC. The WOC TRIB-1 location is sampled during the year prior to each CERCLA FYR. The most recent FYR showed that contaminant levels there have also diminished since site closure.

SWSA 6 Groundwater Monitoring Results

SWSA 6, located at the DOE ORNL facility, is a closed shallow land burial site for LLW and other waste types. SWSA 6 was included in the EPA NPL for cleanup under CERCLA. Portions of SWSA 6 were determined to have received hazardous waste after November 1980 and, therefore, those portions of the site have been regulated under RCRA since 1986, when the determination was made that hazardous materials had been disposed.

The site was placed in interim status under RCRA awaiting final closure in a comprehensive action (the Melton Valley CERCLA Closure Project) that addressed both the RCRA and CERCLA waste units in SWSA 6. To reduce contaminant releases from the RCRA units during the interim status period, in 1988 – 1989 the areas were capped with synthetic membrane caps to prevent rainwater percolation into the buried waste.

Final site closure was accomplished in 2006 when CERCLA remedial actions specified for Melton Valley, including closure of SWSA 6, were completed. The Melton Valley CERCLA remedial actions at SWSA 6 included construction of permanent caps over all the RCRA waste disposal units, as well as most other buried waste units within the waste disposal area. The cap design and construction are RCRA compliant. SWSA 6 closure design and as-built constructed features are documented in the *Phased*

Construction Completion Report for Hydrologic Isolation at Solid Waste Storage Area 6 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee (DOE/OR/01-2285&D1).

As discussed in Section 3.1.2, annual reporting for SWSA 6 has been discontinued under RCRA but will be included in the annual RER. Former RCRA groundwater monitoring requirements for SWSA 6 have been incorporated into the CERCLA watershed-scale monitoring plan (*Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* [DOE/OR/01-1982&D3]). Annual reporting of the groundwater monitoring results for SWSA 6 will focus on monitoring results where constituents of concern are detected.

Groundwater monitoring at SWSA 6 conducted by the WRRP is a continuation of the monitoring previously prescribed for the site by RCRA requirements. The SWSA 6 groundwater monitoring program consists of sampling 10 wells formerly used for RCRA monitoring (Figure 3.15) around the perimeter of SWSA 6 with analysis for VOCs and lead that were designated as hazardous constituents regulated under RCRA. Well 0838 on the SWSA 6 perimeter is sampled to monitor groundwater quality at the mouth of a small valley near the location of a now inactive former surface water monitoring station and was not included in former RCRA monitoring. In addition, radiological constituents and other constituents are analyzed in selected wells at the site to monitor site discharges. Well 0846 is the designated upgradient well for SWSA 6 monitoring. The principal detected contaminants are VOCs, carbon tetrachloride and its degradation product chloroform, and TCE and its degradation products cis-1,2-DCE and 1,2-dichloroethane (DCA). VOCs were disposed in a number of areas in SWSA 6. One area in the eastern portion of the site is the likely source of VOCs detected since site perimeter groundwater monitoring started in the late 1980s. These constituents are detected regularly in wells 0841 and 0842, located on the eastern boundary of SWSA 6. Wells 0841 and 0842 comprise a well pair that includes a bedrock well and a shallower well that monitors groundwater at and above the soil/bedrock interface. Well 0841 monitors groundwater in bedrock at the depth of 36.5 to 56.5 ft bgs, while well 0842 is shallower with a screened interval between 8 and 28 ft bgs.

Figure 3.16 includes monitoring results of VOCs in well 0841 as well as the TCE monitoring history from well 0842. TCE, 1,2-DCA, and carbon tetrachloride are the three chlorinated VOCs in well 0841 that have exceeded their MCLs. In the early monitoring history of well 0841 none of these VOCs were detected. In the late 1990’s TCE became detectable followed by 1,2-DCA and carbon tetrachloride. TCE concentrations increased rapidly in 2000 and 2001 and have decreased somewhat to levels that vary seasonally within a range of about 50 µg/L to 130 µg/L. The 1,2-DCA and carbon tetrachloride fluctuate at concentrations 1 – 2 times their 5 µg/L MCL. Other VOCs that are detected in well 0841 at concentrations less than their MCLs include chloroform, tetrachloroethene (PCE), and cis-1,2-DCE.

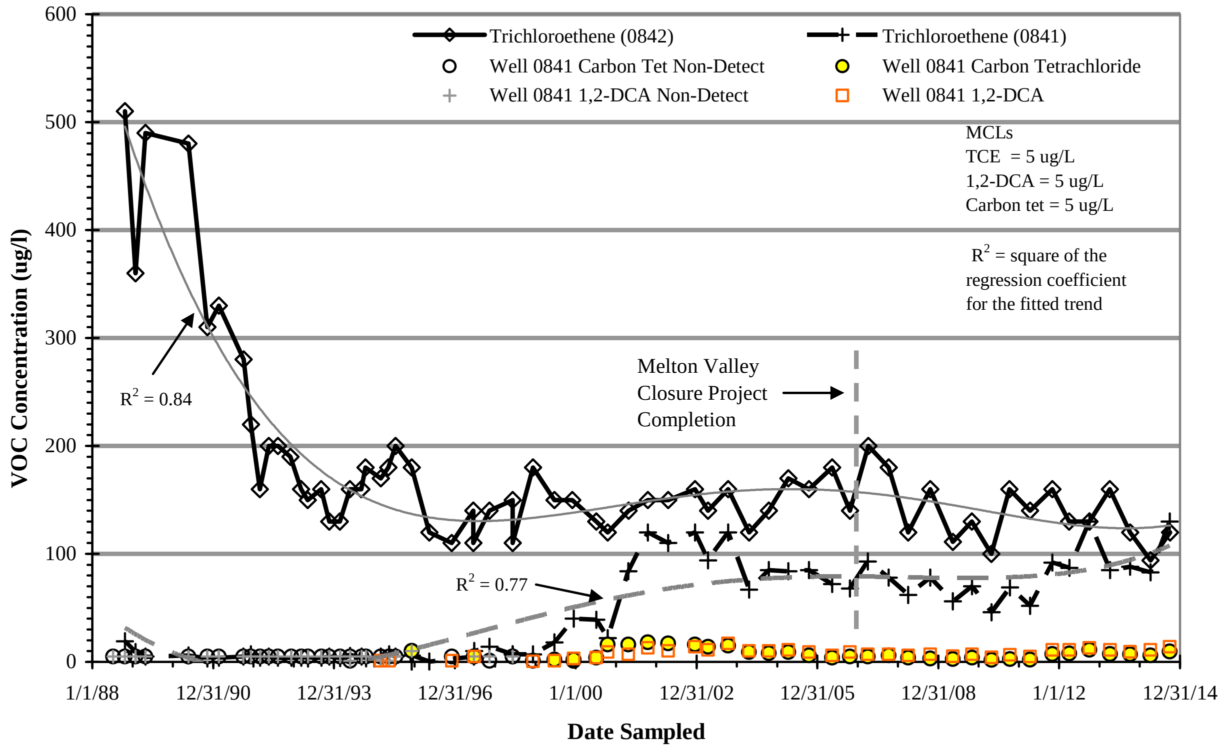


Figure 3.16. Long-term monitoring results for VOCs in SWSA 6 well 0841 and TCE in well 0842.

Figure 3.17 shows the results of long-term monitoring of TCE, carbon tetrachloride, and 1,2-DCA in well 0842. Concentrations of these three VOCs have decreased since the early monitoring period although the concentrations appear to have stabilized within fluctuation ranges of about factors of 2 times since the site closure was completed in 2006. Concentrations of carbon tetrachloride and 1,2-DCA are at approximately twice their MCLs while the TCE concentrations remain more than 20 times the MCL. Well 0842 has had consistently higher TCE concentrations than well 0841 and TCE concentrations in well 0842 have decreased from levels near 500 µg/L in the late 1980s to levels between 100 – 200 µg/L since about 1992. Measured TCE concentrations fluctuate seasonally with higher TCE concentrations typically measured in dry season samples and lower concentrations measured in wet season samples. This fluctuation pattern suggests that recharge of groundwater during the wet season creates a dilutional effect in the groundwater system monitored in these two wells. Following completion of hydrologic isolation of the SWSA 6 waste burial areas, the TCE concentration measured in well 0842 began to decrease somewhat.

The only other well monitored at the perimeter of SWSA 6 that contains measureable chlorinated VOCs is well 0843. During FY 2014 the only detected VOC in well 0843 was cis-1,2-DCE which was present at concentrations less than 3 µg/L. The MCL for cis-1,2-DCE is 70 µg/L.

Lead is also a contaminant of concern in SWSA 6 because of disposal of lead (not lead used as a shielding material). Lead has been detected in groundwater at low concentrations occasionally along the southern edge of SWSA 6. Samples from the SWSA 6 perimeter wells were analyzed for lead and it was detected in both semiannual samples from well 4315 at concentrations of 9.8 and 3.6 µg/L in April and October 2014, respectively. The action level for lead in drinking water is 15 µg/L.

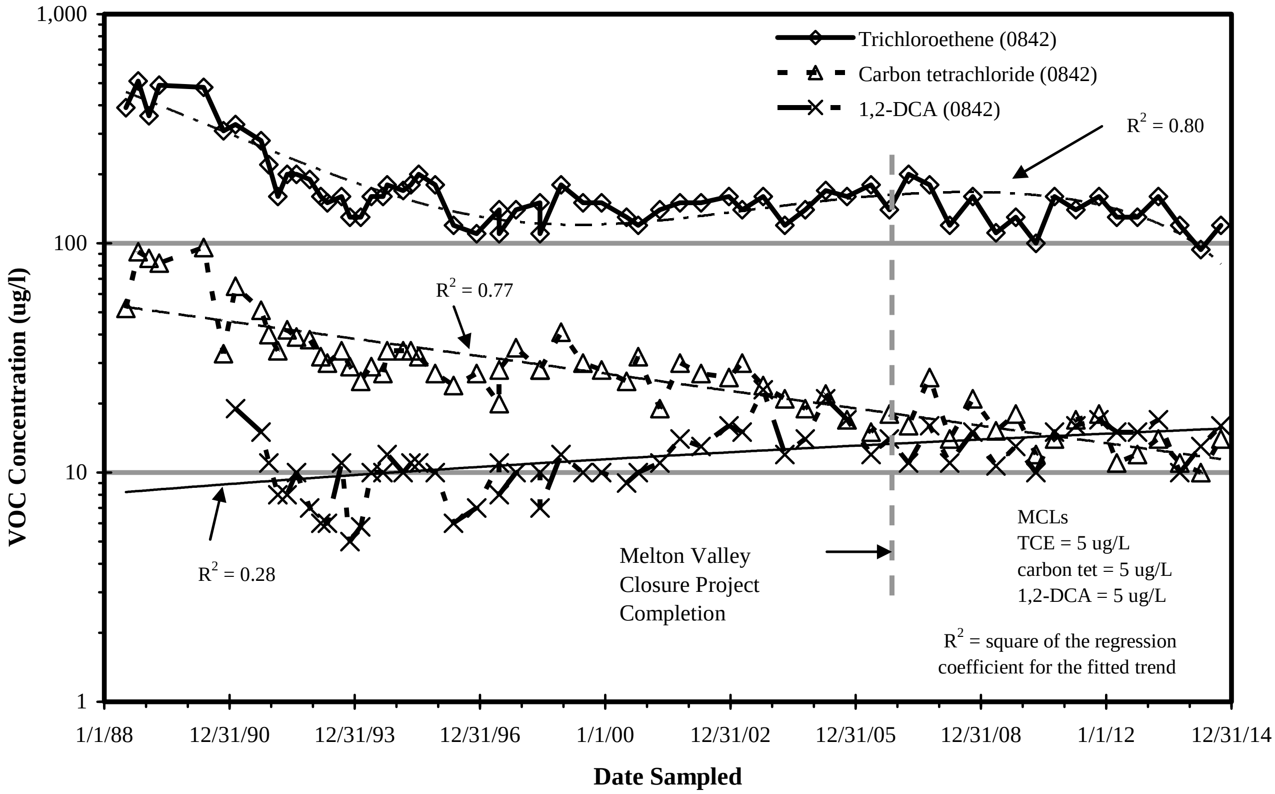


Figure 3.17. Long-term monitoring results for VOCs in SWSA 6 well 0842.

CERCLA radiological monitoring of groundwater is also conducted in these wells. The principal and most mobile radionuclide detected in groundwater is tritium. The highest tritium activities in the RCRA well network are measured in wells 0841, 0842, 0843, 0844, and 4316 along the eastern site boundary. Tritium activity trends exhibit long-term decreases in wells 0841, 0842, and 0843 and in wells 0841 and 0842 levels have decreased to below the MCL-DC of 20,000 pCi/L. Tritium in well 0844 exhibited a long-term increasing trend from 1995 through the spring of 2011 but has decreased through FY 2014. Tritium activity in well 4316 doubled in the period between 1994 and 2008 and has decreased nearly 50% from levels measured in 2008. The groundwater contaminant trends along the eastern edge of SWSA 6 suggest that contamination in bedrock wells is susceptible to trends that started long before Melton Valley closure and those trends are slowly responding to the burial ground capping.

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 3.15) at the Tumulus are sampled to measure the groundwater tritium trends. Graphs of the tumulus area groundwater tritium monitoring data are included in Appendix B.4. Wells 1036 and 1258 exhibit the highest tritium levels. The trend observed at well 1036 appears to have stabilized between 2010 and 2014 at levels around 200,000 pCi/L while tritium levels in well 1258 have been decreasing since the fall of 2010. The tritium level in Well 1039 has shown a slight increase in latter FY 2013 and 2014 following a long period of fairly stable levels near or less than the MCL-DC of 20,000 pCi/L. The overall behavior of tritium in groundwater beneath and adjacent to the Tumulus cap suggests that tritium levels essentially stabilized beneath the capped area and levels are decreasing near and outside the cap.

The reduction in tritium discharges from the Tumulus is a significant component of the decrease in tritium measured in surface water at WAG 6 MS3 which is located nearby (Figure 3.5). The reader is referred back to Section 3.2.1.2.1 for the surface water data presentation.

Melton Valley On-site Exit Pathway and Off-site Wells

On-site exit pathway and off-site groundwater monitoring includes monitoring of wells 1190 and 1191 that are located on White Oak Dam, monitoring of six deep on-site exit pathway wells plus a cluster of three wells between the Clinch River and the western edge of SWSA 6, and monitoring of off-site wells located southwest of the Clinch River (Figure 3.19).

- Wells 1190 and 1191 are about 47 and 26 ft deep, respectively, and are located near the centerline of White Oak Dam. Well 1190 is constructed to monitor groundwater in bedrock at elevation 708 – 718 ft mean sea level (MSL), the upper limit of 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 zone beneath the dam at elevations from 724 – 743 ft MSL, which is approximately equivalent to elevations of the WOCE and the channel of the Clinch River. Tritium and ^{90}Sr are the principal contaminants detected in these wells. Figure 3.18 shows the activity histories from about 1990 through FY 2014 and Figures 3.15 and 3.19 show the location of the wells. In the past tritium levels in well 1191 were higher than those in well 1190 although levels have been decreasing in both wells. In FY 2013 and 2014 the tritium levels in both wells became quite similar at levels near about 1.5 times the 20,000 pCi/L MCL-DC. This convergence of tritium concentrations between the shallower well and the deeper well is a reflection of the overall, long-term reduction of tritium that is present in the WOC aquatic system. The well 1191 tritium data show a nearly 10-fold decrease in levels since the early 1990s. Strontium-90 is not detected in well 1190, which is the deeper, bedrock well. In well 1191, ^{90}Sr has attained near steady-state concentrations since about 2004 at an average of about 150 pCi/L with a standard deviation of about 25 pCi/L.

- As part of the *ROD for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3), in 2004 six groundwater monitoring wells were installed in the western end of Melton Valley to serve as on-site exit pathway 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 White Oak Dam. Locations of these wells are shown on Figure 3.19. Three wells (1008, 1009, and 1010) in a previously constructed well cluster near the southern end of the line of on-site exit pathway wells are also shown. On-site exit pathway wells near the Clinch River on the ORR side were drilled to bottom elevations of about 250 ft aMSL and completed in the transition zone above the brine interface. Based on test results, a total of 36 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 FY 2006, baseline samples were collected and analyzed to evaluate the stabilization of groundwater quality in the sampled zones.

- In FY 2010, off-site groundwater monitoring was initiated west of the Clinch River across from the Melton Valley waste management areas. This action was taken in response to detection of site-related contaminants in some of the on-site exit pathway well monitoring zones in FY 2007 through FY 2009, and because of concern that groundwater withdrawals on the western side of the Clinch River could potentially pull groundwater that has been affected by DOE's waste disposal activities beneath the river. As a precaution, DOE provided funding for extension of utility water supplies through the residential area along Jones Road and has provided water to residents in the area to minimize groundwater withdrawals near the Clinch River.

- The off-site groundwater monitoring project has included installation and sampling of two well clusters (OMW-1 and OMW-2) containing five wells each on a ridgecrest west of the river, modification and sampling of two existing residential water wells (OMW-3 and OMW-4) near the river to create three sampling intervals within each borehole, and sampling of seven existing residential wells in the vicinity. Locations of the off-site wells are shown on Figure 3.19. Goals of the installation of the 16 new sampling zones included in the two ridgecrest well clusters and the two modified existing wells near the river are: 1) to allow measurement of groundwater levels to determine the potential flow directions on the west side of the river in comparison to those on the DOE side of the river and, 2) to allow groundwater sampling from discrete elevation ranges that match elevations where samples are collected from multizone wells on the DOE side of the river. In addition to constructing the off-site wells to sample groundwater from elevations correlative to those on the DOE side of the river, to the extent feasible, the off-site wells were constructed in locations where sample intervals would be in approximately correlative hydrostratigraphic zones on both sides of the river. For example, well 4539 on the DOE side of the river and off-site well cluster OMW-1 intersect the upper portion of the Maryville Limestone stratigraphic unit. Similarly, wells 4540 and 4541 intersect strata also sampled in off-site well cluster OMW-2. In the off-site monitoring network the deepest wells in the two ridgecrest clusters were drilled to allow sampling in the elevation range between 200 – 300 ft aMSL, comparable to the base of multizone wells on the DOE side of the river. Shallower target monitoring elevations are within the 400 – 500, 500 – 600, and 700 – 750 ft aMSL ranges. Residential wells near the Clinch River that were converted to three-zone nested sampling wells were constructed to allow additional head monitoring and groundwater sampling in the nominal 400 – 500, 550 – 600, 600 – 650, 650 – 700, and 700 – 750 ft aMSL ranges. The seven existing residential wells that are monitored are typical open borehole water wells and groundwater from long bedrock intervals is included in the monitoring.

The deep groundwater monitoring data are discussed in terms of sample zone elevation because the local area has surface topographic relief of 200 – 300 ft between Clinch River elevation and the crests of ridges. Therefore, depth references related to different monitoring locations are not directly comparable. Beneath Melton Valley, relatively fresh groundwater extends from the water table downward to an elevation of approximately 350 – 400 ft aMSL. In the freshwater interval bicarbonate is the dominant anion and calcium and sodium are the dominant cations, with sodium concentrations increasing with increasing depth. Beneath the fresh water zone, groundwater contains rapidly increasing concentrations of dissolved solids that include residual components of the naturally occurring ancient brine contained in the bedrock. This deep groundwater is non-potable because of natural salinity and wells constructed in the bedrock at these elevations produce very little water. At elevations ranging from about 250 – 300 ft aMSL beneath Melton Valley (450 – 500 ft below the level of the Clinch River), the groundwater is saline brine that contains extremely high dissolved solids concentrations dominated by sodium and chloride, but also containing calcium, magnesium, potassium, barium, lithium, strontium, and other metal ions. Monitoring data show that there is a transition zone of rapidly increasing chloride concentrations from about 1,000 mg/L at about the 300 ft elevation to 100,000 mg/L or more at about the 200 ft elevation. The brine has a high density (1.2 – 1.3 g/cc compared to densities near 1.0 g/cc for the overlying groundwater) because of the high concentrations of dissolved ions. This strong density contrast between the brines at depth and the overlying fresher groundwater and reduced permeability with depth inhibit the mixing of constituents between the two zones. The on-site exit pathway wells and off-site wells were designed and installed to sample groundwater above the non-potable brine zone.

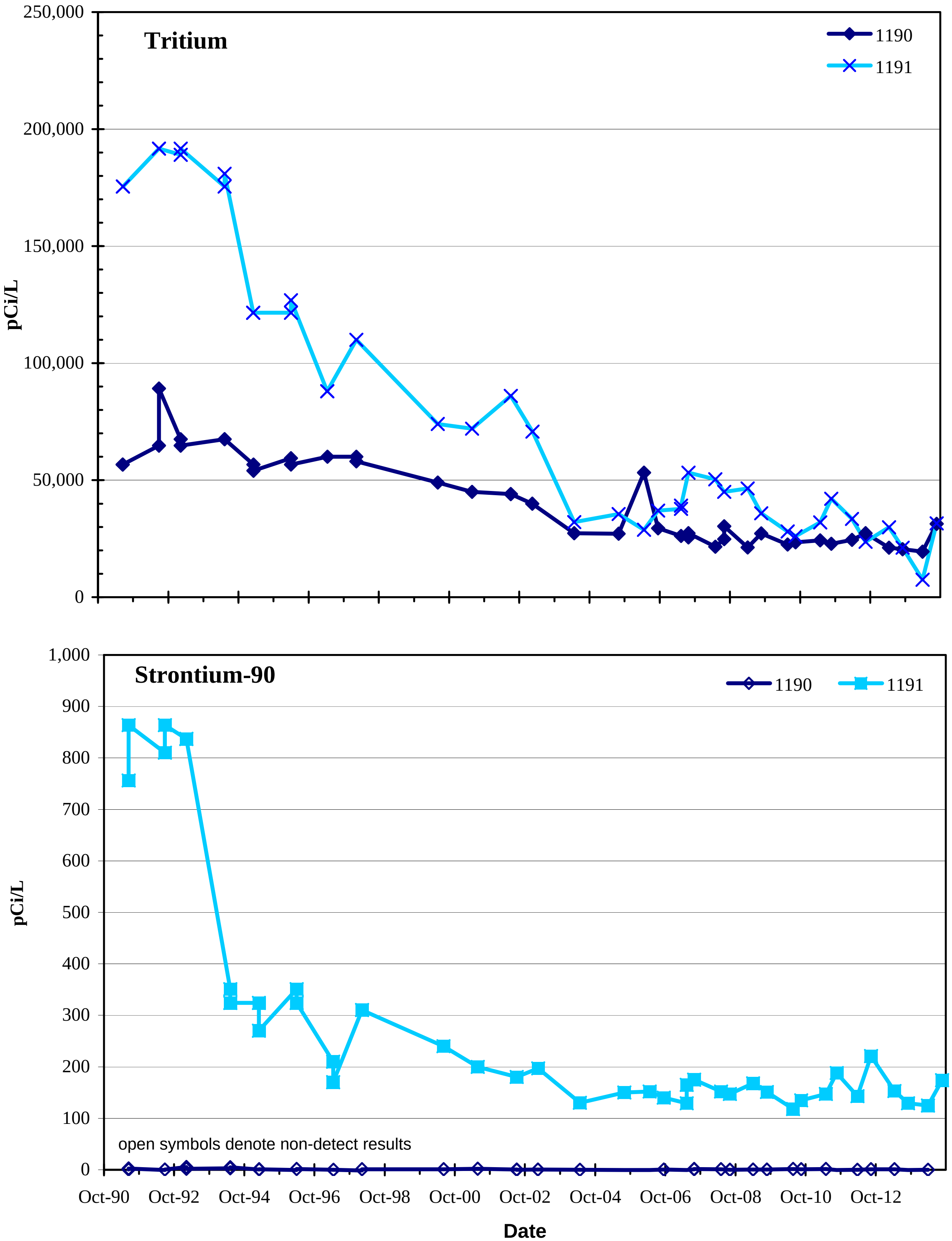


Figure 3.18. White Oak Dam groundwater tritium and ^{90}Sr activity histories.

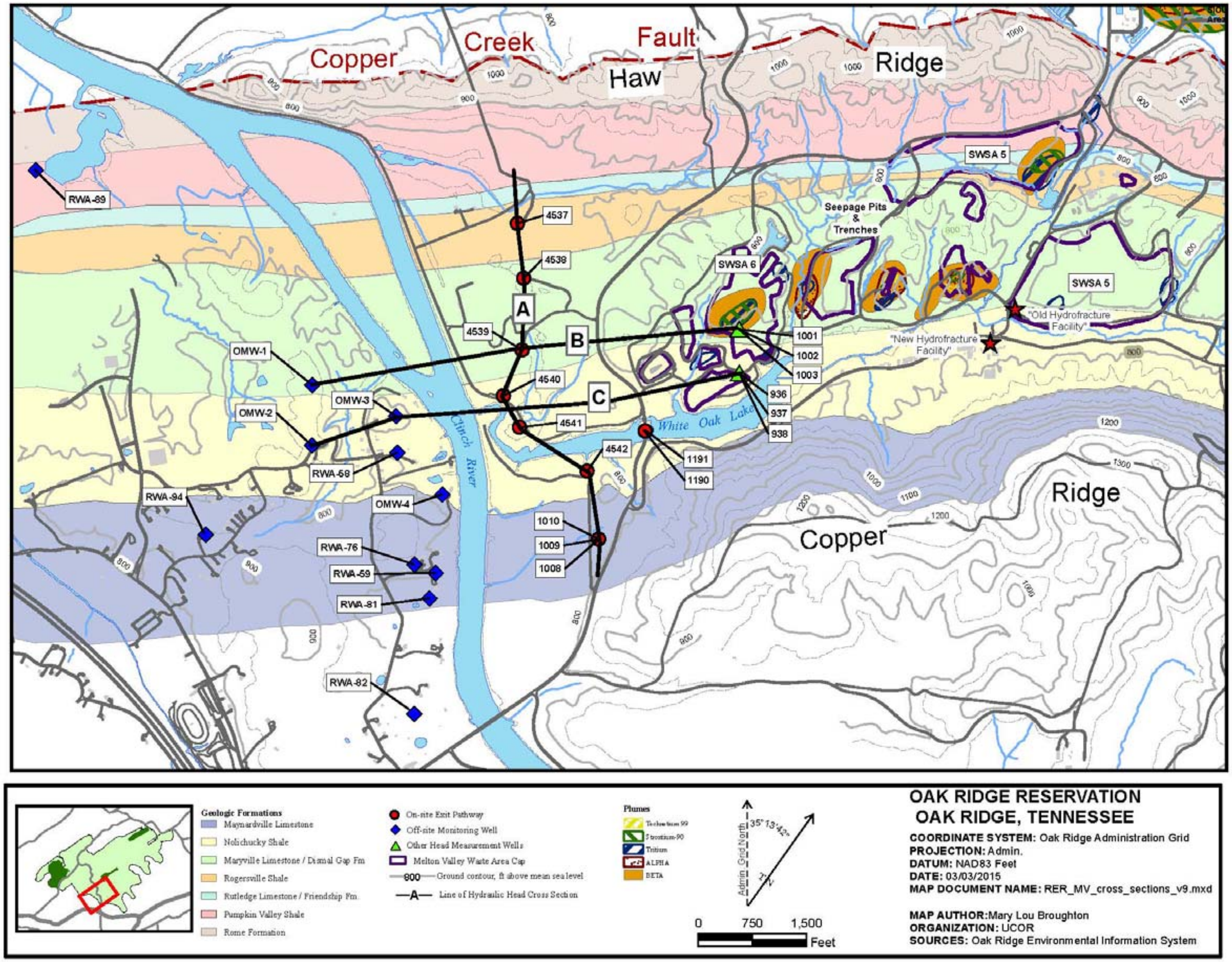


Figure 3.19. Locations of Melton Valley on-site exit pathway and off-site wells.

Melton Valley On-site Exit Pathway and Off-site Wells Groundwater Level Monitoring Results

Groundwater level monitoring is conducted continuously in all four of the off-site well clusters. The purpose of making detailed groundwater level measurements is to provide head data over the range of elevations monitored. The head data are used to develop hydraulic head cross sections that indicate potential directions of groundwater movement based on the relative head differences along the section lines. Groundwater seepage occurs between areas of higher hydraulic head to those of lower hydraulic head. In porous media such as sand and gravel aquifers, groundwater seepage normally occurs in the direction of maximum observed gradient. However, in geologically complex bedrock, with folds, fractures, and faults, such as that observed at Oak Ridge, lines of maximum apparent gradient can indicate barriers to flow because of a lower density of interconnected fractures along that direction compared to another direction where geologic conditions predispose flow to occur. Most plumes in this area tend to follow flow pathways parallel to geologic strike and many occur in confined to semiconfined bedrock zones that have either preferential fracturing (including bedding plane partings), preferential weathering because of bedrock type, or both.

The location of three hydraulic head cross sections (A, B, and C) are shown on Figure 3.19. Figure 3.20 shows the average FY 2014 hydraulic head (and total dissolved solids) in the Melton Valley on-site exit pathway wells along Cross Section A which is parallel to the Clinch River. Areas of relatively low hydraulic head occur in the Rutledge Limestone (Friendship Formation) at the northern end of the cross section and in the Nolichucky Shale beneath the mouth of WOC in the southern part of the section. The low head area in the Rutledge Limestone contains fairly fresh water and is thought to discharge to the Clinch River through openings in the carbonate bedrock. The relatively low head observed near the mouth of WOC aligns with the lowest part of Melton Valley where WOC and WOL are located. Areas of relatively higher head occur near the center of the section in the Maryville Limestone (Dismal Gap Formation) and at the southern end of the section at the toe of Copper Ridge. The area of higher head in the Maryville Limestone zone aligns with the knobs in the middle of Melton Valley where most of the ORNL shallow land burial grounds and the liquid waste seepage pits and trenches are located. Groundwater recharge on the knobs maintains groundwater head in the bedrock in the Maryville Limestone outcrop belt. Although the head gradients indicated on Cross Section A suggest the potential for groundwater flow in the plane of the page, most of the groundwater in bedrock flows through interconnected fractures that are essentially perpendicular to this cross section and groundwater flow is toward the Clinch River (toward the viewer of this figure).

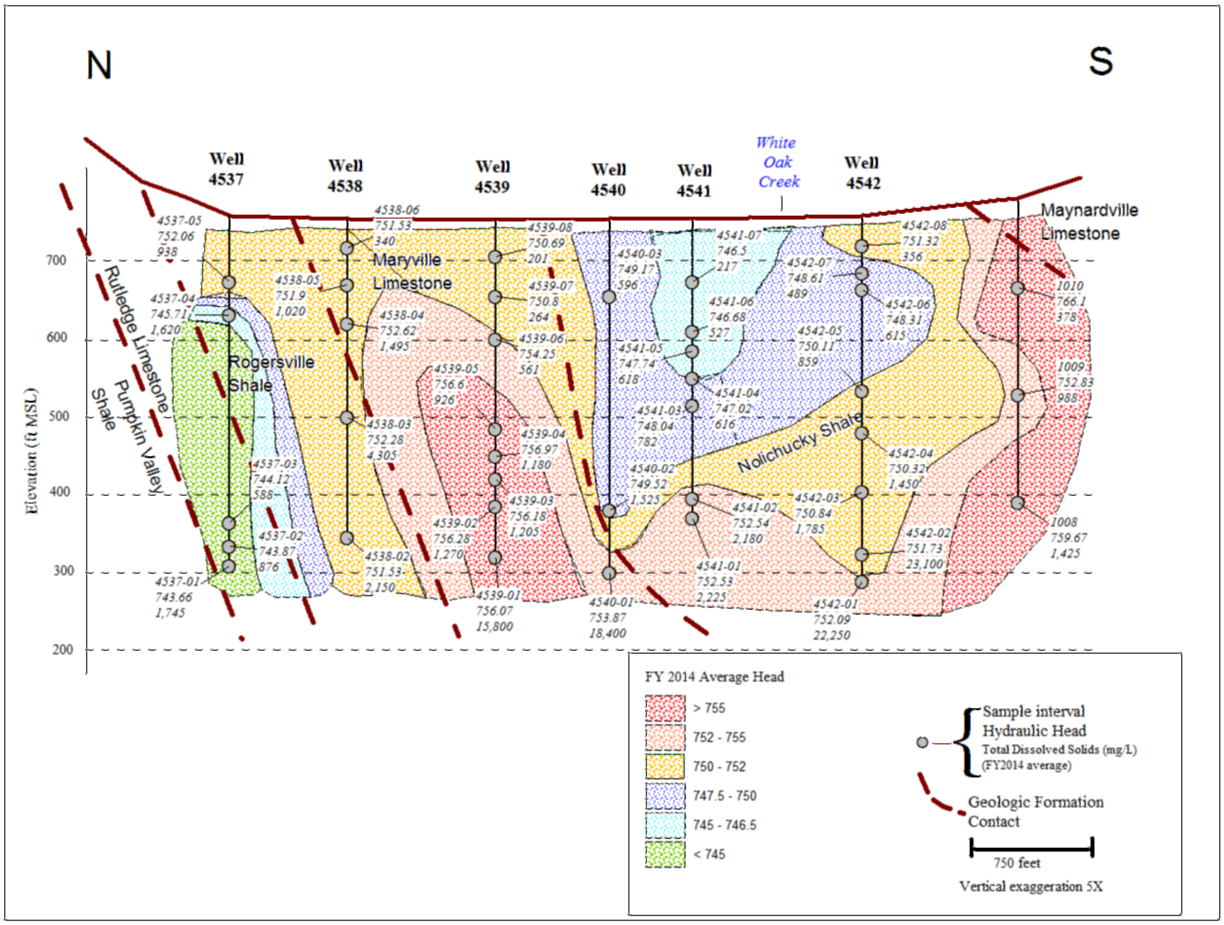


Figure 3.20. Hydraulic head cross section A.

Figure 3.21 shows the hydraulic head and total dissolved solids in the wells along Cross Section B that has its western end on the ridgecrest at OMW-1 and its eastern end near the center of SWSA 6. This section is drawn essentially parallel to geologic strike in the Maryville Limestone as shown on Figure 3.19. The hydraulic head variations along Cross Section B show that a region of head ranging from 775 to > 800 ft aMSL exists beneath the ridgecrest on the western side of the Clinch River. The downward head gradient beneath the ridge indicates that this is a recharge area for groundwater and the gradient, and flow direction, is toward the Clinch River, which has a winter pool elevation of about 737 ft aMSL. The lowest head region on Cross Section B occurs beneath the Clinch River, suggesting discharge to the river. On the eastern side of the Clinch River, the hydraulic head profile shows increasing head levels in the limestone beneath the SWSA 6 area where the profile terminates. Head levels measured at the eastern end of Cross Section B are lower than those beneath the off-site ridgecrest at the western terminus. The general head variations along this profile indicate that groundwater recharge occurs on the upland areas both east and west of the Clinch River where rainfall percolation to the groundwater table maintains the water table head. This head pressure, and associated groundwater movement, translates through interconnected fractures mostly parallel to geologic strike in the bedrock and head pressure is relieved in the discharge area at the Clinch River. The zone beneath the Clinch River acts as a hydraulic sink, as depicted by the 750 ft hydraulic head contour which has higher head areas on both east and west sides.

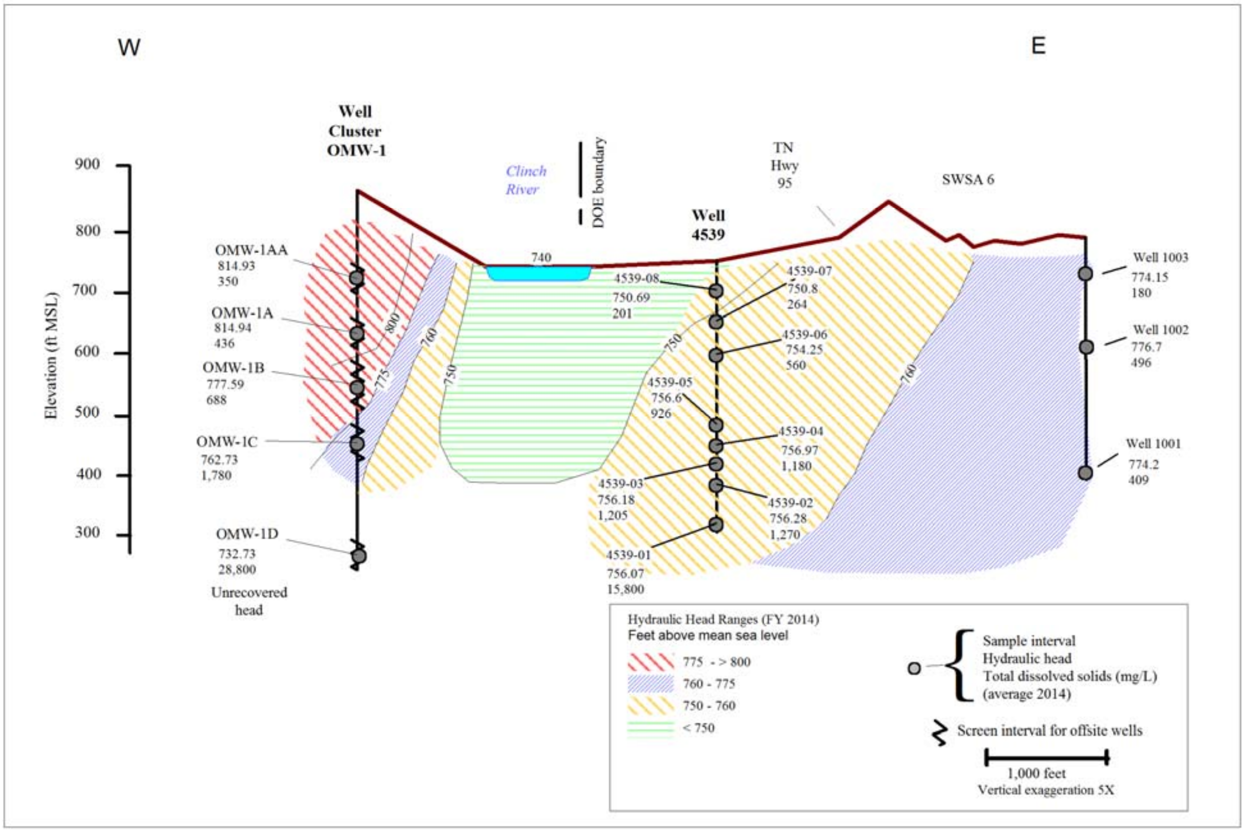


Figure 3.21. Hydraulic head cross section B.

The deepest well in off-site cluster OMW-1 (OMW-1D) is constructed in a very low-yield bedrock zone and, although the screened interval is about 100 ft in length, the well has not fully recovered in 51 mo. since the well development was completed. Because of the slow recovery a continuous monitoring device was not installed in the well; however, groundwater level is measured manually on a weekly frequency. The groundwater level continues to rise steadily with a recovery rate of about 1 ft/week. The well has recovered from an initial water level of about 510 ft aMSL after construction and development in July of 2010 to approximately 736 ft aMSL as of the end of September 2014. The water level in well OMW-1D at the end of FY 2014 was within the Clinch River channel elevation and was continuing to rise slowly. The well is expected to achieve a stabilized head level above the elevation of the Clinch River. However, many more months will be required for full recovery since the rate of recovery gradually diminishes over time. A number of deep investigative wells in the Melton Valley waste disposal areas exhibited similar extremely slow recovery, which is indicative of the low hydraulic conductivity of much of the bedrock at depth.

Figure 3.22 shows the hydraulic head and total dissolved solids profile along Cross Section C (Figure 3.19) which has its western terminus at off-site well cluster OMW-2 and its eastern terminus at wells on a knoll in the southern part of SWSA 6 at well 0938. This section is aligned approximately along geologic strike in the Nolichucky Shale. Similar to Cross Section B, the hydraulic head measured beneath the ridgecrest on the west side of the Clinch River ranges from 775 to > 800 ft aMSL in the upper part of the groundwater system. Also similar to Cross Section B, there is a downward gradient measured between the individual wells within the OMW-2 well cluster. Similar to the behavior of well OMW-1D, the water level measured in the deepest OMW-2 cluster (well OMW-2D) has not recovered to a stable head condition. Although head in well OMW-2D is not fully recovered, the heads at the end of FY 2014 were more than 20 ft higher than the Clinch River water level, which indicates underflow of the ridgecrest in that area is very unlikely.

The overall head distribution in Cross Section C is similar to that in Cross Section B with the lowest observed hydraulic head lying beneath the Clinch River. This section is drawn to coincide with the low groundwater region that underlies WOC and WOL in the Nolichucky Shale outcrop band. Heading east from the Clinch River, the hydraulic head elevation increases gradually but does not reach the levels observed in Cross Section B at a similar distance east of the river. This more gradual gradient is attributed to the more subdued topography along the section line and the observation that groundwater enters bedrock fractures along this profile at lower head elevations than at the eastern end of Cross Section B. Similar to Cross Section B, that area beneath the Clinch River has lower hydraulic head than areas to the east and west, indicating groundwater discharges into the Clinch River from both sides.

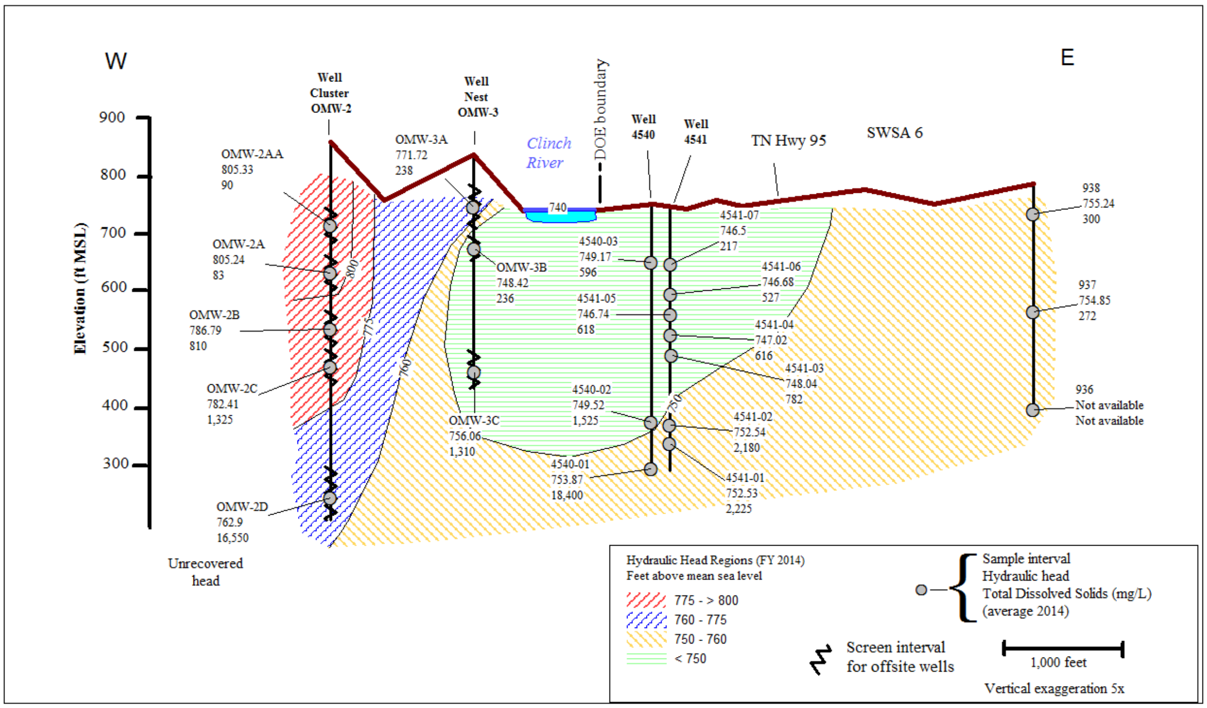


Figure 3.22. Hydraulic head cross section C.

The head data profiles summarized in Figures 3.21 and 3.22 combined with lower topography further to the west suggest that a groundwater seepage boundary occurs beneath the ridgecrest on the western side of the Clinch River near well clusters OMW-1 and OMW-2. The zone of elevated head beneath the ridgeline that extends downward, apparently to the deepest levels monitored, provides a natural barrier to groundwater seepage from east to west. Well hydrographs for the off-site wells are included in Appendix B.5.

Melton Valley On-Site Exit Pathway and Off-site Wells Groundwater Quality Monitoring Results

Groundwater quality monitoring has been conducted in the Melton Valley on-site exit pathway wells since 2006 and four rounds of samples were collected in the off-site wells between July 2010 and the end of FY 2011. Sampling of the off-site wells occurred semiannually during FY 2012 through FY 2014. Revised sampling frequency and parameters were agreed upon in FY 2013 by DOE, EPA, and TDEC and are documented in the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1982&D3).

The analytical results for unfiltered samples from all the wells, both the Melton Valley on-site exit pathway wells and the off-site wells, have been compared to the EPA SDWA primary MCLs. The MCLs are used only as screening criteria; the ROD did not specify MCLs as ARAR-based performance goals for groundwater. Table 3.9 is a summary of the data screening results for primary MCLs and summarizes Mann-Kendall trend evaluations for constituents exceeding MCLs where a sufficient number of detections have occurred.

- The Mann-Kendall approach to trend evaluation analyzes the cumulative direction (increasing, decreasing, or stable) of concentration change of an analyte through time. The criterion used to begin the Mann-Kendall trend analysis on this dataset was that a minimum of four detected results for the analyte of interest had to be available and at least one result exceeded a primary drinking water standard. Analytes with fewer than four detected results were excluded from trend analysis although they are identified in Table 3.9 by the number of detections and an entry of "NA" in the trend evaluation column. The most recent 10 results per analyte per well were used in the Mann-Kendall trend evaluation. In cases where wells have less than 10 total sampling events per well, all available data were included. The method provides a 90% confidence level that the trend is significant.

- The raw data for on-site exit pathway wells were conditioned prior to trend analysis by removal of early-time data points when wells were still equilibrating chemically. Outliers (high or low values, selected based on the coefficient of variation) were removed for the purpose of trend evaluation. Data from all of the available off-site sampling episodes during FY 2011 through FY 2014 for the off-site wells were included in trend evaluation. For metals analyses, when both filtered and unfiltered sample results were available, the unfiltered results were used for trend evaluation. Comparison of filtered to unfiltered results for metals has shown that for some constituents, the unfiltered results are higher than those for filtered samples. This indicates some of the metals are strongly associated with turbidity or suspended solids rather than the dissolved phase.

Well construction activities in the off-site well clusters at OMW-1 and OMW-2 introduced a large amount of cement grout into the boreholes to seal the well casings into the bedrock. This grout has created a pH effect that shows itself as very high pH in the groundwater samples from most of the wells in those two well clusters. Similar effects are not observed at the OMW-3 and OMW-4 wells or in the other monitored residential wells.

Fluoride is widespread in the area and many samples exceed the 4 mg/L MCL. Although fluoride is a common constituent in solid waste leachate and may have been a component of liquid wastes disposed in Melton Valley, fluoride is also a common naturally occurring element and a component of clay minerals common in shales. Review of shallow groundwater monitoring data near the Melton Valley waste disposal areas does not show fluoride plumes emanating from buried waste. Among the several metals that have shown some exceedances of MCLs, barium and thallium are common constituents of geologic brines. A brine sample from a deep monitoring well in a similar hydrostratigraphic setting approximately six miles away in BCV contained higher concentrations of these two elements than the levels reported in Table 3.9. Analysis of field-filtered aliquots for metals has demonstrated that much of the metal concentration for constituents such as cadmium, chromium, and lead is associated with particulates since concentrations in the field-filtered portion were much lower (sometimes non-detectable) than in the unfiltered portion.

Alpha activity is a radiological indicator analysis and may indicate the presence of uranium, thorium, or transuranic radionuclides. However, alpha activity measurement is susceptible to falsely elevated results in water samples containing high dissolved solids, as do many of the Melton Valley groundwater samples. Detailed analysis of alpha-emitting radionuclides frequently does not detect combinations of nuclides that quantitatively match the alpha activity measurement. Analysis for alpha-emitting radionuclides in the

Melton Valley and off-site groundwater has detected low levels of uranium. Beta activity analysis is also an indicator analysis that may indicate the presence of beta-emitting radionuclides and is prone to falsely elevated results when high levels of dissolved solids are present. The most common beta-emitting radionuclide in groundwater at ORNL is ^{90}Sr. Strontium-90 has been detected frequently (in six of 12 samples) in one of the Melton Valley on-site exit pathway wells (4537-02) and has exceeded the 8 pCi/L MCL-DC at that well on two occasions, but was not detected in either sampling event in FY 2014. During FY 2014 ^{90}Sr was detected in April samples collected from on-site exit pathway wells 4537-04 (2.21 pCi/L), 4537-05 (3.22 pCi/L), and 4538-03 (1.6 pCi/L). Strontium-90 was not detected in any other on-site exit pathway wells or in off-site wells west of Melton Valley in FY 2014. The occurrence of ^{90}Sr in the on-site exit pathway well 4537 sampling zones was identified as one of the high priority issues in development of the ORR Groundwater Strategy and will be investigated further based on prioritization of activities in the Groundwater Program.

In autumn 2010 two very low ^{90}Sr detections occurred in off-site wells, OMW-1D and OMW-3C. In the OMW-1D sampling event the detected result was less than 2 pCi/L and ^{90}Sr was not detectable in a duplicate sample collected at the same time and has not been detected in three subsequent samples. One sample from well OMW-3C had an estimated ^{90}Sr result of 1.22 pCi/L in a December 2010 sample. Strontium-90 has not been detected in nine subsequent samples from well OMW-3C. Strontium-90 has not been detected in any of the off-site wells since the winter of 2011.

Although much less widespread than ^{90}Sr, ^{99}Tc is present in groundwater in the Seepage Pits and Trenches area. Technetium-99 has not been detected in the Melton Valley on-site exit pathway wells; however, a single low activity was detected in a sample from well OMW-1C during the third sampling event from the well. The MCL-DC for ^{99}Tc is 900 pCi/L and the detection occurred in December 2010 at an activity of 25 pCi/L. Technetium-99 was not detected in a duplicate sample collected at the same time, nor has it been detected in eleven subsequent samples from well OMW-1C. Technetium-99 was not detected in any of the on-site exit pathway wells or in the off-site wells during FY 2012 through FY 2014.

Table 3.9. Results of data screen for Melton Valley On-site Exit Pathway and Off-Site Wells compared to EPA Primary National Drinking Water Criteria and constituent trend evaluation

Analyte	SL[a]	Units	Station[b]	No. Anal.[c]	No. Det.[d]	No. > MCL[e]	Results			M-K Trend[f]
							Min	Max	Max. Date	
Fluoride	4	mg/L	1008	6	6	6	5.93	7.69	06/18/14	Stable
Fluoride	4	mg/L	1009	7	7	7	9.4	9.89	09/22/10	Stable
Fluoride	4	mg/L	1010	7	3	1	0.119	6.2	06/11/96	NA
Fluoride	4	mg/L	4537-04	13	13	2	1.1	4.19	04/14/14	**Increasing**
Fluoride	4	mg/L	4537-05	14	14	11	2.3	5.58	10/17/12	**Increasing**
Fluoride	4	mg/L	4538-03	16	16	1	1.5	19.7	12/01/04	NA
Fluoride	4	mg/L	4538-04	14	14	9	2.9	5.06	10/23/13	**Increasing**
Fluoride	4	mg/L	4538-05	13	13	7	2.1	4.78	10/24/13	**Increasing**
Fluoride	4	mg/L	4539-02	19	19	17	3	5.6	05/03/06	**Increasing**
Fluoride	4	mg/L	4539-03	15	15	14	3.3	6	05/03/06	Stable
Fluoride	4	mg/L	4539-04	18	18	17	3.5	5.9	02/24/05	Stable
Fluoride	4	mg/L	4539-05	16	16	15	3.5	21.3	08/02/07	**Increasing**
Fluoride	4	mg/L	4539-06	16	16	15	3.5	6.6	07/26/06	**Increasing**

Table 3.9. Results of data screen for Melton Valley On-site Exit Pathway and Off-site Wells compared to EPA Primary National Drinking Water Criteria and constituent trend evaluation (cont.)

Analyte	SL[a]	Units	Station[b]	No. Anal.[c]	No. Det.[d]	No. > MCL[e]	Results			M-K Trend[f]
							Min	Max	Max. Date	
Fluoride	4	mg/L	4540-02	16	16	14	2	5.76	11/19/13	**Increasing**
Fluoride	4	mg/L	4540-03	16	16	14	2.6	6.9	02/15/06	**Increasing**
Fluoride	4	mg/L	4541-01	14	14	12	2.3	5	03/01/05	Stable
Fluoride	4	mg/L	4541-02	17	17	11	2.7	4.45	12/04/13	**Increasing**
Fluoride	4	mg/L	4541-03	16	16	14	2.4	6.26	05/30/12	**Increasing**
Fluoride	4	mg/L	4542-01	15	10	1	0.56	5.67	06/18/12	NA
Fluoride	4	mg/L	4542-03	14	14	13	3.2	9.4	06/06/05	Decreasing
Fluoride	4	mg/L	4542-04	18	18	18	5.2	9.96	12/11/13	**Increasing**
Fluoride	4	mg/L	4542-05	16	16	12	1.6	9.7	08/09/07	Stable
Fluoride	4	mg/L	4542-07	14	14	1	0.3	9.76	08/30/11	NA
Fluoride	4	mg/L	OMW-1B	10	10	10	5.63	6.58	10/24/13	**Increasing**
Fluoride	4	mg/L	OMW-1C	10	10	2	2.76	4.24	04/16/14	**Increasing**
Fluoride	4	mg/L	OMW-2B	10	10	10	5.63	7.99	04/17/14	**Increasing**
Fluoride	4	mg/L	OMW-2C	10	10	4	2.97	4.8	04/16/14	**Increasing**
Antimony	0.006	mg/L	OMW-1D	9	8	5	0.00433	0.0159	07/13/10	Decreasing
Antimony	0.006	mg/L	OMW-3C	10	4	2	0.00301	0.0129	04/30/14	**Increasing**
Arsenic	0.01	mg/L	1009	6	1	1	0.011	0.011	06/09/14	NA
Arsenic	0.01	mg/L	4537-02	14	12	4	0.00527	0.0187	04/09/14	Stable
Arsenic	0.01	mg/L	4541-01	9	2	1	0.00756	0.0112	12/03/13	NA
Arsenic	0.01	mg/L	OMW-1A	14	7	1	0.0049	0.0105	04/18/12	NA
Arsenic	0.01	mg/L	OMW-1B	13	9	8	0.00881	0.023	04/18/13	Stable
Arsenic	0.01	mg/L	OMW-2C	13	8	3	0.00629	0.0147	10/30/12	Stable
Barium	2	mg/L	4539-01	6	6	6	10.4	14.4	09/11/14	Stable
Barium	2	mg/L	4540-01	13	13	13	7.91	30.7	11/18/13	**Increasing**
Barium	2	mg/L	4542-01	11	11	11	4.28	41.7	08/25/10	**Increasing**
Barium	2	mg/L	4542-02	11	11	11	6.94	19.2	12/05/13	**Increasing**
Barium	2	mg/L	OMW-1D	9	9	5	0.352	17.7	04/17/14	**Increasing**
Barium	2	mg/L	OMW-2D	9	9	6	0.273	20.2	04/23/14	**Increasing**

Table 3.9. Results of data screen for Melton Valley On-site Exit Pathway and Off-site Wells compared to EPA Primary National Drinking Water Criteria and constituent trend evaluation (cont.)

Analyte	SL[a]	Units	Station[b]	No. Anal.[c]	No. Det.[d]	No. > MCL[e]	Results			M-K Trend[f]
							Min	Max	Max. Date	
Beryllium	0.004	mg/L	OMW-1C	10	1	1	0.00416	0.00416	07/13/10	NA
Beryllium	0.004	mg/L	OMW-1D	9	1	1	0.0152	0.0152	07/13/10	NA
Cadmium	0.005	mg/L	OMW-1D	9	1	1	0.0158	0.0158	07/13/10	NA
Chromium	0.1	mg/L	4538-02	10	10	1	0.0216	0.125	09/02/09	NA
Chromium	0.1	mg/L	4538-03	11	9	1	0.00427	0.108	07/31/07	NA
Chromium	0.1	mg/L	4540-02	13	13	1	0.00315	0.128	02/12/07	NA
Lead[g]	0.015	mg/L	4538-02	10	10	1	0.00373	0.0175	09/02/09	NA
Lead[g]	0.015	mg/L	4538-03	11	8	1	0.000566	0.0153	07/31/07	NA
Lead[g]	0.015	mg/L	4540-02	13	10	1	0.000528	0.0234	02/12/07	NA
Lead[g]	0.015	mg/L	OMW-1C	10	2	1	0.0007	0.0231	07/13/10	NA
Lead[g]	0.015	mg/L	OMW-1D	9	4	1	0.000635	0.1	07/13/10	NA
Thallium	0.002	mg/L	4538-02	10	4	1	0.00072	0.00253	09/02/09	NA
Thallium	0.002	mg/L	4542-03	9	1	1	0.011	0.011	03/15/10	NA
Thallium	0.002	mg/L	OMW-1C	10	1	1	0.0028	0.0028	07/13/10	NA
Thallium	0.002	mg/L	OMW-1D	9	1	1	0.0104	0.0104	07/13/10	NA
Uranium	0.03	mg/L	OMW-1D	9	3	1	0.000069	0.2	07/13/10	NA
Alpha activity	15	pCi/L	4537-01	14	8	1	2.61	25.5	04/11/12	NA
Alpha activity	15	pCi/L	4538-02	14	8	5	9.2	45.5	08/01/06	Stable
Alpha activity	15	pCi/L	4538-03	16	7	3	3.11	41.7	02/15/05	NA
Alpha activity	15	pCi/L	4539-01	6	1	1	56.6	56.6	09/11/14	NA
Alpha activity	15	pCi/L	4539-02	19	13	4	4.03	221	02/17/05	NA
Alpha activity	15	pCi/L	4539-04	18	7	2	4.82	61.7	05/16/05	NA
Alpha activity	15	pCi/L	4539-05	16	4	1	1.62	37.1	05/16/05	NA
Alpha activity	15	pCi/L	4540-01	18	3	3	34.2	53.5	02/28/05	NA
Alpha activity	15	pCi/L	4540-02	18	6	2	7.52	171	05/08/06	NA
Alpha activity	15	pCi/L	4541-01	14	3	1	5.65	25.7	12/21/04	NA
Alpha activity	15	pCi/L	4541-02	17	2	1	9.18	28.8	08/07/07	NA
Alpha activity	15	pCi/L	4541-04	18	6	2	4.69	1010	05/19/05	NA
Alpha activity	15	pCi/L	4541-05	18	7	3	4.02	22.4	05/10/06	NA
Alpha activity	15	pCi/L	4541-06	18	7	2	5.56	24.4	07/27/06	NA
Alpha activity	15	pCi/L	4542-01	16	3	3	17.8	53.7	06/18/12	NA
Alpha activity	15	pCi/L	4542-04	18	6	3	4.17	19.1	02/22/06	NA

Table 3.9. Results of data screen for Melton Valley On-site Exit Pathway and Off-site Wells compared to EPA Primary National Drinking Water Criteria and constituent trend evaluation (cont.)

Analyte	SL[a]	Units	Station[b]	No. Anal.[c]	No. Det.[d]	No. > MCL[e]	Results			M-K Trend[f]
							Min	Max	Max. Date	
Beta activity	50	pCi/L	4537-01	14	11	1	4.27	116	04/11/12	NA
Beta activity	50	pCi/L	4537-02	16	12	1	2.38	63.5	02/16/11	NA
Beta activity	50	pCi/L	4538-02	14	11	2	7.66	275	08/01/06	Stable
Beta activity	50	pCi/L	4538-03	16	8	6	8.94	1330	07/31/07	NA
Beta activity	50	pCi/L	4539-01	6	5	2	24.3	103	09/11/14	**Increasing**
Beta activity	50	pCi/L	4539-02	19	15	5	5.96	534	02/17/05	NA
Beta activity	50	pCi/L	4539-04	18	13	2	4.63	75	05/16/05	NA
Beta activity	50	pCi/L	4540-01	18	9	3	6.06	166	02/15/06	NA
Beta activity	50	pCi/L	4540-02	18	15	2	4.16	355	05/08/06	NA
Beta activity	50	pCi/L	4541-02	17	5	2	4.4	982	08/07/07	NA
Beta activity	50	pCi/L	4541-04	18	10	5	4.75	873	05/19/05	NA
Beta activity	50	pCi/L	4541-05	18	14	5	3.53	95.6	05/19/05	NA
Beta activity	50	pCi/L	4541-06	18	12	4	4.65	81.2	05/10/06	NA
Beta activity	50	pCi/L	4542-01	16	4	3	40.8	169	06/05/13	NA
Beta activity	50	pCi/L	4542-02	16	5	3	21.7	154	06/06/13	**Increasing**
Beta activity	50	pCi/L	4542-04	18	10	2	3.54	87.4	05/15/06	NA
Beta activity	50	pCi/L	OMW-1D	9	8	7	19.2	112	10/28/13	Stable
Strontium-90[h]	8	pCi/L	4537-01	7	1	1	27.9	27.9	04/11/12	NA
Strontium-90[h]	8	pCi/L	4537-02	12	6	2	1.64	83.2	11/01/05	NA
Strontium-90[h]	8	pCi/L	4540-02	14	4	1	1.34	16.5	05/08/06	NA
Benzene	5	µg/L	OMW-2D	9	7	3	0.86	6.14	11/06/12	Stable
cis-1,2-Dichloroethene	70	µg/L	OMW-1B	10	1	1	80.8	80.8	09/27/10	NA
Methylene chloride	5	µg/L	4538-02	13	3	2	3.4	15	08/01/06	NA
Methylene chloride	5	µg/L	4539-08	16	2	1	2	5.04	05/09/13	NA
Methylene chloride	5	µg/L	4542-04	18	2	1	0.2	8	05/15/06	NA
Methylene chloride	5	µg/L	4542-05	16	1	1	8	8	05/15/06	NA
Trichloroethene	5	µg/L	4537-03	13	1	1	113	113	09/14/10	NA
Trichloroethene	5	µg/L	4539-02	18	2	1	0.88	7.02	08/06/10	NA
Trichloroethene	5	µg/L	4539-08	16	1	1	30.9	30.9	08/13/10	NA
Trichloroethene	5	µg/L	4541-02	17	2	1	2	40.2	08/23/10	NA
Trichloroethene	5	µg/L	OMW-1B	10	1	1	81.1	81.1	09/27/10	NA

Table 3.9. Results of data screen for Melton Valley On-site Exit Pathway and Off-site Wells compared to EPA Primary National Drinking Water Criteria and constituent trend evaluation (cont.)

Analyte	SL[a]	Units	Station[b]	No. Anal.[c]	No. Det.[d]	No. > MCL[e]	Results			M-K Trend[f]
							Min	Max	Max. Date	
Vinyl chloride	2	µg/L	4537-03	13	1	1	7.49	7.49	09/14/10	NA
Vinyl chloride	2	µg/L	4541-02	17	3	1	0.24	2.92	08/23/10	NA
Vinyl chloride	2	µg/L	OMW-1B	10	1	1	2.63	2.63	09/27/10	NA

[a]SLs are EPA Primary National Drinking Water Standards (SDWA MCLs) except beta activity, for which the screening level of 50 pCi/L was used and ^{90}Sr (see footnote h).

[b]See Figures 3.20 through 3.22 for zone locations.

[c]Number of Analyses = total number of analyses for analyte from each location.

[d]Number Detected = number of analyses in which analyte was detectable.

[e]Number > MCL = number of results that were greater than the SDWA MCL.

[f]Quantitative trend analysis based on M-K Test of time-series sampling/analysis results for a maximum of ten sampling events (counting backward from the most recent sampling date). Evaluation is performed if No. Det. >3 and No. above MCL>=2, or a result >MCL is during FY 2014. Based on the methodology described in Gilbert (1987) and Wiedemeier et al. (1999), non-detect analytical results were replaced with the appropriate detection limit or MDA as surrogate values for M-K Test purposes. The M-K Test statistic (S) for each time series trend is calculated and plotted on a 90% confidence level chart. When the calculated S statistic (positive or negative) plots above the equivalent 90% confidence interval for the applicable number of sampling events, the time-series data define an *Increasing* trend if S > 0, or a *Decreasing* trend if S < 0. The time series data define a *Stable* trend if the S statistic plots below the equivalent 90% confidence interval and the associated CV is < 1, whereas *No Trend* is evident if the CV is > 1. NA (not applicable) indicates that the number of constituent detections available do not fulfill the basic criteria to conduct the trend evaluation as of the end of FY 2014.

[g]There is not a drinking water MCL for lead. The lead concentration of 0.015 mg/L is an EPA action level for water utilities to pursue actions to reduce lead concentrations in their distribution system.

[h]8 pCi/L is the MCL-DC listed in 40 CFR 141.66(d)(2), Table A, as the "Average Annual Concentration Assumed to Produce a Total Body or Organ Dose of 4 mrem/yr," which is the MCL for beta particle and photon radioactivity.

CFR = *Code of Federal Regulations*
CV = coefficient of variation
EPA = U.S. Environmental Protection Agency
FY = fiscal year
M-K = Mann-Kendall
Max = maximum
MCL = maximum contaminant level
MCL-DC = maximum contaminant level derived concentration
MDA = minimum detectable activity
Min = minimum
NA = not applicable
SDWA = Safe Drinking Water Act
SL = screening level

During FY 2014 no chlorinated organic compounds were detected in on-site exit pathway wells or in off-site wells. In the past, monitoring on-site and off-site has detected concentrations of TCE, cis-1,2-DCE, VC, and methylene chloride that exceed screening levels. In addition to being a degradation product of carbon tetrachloride under chemically reducing conditions, methylene chloride (dichloromethane) is also a common laboratory chemical in analytical labs and this compound is commonly detected at low levels because of lab atmosphere affects. Methylene chloride can further degrade to methyl chloride and subsequently to methane which can enter subsurface microbial metabolic processes. In the late 1990's, methylene chloride was detected in some wells in SWSA 6 at concentrations as high as 120 ug/L, however, since 2002, the highest concentration measured in wells sampled at SWSA 6 was 11 ug/L measured in the RCRA monitoring well 0837 in April 2007. TCE (a chlorinated ethane) is a common industrial cleaning solvent that can degrade to cis-1,2-DCE and VC through microbial or abiotic mechanisms. Like carbon tetrachloride, chloroform, and methylene chloride, the chlorinated ethenes (TCE, cis-1,2-DCE, and VC) are known groundwater contaminants at the Melton Valley burial grounds, including at SWSA 6 where they are monitored.

Detections of these compounds in the Melton Valley on-site exit pathway wells have been infrequent and concentrations have usually been low with the exception of one event in September 2010. Sampling results showed the presence of TCE, cis-1,2-DCE, and VC at elevated concentrations in two zones in well 4539 in early August 2010 and in off-site well OMW-1B in late September 2010. Concentrations of these chlorinated organic compounds were higher in well OMW-1B than in well 4539. Since approximately six weeks passed between the sampling at well 4539 and well OMW-1B, there is some uncertainty whether well 4539 is in the principal pathway that can connect groundwater flow from the DOE side of the Clinch River to the off-site monitoring well OMW-1B. The wells have been sampled seven times since the 2010 VOC detections and the only subsequent detection of any of these compounds was detection of below MCL concentrations of TCE and cis-1,2-DCE in a deep sampling zone in well 4539 in March of 2011. The detections of the same VOC contaminants on both sides of the river during August and September is thought to have been caused by groundwater level drawdowns in the off-site wells during construction and development of the cluster OMW-1 wells.

During well drilling, the wellbores were completely evacuated of water by the drilling process. Subsequent to the well construction, the well development process extracted several thousand gallons of water collectively from the five wells in the OMW-1 well cluster, and water levels in the individual deeper wells in the cluster were drawn down hundreds of feet below the equilibrated groundwater levels in the bedrock formation. Bedrock formations in the area have low transmissivity, and low water yield to wells, therefore, well recovery times are long following hard pumping stresses. These drawdowns imposed very strong gradients in fractures in bedrock connecting beneath the Clinch River and these induced gradients are thought to be the cause of VOC migration to well OMW-1B. The ongoing monitoring of groundwater levels in the on-site exit pathway and off-site well network demonstrates that normal hydraulic heads in the off-site wells are constantly higher than those near the Clinch River on the DOE side of the river. This head relationship indicates that without pumping stresses from the western side of the Clinch River, groundwater contaminants would be unlikely to migrate beneath the river as far as the OMW-1 and OMW-2 well clusters.

As shown in Table 3.9, the majority of the on-site exit pathway and off-site wells which have had drinking water standard exceedances do not show continuing contamination at those levels. Of the 24 locations that show increasing trends 16 are for fluoride, five are for barium, one is for antimony, and two are for beta activity. Two locations show decreasing trends – one for fluoride and the other for antimony. Fourteen locations show stable trends – six for fluoride, three for arsenic, one for barium, one for alpha activity, two for beta activity, and one for benzene. Fluoride has natural and potential man-made sources in the Melton Valley area. Barium is one of the metals that exceeds drinking water criteria in some wells. Barium is known to be a constituent of naturally occurring deep brines in the area and may have other natural sources in addition to potential man-made sources. The wells that exhibit increasing barium trends are saline waters and most exhibit increasing total dissolved solids trends. In the off-site wells OMW-1D and OMW-2D, these increasing dissolved solids and barium trends are obviously related to the very slow recovery of those wells to the well installation and recovery processes.

A comparison of FY 2014 groundwater analytical results to EPA MCL screening levels for the Melton Valley on-site exit pathway and off-site wells follows:

- During FY 2014, drinking water MCLs were exceeded for alpha activity (15 pCi/L MCL) in four on-site exit pathway well sampling zones and two off-site wells (wells OMW-1D and OMW-2D, both of which produce highly saline groundwater samples and high dissolved solids samples are known to cause high bias in the analytical result). The MCL for total radium alpha activity (5 pCi/L) was exceeded in three deep monitoring zones in on-site exit pathway wells and in one deep off-site well. Beta activity exceeded the 50 pCi/L screening level during FY 2014 in two of the deepest sampling zones in on-site exit pathway wells (4539-01 and 4542-01) and in one deep off-site well (OMW-1D). Similar to the alpha activity, high dissolved solids content in the saline zone contributes to elevated beta activity in the analyses.

- Strontium-90 was not detected in any off-site wells during FY 2014 and was detected in samples from three on-site exit pathway sampling zones at levels less than half the MCL-DC of 8 pCi/L. In the on-site exit pathway wells, sample zone 4537-02 has the most consistent history of ^{90}Sr detection. Zone 4537-02 has been sampled 13 times with seven detected results. The maximum detected concentration (83.2 pCi/L) was from sample zone 4537-02 in November 2005, early in the monitoring history of the on-site exit pathway wells. Three other samples from zone 4537-02 have exceeded the ^{90}Sr MCL-DC of 8 pCi/L. Beyond the results in that sample zone, detections of radiostrontium have tended to be sporadic, both temporally and spatially. A total of 369 radiostrontium analyses have been performed on samples from the on-site exit pathway groundwater samples since the monitoring program was initiated in 2005. Besides the results discussed for zone 4537-02, the remaining 23 radiostrontium detections have been distributed among 13 separate sampling zones. The only other sample result that has exceeded the MCL-DC for ^{90}Sr to date came from zone 4538-02 (12.4 pCi/L in February 2007).

- The MCL for antimony was exceeded in one off-site well (in the deepest sampling interval of well OMW-3) and in none of the on-site exit pathway wells. The arsenic MCL was exceeded in two off-site wells and three on-site exit pathway wells, MCLs were exceeded for barium in four on-site deep exit pathway monitoring zones and in two deep off-site monitoring zones, for benzene in one deep off-site well, for fluoride in 20 on-site exit pathway wells and four off-site wells, and for thallium in one shallow off-site well. The barium and benzene MCL exceedances occur in deep groundwater samples collected from the transition zone between the fresher groundwater at shallower depths and the underlying connate brines which are known to contain these substances derived from natural sources. In addition to being a common indicator of man-made waste sources, fluoride is a common minor groundwater constituent that originates from natural bedrock sources. Areas with natural fluoride concentrations greater than 4 mg/L are known to exist but are uncommon.

3.2.1.2.2.4 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 Bethel Valley 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 the PWTC WAC was tritium. The DOE DCS for tritium is 1.9×10^6 pCi/L (DOE-STD-1196-2011) and the average and maximum tritium concentrations measured in FY 2014 in the collected groundwater were about 5.1×10^5 and 1.8×10^6, respectively, which are somewhat lower than the values measured during FY 2013. During FY 2014, none of the monthly samples contained tritium at concentrations 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 by UT-B at the point of discharge.

3.2.1.2.3 Aquatic Biological Monitoring

The monitoring of fish and benthic macroinvertebrate communities provides a useful measure of watershed trends and whether *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) goals of achieving narrative AWQC and protecting ecological populations are met. Aquatic biological monitoring locations used to gauge the conditions of the Melton Valley watershed, as well as their reference sites, are shown on Figure 3.4. As is the case for most watershed units, biological monitoring data in Melton Branch include contaminant accumulation in fish, fish community surveys, and 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 (WCK 2.3; Figure 3.4).

Redbreast sunfish were collected in 2014 from lower Melton Branch kilometer (MEK) 0.2 and fillets analyzed for mercury, PCBs, metals, and ^{137}Cs. Mean (± standard error [SE]) mercury concentrations in these fish remained similar to those seen in 2013 (average 0.10 ± 0.01 μg/g), below the EPA-recommended AWQC (0.3 μg/g mercury in fish) but higher than typical of reference site concentrations in this species. PCB concentrations were near background levels and in most cases below detection limits, averaging < 0.03 µg/g in the six redbreast sunfish analyzed. As expected, most metals (As, 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. Cesium-137 was not detected in sunfish samples from MEK 0.2.

The monitoring results for WOC below the Melton Branch confluence continue to indicate slight to moderate impacts to fish communities relative to uncontaminated sites, but most stream sites are much improved relative to their ecological status in the mid-1980s (Figures 3.23 and 3.24). After a period of mostly stable numbers of fish species, some improvement in diversity has occurred at the downstream sites as a result of a fish introduction program in 2008 – 2012 and 2014. Two darter species and striped shiner are now routinely found at MEK 0.6 contributing to historically high species richness values for this site, and at WCK 2.3 four to five introduced fish species are found in most samples. In recent collections we have seen an increased number of juvenile fish from our introduced species, indicating their continued colonization of the watershed. The apparent success of these introduced sensitive species is additional evidence that water quality in Melton Valley has improved since the 1980s.

The benthic macroinvertebrate community in lower WOC (WCK 2.3), as measured by the number of pollution-intolerant taxa, remains moderately degraded relative to a comparable reference site and the headwater site in WOC (MBK 1.6 and WCK 6.8), while the macroinvertebrate community in lower Melton Branch (MEK 0.6) continues to show characteristics that indicate conditions are nearly comparable to slightly degraded relative to reference conditions (Figure 3.25). Wide fluctuations in the number of pollution-intolerant taxa at WCK 2.3 in recent years may reflect, in part, changes related to an increase in the frequency of above normal flows caused by increased precipitation. The substrate at this site is dominated by gravels that are more easily dislodged (i.e., they provide less habitat stability) and covered by smaller sediment particles (i.e., increased embeddedness) during modest increases in flow. Disturbances of the substrate caused by rapid increases in discharge during heavy rain can have negative consequences on many species of benthic macroinvertebrates through either increased mortality (e.g., crushing by shifting substrate particles) or loss of usable habitat (e.g., loss of habitable space used by sprawling species). This contrasts upper WOC and the reference site where larger cobbles dominate the substrate and are less likely to be disturbed during brief periods of high flows; thus, minimizing negative effects to macroinvertebrates.

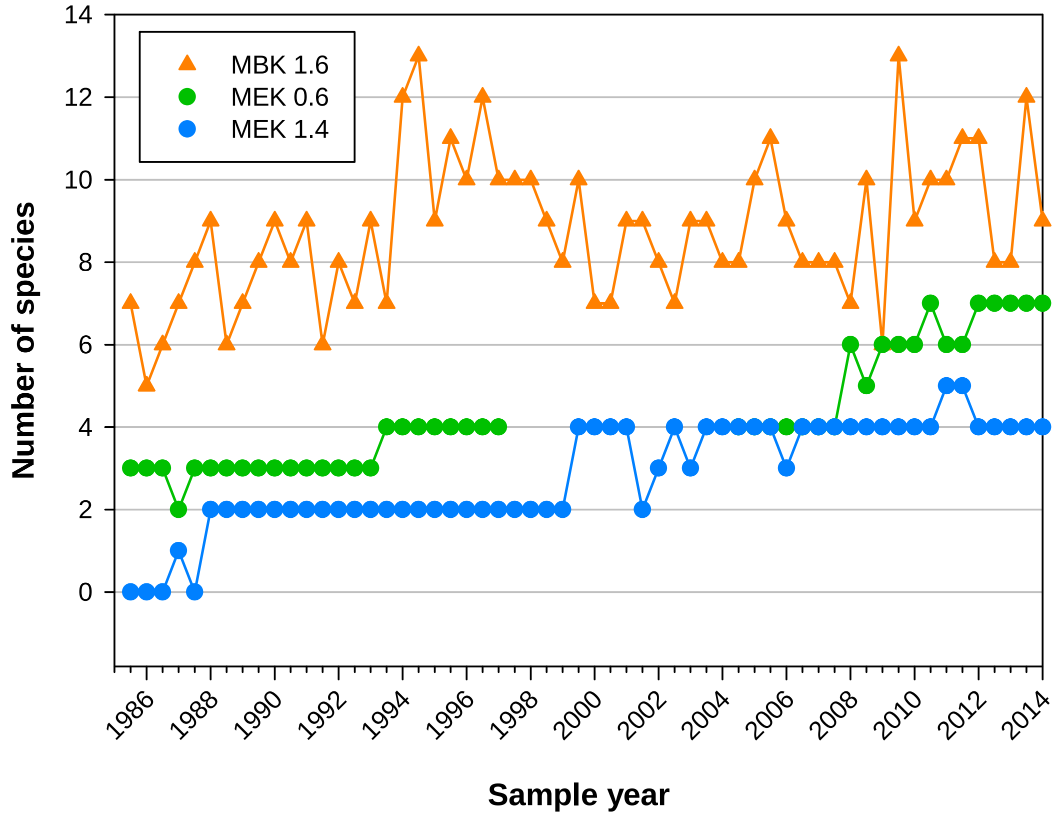


Figure 3.23. Species richness (number of species) in samples of the fish community in Melton Branch (MEK) and a reference stream, Mill Branch (MBK), 1985 – 2014.[a]

[a]Symbols not joined by lines show periods when samples were not collected.

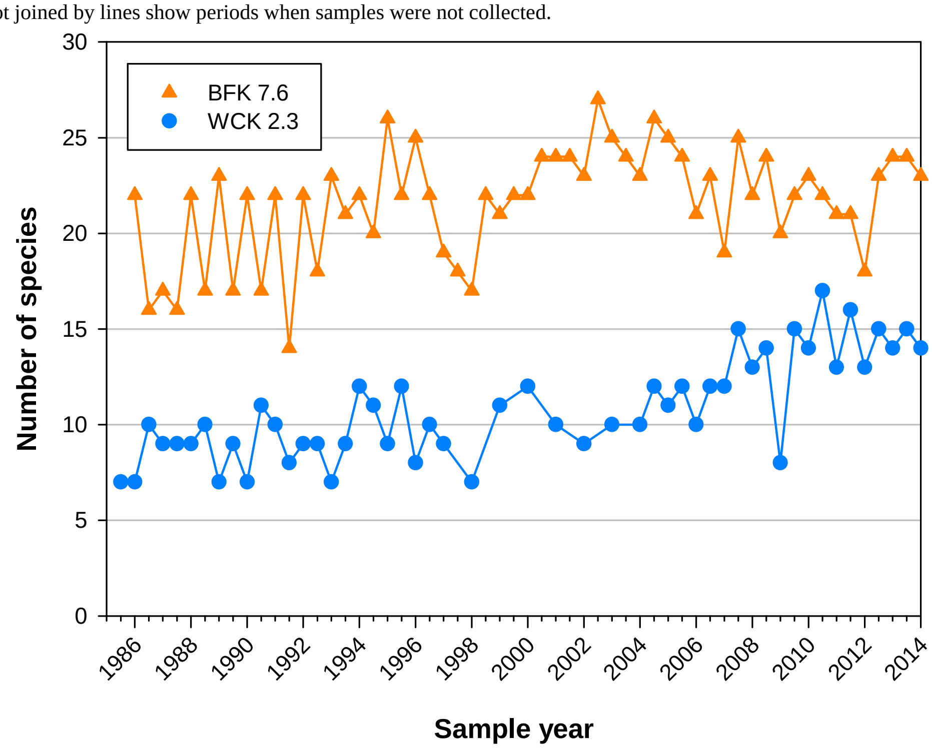


Figure 3.24. Species richness (number of species) in samples of the fish community in lower WOC (WCK 2.3) and a reference stream, Brushy Fork (BFK), 1985 – 2014.

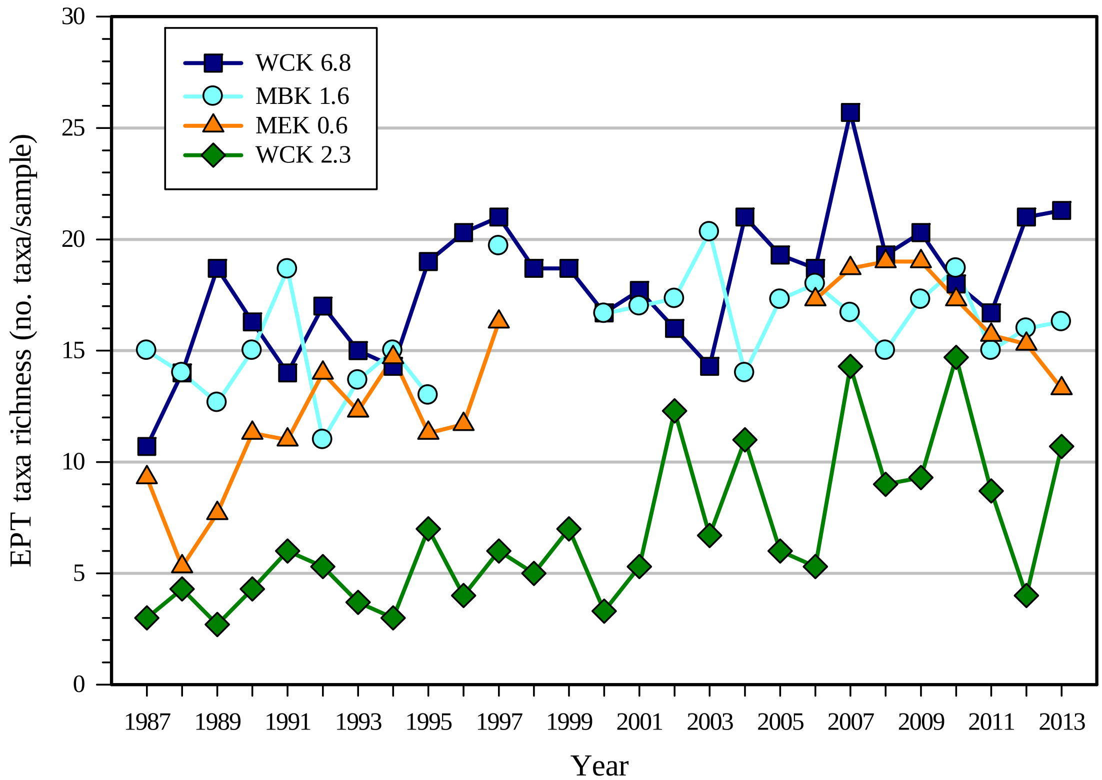


Figure 3.25. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate communities in lower WOC (WCK 2.3), lower Melton Branch (MEK 0.6), and reference sites in upper WOC (WCK 6.8) and Mill Branch (MBK 1.6), April sampling periods, 1987 – 2013.[a,b]

[a]WOC watershed invertebrates are processed in the FY following collection. Samples collected in spring of 2014 have not yet been processed.

[b]Symbols not joined by lines show periods when samples were not collected.

3.2.1.3 Performance Summary

Following is a summary of the FY 2014 Melton Valley watershed performance monitoring;

- Radiological goals for ^{137}Cs, ^{90}Sr, and tritium, which are the principal surface water contaminants in the Melton Valley watershed, were met at the watershed integration point (White Oak Dam). Principal contaminant concentrations at tributary and mainstem monitoring locations remained compliant with goals of the *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3).

- Strontium-90 levels in the HRE Tributary downstream of the HRE facility trended downward during FY 2014 from elevated levels measured during FY 2012 and FY 2013. DOE conducted surface water sampling during FY 2014 that identified the probable source of increased ^{90}Sr as contamination entering a tributary immediately northeast of the HRE facility near an abandoned and remediated LLLW transfer pipeline. Contaminated soil from a pipeline leak in the area was excavated and disposed during the Melton Valley Project completed in 2006. Apparently, after several years of above-average rainfall, contamination has reoccurred in the area. Monitoring in the HRE tributary will continue to observe ongoing trends. This closes an issue identified in the 2014 RER.

- Groundwater level monitoring of the hydrologic isolation areas in Melton Valley showed that performance criteria were met at 47 of 52 locations. Although operation of the SWSA 4 downgradient groundwater collection trench remains challenging, discharges from the area in surface water met ROD goals.

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

- Groundwater analyses conducted on samples from the on-site exit pathway wells since their construction in 2004 and off-site wells have resulted in a number of radionuclides and VOCs being detected periodically in different monitoring locations. An off-site detection of low concentrations of VOCs occurred early in the sampling history from one sampling event in 2010 at one well. It is suspected to have occurred because of well development pumping stresses in the off-site well during construction that caused low head in a discrete fracture zone connected to the vicinity of an on-site exit pathway well where detection of similar VOCs occurred. Neither well has experienced subsequent detections of the VOCs detected in 2010. This detection is considered to exemplify the vulnerability of off-site wells in close proximity to areas of groundwater contamination and highlights the importance of man-induced pumping stresses on influencing contaminant movement in groundwater.

  – During FY 2014, drinking water MCLs were exceeded for alpha activity (15 pCi/L MCL) in four on-site exit pathway well sampling zones and two off-site wells, both of which produce highly saline groundwater samples and high dissolved solids samples are known to cause high bias in the analytical result. The MCL for total radium alpha activity (5 pCi/L) was exceeded in three deep monitoring zones in on-site exit pathway wells and in one deep off-site monitoring well. Beta activity exceeded the 50 pCi/L screening level during FY 2014 in two of the deepest sampling zones in on-site exit pathway wells and in one deep off-site well. Similar to the alpha activity, high dissolved solids content in the saline zone contributes to elevated beta activity in the analyses.

  – Strontium-90 was not detected in any off-site wells during FY 2014 and was detected in samples from three on-site exit pathway sampling zones at levels less than half the MCL-DC of 8 pCi/L.

  – The MCL for antimony was exceeded in one off-site well (in the deepest sampling interval of the well) and in none of the on-site exit pathway wells. The arsenic MCL was exceeded in two off-site wells and three on-site exit pathway wells, MCLs were exceeded for barium in four on-site deep exit pathway monitoring zones and in two deep off-site monitoring zones, for benzene in one deep off-site well, for fluoride in 20 on-site exit pathway wells and four off-site wells, and for thallium in one shallow off-site well. The barium and benzene MCL exceedances occur in deep groundwater samples collected from the transition zone between the fresher groundwater at shallower depths and the underlying connate brines which are known to contain these substances derived from natural sources. In addition to being a common indicator of man-made waste sources, fluoride is a common minor groundwater constituent that originates from natural bedrock sources. Areas with natural fluoride concentrations greater than 4 mg/L are known to exist but are uncommon.

  – The majority of the on-site exit pathway and off-site wells which have had drinking water standard exceedances in the past did not show continuing contamination at those levels during FY 2014. The ROD does not specify ARAR-based performance goals for groundwater. MCLs are used for screening purposes only.

- The biological monitoring results indicate that Melton Branch and lower WOC stream communities are impaired relative to reference sites. Since introduction of new fish species in the watershed, fish communities have improved steadily in both species richness and abundance. However, there is no evidence of improving trends in the benthic macroinvertebrate communities over the last 5 – 10 years, with substantial year to year variation.

3.2.2 Other LTS Requirements

Other LTS requirements for Melton Valley watershed actions are listed in Table 3.10 and described below.

3.2.2.1 Requirements

The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) requires interim LUCs to protect against unacceptable exposures to contamination during and after remediation (Table 3.10). During remediation, interim LUCs were imposed that will remain in effect until final LUCs are established in future, final remedial decisions. The LUC objectives (DOE/OR/01-1826&D3) follow:

- ***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 the LUCs.

- ***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.

- ***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 LUCs.

Table 3.10. Other LTS Requirements for the Melton Valley watershed

Other LTS requirements for LUCs[a]					
Type of control	**Description of control**	**Controlled industrial area**	**Waste management area**	**Surface water and floodplain area**	**Frequency/ Implementation**
1. DOE land notation (property record restrictions)[b] *A. Land use* *B. Groundwater*	*Restrict use of property by imposing limitations. Prohibit uses of groundwater. Control will last until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure. It was recorded by DOE in accordance with state law at the County Register of Deeds office.*	*DOE land notation will be developed on a Melton Valley-wide basis in accordance with the final approved LUCIP.*	*DOE land notation, including boundary survey plats, will be generated for SWSA 4, SWSA 5 (North and South), SWSA 6 (Caps A - E), and Pits and Trenches (Seepage Pits, Trenches 5 through 7, and 7A Leak Site). No additional unit-specific requirements.*	*DOE land notation will be developed on a Melton Valley-wide basis in accordance with the final approved LUCIP.*	*DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s).*
2. Property record notices[c]	*Provide notice to anyone searching records about the existence and location of a hazardous waste landfill(s) and contaminated areas, and limitations on their use. Control will last until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure. Notice will be provided by DOE Environmental Management to the public. This notice will be supplemented with the DOE land notation after completion of remediation (see above).*	*DOE property record notices will be developed on a Melton Valley-wide basis in accordance with the final approved LUCIP and documented in the RAR. No additional unit-specific requirements.*			*DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s).*

Table 3.10. Other LTS Requirements for the Melton Valley watershed (cont.)

Other LTS requirements for LUCs[a]					
Type of control	**Description of control**	**Controlled industrial area**	**Waste management area**	**Surface water and floodplain area**	**Frequency/ Implementation**
3. Zoning notices[d]	*Provide notice to City Planning Commission about the existence and location of hazardous waste landfill(s) and/or PTSM contamination areas and providing use limitations information for zoning/planning purposes if/when MV areas are transferred out of DOE federal control.*	*The ORR including Melton Valley wide area is currently zoned as a federal controlled industrial/research (FIR) area with the City Planning Commission. Zoning notices, 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. 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.*	*The ORR including the Melton Valley floodplain area is currently zoned as a federal controlled industrial/research (FIR) area with the City Planning Commission. Zoning notices, 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.*	*DOE official (or its contractors) will verify no less than annually that information is properly maintained with the City Planning Commission.*
4. EPP program[e]	*Provide notice to worker/developer on the extent of contamination and prohibit or limit excavation/penetration activity. As long as the property remains under DOE control, including transferred property, it remains subject to the EPP program. Implemented by DOE and its contractors; initiated by permit request.*	*Existing DOE/Contractor EPP program remains in effect to provide worker protection*			*DOE official (or its contractors) will verify no less than annually the functioning of permit program against existing procedure*
5. State advisories postings[f] *(e.g., no fishing or contact advisory)*	*Provide notice to resource users of contamination and risks associated with uses. Duration is indefinite, or until use conditions change as determined by the state. Although not a requirement, advisories and postings may be established by TDEC in the future.*	*Not applicable to controlled industrial areas or waste management areas*		*Applicable to White Oak Lake and the White Oak Creek Embayment*	*DOE official (or its contractors) will conduct field survey no less than annually and assess signs condition (i.e., remain intact, erect, and legible)* *DOE official (or its contractors) will verify no less than annually information with Tennessee Wildlife Resources Agency official*

Table 3.10. Other LTS Requirements for the Melton Valley watershed (cont.)

		Other LTS requirements for LUCs[a]			
Type of control	**Description of control**	**Controlled industrial area**	**Waste management area**	**Surface water and floodplain area**	**Frequency/ Implementation**
6. Access controls[g] *(e.g., fences, gates, and portals)*	*Control and restrict access to workers and the public to prevent unauthorized uses. Control will last until concentrations of hazardous substances in the environmental media are at levels to allow for unrestricted use and exposure. Maintained by DOE.*	*Access controls are in place in Melton Valley and maintained by DOE*			*DOE official (or its contractors) will conduct field survey no less than annually of all controls to assess condition (i.e., remain erect, intact, and functioning)*
7. Signs[h]	*Provide notice or warning to prevent unauthorized access. Control will last until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure. Signage maintained by DOE at 20 locations throughout the Melton Valley Watershed near major access points.*	*Signs have been posted on a Melton Valley-wide basis at 20 locations throughout the Melton Valley Watershed near major access points in accordance with the final approved LUCIP. No additional unit-specific requirements.*			*DOE official (or its contractors) will conduct field survey no less than annually of all signs to assess condition (i.e., remain erect, intact, and legible)*
	Provide notice to resource users of contamination and prohibit fishing/contact. Control will last until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure. Signage maintained by DOE at 6 locations around the White Oak Lake and White Oak Creek Embayment at major access points.	*Not applicable to controlled industrial areas or waste management areas*		*Signs have been posted at 6 of the 20 access locations around White Oak Lake and the White Oak Creek Embayment*	*DOE official (or its contractors) will conduct field survey no less than annually of all signs to assess condition (i.e., remain erect, intact, and legible)*
8. Surveillance patrols	*Control and monitor access by workers/ public. Control will last until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure. Established and maintained by DOE*	*Surveillance patrols will be implemented on a Melton Valley-wide basis in accordance with the final approved LUCIP. No additional unit-specific requirements.*			*DOE official (or its contractors) will verify no less than annually against procedures/plans that routine patrols conducted*

Table 3.10. Other LTS Requirements for the Melton Valley watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
SWSA 4	RAR (DOE/OR/01-2343&D1)[i,j]	• Inspection and maintenance of the landfill cover system includes the vegetative cover, erosion control, settlement and subsidence control, maintenance of the gas vent system, fence and roadways • Access controls and signs will be inspected and repaired as needed • Primary maintenance activity is mowing • Groundwater collection system monitoring and maintenance	• Semiannually and after seismic events greater than 4.0 on the Richter scale inspect the cover, compacted fill, or isolation cap outslopes • Semiannually and following any rainfall of 25-yr, 24-h intensity or greater (>5.5 in. in a 24-h period) inspect the surface drainage network • Semiannually inspect the rock buttress outslopes and gas vents • Annually inspect the cap maintenance roads, fences, gates, and signs • Frequency of the site visits for inspections of physical controls will be no less than annually
SWSA 5	RAR (DOE/OR/01-2343&D1)[i,j]	• Inspection and maintenance of the landfill cover system includes the vegetative cover, erosion control, settlement and subsidence control, maintenance of the gas vent system, fence and roadways • Access controls and signs will be inspected and repaired as needed • Primary maintenance activity is mowing • Groundwater collection system monitoring and maintenance	• Semiannually and after seismic events greater than 4.0 on the Richter scale inspect the cover, compacted fill, or isolation cap outslopes • Semiannually and following any rainfall of 25-yr, 24-h intensity or greater (>5.5 in. in a 24-h period) inspect the surface drainage network • Semiannually inspect the rock buttress outslopes and gas vents • Annually inspect the cap maintenance roads, fences, gates, and signs • Frequency of the site visits for inspections of physical controls will be no less than annually

Table 3.10. Other LTS Requirements for the Melton Valley watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
SWSA 6	RAR (DOE/OR/01-2343&D1)[i,j]	• Inspection and maintenance of the landfill cover system includes the vegetative cover, erosion control, settlement and subsidence control, maintenance of the gas vent system, fence, and roadway • Access controls and signs will be inspected and repaired as needed	• Semiannually and after seismic events greater than 4.0 on the Richter scale inspect the cover, compacted fill, or isolation cap outslopes • Semiannually and following any rainfall of 25-yr, 24-h intensity or greater (>5.5 in. in a 24-h period) inspect the surface drainage network • Semiannually inspect the rock buttress outslopes and gas vents • Annually inspect the cap maintenance roads, fences, gates, and signs • Frequency of site visits for inspections of physical controls will be no less than annually
Seepage Pits and Trenches Area	RAR (DOE/OR/01-2343&D1)[i,j]	• Inspection and maintenance of the landfill cover system includes the vegetative cover, erosion control, settlement and subsidence control, maintenance of the gas vent system, fence and roadways • Access controls and signs will be inspected and repaired as needed • Primary maintenance activity is mowing • Groundwater collection system monitoring and maintenance	• Semiannually and after seismic events greater than 4.0 on the Richter scale inspect the cover, compacted fill, or isolation cap outslopes • Semiannually and following any rainfall of 25-yr, 24-h intensity or greater (>5.5 in. in a 24-h period) inspect the surface drainage network • Semiannually inspect the rock buttress outslopes and gas vents • Annually inspect the cap maintenance roads, fences, gates, and signs • Frequency of site visits for inspections of physical controls will be no less than annually
WOCE	AM (Letter) RmAR (ORNL/ER/Sub/91-KA931/4)	• Sediment-retention structure included in regular site inspection program	• Not specified
WAG Cesium Plots	IROD (DOE/OR/01-1059&D4) RAR Postconstruction report (DOE/OR/01-1218&D2)	• The fence enclosure will remain in place	• Perform long-term operations and maintenance as necessary

Table 3.10. Other LTS Requirements for the Melton Valley watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
MSRE D&D Uranium Deposit Removal	AM (DOE/OR/02-1488&D2) RmAR (DOE/OR/01-1918&D2)	• S&M activities for the interim storage of the collector canister holding the uranium-laden charcoal removed from the ACB • Venting of the canister as necessary to maintain a pressure of less than 50 psig • If interim storage is required beyond two years, it will be necessary to denature the collector canister • S&M activities for the ACB performed pursuant to facility authorization basis documents and approved procedures • O&M of the ventilation system to maintain a negative air pressure	• Periodic measurements (daily checks of the pressure gauge and hourly recorder data) • Monthly checks of the CBC for water accumulation and presence of a pump for removing water from the CBC • Annual tests of the pump
White Oak Dam	AM (Time Critical) for Corrective Actions at White Oak Dam (DOE/OR/01-2460&D1) RmAR (DOE/OR/01-2509&D1)	• Routine maintenance includes: repairs to fences and gates; maintenance of signage and postings; maintenance of pole-mounted overhead lights at the site; testing, lubrication and maintenance of the lift gates; vegetation control; and any needed repair of any observed subsidence, erosion damage, animal holes, or other damage to the dam surface (except for the roadway pavement which is the responsibility of state of Tennessee) • Final land use controls will be defined in a future CERCLA decision for ORNL, as necessary • Access to WOL and WOCE will continue to be restricted in accordance with existing ROD and LUCIP requirements	• Periodic inspections in accordance with FEMA guidelines for dam safety

[a]Source for LUCs # 1-8: *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-2343&D1) and 2009 errata. Source of Frequency/Implementation for LUCs # 1-8: *Land Use Control Implementation Plan for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-1977&D6).

[b]DOE land notation (property record restriction) – includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with the original property acquisition records of DOE and its predecessor agencies. This DOE land notation may be referred to as property record restrictions in some ORR RODs.

[c]Property Record Notices – includes conditions that inform, restrict, or prohibit certain uses of real property. They serve also to alert anyone searching for property information about residual contamination/waste disposal areas on the property.

[d]Zoning notices – includes information on the location of hazardous waste disposal areas and residual contamination depicted on a survey plat, which is provided to a zoning authority (i.e., the City Planning Commission) for consideration in appropriate zoning decisions for non-DOE property.

[e]EPP program – refers to the internal DOE/DOE contractor administrative program(s) that requires the permit requester to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or, in the case of contaminated soil or groundwater, will not disturb the affected area without the appropriate precautions and safeguards.

Table 3.10. Other LTS Requirements for the Melton Valley watershed (cont.)

[f]State advisories/postings – refers to health advisory information provided by the TDEC Division of Water Pollution Control related to use or restrictions thereon of surface waters that currently do not meet the designated uses established in Rules of the TDEC Chapter 1200-4-4. Although not required, TDEC may provide advisories and postings in the future. Currently such information is included on signs maintained by DOE that are placed along WOL and WOCE to provide notice to potential users of contamination and prohibit fishing/water contact.

[g]Access controls – physical barriers or restrictions to entry.

[h]Signs – DOE posted command, warning, or direction.

[i]This includes errata DOE/OR/01-2343&D1/A1 and DOE/OR/01-2343&D1/A2 and addendum DOE/OR/01-2343&D1/A3/R1.

[j]LTS requirements are detailed in the Melton Valley Surveillance and Maintenance Plan (DOE/OR/01-2342&D1) attached to the RAR (DOE/OR/01-2343&D1) as Appendix E.

ACB = auxiliary charcoal bed
AM = Action Memorandum
CBC = charcoal bed cell
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D = decontamination and decommissioning
DOE = U.S. Department of Energy
EPP = excavation/penetration permit
FEMA = Federal Emergency Management Agency
FIR = federal controlled industrial/research
IROD = Interim Record of Decision
LTS = long-term stewardship
LUC = land use control
LUCIP = Land Use Controls Implementation Plan
MSRE = Molten Salt Reactor Experiment
MV = Melton Valley
O&M = operations and maintenance
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
psig = pounds per square inch gauge
PTSM = principal threat source material
RAR = Remedial Action Report.
RCRA = Resource Conservation and Recovery Act of 1976
RmAR = Removal Action Report
ROD = Record of Decision
S&M = surveillance and maintenance
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
WAG = Waste Area Grouping
WOCE = White Oak Creek Embayment
WOL = White Oak Lake

The implementation and maintenance of these LUCs are specified in the *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6). Because of the similarity in interim LUC objectives among the three remediation areas, most of the LUCs apply throughout the watershed. Thus, the LUCs are defined as follows:

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

These LUCs are grouped into administrative controls (land use and groundwater deed restrictions, property record notices, zoning notices, permits program, and state advisories) and physical controls (postings, access controls, signs, and security patrols).

The requirements of the *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6) are in Appendix A, along with the required certification. The *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6) requires individual remediation projects within the Melton Valley watershed to identify applicable additional LUCs in the project completion document. None of the Melton Valley completion documents contain additional project-specific LUCs.

While the completion documents do not require additional LUCs, the hydrologic isolation projects include engineering controls that are to be maintained at the 14 separate waste caps. Table 3.10 lists these LTS requirements from the Melton Valley completion documents. Maintenance of the engineering controls at the caps is addressed in the *Melton Valley Surveillance and Maintenance Plan* (DOE/OR/01-2342&D1) that is attached to the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1). This plan covers the S&M required for all remediation completed in Melton Valley. Inspections and maintenance of the engineering controls began immediately upon completion and are implemented in accordance with the *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual* (BJC/OR-2288).

3.2.2.2 Status of Requirements

Appendix A contains the Certification of LUCs for FY 2014. The Land Use Control Assurance Plan (LUCAP) attached to the *Memorandum of Understanding for Implementation of a Land Use Control Assurance Plan (LUCAP) for the United States Department of Energy Oak Ridge Reservation* (DOE/OR/01-1824&D1/A2) requires that the Manager, DOE ORO, annually verify in the RER that

LUCIPs are being implemented on the ORR. A summary of the implementation verification and status of the Melton Valley watershed LUCs follows:

DOE Land Notation (Property Record Restrictions)

- The DOE filed the Melton Valley 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 Book 1290, pages 727-748. The Land Notation includes the principal contaminants left in place and restrictions on the property. Survey plats for each of the waste units were attached to the Land Notation that delineated property that will be restricted in its future use. For FY 2014, this information was verified to be properly filed electronically at the Roane County Register's of Deeds office.

Property Record Notices

- DOE placed the Melton Valley property record notice, officially titled, "Notice of Land Use Restrictions in Melton Valley Area DOE – ORR," 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 DOE website and filed at the DOE Information Center. The notice includes the predominant contaminants of concern; future use limitations of the areas within Melton Valley; the required LUCs; additional contact information; and a figure depicting the three land use zones. This LUC information has been added to Appendix A of the *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6). For FY 2014, this information was verified to be posted electronically on the DOE ORO EM website and to be placed at the DOE Information Center. In addition to the Melton Valley property record notice, the DOE land notation and survey plat were also filed on the web page and at the Information Center. It also was verified that the land notation was properly recorded at the Roane County Register's of Deeds office (see previous section).

Zoning Notices

- For FY 2014, the areas remain under federal control and no Zoning Notice has been filed to date.

EPP Program

- The *Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE/OR/01-1826&D3) requires that an EPP program be in place throughout Melton Valley 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 *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6) 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 ORNL S&M Project Engineer stating that the EPP program was functioning during FY 2014 in accordance with Appendix B of the *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6) and the procedure *Excavation/Penetration Permit for ORNL Site* (PROC-OR-1010). This procedure requires that an EPP log be maintained, that all EPPs at the ORNL be entered into the log and maintained by one person, that an Environmental Compliance Review Form (Form-147b) be completed by ORNL S&M 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. Excavations conducted by UT-B when operating as the prime workgroup are to be performed in accordance with the UT-B procedure, *Initiating and Issuing an Excavation or Penetration Permit,* which requires the ORNL S&M Project Engineer signature on every excavation permit before work can begin. The UT-B excavation permit form also requires that the ORNL S&M Project Environmental Compliance Lead review the area to determine if any CERCLA LUCIPs are established, and if so, specify the relevant details. In FY 2014, there were no excavation permits requested for Melton Valley remediation areas.

State Advisories/Postings

- For FY 2014 a field survey was conducted by the WRRP and the S&M program to verify signs designated in the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1) and 2009 errata were in place, in good condition and legible.

  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 Tennessee Wildlife Resources Agency (TWRA) fishing regulations for these areas.

Access Controls

- In addition to routine site inspections conducted in accordance with the *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual* (BJC/OR-2288), a field survey was conducted for FY 2014 by the WRRP and the S&M program to verify access controls designated in the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1) and 2009 errata were in place, in good condition and functioning properly. All major access points remain guarded or locked at all times, and interior gates are selectively locked. Specifically, access is restricted by security portals at the east and west ends of Bethel Valley Road. There also is a locked gate at the junction of the Melton Valley haul road and the Melton Valley Access Road. Perimeter roads around Melton Valley have gates that allow access for maintenance activities.

Signs

- In addition to routine site inspections conducted by the Melton Valley S&M Program according to the *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual* (BJC/OR-2288) of all remediated areas in Melton Valley, a field survey was conducted for FY 2014 by the WRRP and the S&M program to verify signs designated in the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1) and 2009 errata were in place, in good condition and legible. All signs as identified in the *Remedial Action Report for the Melton Valley Watershed* (DOE/OR/01-2343&D1) and 2009 errata were in place and meeting their intended purpose. Specifically, 20 signs were in place around the Melton Valley 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 to provide notice to potential resource users of contamination and to prohibit fishing/swimming.

Surveillance Patrols

- The *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6) requires that surveillance patrols of selected areas in Melton Valley be effective immediately and be conducted no less frequently than once a quarter. The patrols may be performed as part of the required, routine S&M site inspections. The *Land Use Control Implementation Plan for the Melton Valley Watershed* (DOE/OR/01-1977&D6) 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 2014, surveillance patrols were performed by the ORNL S&M Program as part of routine site inspections in accordance with the *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual* (BJC/OR-2288). Inspections of the capped areas within Melton Valley were performed on a semiannual basis. In addition, routine patrols of various areas within Melton Valley are performed no less than quarterly.

In addition to implementing the physical LUCs, i.e., access controls, signs, and surveillance patrols, as detailed above, the S&M Program also performed inspections of the Melton Valley 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, gates, and signs.

In FY 2014, engineering controls were inspected semiannually by the S&M Program according to the *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual* (BJC/OR-2288) 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 – Hill Cut Test Facility,
- 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.

Maintenance during FY 2014 included repairing leaky piping on the SWSA 6 Hill Cut Test Facility drainage system. All caps were noted to have good vegetative coverage, and were mowed a minimum of once during the year.

3.3 SINGLE-PROJECT ACTIONS

3.3.1 WOCE Sediment Retention Structure

Location of the WOC Sediment Retention Structure is shown on Figure 3.1. The scope of this action was the construction of a sediment retention structure at the mouth of WOC to contain the sediments in lower WOCE and minimize contaminant transport off-site to the Clinch River and Watts Bar Reservoir. The Sediment Retention Structure 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.

3.3.1.1 Other LTS Requirements

Other LTS requirements are listed in Table 3.10 and shown on Figure 3.2 and include only inspection and maintenance of the sediment retention structure.

3.3.1.2 Status of Requirements

The site was inspected monthly in FY 2014 by the 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 Sediment Retention Structure, and identify any evidence that there had been any movement or shift of the embayment structure. No maintenance was required during FY 2014.

3.3.2 WAG 13 Cesium Plots

The location of the WAG 13 Cesium Plots 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.

3.3.2.1 Other LTS Requirements

Other LTS requirements are listed in Table 3.10 and shown on Figure 3.2 and include only long-term S&M of the fenced enclosure.

3.3.2.2 Status

The site underwent quarterly inspections in FY 2014 conducted by the 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. Minor maintenance included repairing four minor breaks in barbed wire on the fence and cutting vegetation from around the fence. No additional maintenance was required, and routine mowing was performed.

3.3.3 MSRE Uranium Deposit Removal

The location of the MSRE 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 to ensure that less than a critical mass remains.

3.3.3.1 Other LTS Requirements

Other LTS requirements listed in Table 3.10 and shown on Figure 3.2 are specified in the *Removal Action Report for Uranium Deposit Removal at the Molten Salt Reactor Experiment* (DOE/OR/01-1918&D2) and include S&M for the interim storage of the collector canister holding the uranium-laden charcoal removed from the auxiliary charcoal bed. Specifically, requirements include 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 pound per square inch gauge (psig).

3.3.3.2 Status of Requirements

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 performed on the charcoal canister in FY 2014.

3.3.4 White Oak Dam

The location of the White Oak Dam is shown on Figure 3.1. The goal of this time-critical removal action was to maintain the containment of contaminated sediment in WOL and improve the stability of the highway embankment that makes up part of White Oak Dam.

3.3.4.1 Other LTS Requirements

The other LTS requirements associated with the *Removal Action Report for Corrective Actions at White Oak Dam* (DOE/OR/01-2509&D1) are listed in Table 3.10 and shown on Figure 3.2 and include periodic inspections. The modifications to White Oak Dam completed under this removal action require no active operation or maintenance. The improved armoring of the upstream and downstream slopes of the dam uses stone and large rip-rap that has been designed to perform this function without active maintenance; similarly, the grouted box culvert requires no active operation or maintenance. Periodic inspections will be performed in accordance with Federal Emergency Management Agency (FEMA) guidelines for dam safety. Dams located on federal property are self-regulated by the federal agency managing that property. DOE regulates all dams on DOE property from DOE Headquarters Office of Corporate Safety Programs. URS | CH2M Oak Ridge LLC (UCOR) and its subcontractors have overall responsibility for operating and maintaining the White Oak Dam and contiguous property on behalf of DOE ORO, including routine inspections of the White Oak Dam to ensure dam safety. The UT-B has responsibilities at the dam for monitoring the water flow and water level, environmental sampling, and for responding to abnormal incidents. The Tennessee Department of Transportation (TDOT) controls road closure and inspection, operation, and maintenance of the bridge and highway.

The *Management Plan for White Oak Dam, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (UCOR-4178) delineates responsibilities for the operation, maintenance, routine inspections, and response to abnormal conditions for the White Oak Dam and associated facilities, and provides the schedule and content of routine and post-event dam inspections. Routine inspections and maintenance of the White Oak Dam include: repairs to fences; maintenance of signage and postings; maintenance of pole-mounted overhead lights at the site; testing, lubrication and maintenance of the lift gates; vegetation control; and any needed repair of any observed subsidence, erosion damage, animal holes, or other damage to the dam surface (except for the roadway pavement which is the responsibility of the state of Tennessee). Special events that require inspections include: overtopping or an event such as an earthquake that exceeds 4.0 on the Moment Magnitude Scale (MMS), a serious vehicle accident on the dam that goes beyond the roadway, and aircraft crash into the dam, a tornado that could have damaged the dam, or high water going onto the roadway (754.8 ft MSL).

3.3.4.2 Status of Requirements

In FY 2014, the site underwent required quarterly inspections by S&M Program craft personnel and annual inspections by the facility manager in accordance with the *Management Plan for White Oak Dam, Oak Ridge National Laboratory, Oak Ridge, Tennessee* (UCOR-4178). Electrical issues with the gates were repaired, and the gates were tested monthly. There were no additional problems, and there were no special events requiring inspections.

3.4 MELTON VALLEY WATERSHED ISSUES AND RECOMMENDATIONS

The issues and recommendations for the Melton Valley watershed are in Table 3.11.

Table 3.11. Melton Valley watershed issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
1. Several wells in Melton Valley have chronically not attained the ROD goal for groundwater level within hydrologically isolated areas.	1. Two wells in SWSA 6 and 3 wells in SWSA 4 have not attained the ROD goal for groundwater level control inside hydrologically isolated areas. A review of conditions, including potential modifications to monitoring and applicable CERCLA documentation, is planned.	DOE	FY 2016
Issue Carried Forward			
None			
Completed/Resolved Issues[b]			
2. Increasing trend for ^{90}Sr has been observed during FY 2012 and FY 2013 in HRE tributary monitoring data. (2014 RER)	1. DOE conducted additional sampling in the HRE tributary that identified the abandoned LLLW pipeline along the north side of Melton Valley Drive as the probable source of ^{90}Sr that causes the increasing concentration trend observed at the HRT-3 monitoring location. Strontium-90 levels measured in surface water near the source area were less than the Melton Valley ROD remediation level for surface water. Monitoring in the HRE Tributary will continue consistent with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1982&D3).	DOE	FY 2015

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the *2015 Remediation Effectiveness Report*. An "Issue Carried Forward" is an issue identified in a previous year's RER for FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.

[b]The year in which the issue originated is in parentheses, e.g., (2013 RER).

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy
FY = fiscal year
FYR = Five-Year Review
HRE = Homogeneous Reactor Experiment
LLLW = liquid low-level waste
RER = Remediation Effectiveness Report
ROD = Record of Decision
SWSA = Solid Waste Storage Area

3.5 REFERENCES

BJC/OR-2288. *Oak Ridge National Laboratory Surveillance & Maintenance Program Facility Inspection and Training Manual*, 2006, Bechtel Jacobs Company LLC, Oak Ridge, TN.

Crane, J. L., January 24, 2013. U.S. Environmental Protection Agency, Region 4, Atlanta, GA, letter to J. M. Japp, U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

DOE/OR/01-1824&D1/A2. *Land Use Control Assurance Plan for the Oak Ridge Reservation, Oak Ridge, Tennessee*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1826&D3. *Record of Decision for Interim Actions for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1862&D4. *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1918&D2. *Removal Action Report for Uranium Deposit Removal at the Molten Salt Reactor Experiment at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2001, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1977&D6. *Land Use Control Implementation Plan for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee,* 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1982&D3. *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee,* 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2088&D2. *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*, 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2200&D1. *Waste Handling Plan for the Molten Salt Reactor Experiment Remediation of Secondary Low-Level Waste Under the Melton Valley Closure Project at Oak Ridge, National Laboratory, Oak Ridge, Tennessee*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2200&D1/A1. *Addendum to the Waste Handling Plan for the Molten Salt Reactor Experiment Remediation of Secondary Low-Level Waste under the Melton Valley Closure Project at Oak Ridge, National Laboratory, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2256&D1. *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*, 2008, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2285&D1. *Phased Construction Completion Report for Hydrologic Isolation at Solid Waste Storage Area 6 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2342&D1. *Melton Valley Surveillance and Maintenance Plan, Oak Ridge, Tennessee*, 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2343&D1. *Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2343&D1/A1. *Addendum to Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2343&D1/A2. *Addendum to Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2343&D1/A3/R1. *Addendum to the Remedial Action Report for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2509&D1. *Removal Action Report for the Corrective Actions at White Oak Dam, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2621&D1. *Action Memorandum for Time-Critical Removal Action for the Sludge Test Area Buildout at the Transuranic Waste Processing Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1671&D2. *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*, 1998, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for the Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE-STD-1196-2011. *Derived Concentration Technical Standard*, 2011, U.S. Department of Energy, Washington, D.C.

Gilbert, R. O. 1987. Statistical Methods for Environmental Pollution Monitoring, Chapter 16.4 Mann-Kendall Test, pp 208-217, and Appendix A, Table A.18 Probabilities for Mann-Kendall Non-Parametric Test for Trend, p. 272, John Wiley & Sons, Inc., New York, NY.

McMillian, W. G. and Japp, J. M., July 24, 2013. U.S. Department of Energy, Oak Ridge Office, Oak Ridge, TN, letter to J. L. Crane, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, and R. Petrie, Tennessee Department of Environment and Conservation, Oak Ridge, TN.

McMillian, W. G. and Japp, J. M., March 27, 2013. U.S. Department of Energy, Oak Ridge Office, Oak Ridge, TN, letter to J. L. Crane, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, and R. Petrie, Tennessee Department of Environment and Conservation, Oak Ridge, TN.

Petrie, R., January 9, 2013. State of Tennessee Department of Environment and Conservation, Oak Ridge, TN, letter to J. M. Japp, U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

PROC-OR-1010. *Excavation/Penetration Permit for ORNL Site*, latest revision, URS | CH2M Oak Ridge LLC, Oak Ridge, TN.

UCOR-4178. *Management Plan for White Oak Dam, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 2012, URS | CH2M Oak Ridge LLC, Oak Ridge, TN.

Wiedemeier, T. H., H. S. Rifai, G. J. Newell, and J. T. Wilson. 1999. Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface. John Wiley & Sons, Inc., New York, NY.

This page intentionally left blank.

4. BEAR CREEK VALLEY WATERSHED

4.1 INTRODUCTION AND STATUS

4.1.1 Introduction

The BCV watershed contains closed and active waste disposal facilities. Table 4.1 lists the CERCLA actions within the watershed and identifies those with monitoring or other LTS requirements. Figure 4.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Only sites that have LTS requirements (Table 4.1) are included in these performance evaluations. End uses of a site form the basis of RAOs and determine access restrictions and allowable activities at the site. Figure 4.2 shows ROD-designated end uses within the watershed and interim controls requiring LTS.

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.

The EMWMF is an operating CERCLA waste disposal facility located in the BCV watershed. Operation of the EMWMF is an ongoing CERCLA action to dispose waste from CERCLA response actions on the ORR and associated sites. The CERCLA action status of the EMWMF is not reported in this document but is evaluated in the EMWMF annual PCCR.

For a complete discussion on background information and performance metrics for each remedy, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chapter 8 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

4.1.2 Status Update

During FY 2014, no additional CERCLA actions were implemented or completed, nor were any associated FFA documents submitted or approved for CERCLA actions located in BCV. Monitoring in support of performance assessments and evaluations continued.

4.2 BCV PHASE I ROD

4.2.1 Performance Monitoring

4.2.1.1 Performance Goals and Monitoring Objectives

The remedy in the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) includes 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.

Several single-project decisions within BCV watershed predate the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4). These earlier actions do not contain specific performance criteria for reduction of contaminant flux or risk reduction at the watershed scale. The *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4), 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 *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) also includes expected outcomes for the selected remedy against which effectiveness of individual actions is measured. The *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) 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.

This section presents the remediation goals, performance metrics, and progress toward achieving the goals in the BCV watershed. Annual performance measurements obtained during FY 2014 are presented along with historic monitoring results.

The RAOs for the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) are 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 the BCV watershed are identified on Figure 4.2. Consistent with the RAOs, water quality goals are also established for each zone as stated in Table 4.2 although chemical-specific ARAR-based performance criteria are not included for groundwater. In addition to the watershed-wide water quality goals, the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) provides site-specific water quality goals for the S-3 Site Pathway 3 and the Boneyard/Burnyard (BYBY) actions (Table 4.3).

Table 4.1. CERCLA actions in BCV watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
Watershed-scale actions			
BCV Phase I ROD	ROD (DOE/OR/01-1750&D4): 06/16/00	**Actions complete**	
	LUCIP (DOE/OR/01-2320&D1) submitted 09/29/06	• BYBY PCCR (DOE/OR/01-2077&D2) approved 01/12/04	Yes/Yes
		• Oil Landfarm Soils Containment Pad RAR (DOE/OR/01-1937&D2) approved 07/16/01	No/No
Single-project actions			
BCV OU 2 (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
S-3 Site Tributary Interception (Pathways 1 and 2)	AM (DOE/OR/01-1739&D1): 06/25/98	RmAR (DOE/OR/01-1945&D2): approved 02/11/02	Terminated
	AM Addendum (DOE/OR/01-1739&D1/A1): 10/20/00	RmAR Addendum (DOE/OR/01-1836&D1/A1): approved 06/20/07 (shutdown Pathways 1 and 2 system)	Terminated
BCBG Unit D-East	AM (DOE/OR/01-2036&D1): 08/12/02	RmAR (DOE/OR/01-2048&D2): approved 05/09/03	No/No
EMWMF Haul Road Construction	ROD (DOE/OR/01-1791&D3: 11/02/99 ESD (DOE/OR/01-2194&D2): 01/11/05	PCCR (DOE/OR/01-2296&D1): approved 04/02/06 (Haul Road)	No/No[c]

[a]Detailed information of the status of actions is from Appendix E of the FFA and is available at <http://www.ucor.com/ettp_ffa_appendices.html>.

[b]"No/No" indicates no monitoring/other LTS requirements are identified in the CERCLA action completion document beyond those identified in the watershed ROD. Refer to Table 4.5 for watershed-scale monitoring requirements and Figure 4.2 and Table 4.12 for watershed-scale LUCs and other LTS requirements.

[c]The EMWMF Haul Road Construction is a completed action under the EMWMF ROD. Operation of the EMWMF is an ongoing CERCLA action to dispose waste from CERCLA response actions on the ORR. The CERCLA action status of the EMWMF is evaluated in a separate report.

AM = Action Memorandum
BCBG = Bear Creek Burial Ground
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
ESD = Explanation of Significant Differences
EMWMF = Environmental Management Waste Management Facility
FFA = Federal Facility Agreement
LTS = long-term stewardship
LUC = land use control
LUCIP = Land Use Control Implementation Plan
ORR = Oak Ridge Reservation
OU = operable unit
PCCR = Phased Construction Completion Report
RAR = Remedial Action Report
RmAR = Removal Action Report
ROD = Record of Decision
S&M = surveillance and maintenance

This page intentionally left blank.

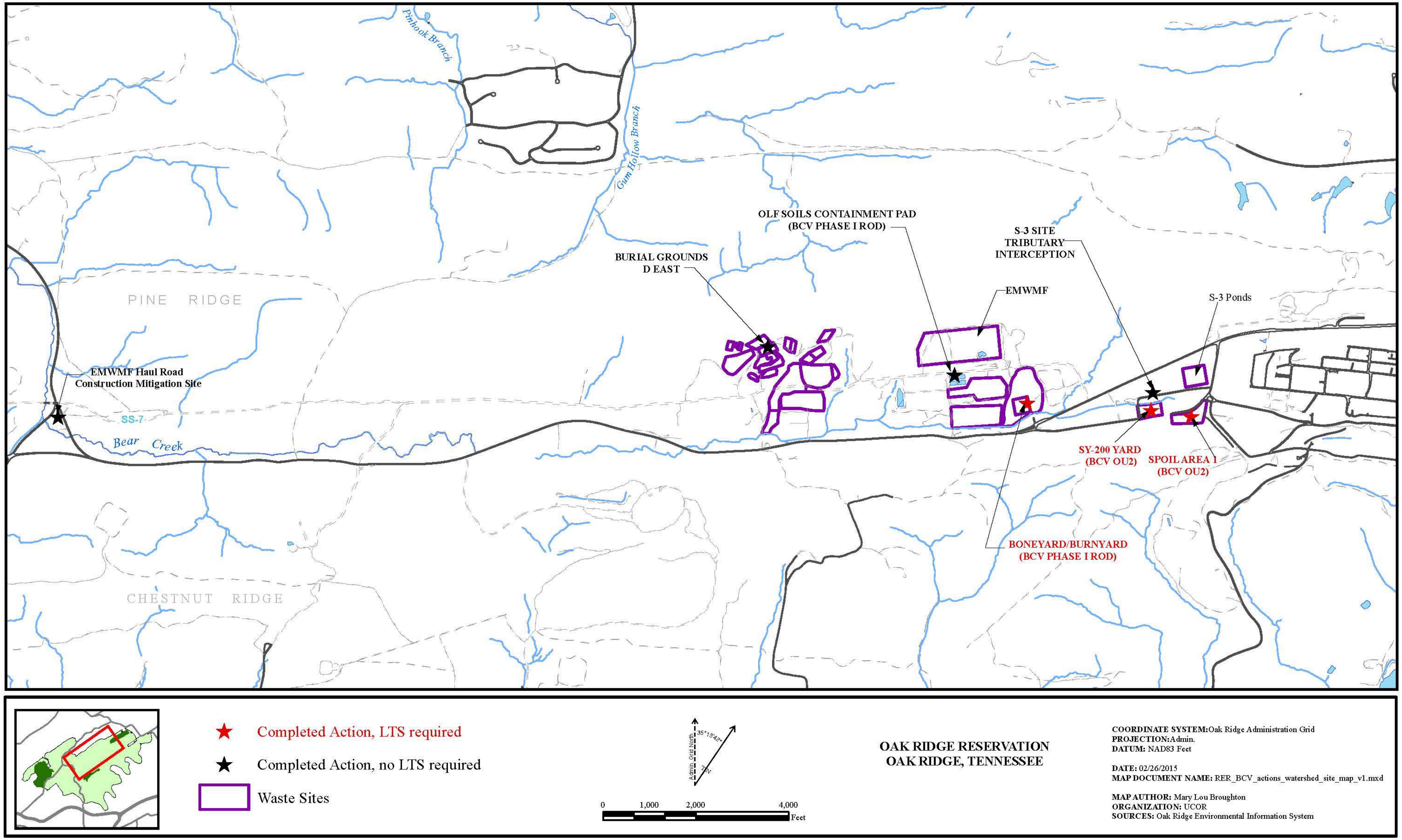


Figure 4.1. BCV watershed.

This page intentionally left blank.

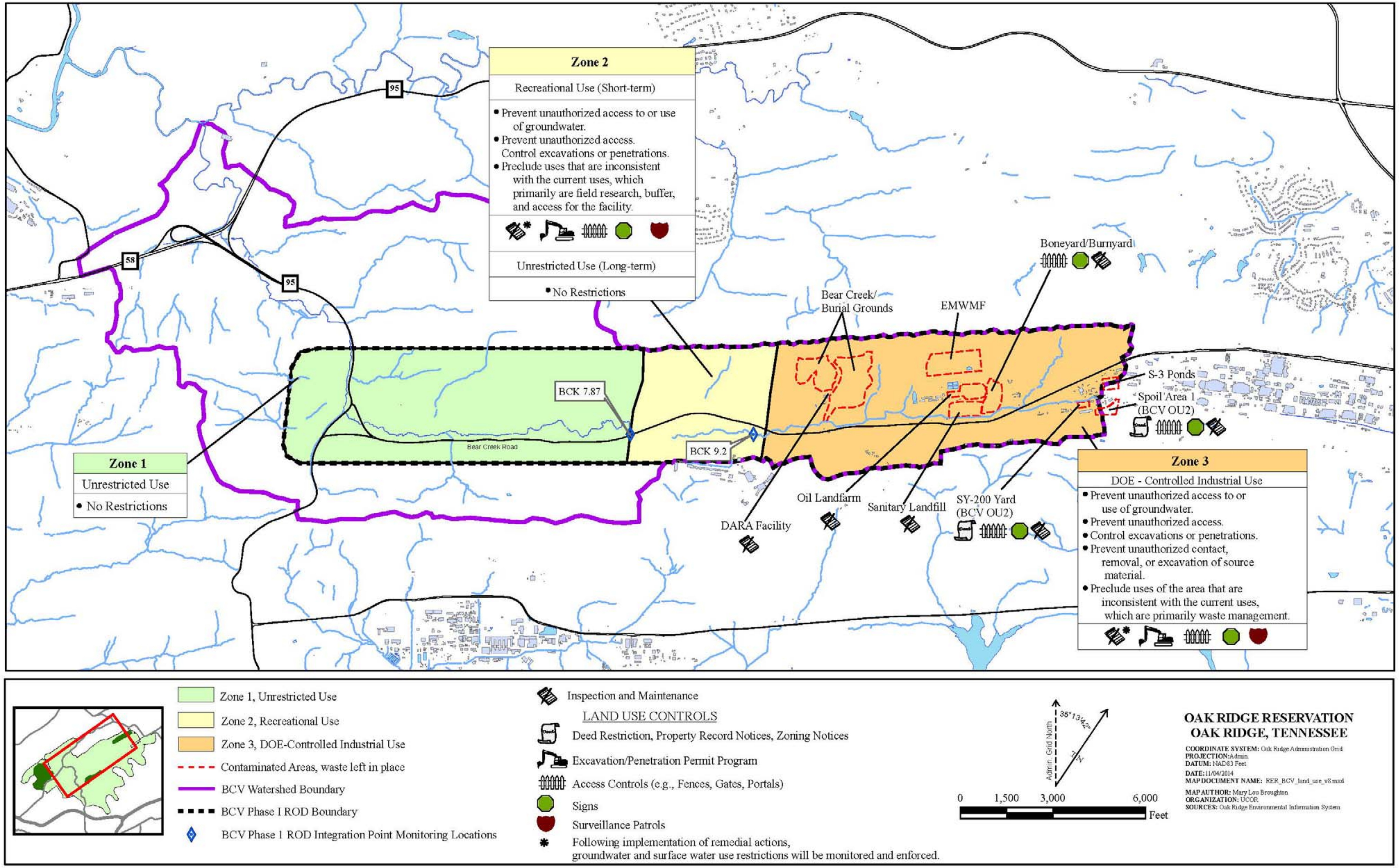


Figure 4.2. BCV Phase I ROD-designated end use and interim controls requiring LTS.

This page intentionally left blank.

Table 4.2. Groundwater and surface water goals, BCV watershed[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 *Record of Decision for the Phase 1 Activities in Bear Creek Valley* ([DOE/OR/01-1750&D4] page 2-13).

AWQC = ambient water quality criteria
BCV = Bear Creek Valley
MCL = maximum contaminant level

Table 4.3. Site-specific goals for RAs at the S-3 Site Pathway 3 and the BYBY[a]

Remedial action goals for S-3 Site Pathway 3	***Remedial action goals for BY/BY***
• *Prevent expansion of the nitrate plume into Zone 1* • *Reduce concentration of cadmium in NT-1 and upper Bear Creek to meet AWQC*[b] • *Prevent future increase in release of uranium to Bear Creek to maintain annual flux below 27.2 kg total Uranium 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.*	• *Reduce flux of uranium in NT-3 at confluence with Bear Creek to 4.3 kg/yr* • *Reduce concentration of mercury in NT-3 to meet AWQC (12 ng/L at the time – now 51 ng/L)*

[a]Source: Table 2.2 of *Record of Decision for the Phase 1 Activities in Bear Creek Valley* ([DOE/OR/01-1750&D4] page 2-14).
[b]The *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) originally established the cadmium concentration performance standard as 3.9 µg/L. This standard changed to 0.25 µg/L due to a change in the promulgated AWQC.

AWQC = ambient water quality criteria
BYBY = Boneyard/Burnyard
BCK = Bear Creek kilometer
FFA = Federal Facility Agreement
NT = North Tributary
RA = remedial action

The source removal actions related to principal threat source materials and groundwater control actions specified in the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) were intended 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.
- **Oil Landfarm Area.** Actions in the Oil Landfarm Area include:
  - Remove waste stored in Oil Landfarm Soil Containment Pad for commercial off-site disposal and dismantle structure.
  - Excavate source areas in BYBY and contaminated floodplain soils and sediments. Excavated materials meeting the EMWMF WAC 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 *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) was initiated in FY 2000. RAs in the Oil Landfarm Area are complete (BYBY and Oil Landfarm Soil Containment Pad). Other key components of the remedy (S-3 Pathway 3 and DARA facility) have not yet been implemented. An early action addressing S-3 Pathways 1 and 2 was terminated. Response actions for all three components (i.e., Pathways 1, 2 and 3) will be included in the future design considerations for Pathway 3 or in the final groundwater decision for BCV.

The ROD included expected outcomes, target risk levels, and timeframes for attainment of goals for each of the BCV watershed end uses (Table 4.4).

4.2.1.2 Evaluation of Performance Monitoring Data

This section presents the monitoring data that evaluates progress toward meeting the goals of the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4). Performance monitoring includes surface water monitoring, groundwater monitoring, and biological monitoring. The performance metrics and monitoring parameters for each location are outlined in Table 4.5. Performance monitoring outlined in Table 4.5 as well as other baseline and trend monitoring are shown in Figure 4.3 and discussed below.

4.2.1.2.1 Surface Water

4.2.1.2.1.1 Surface Water Quality Goals and Monitoring Requirements

The goals of the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) include AWQC compliance and annual mass (flux) reductions for nitrate and uranium at several locations throughout the watershed. AWQC sampling is conducted in the year prior to each CERCLA FYR. The most recent presentation and evaluation of progress toward meeting AWQC in BCV was reported in the *2011 Remediation Effectiveness Report (*DOE/OR/01-2505&D2*) and the 2011 Third Reservation-Wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge*

Reservation, Oak Ridge, Tennessee (DOE/OR/01-2516&D2). Monitoring is keyed to the boundaries between the three zones defined in the ROD. Key surface water monitoring locations include Bear Creek kilometer (BCK) 9.2, BCK 12.34, NT-3, SS-5, and NT-8 (Figure 4.3). BCK 9.2 is the integration point near the border of Zones 2 and 3. BCK 12.34 is located near the Bear Creek headwater and serves as an integration point for surface water contaminant discharges from the S-3 Ponds area. NT-3 was historically heavily impacted by contaminant discharges from BYBY which has been remediated. NT-8 carries runoff and contaminants from the western end of the Bear Creek Burial Grounds (BCBGs) to Bear Creek just a short distance from the western end of Zone 3 and above the integration point at BCK 9.2.

Zone 1

Zone 1 of BCV watershed constitutes the valley area west of BCK 7.87 (Figure 4.3). Surface water quality is monitored at BCK 7.87. The surface water quality goal for Zone 1 is to meet risk levels consistent with unrestricted use (residential) and to meet AWQC (Table 4.4). Zone 1 surface water monitoring results are compared to AWQC and risk-based concentrations for residential exposure in each CERCLA FYR. The AWQC comparison includes quarterly grab samples for metals and anions during the year prior to each FYR.

Zone 2

Zone 2 of BCV watershed constitutes the section of the valley located between BCK 7.87 and BCK 9.2 (Figure 4.3) and functions as a buffer zone between Zones 1 and 3. The long-term goal for Zone 2 is to improve surface water quality consistent with eventually achieving unrestricted use in 50 years. At BCK 9.2, the monitoring location for Zone 2 surface water, weekly flow-proportional samples are collected for isotopic uranium analysis and monthly grab samples are collected for nitrate analysis. Uranium and nitrate monitoring at BCK 9.2 represents the contribution in surface water from all sources within the Bear Creek watershed migrating from Zone 3 into Zone 2. In addition, quarterly samples for metals, VOCs, and nitrate are collected in the year prior to each CERCLA FYR. Zone 2 surface water results at BCK 9.2 are compared to the uranium flux goal of ≤34 kg/yr from the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) annually and to AWQC during the FYR (Table 4.5). In addition, results for uranium and nitrate at BCK 9.2 are compared to risk-based concentrations for residential exposure.

Table 4.4. Expected outcome of the selected remedy, BCV watershed[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 activities; surrounding area available for additional controlled industrial use*	*Area devoted to waste management; proposed on site 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: *Record of Decision for the Phase 1 Activities in Bear Creek Valley* ([DOE/OR/01-1750&D4] 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.*

AWQC = ambient water quality criteria
BCBGs = Bear Creek Burial Grounds
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
MCLs = maximum contaminant levels
N/A = not applicable
NT = North Tributary
OLF = Oil Landfarm
RAO = remedial action objective
TBD = to be determined
Y-12 = Y-12 National Security Complex

Zone 3

Zone 3 of Bear Creek watershed is the section of the valley east of BCK 9.2 (Figure 4.3) 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 end use. Surface water is monitored at a number of locations within Zone 3, including monitoring required specifically for the S-3 ponds Pathway 3 and the BYBY (Figure 4.3, Table 4.5).

Monitoring for the S-3 Ponds Pathway 3 is conducted at surface water locations BCK 12.34, NT-1, and NT-2. BCK 12.34 has continuous flow monitoring, and weekly flow-proportional composite samples are analyzed for nitrate, ^{234}U, ^{235}U, and ^{238}U. In addition, monthly grab samples are collected at BCK 12.34 for metals, including cadmium. Quarterly grab samples for metals, including cadmium, are collected at NT-1. NT-2 has continuous flow monitoring and weekly flow-proportional composite samples are analyzed for nitrate.

Effectiveness of remediation at the BYBY is measured by water quality in the NT-3 stream. NT-3 has continuous flow measurements and weekly flow-proportional composite samples are analyzed for ^{234}U, ^{235}U, and ^{238}U. The *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) requires surface water at NT-3 to meet AWQC and be below risk-based concentrations for an industrial receptor exposure to surface water (1E-5 ELCR).

The *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) includes the following uranium flux goals:

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

Other uranium flux monitoring locations include BCK 11.54 and NT-8, which both have continuous flow monitoring and weekly flow-proportional composite samples that are analyzed for ^{234}U, ^{235}U, and ^{238}U. BCK 11.54, a Bear Creek main stream station, is located downstream of NT-3 (Table 4.5 and Figure 4.3), and functions as an upstream integration point for the BCBGs. Monitoring at NT-8 is instrumental in determining relative contribution of the BCBGs to uranium flux at BCK 9.2. Further monitoring is conducted in Zone 3 for the FYR and is detailed in Table 4.5.

Table 4.5. BCV watershed CERCLA performance monitoring[a]

Area/Site	Media	Monitoring location	Schedule	Parameters	Performance standard
Zone 1	Biota	BCK 3.3	Semiannual survey and bioaccumulation monitoring	Fish and benthic macroinvertebrate species richness and density; bioaccumulation of mercury, metals (including uranium), and PCBs in stoneroller minnows; bioaccumulation of mercury and PCBs in rockbass	Measure changes in quality of aquatic habitat as compared to reference sites
	Surface water	BCK 3.3, BCK 4.55	Quarterly grab sample (in year prior to FYR)	Metals, including total and isotopic uranium, and mercury; VOCs; and nitrate[f]	AWQC, risk-based[e]
	Groundwater	SS-6, SS-7, and SS-8 springs	Quarterly grab sample (in year prior to FYR)	Metals, including total and isotopic uranium, and mercury; VOCs; and nitrate[f]	TBD[b] Trend monitoring
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 (Picket W)	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]
			Weekly flow-proportional composite samples	Uranium (isotopic)	Uranium flux ≤ 34 kg/yr
			Monthly grab samples	Nitrate	Trend, risk-based
	Groundwater	GW-683, GW-684 (Picket A)	Semiannual grab samples	Metals (including mercury, cadmium, and total uranium); nitrate, and isotopic uranium	TBD[b] trend monitoring
		SS-5 Spring	Quarterly grab samples (in year prior to FYR)	Metals, including total uranium and mercury, VOCs, and nitrate	

Table 4.5. BCV watershed CERCLA performance monitoring (cont.)

Area/Site	Media	Monitoring location	Schedule	Parameters	Performance standard
Zone 3	Biota	BCK 9.9	Semiannual survey and bioaccumulation monitoring	Fish and benthic macroinvertebrate species richness and density; Bioaccumulation of mercury, metals (including uranium), and PCBs in stoneroller minnows (whole body)	Measure changes in quality of aquatic habitat as compared to reference sites
		BCK 12.4	Semiannual survey and bioaccumulation monitoring	Fish and benthic macroinvertebrate species richness and density; Bioaccumulation of mercury, metals (including uranium) in stoneroller minnows (whole body)	
	Surface water	BCK 12.34	Quarterly grab samples (in year prior to FYR)	Metals, including cadmium, mercury, and isotopic and total uranium (with an MDL of 0.004 mg/L); VOCs, nitrates[f]	AWQC, risk-based[e] – within five years, Uranium ≤ 27.2 kg/yr, Cadmium ≤ 0.25µg/L, Nitrates – 40% seasonal reduction, Nitrate trend
		NT-1	Quarterly grab samples (in year prior to FYR)	Total and isotopic uranium; VOCs, and nitrate[f]	AWQC, risk-based[e]
		NT-2	Quarterly grab samples (in year prior to FYR)	Metals, including total uranium and mercury, VOCs, and isotopic uranium[f]	AWQC, risk-based[e]
		NT-3	Quarterly grab samples (in year prior to FYR)	Metals, including total uranium and mercury; nitrate, and VOCs[f]	AWQC, risk-based[e] – within five years; mercury ≤ 51 ng/L
		BCK 11.54	Quarterly grab samples (in year prior to FYR)	Metals, including total uranium and mercury; nitrate; and VOCs[f]	AWQC, risk-based[e]
			Weekly flow-proportional composite samples	Uranium (isotopic)	Uranium trend
		NT-8	Weekly flow-proportional composite samples	Uranium (isotopic)	Determine relative contribution of the BCBGs to uranium flux at BCK 9.2
			Quarterly grab samples (in year prior to FYR)	Metals, including total uranium and mercury; nitrate; and VOCs	AWQC, risk-based[e]

Table 4.5. BCV watershed CERCLA performance monitoring (cont.)

Area/Site	Media	Monitoring location	Schedule	Parameters	Performance standard
BYBY	Surface water	NT-3	Weekly flow-proportional composite samples	Uranium (isotopic)	Uranium flux ≤ 4.3 kg/yr
			Quarterly grab samples (in year prior to FYR)	Metals, including mercury; VOCs	AWQC mercury ≤ 51 ng/L
		BCK 11.84	Quarterly grab samples (in year prior to FYR)	Metals, including mercury and total uranium; nitrate; VOCs; and isotopic uranium	AWQC mercury ≤ 51 ng/L
	Biota	NT-3	Semiannual survey (until recovery complete)	Fish and benthic macroinvertebrate species richness and density	Aquatic community data compared to data available for similar reference streams on the ORR
			Riparian vegetation recovery complete. Annual survey discontinued in FY 2012.	Riparian vegetation 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
S-3 Ponds Pathway 3[c]	Surface water	BCK 12.34	Weekly flow-proportional composite samples	Isotopic uranium and nitrate	Uranium flux ≤ 27.2 kg/yr; Nitrate – 40% seasonal reduction
			Monthly grab sample	Metals, including cadmium	Cadmium ≤ 0.25 µg/L; AWQC – within five years
		NT-1	Quarterly grab samples	Metals, including cadmium	Cadmium ≤ 0.25 µg/L
		NT-2	Weekly flow-proportional composite samples	Nitrate (flux)	Nitrate – 40% seasonal reduction in flux
S-3 Pathways 1 and 2[d]	Monitoring to evaluate the effectiveness of the S-3 Pathways 1 & 2 treatment system is discontinued[g]				

[a]This table summarizes requirements for monitoring included in the *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2457&D2/A1). Note that changes to the FYR monitoring were approved in Erratum FY14-BCV-01 on October 8, 2014, and affect the FY 2015 monitoring.

[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.

Table 4.5. BCV watershed CERCLA performance monitoring (cont.)

[d]Correspondence from regulators (DOE/OR/01-1836&D1/A1) 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 have included mercury and PCBs. The correct parameters were approved in the *Water Resources Restoration Program Sampling and Analysis Plan for the Bear Creek Valley Watershed, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2457&D2/A1).

[e]Risk-based concentrations of 1E-5 residential receptor for Zones 1 and 2 and industrial for Zone 3.

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

[g]Correspondence from regulators (DOE/OR/01-1836&D1/A1) 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.

AWQC = ambient water quality criteria
BCBGs = Bear Creek Burial Grounds
BCK = Bear Creek kilometer
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
FY = fiscal year
FYR = Five-Year Review
GW = groundwater
IP = integration point
MCL = maximum contaminant level
MDL = minimum detection limit
NT = North Tributary
ORR = Oak Ridge Reservation
PCB = polychlorinated biphenyls
RA = remedial action
RI = Remedial Investigation
SS = surface spring
TBD = to be determined
VOC = volatile organic compound

This page intentionally left blank.

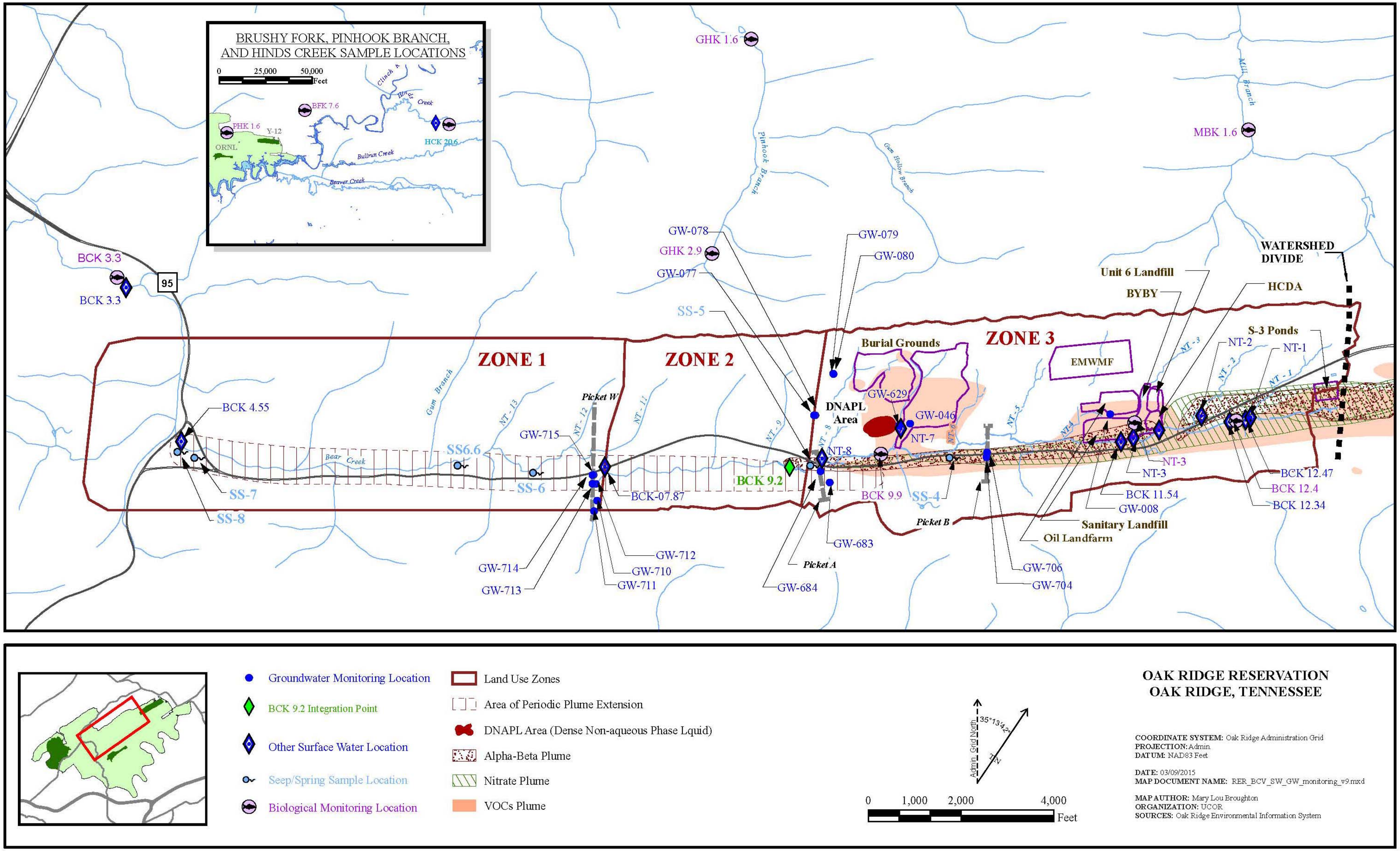


Figure 4.3. Monitoring locations in BCV watershed.

This page intentionally left blank.

4.2.1.2.1.2 Surface Water Monitoring Results

The discussion of surface water results is presented in this section in sequence of end use zone. The monitoring emphasis is on measuring remediation related reductions of contaminants of concern 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 3.6 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee, Volume 1 – Main Text* (DOE/OR/01-2516&D2).

Zone 1

Surface water monitoring results are compared to AWQC, and evaluated against the risk-based concentrations for residential exposure to surface water (1E-5) consistent with the unrestricted land use goals. Zone 1 surface water sampling and data evaluations are presented in the CERCLA FYR documents. The *2011 Third Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2516&D2) presented the most recent results and determined that no chemicals exceeded AWQCs in Zone 1 surface water and that, although detectable, uranium concentrations were less than the Primary Drinking Water Standard and ^{99}Tc was present in Bear Creek at BCK 7.87 at levels of approximately 3% or less of the MCL-DC (900 pCi/L). (Note: MCLs are used for screening purposes. They are not ARARs for surface water.)

Zone 2

Surface water monitoring was conducted at BCK 9.2, where upstream flow from Zone 3 source areas enters Zone 2. 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 integration point for surface water being discharged from sources in Zone 3.

Uranium isotopes are measured at BCK 9.2 to enable comparison with the 1E-5 risk-based residential exposure concentrations. The uranium isotopic data is also used to calculate the mass of uranium present in terms of the total annual uranium mass discharge (flux) from Zone 3 into Zone 2. Risk based activities for each uranium isotope (1E-5 risk level) are shown in the top row of Table 4.6. These risk-based values are updated annually based on current risk assessment criteria. The FY 2014 average activities of ^{234}U, ^{235}U, and ^{238}U were 7.0, 0.7, and 17.5 pCi/L, respectively. The value for ^{238}U exceeded the risk-based activity of 6.10 pCi/L. These risk-based goals are equivalent to the hypothetical residential exposure goal of a 1E-5 ELCR attributable to the uranium isotopes in the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4). Table 4.6 and Figure 4.4 present the historic average activity of isotopes of uranium and concentration of nitrate and annual average rainfall since the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) was implemented. Over the period of monitoring, ^{235}U has been less than the 7.35 pCi/L risk-based activity in Zone 2. During FY 2012 through FY 2014 the annual average ^{234}U activity levels have attained the watershed risk-based goal. Additional discussion of contaminant transport from Zone 3 into Zone 2 is presented below.

Table 4.6. Historic average activity of uranium isotopes and concentration of nitrate at the integration point (BCK 9.2)

FY	^{234}U pCi/L	^{235}U pCi/L	^{238}U pCi/L	Nitrate mg/L	Average ORR rainfall[a]
Risk-based concentration[b]	7.46	7.35	6.10	46	-
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
2011	**7.6**	0.7	**17.6**	6.1	59.2
2012	6.3	0.6	**16.1**	4.8	61.8
2013	7.4	0.7	**17.0**	5.7	63.7
2014	7.0	0.7	**17.5**	4.6	48.8

Bold values indicate the risk-based concentration is exceeded.

[a]Average rainfall in in. for rain gauges at Y-12, ETTP, ORNL, and DOE town site.
[b]Risk-based concentrations (1E-5 for radionuclides and HQ=1 for nitrate) from EPA, regional screening tables accessed November 2014 <http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm>, <http://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search>.

BCK = Bear Creek kilometer
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ETTP = East Tennessee Technology Park
FY = fiscal year
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
Y-12 = Y-12 National Security Complex

Nitrate concentrations measured at BCK 9.2 since approval of the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) are compared to the risk-based concentrations. Since FY 2000, the average annual nitrate concentrations in surface water at the integration point (BCK 9.47 prior to FY 2006 and BCK 9.2 thereafter) have not exceeded the risk-based (Hazard Quotient [HQ] of 1) residential exposure concentration. During FY 2004 – 2014, 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 nitric 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. BCK 9.2 flux measurements are discussed below for comparative purposes to Zone 3 sampling locations.

Zone 3

During FY 2014, surface water monitoring in Zone 3 included the ongoing monitoring of uranium flux at several locations, and nitrate concentration monitoring near the S-3 Ponds area and at the BCK 9.2 integration point.

Surface water monitoring includes sampling at the integration point (BCK 9.2) and intermediate monitoring stations, including tributary monitoring of specific RA areas. Two key metrics were identified in the ROD for effectiveness of remediation in Zone 3—reduction of risk levels and uranium flux at the integration point (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, ^{238}U activities at BCK 9.2 consistently exceed the risk-based concentration and in all years prior to FY 2012 except FY 2005 ^{234}U activities exceeded the risk-based concentration.

The post-*Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) history of measured uranium fluxes at BCK 9.2 and BCK 12.34, along with annual rainfall, are summarized in Table 4.7 and Figure 4.5. The watershed flux goal (≤ 34 kg/yr) for the Zone 3 integration point was not met in FY 2014 based on the approximately 96 kg of uranium discharge measured at BCK 9.2. The FY 2014 uranium flux at BCK 12.34 was approximately 24.0 kg which is less 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 2014, a uranium flux of approximately 1.9 kg was measured at the mouth of NT-3. This uranium discharge achieved the 4.3 kg/yr flux goal for the stream following remediation of the BYBY. Additional discussion of the NT-3 uranium discharge is provided in discussion of the BYBY remedy effectiveness evaluation later in this section.

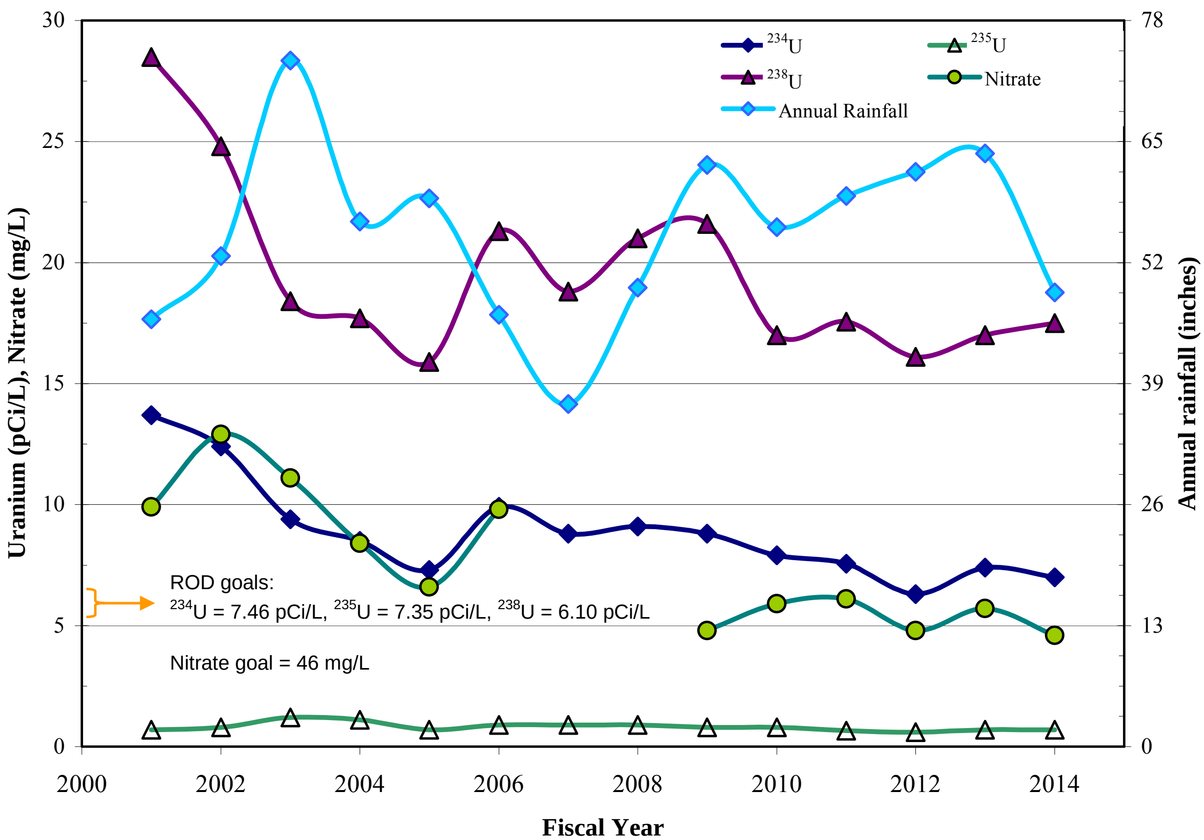


Figure 4.4. Average annual uranium isotope activity, nitrate concentration at BCK 9.2, and annual rainfall.

Table 4.7. Uranium flux[a] at flow-paced monitoring locations in BCV watershed

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
2011	**108.7**	9.1	40	36.7	**16.3**	**37.8**	59.2
2012	**114.9**	9.2	43.3	45.4	**13.6**	**32.9**	61.75
2013	**122.3**	9.5	64.0	47.6	**22.3**	**40.3**	63.73
2014	**95.6**	7.7	72.4	38.6	1.87	24.0	48.8

Bold values indicate the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) goal for uranium flux has not been met**.**

[a]All flux values are kg of uranium/yr.
[b]Average rainfall in in. 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.

BCK = Bear Creek kilometer
BCV = Bear Creek Valley
DOE = U.S. Department of Energy
ETTP = East Tennessee Technology Park
FY = fiscal year
NT = North Tributary
ORNL = Oak Ridge National Laboratory
ROD = Record of Decision
SS = surface spring
Y-12 = Y-12 National Security Complex

Review of Figure 4.5 shows the relationship between annual total 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 incompletely contained buried/below-grade contaminant 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-*Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) monitoring period, as demonstrated by the relatively high correlations between rainfall and uranium discharge flux shown in Figure 4.6. The higher mass flux and the greater positive slope of the trend at BCK 9.2 than at BCK 12.34 reflect 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 continuous flow-paced monitoring of NT-8 started in FY 2008. During FY 2014 monitoring of NT-8 documented that approximately 72 kg of uranium was discharged directly to Bear Creek (Table 4.7). Implementation of an NT-8 Surface Water action is a potential project identified in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2). Investigations and projects during groundwater strategy implementation will be sequenced according to ORR-wide groundwater issues prioritization.

Estimates were made of the uranium contributions from NT-5 and NT-7. These estimates suggest that NT-5 contributed approximately 0.29 kg of uranium and NT-7 may have contributed approximately 2.6 kg of uranium during FY 2014.

Including all directly measured and estimated uranium sources contributing to the stream (BCK 12.34, NT-3, NT-5, NT-7, and NT-8), the mass balance of uranium in the Bear Creek system during FY 2014 shows that about 101 kg of uranium were measured or estimated to enter Bear Creek from gauged stream locations in Zone 3 and 96 kg of uranium were measured discharging from Zone 3 at BCK 9.2. This mass balance assumes that the SS-5 uranium discharge represents water previously measured at one or more upstream locations that infiltrated to groundwater that returned to the surface at SS-5, and that the BCK 11.54 station measures uranium fluxes previously measured at BCK 12.34 or NT-3. These data indicate a mass balance surplus of about 5% for the measured/estimated inputs compared to the measured uranium discharge at BCK 9.2 during FY 2014. This low mass balance difference is considered to be an indication of good data quality in the flow measurements and laboratory analyses of uranium.

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 in FY 2014 were about 20.4, 2.1, and 43.4 pCi/L, respectively. These results are based on analysis of weekly frequency continuous, flow-paced composite samples. The average activity level for ^{234}U met the industrial risk-based activity goal of about 23 pCi/L. The activity level for ^{238}U exceeded the industrial risk-based activity of about 18 pCi/L, using exposure frequency of 250 d/y, exposure duration of 25 years and one L/d ingestion rate. The ^{235}U has been less than the 22 pCi/L industrial exposure goal since the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) was implemented.

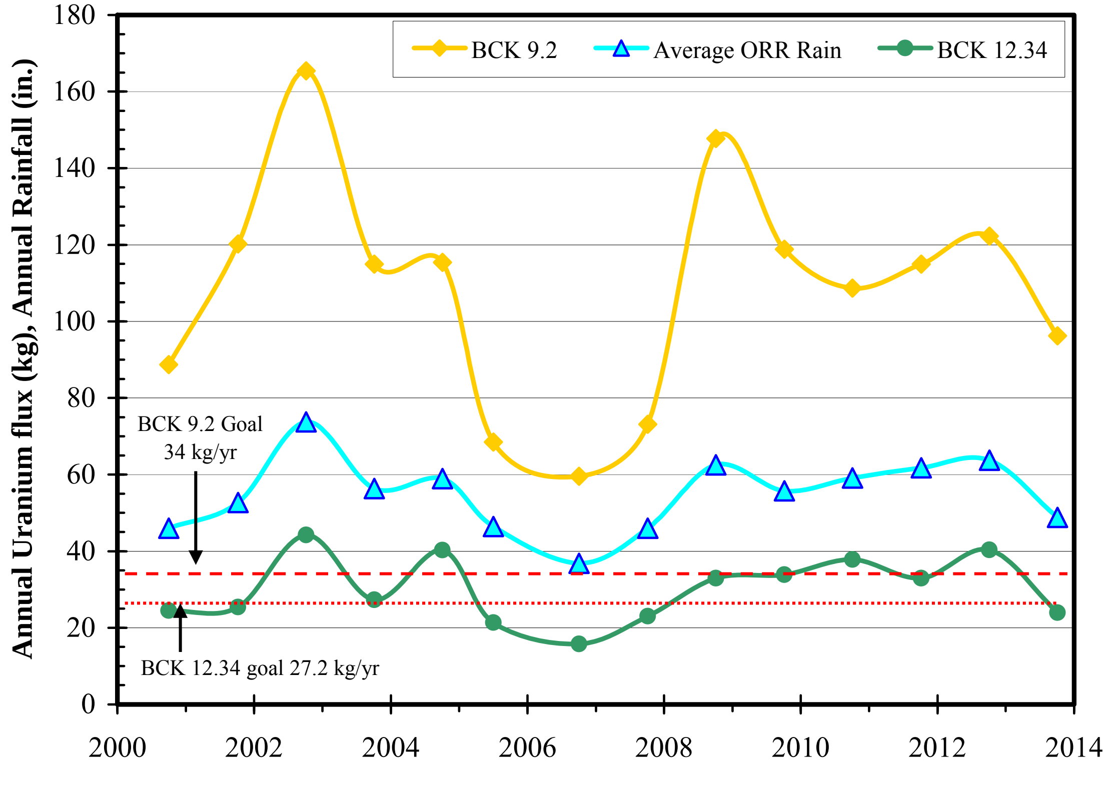


Figure 4.5. Post-ROD uranium flux at BCK 9.2 and BCK 12.34 and annual rainfall.

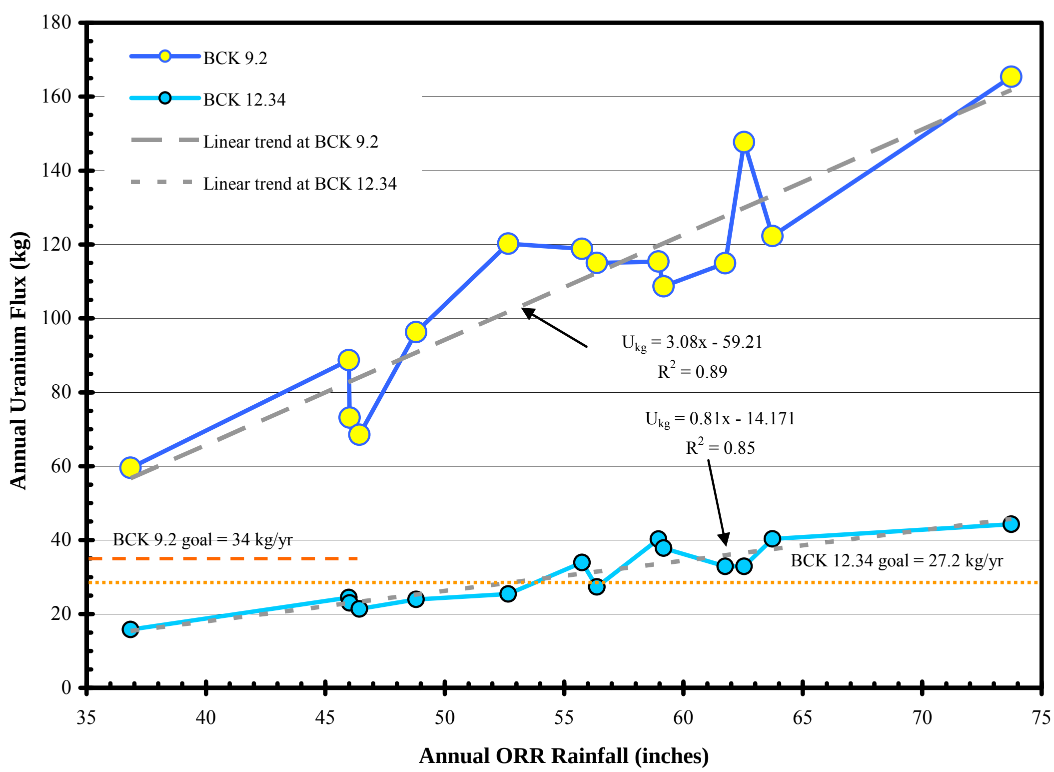


Figure 4.6. Average annual rainfall vs. annual uranium flux at BCK 9.2 and BCK 12.34.

Nitrate and cadmium are also key contaminants of concern in surface water in BCV. The principal source of nitrate contamination is legacy disposal of nitric 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 for nitrate in an industrial end use scenario is 184 mg/L. Figure 4.7 shows the average nitrate concentration in surface water at BCK 12.34, along with the annual average 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 2014, the average nitrate concentration was 38.7 mg/L based on 52 weekly grab sample results. None of the grab samples collected during FY 2014 exceeded the preliminary remediation goal for nitrate. During the below average rainfall conditions of FY 2007 and 2008, the nitrate preliminary remediation goal was occasionally exceeded because of the absence of upstream runoff that dilutes groundwater seepage into NT-1 near the S-3 Ponds site.

The principal source of cadmium is also disposed liquids from the S-3 ponds. Figure 4.8 shows the cadmium concentrations over time since FY 2000 at NT-01 and BCK 12.34. 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 2014 contained an average of 2.5 µg/L cadmium with a maximum measured concentration of 4.9 µg/L. In monthly samples collected at the Zone 3 integration point (BCK 9.2) during FY 2014 cadmium was detected in a single sample at a concentration of 1.6 µg/L which does exceed the AWQC level of 0.25 µg/L. In the other 11 samples cadmium was not detected at a detection limit of 0.13 µg/L which is well below the AWQC level. These results indicate that cadmium from the S-3 Ponds source is strongly attenuated before the stream enters Zone 2.

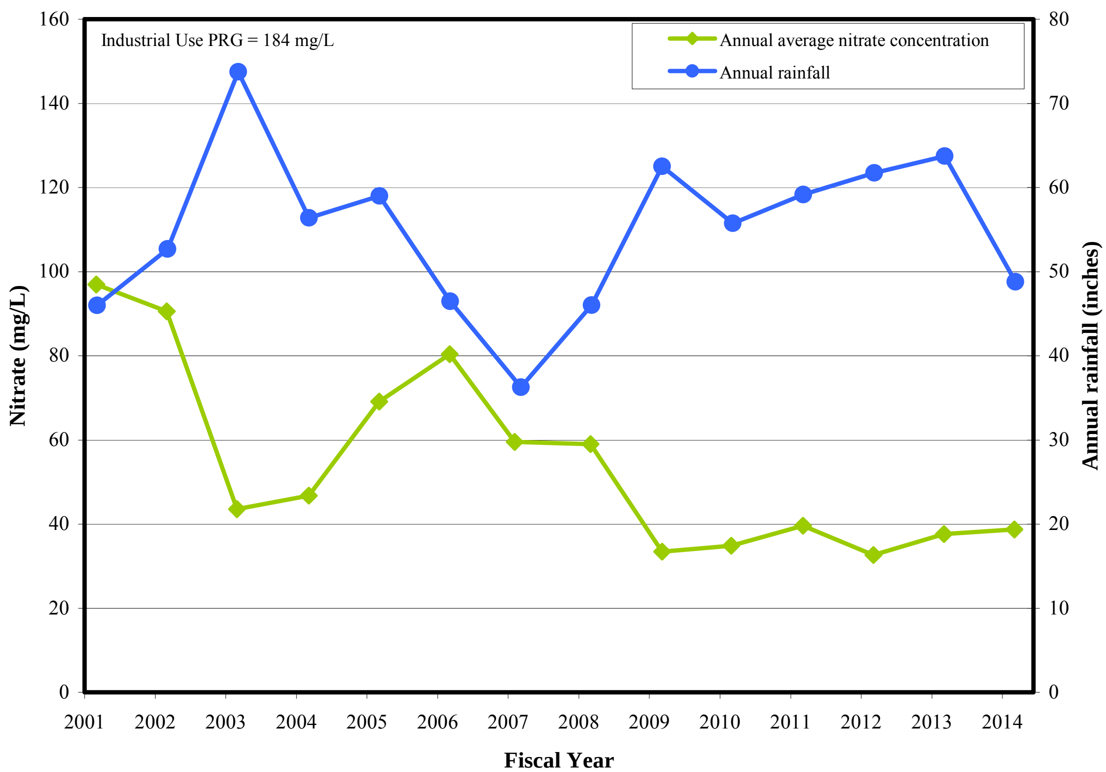


Figure 4.7. BCK 12.34 annual average nitrate concentration and annual rainfall.

BYBY

Effectiveness of remediation at the BYBY is measured by water quality in the NT-3 stream (Figure 4.3). In addition to surface water monitoring at the BYBY, the *Phased Construction Completion Report for the Bear Creek Valley Boneyard/Burnyard* (DOE/OR/01-2077&D2) specifies monitoring of benthic macroinvertebrate and fish communities in NT-3. Benthic macroinvertebrate and fish community monitoring are presented in Section 4.2.1.2.3.

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 post-remediation years until FY 2010. Regulatory approval to discontinue flow paced composite sampling at NT-3 and to replace it 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.

Immediately following BYBY remediation, uranium activities in NT-3 decreased significantly and uranium isotope ratios also changed. Table 4.8 is a tabulation of annual average activities of ^{238}U and ^{234}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. Subsequent to the initial post-remediation decrease in both uranium activities and fluxes, increases in uranium activities and fluxes have been measured.

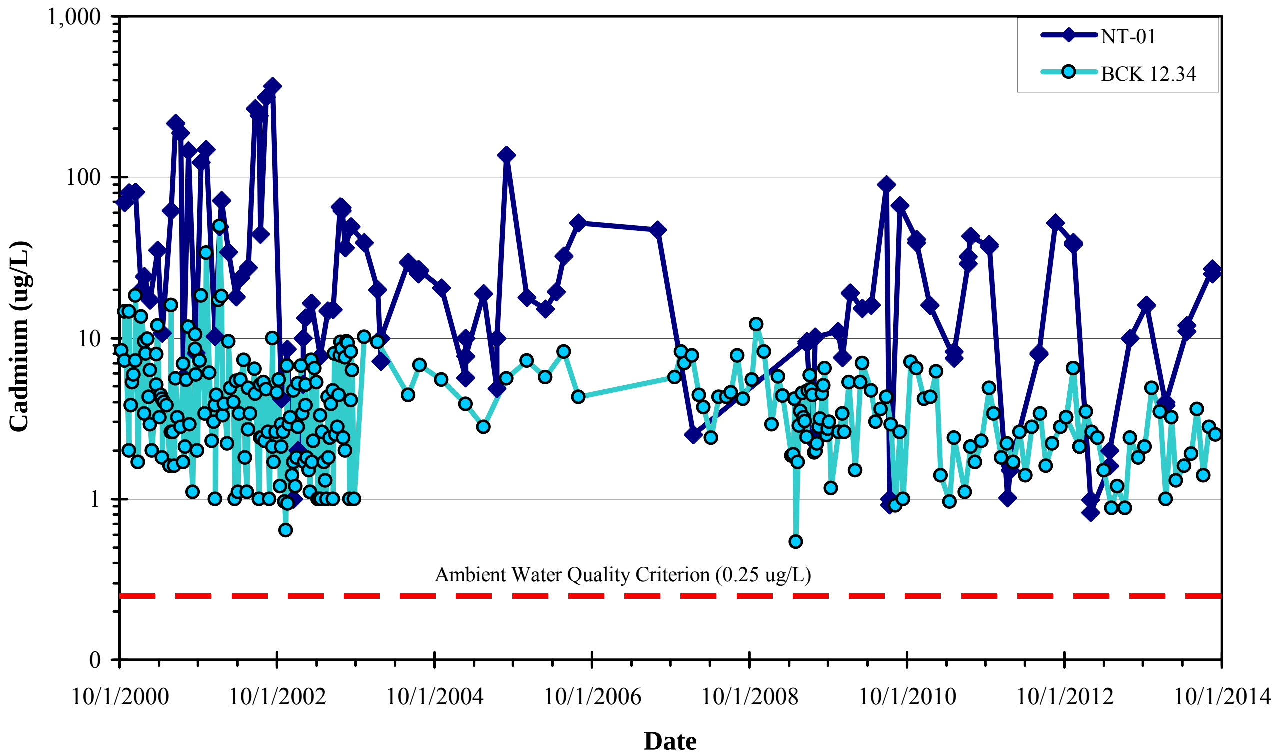


Figure 4.8. Cadmium concentrations at NT-1 and BCK 12.34.

Table 4.8. Annual average ^{234}U and ^{238}U activities at NT-3

FY	Average ^{234}U (pCi/L)	Average ^{238}U (pCi/L)	Average $^{238}U/^{234}U$ ratio	Comments
1999	208	450	2.16	
2000	230	514	2.24	
2001	196	476	2.43	
2002	135	292	2.15	BYBY remediation completed
2003	14	14	1.02	Continuous sampling
2004	7	6	0.85	Continuous sampling
2005	13	14	1.06	Continuous sampling
2006	17	16	0.93	Continuous sampling
2007	46	42	0.91	Continuous sampling
2008	41	39	0.94	Monthly grab sampling
2009	42	40	0.94	Monthly grab sampling
2010	24	22	0.96	Continuous sampling resumed
2011	32	30	0.94	Continuous sampling
2012	20	19	0.93	Continuous sampling
2013	16	15	0.95	Continuous sampling
2014	7.2	7.1	0.99	Continuous sampling

BYBY = Boneyard/Burnyard
FY = fiscal year
NT = North Tributary

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 4.8 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 two to three (indicative of a depleted uranium source having a high fraction of ^{238}U) downward to average values near one. The $^{238}U/^{234}U$ 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 4.9, two other waste disposal units remain in the NT-3 watershed – the Hazardous Chemical Disposal Area and the Unit 6 Landfill. The 2011 RER (DOE/OR/01-2505&D2) contained a summary of sampling results from grab samples collected at several locations in NT-3. Those results showed that uranium was entering the NT-3 stream downslope from the western side of the Unit 6 Landfill. Those samples did not contain nitrate or ^{99}Tc which would be indicators of breakthrough of the S-3 Ponds contaminant plume into NT-3. An investigation of soil and groundwater contaminant distributions in the vicinity of the Unit 6 Landfill and NT-3 would be required to better understand the source of uranium entering NT-3. Such an investigation is one of the future potential projects listed in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2628/V1&V2&D2).

In addition to being a significant source of uranium to Bear Creek, the BYBY was also a source of mercury contamination. Surface water samples collected from the NT-3 monitoring station prior to the BYBY RA contained high concentrations of total mercury with concentrations in the 200 – 500 ng/L range in 1994 to 1999. In 2001 a value of nearly 660 ng/L was measured. Following completion of the BYBY RA in 2002 the mercury concentrations decreased rapidly with several detected spikes which have subsided to concentrations that are generally less than the AWQC level of 51 ng/L. The most recent criterion exceedance recorded in available data was measured in December 2006. Mercury concentrations at NT-3 in FY 2014 were below AWQC which met the ROD goal. The October 2013 total mercury result was 4.1 ng/L and the May 2014 result was 11.5 ng/L.

Methylmercury data are available for NT-3 from samples collected since winter 2010. The methylmercury concentrations measured in NT-3 are relatively high as a fraction of the total mercury and in an absolute sense when compared to those measured elsewhere on the ORR. The NT-3 methylmercury concentrations range from a low value of 0.15 ng/L to a high of 0.49 ng/L measured in May 2014.

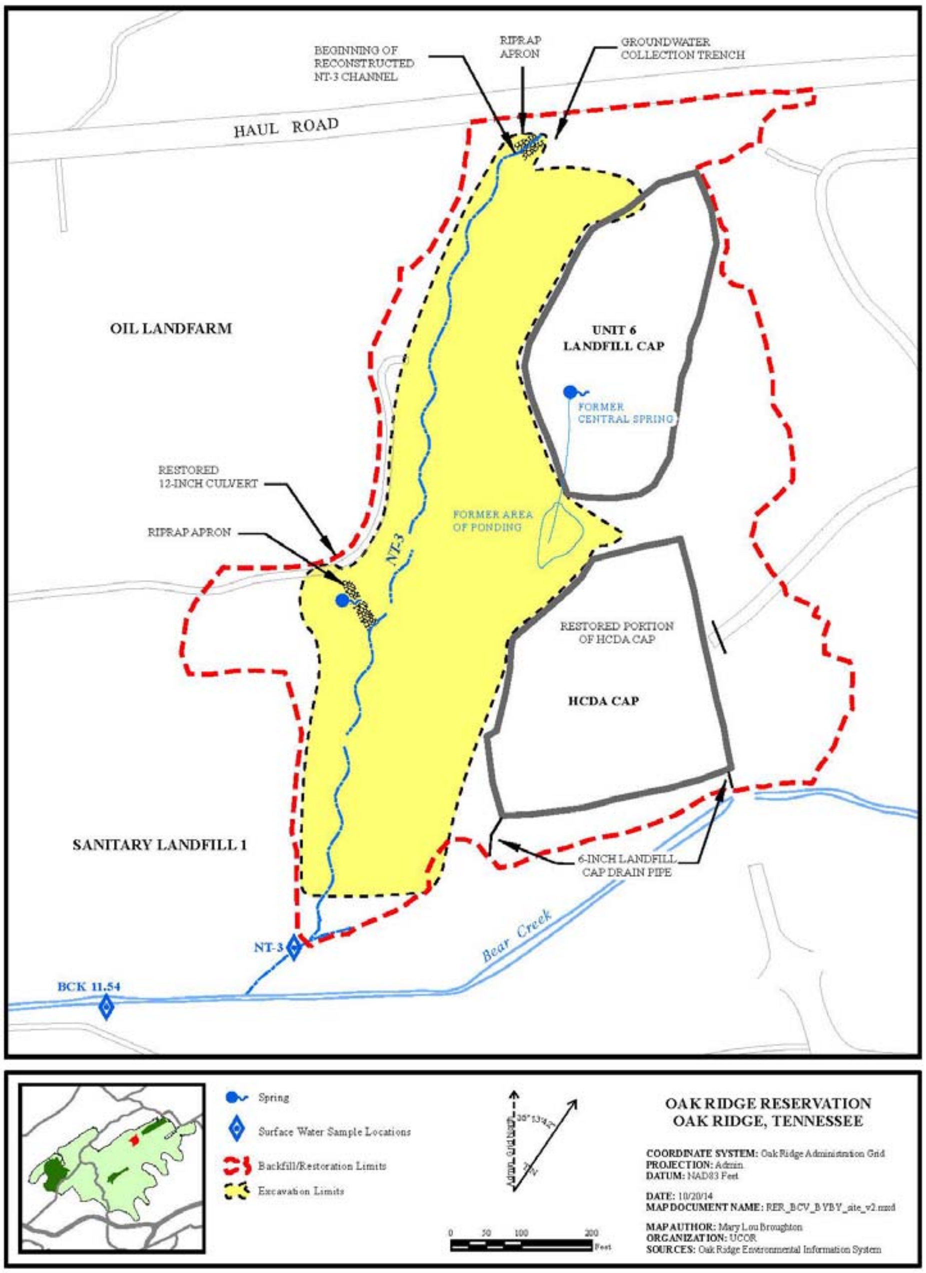


Figure 4.9. Location of BYBY site and monitoring locations.

4.2.1.2.2 Groundwater

The most significant impacts to groundwater in BCV occur within Zone 3 beneath and downgradient from the liquid and solid waste disposal areas. Some groundwater contamination is known to extend from Zone 3 westward into Zones 1 and 2 in the Maynardville Limestone. Geologic and hydrogeologic conditions in BCV are complex. The bedrock formations that underlie the principal contaminant source areas include about 1,200 ft of stratigraphic thickness of thin- to medium-bedded, mixed clastic and carbonate rock types (from youngest to oldest by depositional age consisting of the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale). Some of the limestone beds within these predominantly clastic bedrock units are important to groundwater contaminant transport through fractures and larger openings caused by chemical weathering.

The youngest depositional geologic unit in the Conasauga Group is the Maynardville Limestone that is comprised of about 400 ft (stratigraphic thickness) of relatively pure carbonate bedrock. The Maynardville Limestone has been informally subdivided into as many as six distinct lithostratigraphic facies. These lithofacies represent slightly different depositional settings and/or zones that have experienced different post-depositional changes to their primary porosity. These differences in primary bedrock porosity make the zones susceptible to differential chemical weathering and formation of cavities and connected conduits that conduct groundwater flow. Of note is that the lithostratigraphic zone at the top of the Maynardville Limestone has the highest primary porosity and is coincident with a prominent zone of karst development that is a primary contaminant plume pathway. The Maynardville Limestone occupies the lowest topographic position and lies beneath Bear Creek. These lithostratigraphic facies tend to be laterally discontinuous and vary in thickness along geologic strike. In addition to the bedrock depositional heterogeneities, geologic structural features such as joints and fractures, intraformational thrust faulting, and cross-strike faulting further complicate groundwater migration through bedrock.

The role of local faults on groundwater transport may vary by the bedrock lithologies involved. For instance, cross faults that offset the thin- to medium-bedded clastic dominated formations may actually interrupt strike-parallel groundwater movement by abutting clastic beds against carbonate beds effectively forming local barriers to strike-parallel flow. On the other hand, cross faults in massive carbonate bedrock may facilitate flow through the associated fractures with enhancement by chemical weathering processes, thus increasing cross-strike flow. The karst conditions in the Maynardville Limestone facilitate contaminant movement via conduit flow. Such contaminant transport has both continuous and episodic aspects. Interconnections in conduit systems can produce conditions under which flow paths can shift both spatially and vertically depending on groundwater levels and total surface water and groundwater system flow volumes.

The following sections present summary data evaluations of the principal groundwater contaminants in BCV. ROD-based groundwater quality goals for each zone are listed in Table 4.2. Table 4.5 includes the BCV watershed CERCLA performance monitoring requirements that are used to evaluate attainment of these goals. The groundwater goals in the ROD do not include meeting chemical-specific ARAR-based remediation levels. Groundwater sampling locations are shown on Figure 4.3.

Zone 1

As noted in Table 4.2, the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) goal is to “maintain clean groundwater and surface water so that the area continues to be acceptable for unrestricted use.” MCLs are used in Zone 1 as the screening criteria and concentration trends are used elsewhere to evaluate performance. With this goal in mind, during FY 2014 groundwater monitoring in Zone 1 included sampling of three springs (SS-6, SS-7, and SS-8) and six monitoring wells (GW-710 through GW-715) that sample groundwater from the Maynardville Limestone near the Zone 1/Zone 2 boundary. This line of wells is referred to as Picket W. Well construction information for the wells in Picket W wells is summarized in Table 4.9. The wells are completed at a wide range of depths and elevations and open or screened intervals provide broad coverage of the several locally defined stratigraphic members of the Maynardville Limestone. Currently the wells are monitored semiannually for nitrate; metals, including uranium; VOCs, and radiological constituents.

Table 4.9. Well construction information for wells in Zone 1, Picket W

Well ID	Well Type	Ground Surface Elevation	Sample Zone Top Depth	Sample Zone Bottom Depth	Sample Zone Top Elevation	Sample Zone Mid-point Elevation	Sample Zone Bottom Elevation
GW-710	Open	906.83	539.7	744.5	367.13	264.73	162.33
GW-711	Open	901.96	616	666.2	285.96	260.86	235.76
GW-712	Open	873.61	441.5	457.5	432.11	424.11	416.11
GW-713	Open	877.83	305	315.2	572.83	567.73	562.63
GW-714	Open	872.3	115.1	145	757.2	742.25	727.3
GW-715	Screen	872.17	33.1	43.1	840.17	834.17	828.17

Depth data are ft bgs and elevation data are in ft aMSL.

aMSL = above Mean Sea Level
bgs = below ground surface
GW = groundwater
ID = identification

Wells GW-710 and GW-711 are very deep wells (about 745 ft and 666 ft, respectively) and their water chemistry is dominated by sulfate, chloride, calcium, and sodium. Drilling records indicate that bedrock penetrated in well GW-710 between depths of 350 ft and 699.5 ft bgs contained no water producing fractures. The well depth was extended an additional 45 ft at which point a yield of 5 to 10 gal/hr was obtained. In GW-711, groundwater bearing zones were not present in the depth range of 421 to 650 ft bgs but sufficient water to provide samples was encountered between 650 and 666 ft depth. Development water from both wells GW-710 and GW-711 were described as greenish in color attributed to dissolve ferrous iron that became an orange precipitate after contact with the air. The development water from both wells had a petroliferous odor that was attributed to naturally occurring organic compounds in the bedrock. As shown in Table 4.9, the open interval in GW-710 is about 205 ft in vertical length and its top elevation is approximately 80 ft higher than the top of the open zone in GW-711. The groundwater at the sampled depths contains approximately 4,000 mg/L total dissolved solids. Specific conductance values in GW-710 fluctuate in the range of about 3,000 to 5,000 µmho/cm while those in GW-711 tend to lie in the range 4,500 – 5,000. The somewhat lower specific conductance levels in GW-710 may be caused by somewhat lower dissolved solids groundwater from the 80 ft higher elevation sampling zone entering the open interval during periods of greater groundwater recharge. Dissolved oxygen is low (< 2.5 ppm in GW-710 and less than 1 ppm in GW-711) in this deep groundwater and redox values are fairly strongly reducing at levels below -100 mV. These are indications that the groundwater in these zones have limited interaction with fresh recharging waters at the top of the aquifer.

The only VOCs detected in wells in Picket W in FY 2013 and FY 2014 were low (< 5 µg/L) concentrations of petroleum hydrocarbons detected in samples from well GW-710. The source of these hydrocarbons is suspected to be naturally occurring petroleum hydrocarbons that slowly leach from bedrock into deep groundwater as previously mentioned in relation to well development observations. Table 4.10 lists available nitrate concentrations in wells GW-710 through GW-715 from FY 2000 to

FY 2014. Nitrate is detected in wells GW-710 and GW-711 at concentrations of approximately 0.03 mg/L and is sometimes not detectable at the 0.01 mg/L level. Technetium-99 is not detected in wells GW-710 and GW-711. Uranium-234 is periodically detectable at < 0.5 pCi/L while ^{235}U and ^{238}U are not detected in these wells. Site related contaminants do not exceed the Bear Creek ROD goal for Zone 1 in wells GW-710 and GW-711.

Well GW-712 is nearly 460 ft deep and has a 16 ft long open interval in bedrock from which groundwater samples are obtained. Well GW-712 samples fresher groundwater than the deeper wells with specific conductance in the 300 – 450 µmho/cm range. Dissolved oxygen levels hover near 1 ppm or slightly less and the redox fluctuates from higher levels near 50 mV to low levels < -200 mV. These fluctuations are considered to be indicative of episodic interactions of fresher recharge water with more sluggishly moving groundwater. The maximum nitrate concentration detected in well GW-712 in FY 2013 and FY 2014 was 0.21 mg/L. Technetium-99 was not detected in well GW-712 during sampling in FY 2013 and FY 2014. During FY 2014, ^{234}U and ^{235}U were detected in one of two samples at activities of 0.234 and 0.0788 pCi/L, respectively, and ^{238}U was not detected. Site related contaminants do not exceed the Bear Creek ROD goal for Zone 1 in wells GW-712.

Well GW-713 is about 315 ft deep and samples groundwater from a 10 ft long open interval in bedrock. Specific conductance of the groundwater in this well fluctuates in the range of about 300 – 500 µmho/cm, although in the early 2000's levels were in the 700 – 1,000 µmho/cm range. Dissolved oxygen tends to fluctuate in the range of about 1 – 2 ppm, although a number of higher values have been observed. Redox fluctuates in the range of about -50 to -200 mV. Well GW-713 has experienced periodic trace-to-low (maximum 14 µg/L) concentrations of PCE, TCE, 1,1,1-trichloroethane (TCA), and 1,2-DCE. VOCs have not been detected in well GW-713 since January 2008. 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 and was detected at 0.039 and 0.053 mg/L in samples collected in January and July 2014, respectively. Technetium-99 has not been detected in samples from well GW-713. Uranium isotopes have been intermittently detected in well GW-713 at low activities (< 1.7 pCi/L). Uranium-234 was detected at 0.421 pCi/L in January 2014, however ^{235}U and ^{238}U were not detectable and no uranium isotopes were detected in the July sample. Overall, the effects of upstream contaminant sources on well GW-713 have diminished over time. Site related contaminants do not exceed the Bear Creek ROD goal for Zone 1 in wells GW-713.

Well GW-714 is about 145 ft deep and has a 30 ft long open interval in bedrock from which samples are drawn. Specific conductance in recent years has fluctuated in the 400 – 600 µmho/cm range although in the early 2000's levels fluctuated in the 400 – 800 or higher µmho/cm range. Dissolved oxygen typically fluctuates in the 0.2 – 2 ppm range although several higher values were reported in past years. Redox typically fluctuates in the range of about 50 – 200 mV. 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 0.45 mg/L in January and July 2014, respectively. Technetium-99 is not detected in well GW-714. The nitrate monitoring results are shown graphically on Figure 4.10 along with results from Zone 1 springs. Uranium-234 and ^{238}U isotopes are regularly detected in well GW-714. During FY 2014, ^{234}U was detected at 0.929 and 1.09 pCi/L and ^{238}U was detected at 0.791 and 1.66 pCi/L respectively in January and July. Uranium-235 is not routinely detected in well GW-714 and was not detected in either January or July 2014. The ^{238}U activities measured in well GW-714 during FY 2014 were similar to those that were seen during the 2003 and 2004 above average rainfall period. Although the annual rainfall across the ORR during FY 2014 was below average, the increase in ^{238}U detected in well GW-714 may be related to the several preceding years of above average rainfall. Site related contaminants do not exceed the Bear Creek ROD goal for Zone 1 in wells GW-714.

Well GW-715 is about 43 ft deep and has a 10 ft long screen in the monitoring interval. This well has not been actively monitored since its removal from the required RCRA groundwater monitoring regime in BCV. Sampling of well GW-715 was resumed in FY 2014 to provide a more complete understanding of groundwater conditions in this portion of Zone 1 and to support DOE's ORR Groundwater Program. FY 2014 specific conductance values were approximately 400 µmhos/cm while measurements from the early 2000's ranged from a low of < 200 µmhos/cm to several values in the 500 – 700 µmhos/cm range. Dissolved oxygen levels in GW-715 are typical of the very shallow groundwater zone it samples with levels fluctuating in the range of about 3.4 – 6 ppm. This well samples the most oxygen-rich groundwater of all the wells in Picket W. Redox levels in GW-715 have only been measured in FY 2014 and recorded values lie in the range of 100 – 200 mV. During FY 2014 nitrate was detected at 0.46 and 2.1 mg/L in February and July, respectively. The GW-715 nitrate results are shown graphically on Figure 4.10 along with results from the Zone 1 springs. Technetium-99 was not detected in this well in the February sample but was present at 11.3 pCi/L in the July sample. Uranium 234 and ^{238}U were detected in both samples from well GW-715 during FY 2014 but $^{235/236}$U was not detected in either sample. The ^{234}U activities were 0.542 and 2.37 pCi/L for February and July samples, respectively, while the ^{238}U activities were 2.37 and 5.72 pCi/L for the same sample periods. The ^{238}U/^{234}U ratio observed in well GW-715 is similar to the ratios observed in Bear Creek surface water sampled at BCK 9.2. This observation indicates that the groundwater sampled by well GW-715 is in fairly direct communication with the stream as is typical in shallow wells in karst settings. In the GW-715 metals analyses, uranium was not detected at the 4 µg/L detection level in the February sample but was measured at 20 µg/L in the July sample. The MCL for uranium as a metal is 30 µg/L. Although site related contaminants are present in groundwater in well GW-715 their concentrations are less than the MCL screening levels.

Collectively, the data from groundwater monitoring in Picket W wells indicates that the impacts to Zone 1 groundwater in this well transect are observed predominantly in the shallow groundwater which is most interactive with epikarst groundwater contaminant transport which is spatially and temporally interactive with the surface water contaminant transport in Bear Creek.

Table 4.10. Nitrate concentrations measured in wells GW-710, GW-711, GW-712, GW-713, GW-714, and GW-715[a]

GW-710 (744 ft deep)			GW-711 (666 ft deep)			GW-712 (458 ft deep)			GW-713 (314 ft deep)			GW-714 (145 ft deep)		GW-715 (43.1 ft deep)	
Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)[b]	Date	Nitrate (mg/L)[b]
						1/10/2000	0.02		1/6/2000	0.67		1/5/2000	0.46	1/5/2000	3.4
						7/10/2000	1.4		7/10/2000	1.3		7/11/2000	4	7/11/2000	2.9
						1/2/2001	0.03		1/3/2001	0.33		1/2/2001	3.7	1/2/2001	3.3
						7/2/2001	0.02	U	7/10/2001	0.061		7/2/2001	1.8	7/9/2001	1.4
						1/3/2002	0.02	U	1/3/2002	0.02	U	1/2/2002	1.6	1/2/2002	1.3
						7/1/2002	0.034		7/1/2002	0.02	U	7/1/2002	1.7	7/1/2002	4.2
1/15/2003	0.56	U	1/15/2003	0.56	U	1/6/2003	0.13		1/6/2003	0.16		1/6/2003	1.6	1/7/2003	1.4
7/14/2003	0.28	U	7/14/2003	0.28	U	7/7/2003	0.22		7/7/2003	0.2		7/7/2003	1.3	7/7/2003	0.91
						1/6/2004	0.02	U	1/5/2004	0.02	U	1/5/2004	1.1	1/5/2004	0.67
						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		
						1/5/2011	0.051		1/13/2011	0.01	U	1/5/2011	0.61		
						7/7/2011	0.01	U	7/7/2011	0.01	U	7/6/2011	0.16		
						1/4/2012	0.01	U	1/9/2012	0.057		3/22/2012	0.43		
						7/11/2012	0.01	U	7/16/2012	0.01	U	7/2/2012	0.33		
2/25/2013	0.019		2/25/2013	0.019		1/2/2013	0.013		1/3/2013	0.01	U	1/2/2013	0.44		

Table 4.10. Nitrate concentrations measured in wells GW-712, GW-713, GW-714, and GW-715[a] (cont.)

GW-710 (744 ft deep)			GW-711 (666 ft deep)			GW-712 (458 ft deep)			GW-713 (314 ft deep)			GW-714 (145 ft deep)		GW-715 (43.1 ft deep)	
Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)	Qualifier	Date	Nitrate (mg/L)[b]	Date	Nitrate (mg/L)[b]
9/9/2013	0.026		9/9/2013	0.014		7/1/2013	0.011		7/2/2013	0.012		7/1/2013	0.51		
2/25/2014	0.01	U	2/25/2014	0.01	U	1/2/2014	0.02	J	1/6/2014	0.039	J	1/2/2014	0.55	2/26/2014	0.46
7/31/2014	0.03		7/31/2014	0.025		7/7/2014	0.021		7/7/2014	0.053		7/7/2014	0.45	7/30/2014	2.1

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

EPA = U.S. Environmental Protection Agency
GW = groundwater well
J = estimated value
MCL = maximum contaminant level
U = not detected

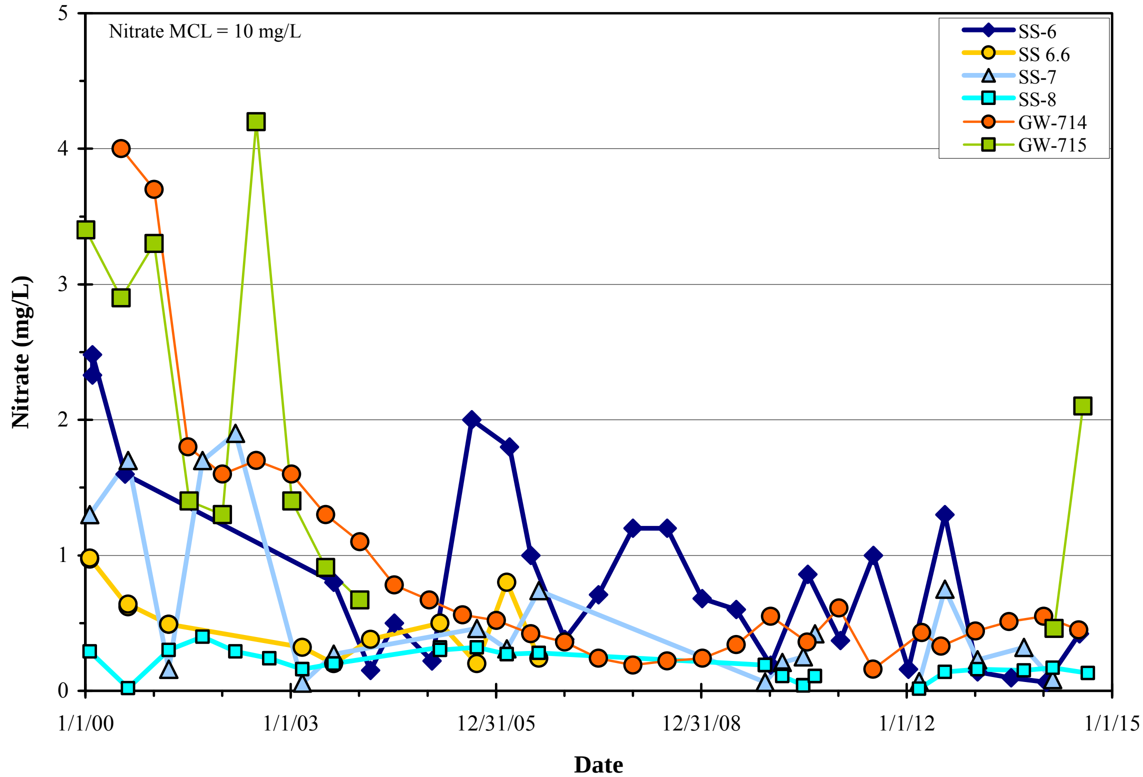


Figure 4.10. Nitrate concentrations in Zone 1 springs and wells GW-714 and GW-715.

Three springs (SS-6, SS-7, and SS-8) were monitored in Zone 1 in FY 2014 (Figure 4.3). Sampling of these springs was conducted semiannually during the high-flow wet season (typically during winter) and during the low-flow dry season (during summer months). Figure 4.10 shows nitrate concentrations in the Zone 1 springs and wells where consistently detectable from 2000 through FY 2014. Nitrate is commonly detected at BCV Zone 1 springs and in wells GW-714 and GW-715 at concentrations less than 50% of the MCL (10 mg/L).

Springs in BCV discharge groundwater from bedrock flow pathways and all discharge into Bear Creek. The springs act as integration points 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 Bear Creek surface water and groundwater commingle. This commingling 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 Zone 1 springs are resurgence points for groundwater originating from within BCV and groundwater inputs from the northern slopes of Chestnut Ridge. Analyses are performed for a broad suite of parameters, such as 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.

Table 4.11 contains the results of uranium isotope analyses conducted on Zone 1 spring samples from FY 2000 through FY 2014. The FY 2014 levels detected in Spring SS-6 are consistent with those of previous years. Also included in Table 4.11 is the total uranium concentration calculated from the results of detected (unqualified) isotopic activities.

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-8 water, and the combined discharge monitored at BCK 9.2. The $^{238}U/^{234}U$ ratios indicate that within Zone 1 there is evidence that groundwater in a conduit that originates from upstream of NT-8 discharges intermittently at Spring SS-6 (at times SS-6 has no visible flow although standing water is present in the spring orifice). The uranium isotope ratios for other springs in Zone 1 all indicate that they are resurgence points for groundwater that entered the system from sinking groundwater downstream of the NT-8 sinking reach.

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-DC 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. Technetium-99 was not detected in springs SS-6, SS-7, or SS-8 samples in FY 2014.

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. VOCs were not detected in any of the three springs sampled in Zone 1 during FY 2014.

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 4.3. Contaminant concentrations continue to remain low and per the approved *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-2457&D2/A1) will continue to be monitored and reported on yearly in the RER. The uncertainties about groundwater contaminant levels and flow paths in BCV Zones 1 and 2 have been identified as issues in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2). Evaluation of potential pathways and installation of additional wells will be included in investigations during groundwater strategy implementation and will be sequenced according to ORR-wide groundwater issues prioritization.

Table 4.11. Uranium isotope activities in Zone 1 Spring samples, 2000 – 2014

Uranium isotopic data for SS-6

Date	^{234}U (pCi/L)	^{235}U (pCi/L)	^{238}U (pCi/L)	Total U[a] 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	--[b]
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	-0.0675±.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
1/12/2011	1.01±0.42	0.119±0.159 U	1.3±0.45	3.9
7/7/2011	2.05±0.607	0.283±0.237	3.02±0.735	9.3
1/10/2012	0.606±0.405	0.104±0.202 U	0.677±0.4	2.1
7/24/2012	1.76±0.62	0.13±0.218 U	2.57±0.651	7.8
1/14/2013	0.149±0.264 U	-0.132±0.132 U	0.259±0.223 U	4 U
7/11/2013	0.267±0.269 U	-0.00874±0.149 U	0.448±0.265	4 U
1/16/2014	0.33±0.176	0.0745±0.104 U	0.357±0.205	4 U
7/10/2014	0.862±0.279	0.0965±0.0959 U	1.03±0.303	4 U

Uranium isotopic Data for SS-6.6

Date	^{234}U (pCi/L)	^{235}U (pCi/L)	^{238}U (pCi/L)	Total U[a] 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	--
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	--
3/2/2004	2.42±1.79 J	0.48±0.93 U	0.9±1.2 U	--
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

Table 4.11. Uranium isotope activities in Zone 1 Spring samples, 2000 – 2014 (cont.)

Uranium isotopic data for SS-7					*Uranium isotopic data for SS-8*				
Date	**^{234}U (pCi/L)**	**^{235}U (pCi/L)**	**^{238}U (pCi/L)**	**Total U[a] µg/L**	**Date**	**^{234}U (pCi/L)**	**^{235}U (pCi/L)**	**^{238}U (pCi/L)**	**Total U[a] µg/L**
1/25/2000	2.89±0.91	0.5±0.36 J	5.25±1.37	15.9	1/25/2000	0.15±0.23 U	0.04±0.11 U	0.2±0.23 U	--
8/16/2000	3.68±1.24	0.41±0.39 J	5.58±1.67	16.9	8/16/2000	0.7±0.47 J	0.12±0.21 U	0.45±0.37 J	--
3/22/2001	0.34±0.23 J	-0.01±0.01 J	0.64±0.33	1.9	3/22/2001	0.27±0.35 U	-0.12±0.09	0.06±0.06 U	--
9/18/2001	2.26±0.56	0.19±0.14 J	3.75±0.82	11.4[1]	9/18/2001	0.18±0.19 J	0.18±0.19 U	0.25±0.22 J	--
3/12/2002	1.59±0.54	-0.01±0.01 U	3.77±0.97	11.4	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	1.07±0.53	0.4±0.34 J	0.37±0.3 J	1.70E-04	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	0.72±0.4	0.13±0.18 U	1.59±0.63	4.8	8/19/2003	0.1±0.25 U	-0.04±0.04 U	0.03±0.09 U	--
					8/19/2003	0.18±0.2 U	0 J	0.25±0.22 J	--
					3/8/2005	1.25±0.73 J	0.42±0.47 U	1.71±0.86	5.2
					3/8/2005	1.64±0.77	0.57±0.48 J	3.74±1.23	0.11
9/21/2005	2.69±0.83	0.16±0.22 U	3.4±0.96	10.3	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	0.74±0.41	0.2±0.23 U	1.21±0.54	3.7	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	2.76±0.98	0.07±0.17 U	6.13±1.6	18.6	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	0.724±0.461	0.252±0.279 U	0.24±0.28 U	1.20E-04	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	0.791±0.49	0.19±0.237 U	0.785±0.469	2.4	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	1.06±0.428	0.0723±0.147 U	1.34±0.47	4.1	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	1.16±0.47	0.346±0.255	1.81±0.576	5.6	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
3/7/2012	0.184±0.208 U	-0.0369±0.148 U	0.143±0.191 U		3/7/2012	0.165±0.197 U	0.0824±0.139 U	-0.0363±0.119 U	--
7/24/2012	1.47±0.504	0.0946±0.143 U	2.6±0.647	7.9	7/24/2012	0.279±0.251 U	0.0364±0.154 U	0.0971±0.146 U	--
1/14/2013	0.443±0.255	0.0175±0.111 U	1.16±0.38	4 U	1/14/2013	0.172±0.169 U	-0.0136±0.114 U	0.163±0.154 U	4 U
9/17/2013	1.2±0.408	0.181±0.184 U	2.23±0.528	7.5	9/17/2013	0.359±0.234	0.0572±0.128 U	0.0768±0.151 U	4 U
2/18/2014	1.6±0.442	0.156±0.154 U	4.29±0.698	4 U	2/18/2014	0.19±0.198 U	-0.0208±0.108 U	0.0833±0.124 U	4 U
8/25/2014	0.887±0.309	0.0511±0.096 U	1.26±0.362	5.1	8/25/2014	0.314±0.173	0.0337±0.0801 U	0.113±0.118 U	4 U

[a]Total uranium mass calculated from detected individual isotope.

Bold value indicates sample concentration exceeds 30 µg/L MCL for uranium.

J = estimated value
MCL = maximum contaminant level
SS = surface spring
U = not detected

Zone 2

Groundwater monitoring used to evaluate conditions in the eastern end of Zone 2 consists of sampling six wells along the boundary with Zone 3 near the western end of the BCBGs. Well locations are shown on Figure 4.3. Four of these wells (GW-077 through GW-080) are located west of NT-8 and north of Bear Creek Road in the Conasauga Group clastic bedrock formations and the other two wells are constructed in the Maynardville Limestone to the south of Bear Creek Road along the transect designated as Picket A (Figure 4.3).

The groundwater quality goal for Zone 2 is to eventually achieve unrestricted use and, therefore, MCLs and residential risk-based concentrations are used as screening comparison levels.

Wells GW-077 (100 ft deep, screened between 814.4 and 827.3 ft aMSL), and GW-078 (21 ft deep, screened between 893.4 and 902.8 ft aMSL) sample groundwater in the Nolichucky Shale. Wells GW-079 (65 ft deep, screened between 912.3 and 927.3 ft aMSL) and GW-080 (30 ft deep, screened between 947.4 and 956.3 ft aMSL) sample groundwater from the Rogersville Shale Formation. All four of these wells are sampled for uranium and VOCs. Neither uranium nor VOCs were detected in any of these four wells during FY 2014. 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 dense non-aqueous phase liquid (DNAPL) area beneath the BCBGs cannot be evaluated with the existing well network. This scarcity of groundwater monitoring opportunities in this area west of the BCBGs was identified as an issue in previous RERs and in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2).

Wells GW-683 and GW-684 sample bedrock groundwater from Maynardville Limestone upgradient of spring SS-5 and are monitored semiannually for metals, including uranium, nitrate, VOCs, and radiological constituents. Well GW-683 is 197.5 ft deep (screened interval elevation 772.65 to 835.55 ft aMSL) and well GW-684 is 129.6 ft deep (screened interval elevation 765.93 to 789.13 ft aMSL). The principal contaminants detected in these wells that presently or have historically exceeded the screening criteria are nitrate and uranium isotopes (Figure 4.11). 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. In the years 2000 to 2002 ^{238}U exceeded the risk-based criterion in wells GW-683 and GW-684. Greater than average rainfall during 2003 and 2004 caused dilution of groundwater in the Maynardville karst plume pathway and the uranium activities decreased to less than the risk-based criterion. Levels rose somewhat during the drought years 2006 to 2008 and have decreased again during the several recent years of higher than average annual rainfall. Technetium-99 was not detected in well GW-683 during FY 2013 semiannual sampling and was detected at < 10 pCi/L in the July 2014 sample from well GW-684. Although very low (< 5 ng/L) concentrations of mercury have been detected in both wells in past years, it was not detected in either well during FY 2014. When detectable, alpha activity was less than 10 pCi/L and beta activity was less than 11 pCi/L in wells GW-683 and GW-684. No VOCs were detected in either of these wells during FY 2014.

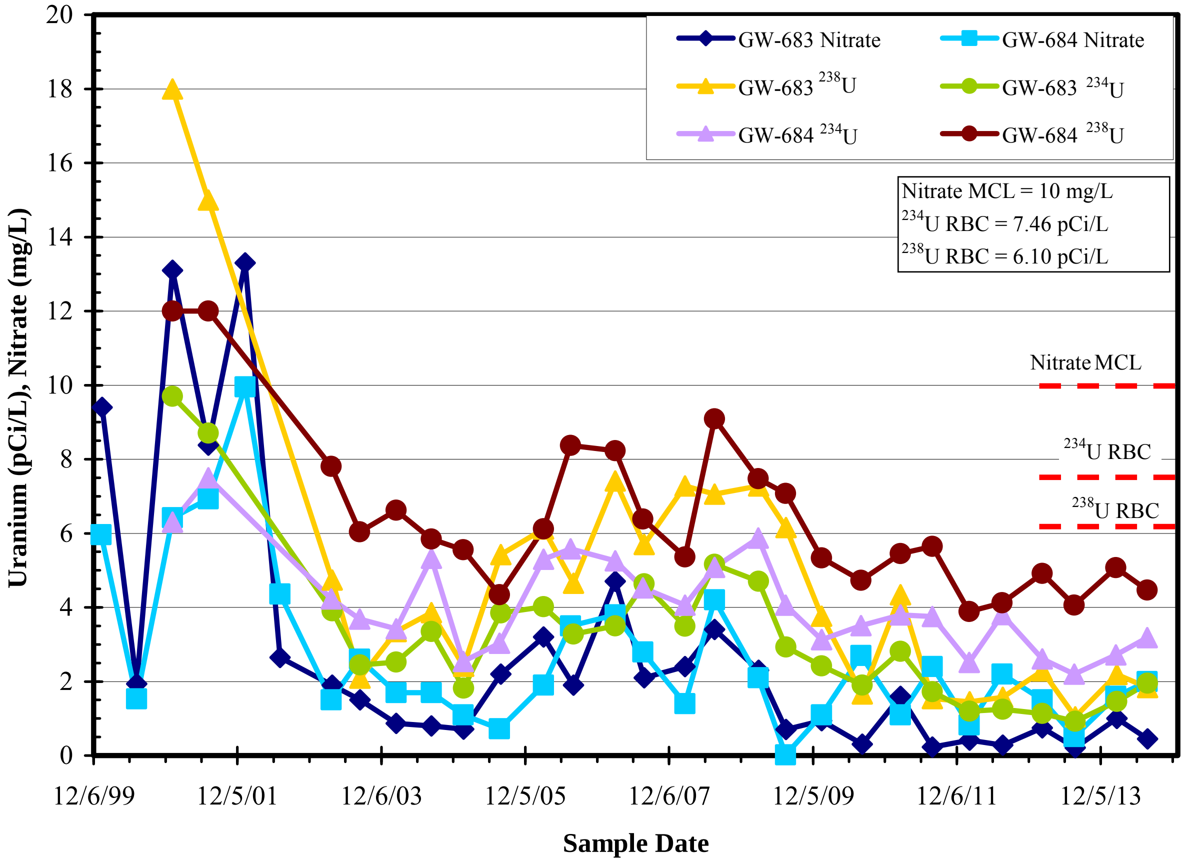


Figure 4.11. Constituents detected above risk-based concentration or MCL at wells GW-683 and GW-684.

Wells GW-683 and GW-684 sample groundwater contamination that originates from upgradient sources, including the S-3 Ponds and portions of the BCBGs, and flows through karst conduits in the Maynardville Limestone prior to rising to discharge into Bear Creek at spring SS-5 (Figure 4.3). Although a portion of the groundwater contaminant plume shown on Figure 4.3 terminates at the known plume discharge point at SS-5, detection of contaminants linked to the S-3 Ponds plume from upstream of the BCBGs in Spring SS-6 further downgradient in Zone 1 indicates the presence of some discrete conduit flow connecting Zones 1 and 3. Wells do not exist in the Maynardville Limestone in Zone 2 that could help delineate the contaminant transport characteristics in that area. Groundwater sampling further to the west at the Picket W wells (Figure 4.3) shows the presence of nitrate and uranium as discussed previously in the Zone 1 groundwater section. Transient episodes of groundwater contaminant migration occur through bedrock groundwater flow pathways through Zone 2 and into Zone 1. A scarcity of groundwater monitoring wells in appropriate locations and depths in Zone 2 makes it impossible to precisely map and track groundwater contaminant transport pathways that may emanate from DNAPL at depth beneath the BCBGs. This scarcity of wells in Zone 2 near the Zone 3 boundary capable of detecting contaminant migration in key geologic positions was identified as an issue in previous RERs and in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2).

Zone 3

Existing CERCLA decision documents pertinent to BCV do not stipulate groundwater actions or remediation levels to be attained within Zone 3. The ROD indicates source area RAs 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 4.3). Contaminant plumes in BCV, as interpreted by the Y-12 Groundwater Protection Program (GWPP), are shown in Figure 4.3.

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. Well GW-704 samples groundwater from a depth of 256 ft (screened between 685.99 and 697.49 ft aMSL) and well GW-706 samples groundwater from a depth of 182 ft (screened between 743.28 and 769.68 ft aMSL). The wells are located midway between BCK 11.54 and SS-5. Samples from 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 4.12. During FY 2014, contaminant levels continued their seasonal fluctuations and were consistent with previous years.

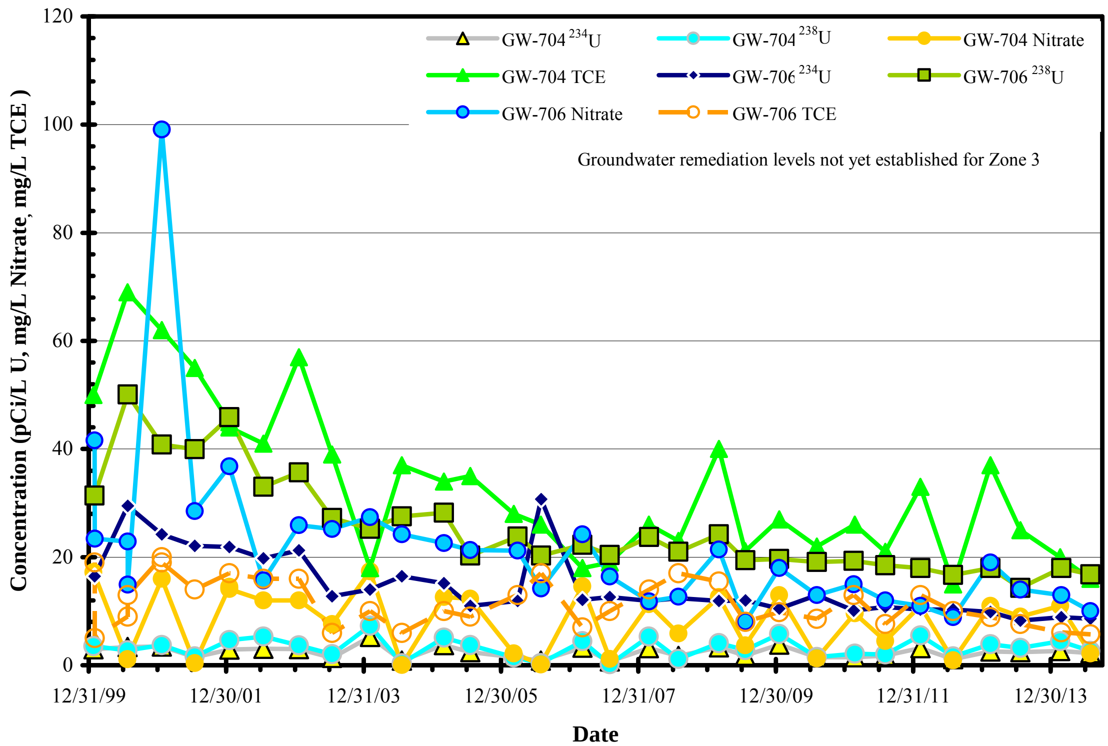
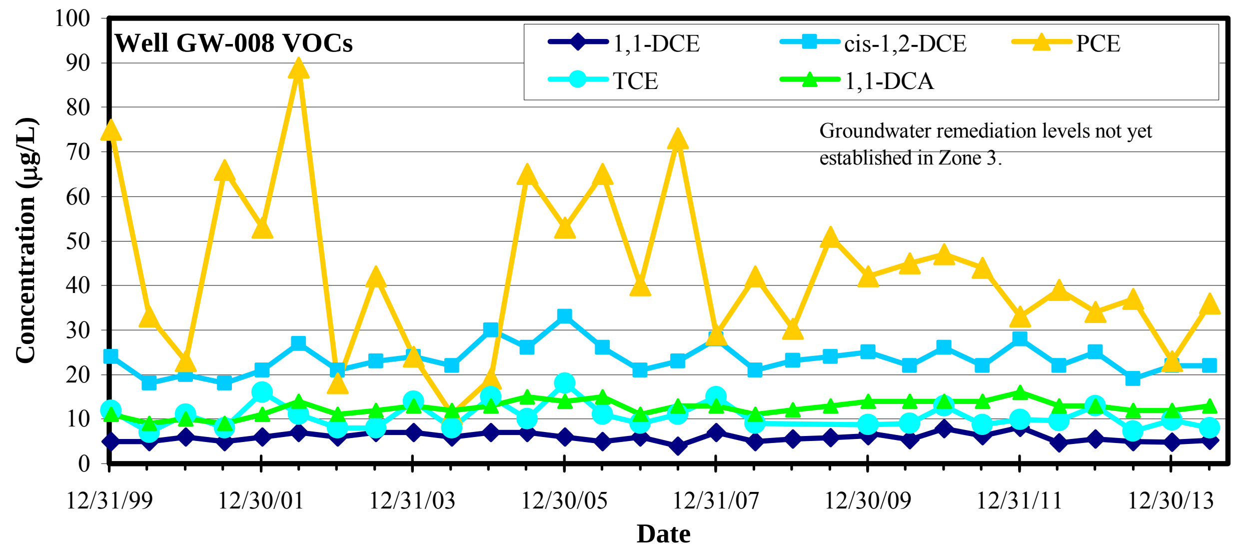
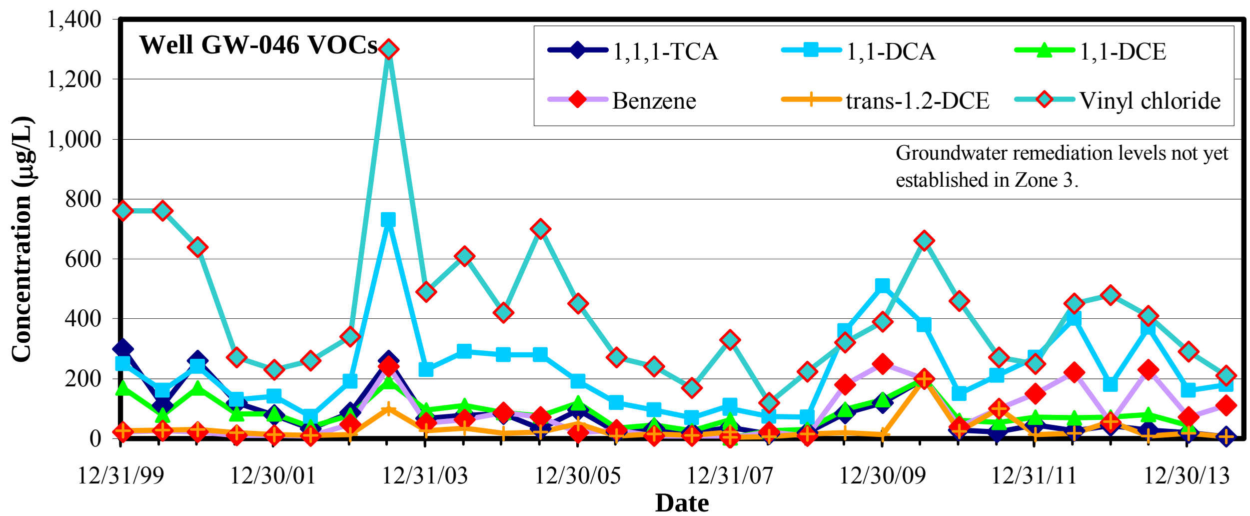


Figure 4.12. Principal contaminant trends in wells GW-704 and GW-706.

Both shallow and deep sources of VOC contamination are present at the BCBGs. VOC liquids were disposed in some shallow waste burial trenches in Burial Ground A-South with resultant shallow and deep contamination. As shown on Figure 4.3, wells GW-008 is located near the Oil Landfarm and GW-046 is located to the east of NT-7 near the southwest corner of Burial Ground A-South. Both of these relatively shallow wells are in areas that are impacted by past disposal of VOC compounds. Well GW-008 samples groundwater from a depth of about 25 ft (screened between 936.61 and 949.11 ft aMSL) and GW-046 samples groundwater from a depth of about 20 ft (screened between 897.83 and 913.13 ft aMSL). Concentration trends for the principal contaminants of concern in these wells are shown in Figure 4.13. The relatively low VOC concentrations in GW-008 did not change greatly during FY 2014. Well GW-046, which is located downgradient from an area where large quantities of liquid wastes were disposed by percolation into shallow waste burial trenches, contains much higher VOC concentrations. During 2014, VOC concentrations measured in GW-046 generally decreased from higher levels measured during FY 2013. This decreasing behavior may be a response to the lower than average rainfall that occurred in FY 2014 compared to the several preceding years. Short-term VOC concentration fluctuations notwithstanding, the data from these two wells indicate that the VOC contaminant source terms in both of these areas are essentially constant.

Groundwater surveillance monitoring of the BCBGs conducted by the Y-12 GWPP documents increasing VOC concentrations in the noncarbonate, fractured bedrock underlying the area. In a sample collected at a depth of 270 ft in well GW-629 (shown in Figure 4.3) by the Y-12 GWPP in 2009 PCE, TCE, and 1,1-DCA were measured at concentrations of 180 ppm, 24 ppm, and 11 ppm, respectively. These contaminants are not detected to date in wells GW-077 (100.5 ft deep) and GW-078 (21.1 ft deep) that lie farther west of the burial grounds and Bear Creek Tributary NT-8. However, PCE, TCE, and cis-1,2-DCE are detected in surface water in NT-8.





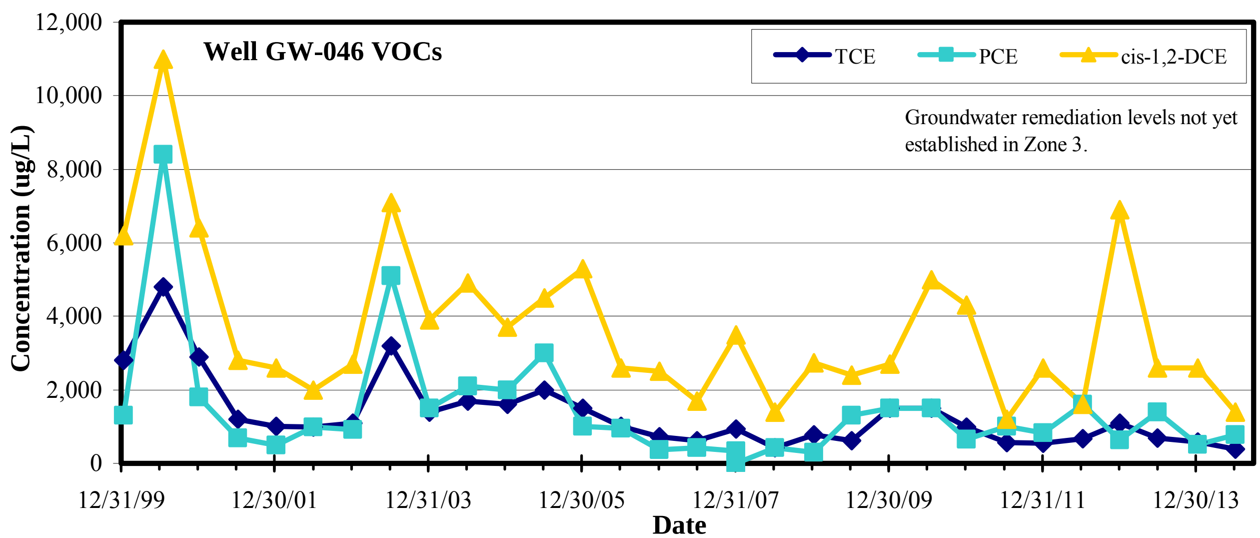


Figure 4.13. VOC concentration trends in wells GW-008 and GW-046.

4.2.1.2.3 Aquatic Biological Monitoring

4.2.1.2.3.1 Watershed Biological Monitoring

Aquatic biological monitoring of stream sites in BCV watershed (Figure 4.3) is used to measure the effectiveness of watershed-scale RAs. Biological monitoring data for streams in BCV include results on (1) contaminant accumulation in fish, (2) fish community surveys, and (3) benthic macroinvertebrate community surveys.

To evaluate instream contaminant exposure and potential human and ecological risks in the BCV 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 4.3). An evaluation of overall ecological health of the streams is conducted by monitoring fish and benthic macroinvertebrate communities at BCK 3.3, BCK 9.9, BCK 12.4, and NT-3 (a tributary to Bear Creek).

Mean mercury concentrations in rockbass from lower Bear Creek (BCK 3.3) decreased in FY 2014, averaging 0.68 µg/g in fall 2013 and 0.69 µg/g in spring 2014 (Figure 4.14), but remain above the EPA-recommended fish-based AWQC of 0.3 µg/g. Though this decrease is significant, mercury concentrations in fish collected from this site had been steadily increasing for the past five years, and FY 2014 concentrations remain elevated with respect to concentrations seen prior to 2009 and are still over three-fold higher than those found in the same species from the Hinds Creek reference site (Hinds Creek kilometer [HCK] 20.6, Figure 4.3) (Hinds Creek mean of 0.22 µg/g in FY 2014). While the fish collected in FY 2014 were larger in both fall and spring than those collected in FY 2013, the differences in size between the years was not statistically significant so the decrease is not likely to be due to the size of fish alone.

Concentrations in fish collected in upper Bear Creek (BCK 9.9) continue to be lower than those in fish collected at the lower site, partly due to differences in species monitored between the two sites. While the lower stretches of Bear Creek are often impounded due to beaver dams which create the deeper pools suitable for rock bass habitat, the upper stretches of Bear Creek are less suitable for rock bass, and the sunfish species most often encountered in the stretch of Bear Creek between BCK 4.6 and BCK 9.9 is the redbreast sunfish, which feed on lower trophic level prey and typically have between 15 – 40% lower mercury concentrations than rock bass collected from the same site. Average mercury concentrations in redbreast sunfish from this stretch of the creek were just slightly higher than the EPA AWQC value in 2014, comparable to concentrations seen in the previous four years (Figure 4.14).

As seen at many other monitoring sites, mean PCB concentrations in sunfish collected from Bear Creek have fluctuated significantly over time, but with concentrations averaging between 0.2 – 0.7 µg/g in 2014 (Figure 4.15) remain elevated with respect to the Hinds Creek reference site. Concentrations in fish collected from BCK 9.9 have generally been higher than in fish collected further downstream at BCK 3.3, but there is significant inter-annual variability and concentrations appear to be decreasing in redbreast collected from the upper site.

While regulatory guidance and human health risk levels have varied widely for PCBs over the years, in the recent years in the state of Tennessee, the water quality criterion (0.00064 µg/L for total PCBs) has been used by TDEC to calculate the fish tissue concentration triggering impairment and a TMDL (TDEC 2007) under its TMDL Program, and this concentration is 0.02 mg/kg in fish fillet (TDEC 2010a,b,c). TMDLs are used to develop controls for reducing pollution from both point and non-point sources in order to restore or maintain the quality of a water body and ensure it meets the applicable water quality standards. The fish PCB concentrations in Bear Creek are still well above the calculated TMDL concentration.

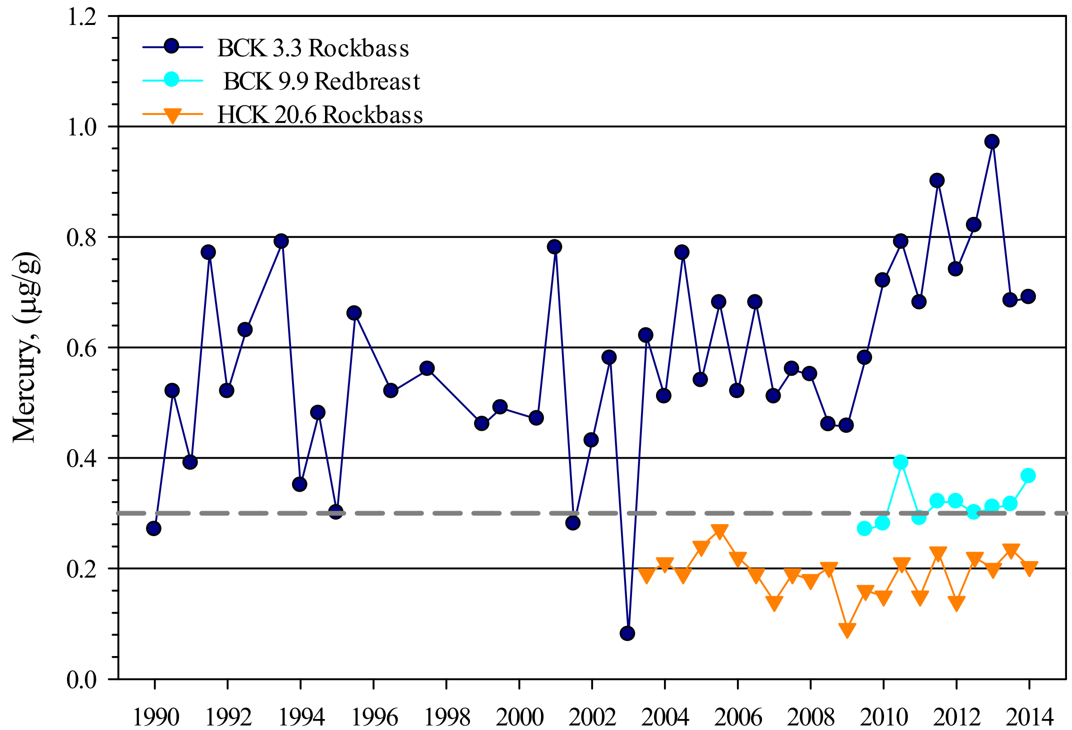


Figure 4.14. Mean concentrations of mercury in rockbass from BCK 3.3, redbreast sunfish from BCK 9.9, and rockbass from the Hinds Creek reference site (HCK 20.6) 1990 – 2014.

Dashed line indicates EPA recommended AWQC for mercury (0.3 µg/g in fish).

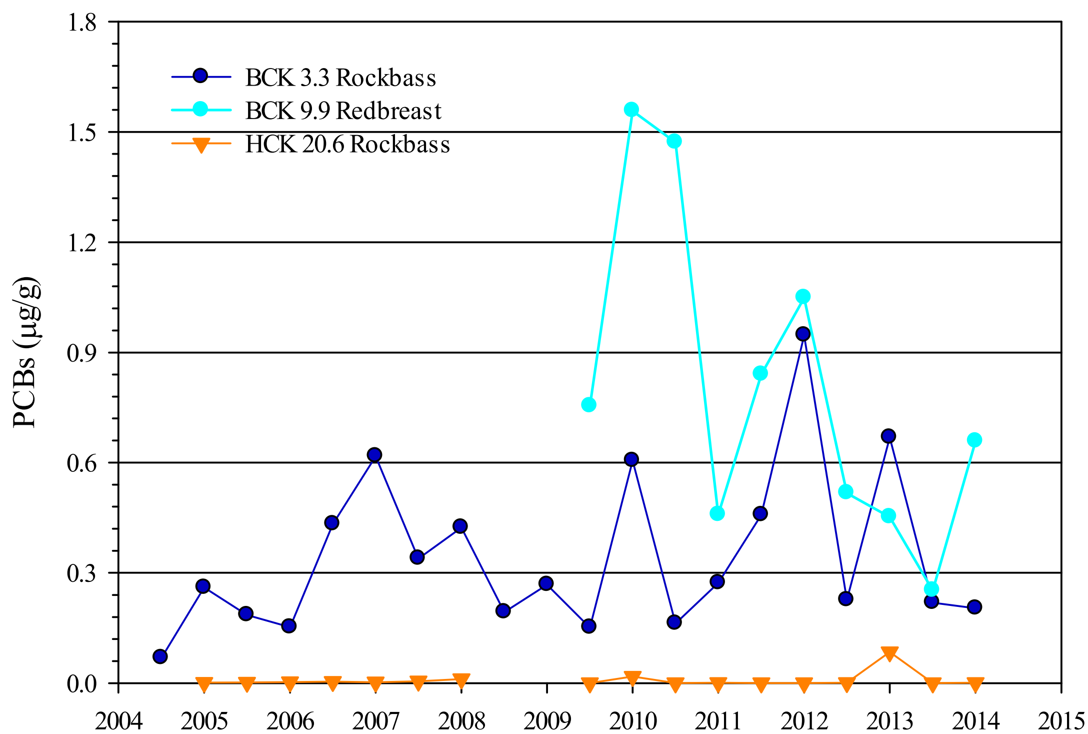


Figure 4.15. Mean concentrations of PCBs in rockbass from BCK 3.3, redbreast sunfish from BCK 9.9, and rockbass from the Hinds Creek reference site (HCK 20.6) 2004 – 2014.

Though there has been much variability over the years, concentrations of nickel, cadmium, and uranium in stoneroller minnows have historically been highest in upper Bear Creek and have decreased with distance downstream (Figure 4.16, Figure 4.17, and Figure 4.18, respectively). These metals have also been substantially higher than reference fish concentrations, and continued this trend in FY 2014. In 2014, nickel concentrations averaged between 0.65 – 1.45 µg/g at all three Bear Creek sites, which was significantly higher than the 0.28 µg/g concentration from the reference site. Uranium concentrations in minnows for FY 2014 were comparable to the results from FY 2013. Cadmium concentrations remain higher in fish from the uppermost Bear Creek site. The high annual and seasonal variability in metal concentrations in forage fish collected from Bear Creek is presumably due to temporal differences in precipitation, flow, and relative percentages of deep or shallow groundwater sources.

PCB concentrations in stoneroller minnows in FY 2014 averaged between 1.2 – 3.4 µg/g, continuing the long-term trend of elevated levels in fish (Figure 4.19). PCB levels in minnows collected from the uppermost site in Bear Creek (BCK 12.4) were historically measured, but since concentrations were relatively low, and the primary source of PCBs to the watershed was thought to originate from NT-7 near BCK 9.9, this sampling was discontinued in 2003. PCB concentrations 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 since a big spike in the 2004 timeframe. At BCK 3.3, fish concentrations similarly spiked in 2004, after which concentrations stabilized at a relatively high range of 2 µg/g PCBs.

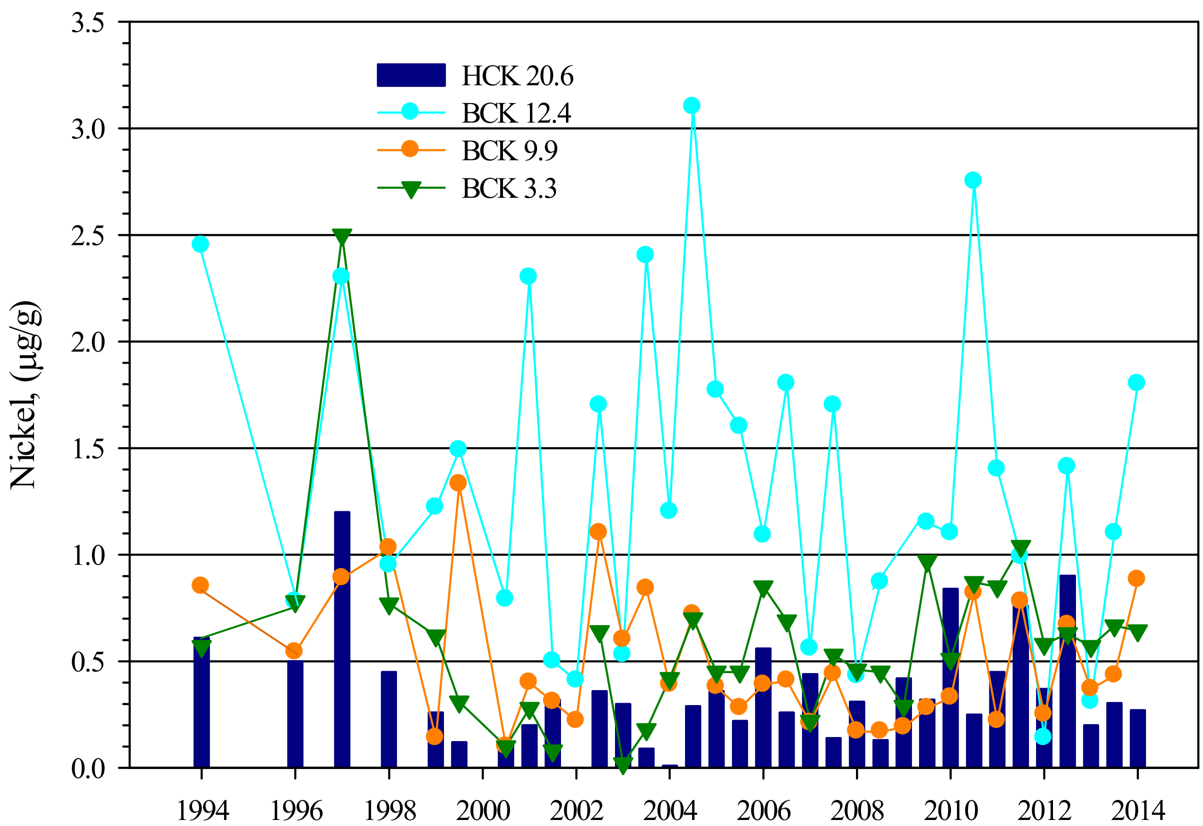


Figure 4.16. Mean nickel concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994 – 2014.

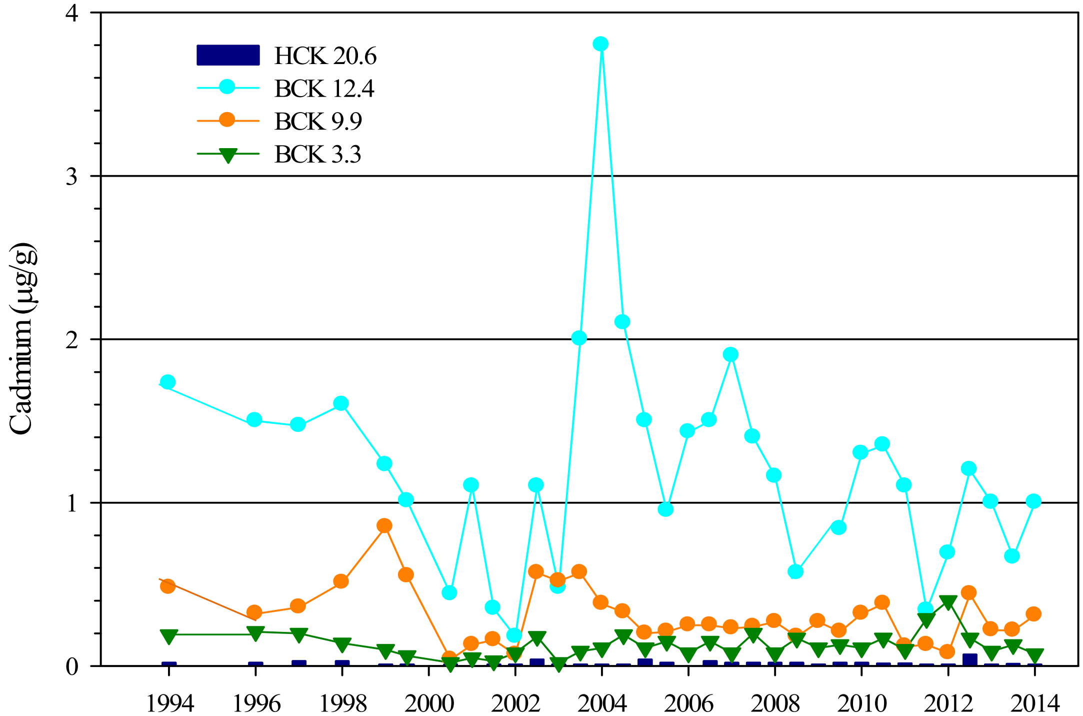


Figure 4.17. Mean cadmium concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994 – 2014.

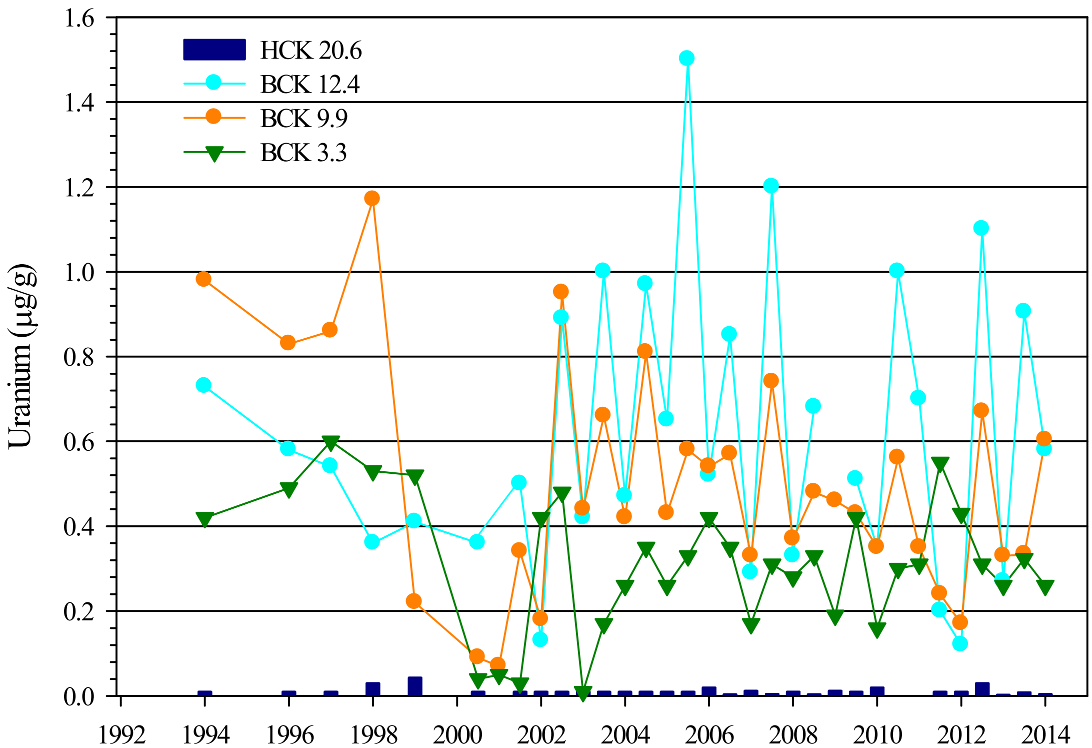


Figure 4.18. Mean uranium concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994 – 2014.

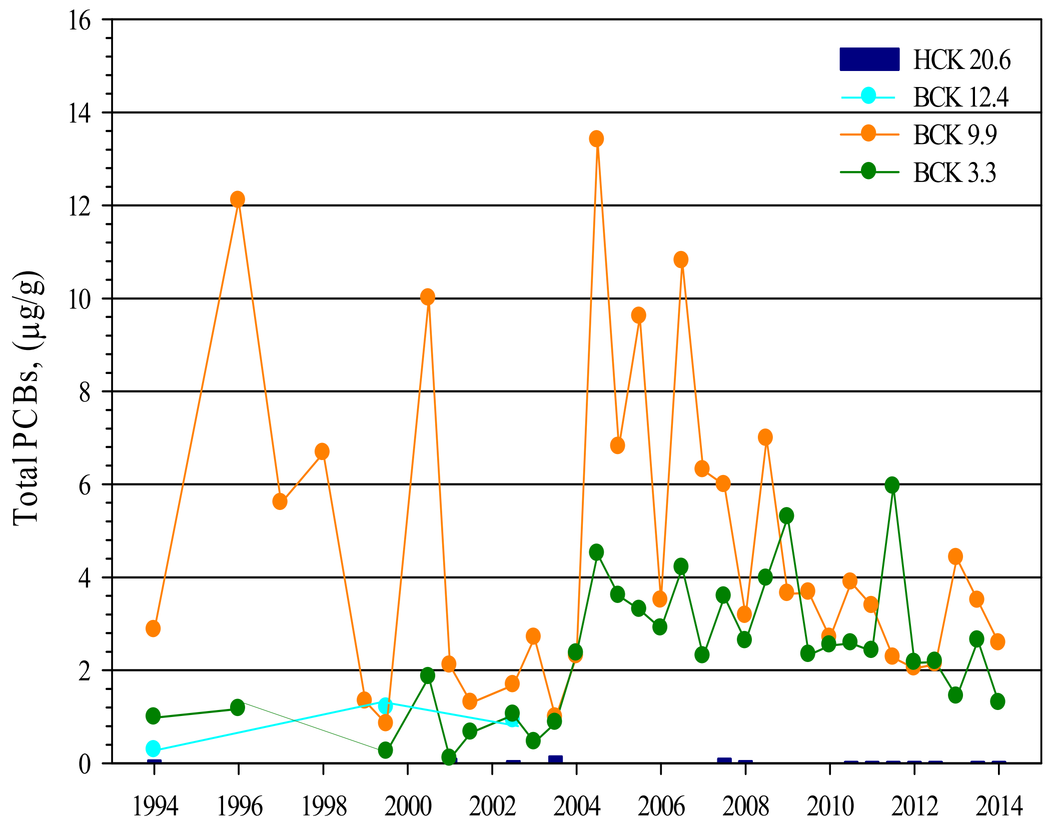


Figure 4.19. Mean PCB concentrations in stoneroller minnows at three sites in Bear Creek and a reference site (HCK 20.6), 1994 – 2014.

The fish communities in Bear Creek have generally been stable with some annual variation in terms of species richness, including in 2011 and 2012 when species richness was several points higher than the historical average at the lowermost site (BCK 3.3). The downstream sites (BCK 3.3 and BCK 9.9) have lower numbers of species relative to a larger reference stream (BFK 7.6), but are similar to or higher than a smaller reference stream (MBK 1.6) (Figure 4.20). In general both Bear Creek sites are somewhat limited in sensitive species, and when occasionally observed are low in abundance and may be transitory. BCK 12.4 and NT-3 fish communities are below total richness values of comparable reference streams (MBK 1.6 and Pinhook Branch kilometer [PHK] 1.6), suggesting they are more susceptible to stress (Figure 4.21). Previous studies have shown that during low rainfall months in late summer and fall, the upper Bear Creek sites receive a greater percentage of stream flow from contaminated groundwater, which likely contributes to measured stream toxicity (Peterson, et. al., 2000) and biota impairment. Both sites may also be affected by habitat limitations, especially a lack of pool depth during low flow periods. However, recent stream mitigation efforts at BCK 12.4 have the potential to enhance these habitat limitations by creating a more balanced pool:riffle ratio and increasing the amount of available habitat by means of narrowing this previously channelized section of stream.

Upper Bear Creek (BCK 12.4) and NT-3 continue to support notably fewer pollution-intolerant benthic macroinvertebrate taxa than nearby reference streams, with the differences between these and the reference sites generally most pronounced during October sampling periods (Figure 4.22). Trends at NT-3 since 2012, however, appear to indicate that this site may be experiencing a modest increase in the number of pollution intolerant taxa. Results for BCK 9.9 appear to suggest a possible modest improvement in the number of pollution intolerant taxa present at that site as well. More favorable flows over longer periods from higher amounts of precipitation after 2007 may, in part, be contributing to apparent improvements at these sites. The condition of the macroinvertebrate community at the most downstream site on Bear Creek (BCK 3.3) continues to be comparable to that of the reference sites.

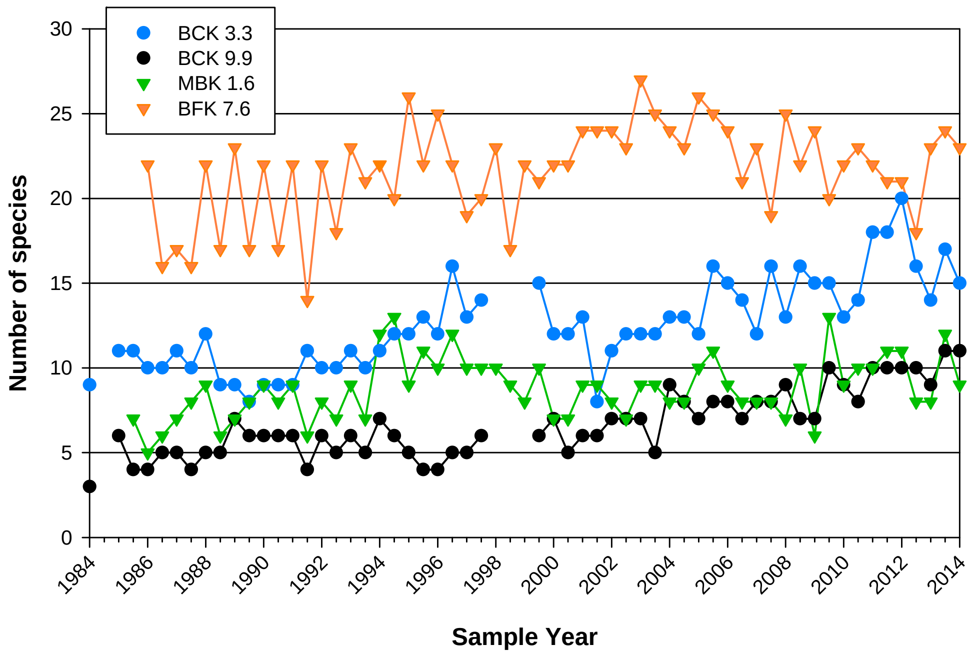


Figure 4.20. Species richness (number of species) in samples of the fish community in lower Bear Creek (BCK), and reference streams, Brushy Fork (BFK) and Mill Branch (MBK), 1984 – 2014.[a]

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

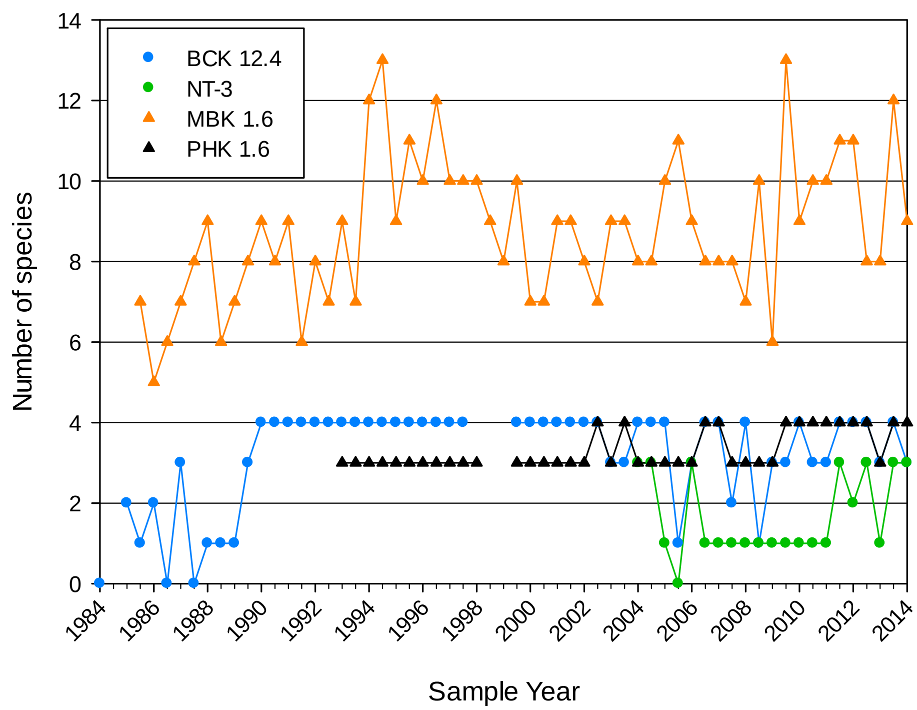


Figure 4.21. Species richness (number of species) in samples of the fish community in upper Bear Creek (BCK), NT-3, and two reference streams, Mill Branch (MBK) and Pinhook Branch (PHK), 1984 – 2014.[a]

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

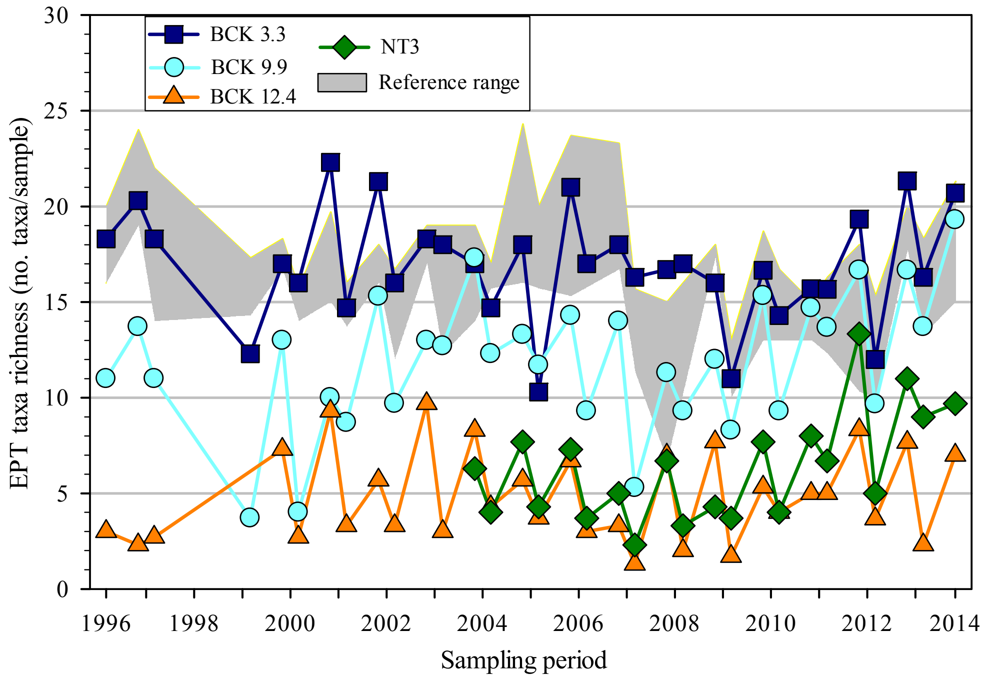


Figure 4.22. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in Bear Creek, NT-3, and range of mean values among reference streams (two sites in Gum Hollow Branch and one site in Mill Branch), for October and April sampling periods from 1996 – 2014 (FY 2014) beginning with October 1996.

Tick marks centered between April and October sampling periods for years after 1996.
NT-3 = North Tributary #3 to Bear Creek
EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies and caddisflies.

4.2.1.3 Performance Summary

Following is a summary of the FY 2014 BCV watershed performance monitoring:

- Surface water monitoring at the integration point (BCK 9.2) showed that the *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) goal of ≤34 kg/yr of uranium was not attained. The measured uranium flux at the integration point in FY 2014 was about 96 kg which is nearly three times the ROD goal. An estimated one-quarter of the uranium flux is attributed to surface water discharged from the S-3 Ponds plume, about 75% of the uranium flux originated in the BCBGs, and approximately 2% originated from NT-3. The uranium mass balance estimate for the integration point monitoring at BCK 9.2 compared to the sum of upstream contributing stations was within 5% during FY 2014 which is considered a good mass balance considering the complex nature of surface water and shallow groundwater flow in the area. The annual uranium discharge flux is directly related to the total annual rainfall and during recent years Oak Ridge has experienced above average rainfall amounts. Rainfall in FY 2014 was slightly below average.

- NT-8 near the BCBGs continues to be a the largest contributor of uranium to Bear Creek having accounted for 72.4 kg of uranium during FY 2014 . Implementation of an NT-8 Surface Water action is a potential project identified in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2). Investigations and projects during groundwater strategy implementation will be sequenced according to ORR-wide groundwater issues prioritization.

- Nitrate concentrations meet applicable ROD criteria at the watershed integration point (BCK 9.2). Cadmium concentrations exceeded AWQC requirements at NT-1 and at the BCK 12.34 monitoring location near the S-3 Ponds contaminant source.

- The average nitrate concentration measured at BCK 12.34 near the S-3 Pond source area was less than the industrial risk-based concentration.

- In Zone 1, the western half of BCV, groundwater contaminant concentrations continue to remain low. However, there are uncertainties about groundwater contaminant levels and flow paths that have been identified in the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2628/V1&V2&D2). Evaluation of potential pathways and installation of additional wells will be included in investigations during groundwater strategy implementation and will be sequenced according to ORR-wide groundwater issues prioritization. Evaluation of uranium isotope ratios in the Zone 1 springs and wells shows that spring SS-6 is unique in the area in that its uranium appears to originate from upstream of NT-8 while all the other Zone 1 locations show uranium isotopic signatures that reflect the influence of NT-8 discharges.

- Mean mercury concentrations in rockbass in lower Bear Creek (BCK 3.3) remained elevated and are above EPA-recommended AWQC.

- PCB concentrations in stoneroller minnows continued the long-term trend of elevated levels but decreasing since a big spike in 2004.

4.2.2 Other LTS Requirements

Other LTS requirements for BCV watershed actions are listed in Table 4.12 and described below.

4.2.2.1 Requirements

Watershed-scale Requirements

LTS requirements outlined in the *Record of Decision for the Phase I Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) include LUCs to restrict groundwater and surface water use consistent with designated end use for each zone (Figure 4.2). Objectives of these LUCs include preventing unauthorized contact, removal, or excavation of buried waste in the BCV watershed; precluding residential or recreational use of Zone 3; and preventing unauthorized access to contaminated groundwater in the BCV watershed. The *Record of Decision for the Phase I Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) 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. The *Record of Decision for the Phase I Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) was completed prior to uniform adherence to a LUC section; hence, no approved LUC table exists for this decision as it does for the other watershed RODs. Table 4.12 lists the other LTS requirements for the BCV watershed as they are written in the *Record of Decision for the Phase I Activities in Bear Creek Valley* (DOE/OR/01-1750&D4).

- <u>BYBY</u>—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 Oil Landfarm Soil Containment Pad.

- S-3 Ponds Pathway 3—Access will be controlled and restricted. Once action is complete, inspection and maintenance of the passive *in situ* treatment system will be required.

- DARA—Access will be controlled and restricted.

Single-Project Scale Requirements

- BCV Operable Unit 2—Maintain the vegetative soil cover.

4.2.2.2 Status of Requirements

Watershed-scale

LUCs in place in the BCV watershed were maintained throughout FY 2014 as part of the Y-12 S&M Program and in conjunction with Babcock & Wilcox (B&W) Y-12, which transitioned to management under Consolidated Nuclear Solutions, LLC (CNS) on July 1, 2014.

Individual RAs under the *Record of Decision for the Phase I Activities in Bear Creek Valley* (DOE/OR/01-1750&D4) underwent routine site inspections conducted by the Y-12 S&M Program as follows:

- BYBY—All components of the site were inspected semiannually in FY 2014, 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. In FY 2014, maintenance included correction of two drains to replace a damaged screen and correct the corrugated pipe as well as performing routine mowing at the site.

- S-3 Ponds Pathway 3 and DARA Solids Storage Facility—These RAs have not yet been implemented. Access control requirements were maintained in FY 2014 as part of general Y-12 plant controls 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.

Single-Project Scale

Spoil Area 1 and the SY-200 Yard sites of the BCV Operable Unit 2 were inspected quarterly by the Y-12 S&M Program in FY 2014 for erosion of the cover, integrity of surface drainage, evidence of rodent damage, property signs, unlocked gates, and presence of unauthorized material in the area. Maintenance requests were submitted to replace sign and repair cracks in the asphalt parking lot at the SY-200 Yard. Both sites received routine mowing. For FY 2014, the deed restrictions for both areas were verified to be properly filed electronically at the Anderson County Register's of Deeds office via http://www.andersondeeds.com.

4.3 BCV ISSUES AND RECOMMENDATIONS

The issues and recommendations for the BCV watershed are in Table 4.13.

Table 4.12. Other LTS requirements for the BCV watershed

Areas	Project Documents	Other LTS Requirements	Frequency/Implementation
Other LTS requirements for the BCV Watershed and Specific Areas[a]			
BCV Watershed	Phase I ROD (DOE/OR/01-1750&D4)	• Surveillance and maintenance activities in BCV will be continued • Controlled industrial land use in Zone 3 and access restrictions in Zones 1 and 2 will be maintained • Prevent unauthorized contact, removal, or excavation of buried waste in the BCV • Preclude residential use in Zones 2 and 3 • Prevent unauthorized access to contaminated groundwater in BCV • Continue access restrictions for the S-3 disposal area • Maintain existing cap (BYBY and Hazardous Chemicals Disposal Area, Oil Landfarm, Sanitary Landfill-1) • Continued S&M of access controls and surface cover (Spoil Area 1 landfill, SY-200 Yard • Posted signs and security patrols of the areas outside the fenced Y-12 Plant boundaries (most areas under the ROD except S-3 site) • DOE will limit public access • Institutional controls in place at the BCBGs will be maintained until remediation decisions for the BCBGs are addressed in future CERCLA decisions • Continue compliant storage of DARA mixed waste until it can be disposed	• Following implementation of remedial actions, S&M of the site will be conducted under the Y-12 Plant sitewide S&M program • Monitoring and enforcement of use restrictions on groundwater and surface water will be conducted as part of the Y-12 Plant sitewide S&M and water quality programs pending the completion of future CERCLA decisions • A review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment
BYBY	PCCR (DOE/OR/01-2077&D2)	• Surveillance activities include inspection of capped areas for unwanted vegetation and erosion and inspection of access controls to site • Routine maintenance includes mowing of capped areas • Non-routine maintenance performed as necessary • After vegetation has been established and the site has been stabilized, the metal cap will be removed from the culvert north of the Haul Road	• Inspect site quarterly until site is stabilized • Inspect site on semiannual basis once stabilized

Table 4.12. Other LTS requirements for the BCV watershed (cont.)

Other LTS requirements for the BCV Watershed and Specific Areas[a]			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
Spoil Area 1 and SY-200 Yard	BCV OU 2 ROD (DOE/OR/02-1435&D2)	• Institutional controls must be maintained indefinitely • 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 (primarily external exposure and inhalation of ^{226}Ra) • Restrictions will also require the incorporation of indoor radon mitigation measures in accordance with EPA guidelines for any future structure built on site	• Periodic physical surveillance of the soil cover and other features of the site and maintenance or repair, as required • A FYR will be conducted after completion of remedial action to ensure remedy continues to protect human health and the environment

[a]The BCV Phase I ROD was completed prior to uniform adherence to the LUC section; hence, no approved LUC table exists for this decision. Additional LTS for specific areas are determined by each remediation project and listed in the project specific PCCR.

BCBGs = Bear Creek Burial Grounds
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DARA = Disposal Area Remedial Action
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
FYR = Five-Year Review
LTS = long-term stewardship
LUC = land use control
OU = operable unit
PCCR = Phased Construction Completion Report
ROD = Record of Decision
S&M = surveillance and maintenance
Y-12 = Y-12 National Security Complex

Table 4.13. BCV watershed issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issue Carried Forward			
None			
Completed/Resolved Issues[b]			
None			

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the 2015 RER. An "Issue Carried Forward" is an issue identified in a previous year's RER for FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.

[b]The year in which the issue originated is provided in parentheses, e.g., (2013 RER).

BCV = Bear Creek Valley
FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report

4.4 REFERENCES

DOE/OR/01-1750&D4. *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1836&D1/A1. *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*, 1993, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2077&D2. *Phased Construction Completion Report for the Bear Creek Valley Boneyard/Burnyard Remediation Project at the Y-12 National Security Complex, Oak Ridge, Tennessee*, 2003, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2457&D2/A1. *Bear Creek Valley Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2505&D2. *2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,* 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2628/V1&V2&D2. *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee, Volumes 1 and Volume 2*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Peterson, M. J., J. M. Loar, L. A., Kszos, M. G. Ryon, J. G. Smith. 2000. *Biomonitoring for environmental compliance at select DOE facilities: fifteen years of the Biomonitoring and Abatement Program*. Proceedings of the 25th Annual Conference of the National Association of Environmental Professionals. Overcoming Barriers to Environmental Improvement. National Association of Environmental Professionals publication.

TDEC 2007. State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October 2007. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Approved March 2008.

TDEC 2010a. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Melton Hill Reservoir: Lower Clinch River Watershed (HUC 06010207), Anderson, Knox, Loudon, and Roane Counties, Tennessee.

TDEC 2010b. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Watts Bar Reservoir: Watts Bar Lake Watershed (HUC 06010201), Lower Clinch River Watershed (HUC 06010207), and Emory River Watershed (HUC 06010208), Loudon, Meigs, Morgan, Rhea, and Roane Counties, Tennessee.

TDEC 2010c. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Fort Loudon Reservoir: Fort Loudon Lake Watershed (HUC 06010201), Blount, Knox, and Loudon Counties, Tennessee.

5. CHESTNUT RIDGE

5.1 INTRODUCTION AND STATUS

5.1.1 Introduction

Chestnut Ridge is not physically situated within one of the five established watersheds but is located south of the Y-12 (Figure 5.1). An integrated Remedial Investigation/Feasibility Study (RI/FS) has not been conducted on Chestnut Ridge and decision processes for the several CERCLA units in the area to date have been single-action project decisions. Table 5.1 lists CERCLA actions on Chestnut Ridge and identifies those with monitoring or other LTS requirements. Figure 5.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Figure 5.2 shows interim controls requiring LTS.

For a complete discussion of background information and performance metrics for each remedy, a compendium of all CERCLA decisions on Chestnut Ridge is provided in Chapter 9 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

5.1.2 Status Update

During FY 2014, no additional CERCLA actions were implemented or completed, nor were any associated FFA documents submitted or approved for CERCLA actions located on Chestnut Ridge. Monitoring in support of performance assessments and evaluations continued.

5.2 UNITED NUCLEAR CORPORATION DISPOSAL SITE

5.2.1 Performance Monitoring

5.2.1.1 Performance Monitoring Goals and Objectives

The United Nuclear Corporation (UNC) Disposal Site is a 1.3 acre landfill located near the crest of Chestnut Ridge south of Y-12 (Figure 5.1 and Figure 5.3). The *Record of Decision United Nuclear Corporation Disposal Site Declaration* (DOE 1991) was approved in June 1991. Field activities began in May 1992 and were completed in August 1992. Remedial activities included a multilayer cover system, access controls, and groundwater monitoring using existing wells.

This waste disposal facility utilized an unlined excavation in the thick soils near the crest of Chestnut Ridge 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 Disposal Site uranium recovery facility in Wood River Junction, Rhode Island. In addition, Formerly Utilized Sites RA Program 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.

Table 5.1. CERCLA actions in Chestnut Ridge

CERCLA action	Decision document and date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required
Single-project actions			
UNC Disposal Site	ROD: 06/28/91	PCR (DOE/OR/01-1128&D1) approved 09/06/94	Yes/Yes
KHQ	NFA ROD[b] (DOE/OR/02-1398&D2): 09/29/95	RA completed under approved RCRA closure plan	Yes/Yes
FCAP/Upper McCoy Branch	ROD (DOE/OR/02-1410&D3): 02/21/96	RAR (DOE/OR/01-1596&D1) approved 06/03/97	Yes/Yes

[a]Detailed information of the status of ongoing actions is from Appendix E of the *Federal Facility Agreement* (DOE/OR-1014) and is available at <http://www.ucor.com/ettp_ffa_appendices.html>.

[b]*Record of Decision for Kerr Hollow Quarry at the Oak Ridge Y-12 Plant* (DOE/OR/02-1398&D2) defers all LTS requirements to the RCRA post-closure permits.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
FCAP = Filled Coal Ash Pond
KHQ = Kerr Hollow Quarry
LTS = long-term stewardship
NFA = No Further Action
PCR = Post-Completion Report
RA = remedial action
RAR = Remedial Action Report
RCRA = Resource Conservation and Recovery Act
ROD = Record of Decision
UNC = United Nuclear Corporation

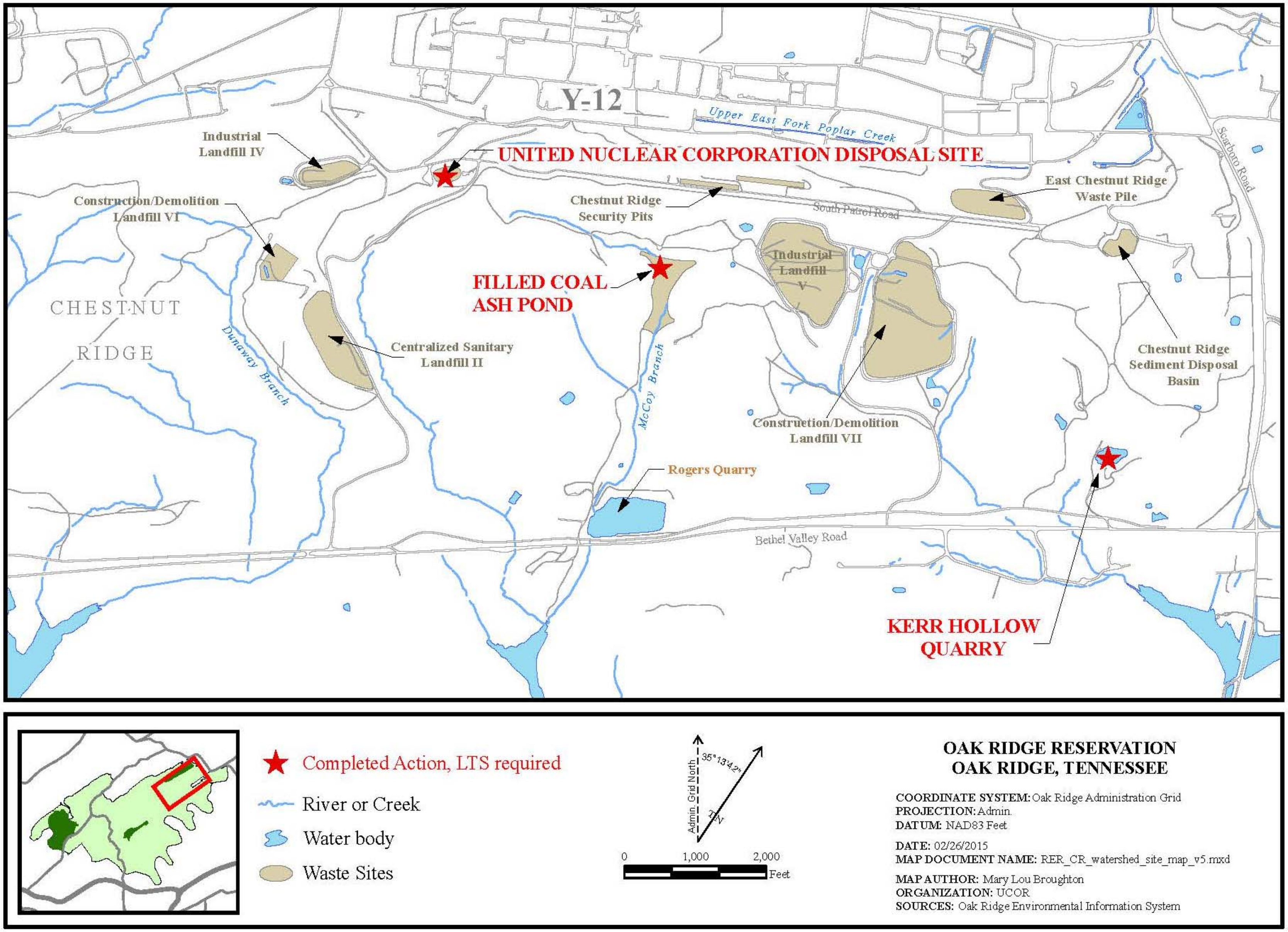


Figure 5.1. CERCLA actions on Chestnut Ridge.

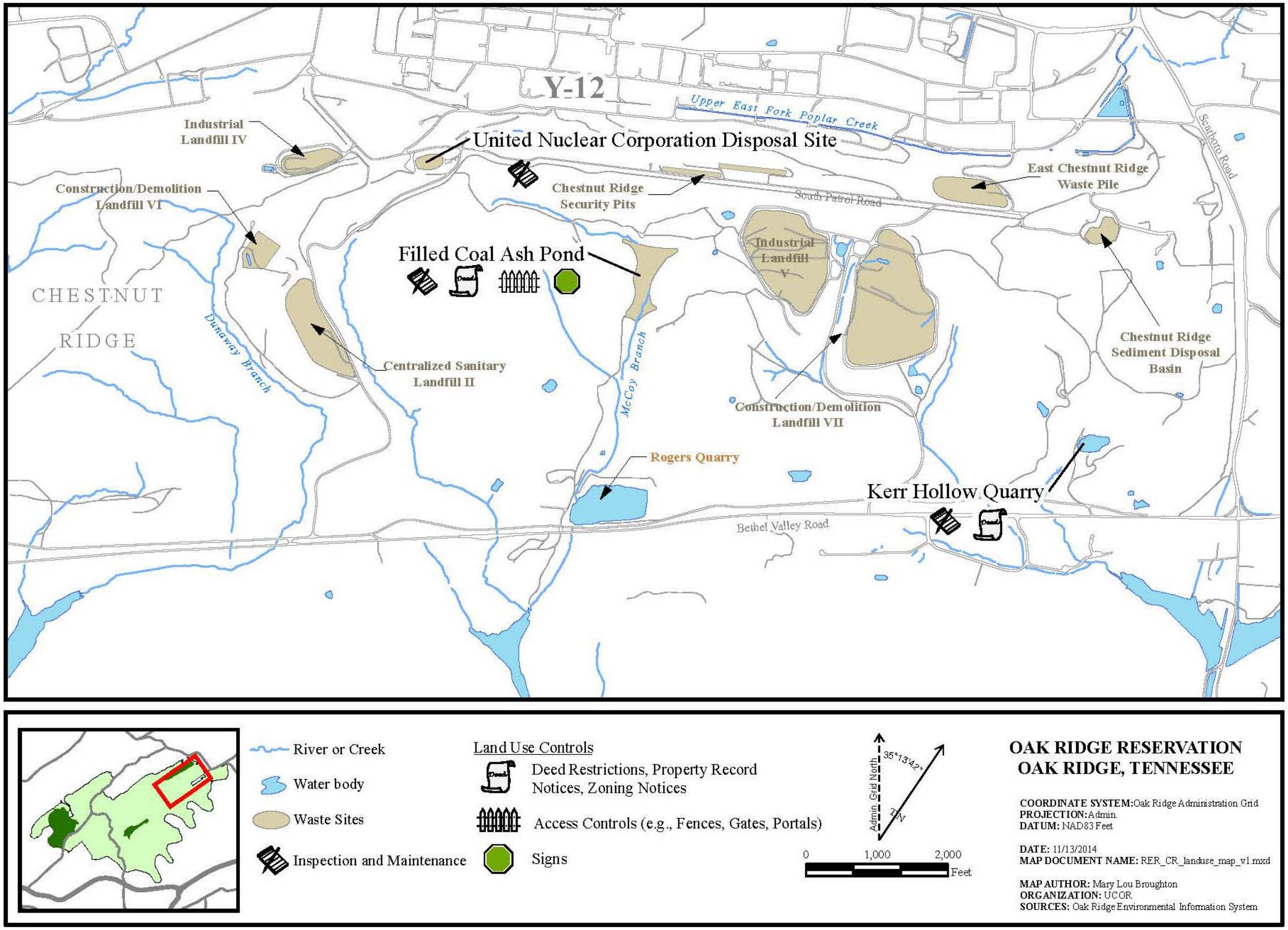


Figure 5.2. Chestnut Ridge interim controls requiring LTS.

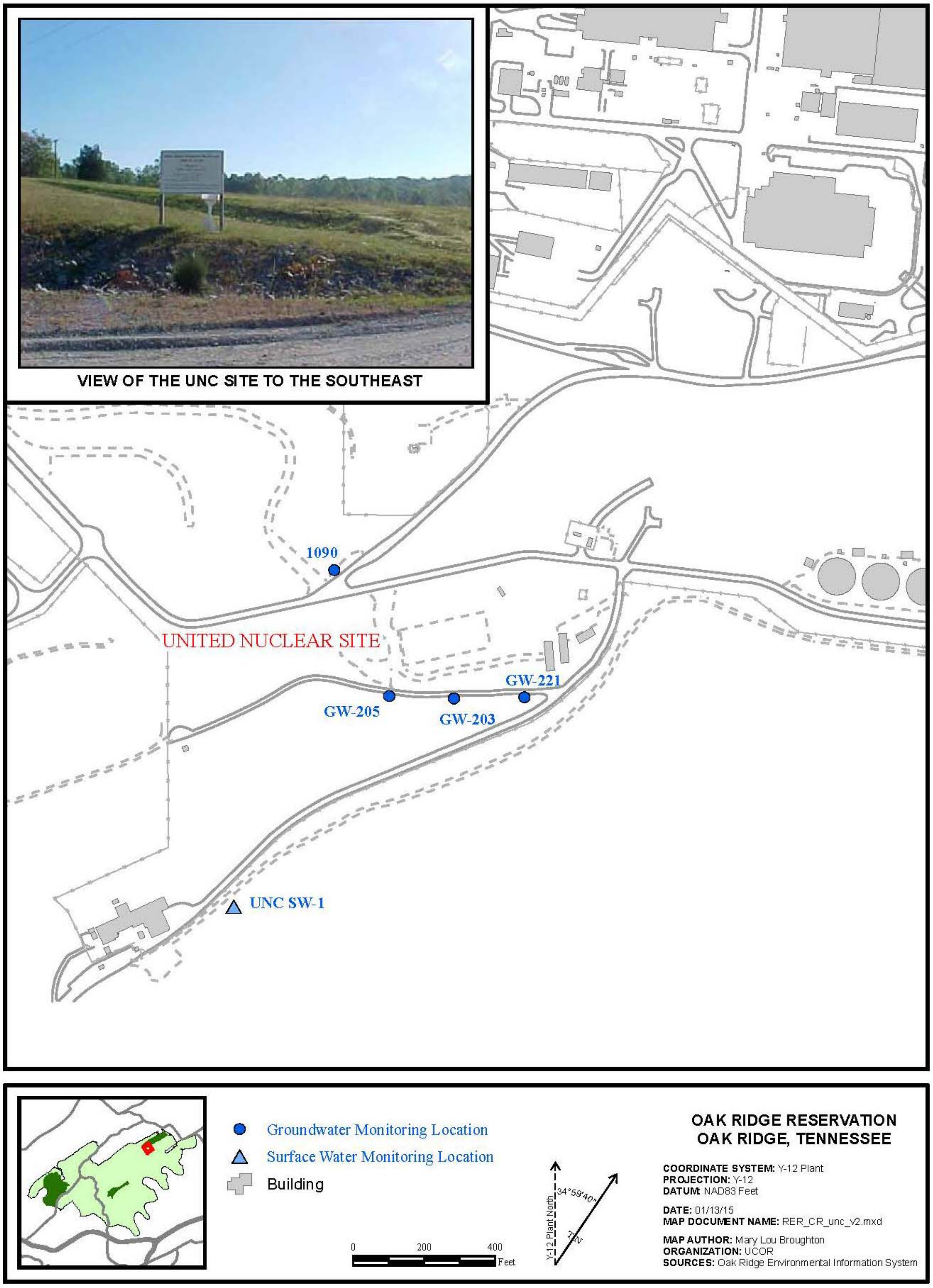


Figure 5.3. UNC Disposal Site.

The major goal of the UNC Disposal Site RA (DOE 1991) 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 *Feasibility Study for the United Nuclear Corporation Disposal Site* (ES/ER-15&D1) 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 expected performance of the remedy in the *Record of Decision United Nuclear Corporation Disposal Site Declaration* (DOE 1991) is to control contaminant migration so that nitrate is less than the MCL of 10 mg/L and no more than 2 pCi/L of ^{90}Sr will occur in groundwater, which is within the CERCLA ELCR risk range of 10^{-4} to 10^{-6}. Further, the groundwater concentration "is not expected to exceed 8 mg/L for nitrate." The *Post-Construction Report for the United Nuclear Corporation Disposal Site* (DOE/OR/01-1128&D1) specifies implementation of a groundwater monitoring program. Although specific frequencies, locations, and analytes are not mandated by the *Post-Construction Report for the United Nuclear Corporation Disposal Site* (DOE/OR/01-1128&D1), groundwater is monitored for contaminants of concern (nitrate and ^{90}Sr) on which performance assessment is based.

5.2.1.2 Evaluation of Performance Monitoring Data

Monitoring at the UNC site consists of semiannual sampling at one upgradient well (well 1090) and three downgradient wells (GW-203, GW-205, and GW-221) and one downgradient surface water location (UNC SW-1) shown on Figure 5.3 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 5.2. Potassium-40 was analyzed in well GW-205 and the UNC SW-1 (Table 5.2).

In FY 2014, 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. Nitrate concentrations in well GW-203 were comparable to those measured in the upgradient well. Nitrate concentrations in the other downgradient wells were below the concentrations in the upgradient well. In FY 2014, ^{90}Sr was not detected in any of the site monitoring locations.

Gross alpha activity was detected in well GW-205 at 2.46 pCi/L in August 2014 but was not detected in any of the other well samples during FY 2014. The alpha activity detected in well GW-205 was well below the MCL of 15 pCi/L. Gross beta activity was measureable in both semiannual samples collected from well GW-205 in FY 2014. The highest measured beta activity was 9.25 pCi/L which remains well below the 50 pCi/L screening level. Gross beta was not detected at any of the other site monitoring locations during FY 2014.

The history of monitoring at well GW-205 started in 1987. In 1998 the well purge method was changed from a standard three-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 ranged between 9.5 and 10.5. The well was aggressively redeveloped in autumn 2010 after which pH levels in the well decreased. During FY 2014, the pH at well GW-205 was 9.13 in March (Quarter 2) and 9.28 in July (Quarter 4), which is within the observed range of fluctuation since well redevelopment.

Table 5.2. Analytical results for performance indicator constituents at the UNC Disposal Site, FY 2014

Date	Upgradient well 1090	Downgradient wells GW-203	GW-205	GW-221	Downgradient spring UNC SW-1
			Nitrate (mg/L)		
Q2-14	0.98	0.98	0.27	0.57	0.045
Q4-14	0.86	0.9	0.33	0.48	0.085
			Gross alpha (pCi/L)		
Q2-14	<3.25 U	<3.26 U	<2.69 U	<2.81 U	<2.3 U
Q4-14	<2.19 U	<1.52 U	2.46	<1.85 U	<2.8 U
			Gross beta (pCi/L)		
Q2-14	<3.68 U	<3.3 U	9.25±1.93	<3.17 U	<2.98 U
Q4-14	<2.84 U	<2.4 U	8.61±1.49	<2.51 U	<3.47 U
			^{90}Sr (pCi/L)		
Q2-14	<2.24 U	<2.38 U	<2.12 U	<1.83 U	<1.87 U
Q4-14	<1.58 U	<2.14 U	<2.14 U	<2.05 U	<1.75 U
			^{40}K (pCi/L)		
Q2-14	-	-	<162 U	-	<203 U
Q4-14	-	-	<147 U	-	<140 U

Bold value indicates gross alpha above the SDWA MCL (15 pCi/L) or gross beta above the 50 pCi/L screening level used to trigger analyses to determine beta emitting radionuclides present in public water supplies (65 FR 76708 – 76753).

FR = Federal Register
FY = fiscal year
GW = groundwater well
MCL = maximum contaminant level
SDWA = Safe Drinking Water Act
U = not detected or result less than minimum detectable activity
UNC = United Nuclear Corporation

Table 5.3 presents the ^{90}Sr analytical results for the four monitoring wells at the UNC Disposal Site. Strontium-90 has been detected sporadically at low concentrations in groundwater adjacent to the UNC Disposal Site. The FY 2006 17.8 pCi/L result from well GW-205 exceeded the SDWA MCL-DC of 8 pCi/L but was below the *Feasibility Study for the United Nuclear Corporation Disposal Site* (ES/ER-15&D1) estimate of a maximum groundwater ^{90}Sr concentration of 50 pCi/L. Strontium-90 was not detected at any of the site monitoring locations during FY 2014.

During FY 2014, 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 levels are below drinking water criteria and are lower than results from site monitoring wells. None of the radiological parameters analyzed were present above detection limits.

5.2.1.3 Performance Summary

Gross beta activity continues to be observed in downgradient well GW-205 although levels have decreased significantly since the well was redeveloped in 2010. The gross beta activity is attributed predominantly to the presence of potassium containing a natural radioactive ^{40}K component. Strontium-90 has been detected intermittently in the well but was not detected in FY 2014. The downgradient spring (UNC SW-1) exhibits data consistent with results from downgradient monitoring wells at the site.

Table 5.3. UNC Disposal Site groundwater ^{90}Sr results[a]

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
Mar-11	<2.3 U	<1.92 U	<1.88 U	<1.99 U
Aug-11	<1.88 U	<1.89 U	3.06 ±0.941	2.34 ± 0.872
Feb-12	<2.17 U	<2.05 U	<2.02 U	<2.13 U
Aug-12	<2.16 U	<2.26 U	7.1	<2.39 U
Feb/Mar-13	<1.92 U	<2.05 U	<1.98 U	<2.15 U
Jul-13	<2.12 U	<2.33 U	<2.16 U	<2.13 U
Feb/Mar-14	<2.24 U	<2.38 U	<2.12 U	<1.83 U
Aug/Sep-14	<1.58 U	<2.14 U	<2.14 U	<2.05 U

[a]All values pCi/L.

Bold value ^{90}Sr exceeds the 8 pCi/L MCL-DC.

GW = groundwater well
J = estimated value
MCL-DC = maximum contaminant level derived concentration
U = reported concentration was below the minimum detectable activity
UNC = United Nuclear Corporation

5.2.2 Other LTS Requirements

Other LTS requirements for Chestnut Ridge are listed in Table 5.4 and described below.

5.2.2.1 Requirements

The *Post-Construction Report for the United Nuclear Corporation Disposal Site* (DOE/OR/01-1128&D1) requires that surveillance activities continue for 30 years from completion of remediation to ensure that the cap adequately contains the waste in the site. 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 includes mowing and replacement of any topsoil and vegetation, as required.

5.2.2.2 Status of Requirements

All components of the UNC Disposal Site were inspected semiannually in FY 2014 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. No maintenance of the site was required in FY 2014 except routine mowing. Additionally, the UNC Disposal Site is located within the Y-12 property protection area and, as such, is not accessible to the public. The area is routinely patrolled by Y-12 security personnel.

5.2.3 UNC Site Issues and Recommendations

There are no recommendations.

Table 5.4. Other LTS Requirements for Chestnut Ridge

Other LTS requirements for Completed Actions in Chestnut Ridge[a]			
Specific Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
UNC Disposal Site	PCR (DOE/OR/01-1128&D1)	• Site inspections will continue for a period of 30 years following this remedial action to ensure that the cap is adequately containing the wastes in the site • Routine maintenance will include mowing of the site and the replacement of any topsoil and vegetation that may have been washed from the site	• Inspect site quarterly during the first two years • Inspect site on semiannual basis after first two years
KHQ	ROD (DOE/OR/02-1398&D2)[b] PCP (TNHW-128)[c]	• Regular inspection and maintenance include the site-security fence, survey benchmarks, and the groundwater monitoring wells • Submit notice to local zoning authority with record of the type, location, and quantity of hazardous wastes disposed • Record a notice in the deed/survey plat	• Inspect site quarterly throughout the postclosure care period • The status of the site under CERCLA will be reviewed every five years • The status of the site will be reviewed as part of the RCRA postclosure permit process at least every 10 years
FCAP	RAR (DOE/OR/01-1596&D1)	• Routine inspections will verify the establishment and health of the wetland plants • Deed restrictions per the ROD filed at the Anderson County courthouse • Ash pond and dam are isolated from the public through ORR institutional controls. The site is restricted by fencing and bar gates. • Site is located in the “No Hunting Safety/Security Zone” between the Y-12 Plant and Bethel Valley Road • Signs placed at bar gate and around pond indicate that this area is restricted and that permission is required before beginning any excavation or construction activities at the site • Adequate inspections and maintenance of the dam, spillway channel, adjacent slopes, settling basin, and wetlands • Inspector will look for evidence of erosion, such as rill or gully development, and slope instability at the dam and adjacent areas. Also check general condition of the vegetative cover on the dam, looking for dead spots, excessive weed growth, or invasion of unwanted species. • The emergency spillway and any drainage control structures will be inspected as part of the general facility inspection. The spillway inlet and outlet, as well as the main channel, will be inspected for blockage, settlement, ponding, unwanted vegetation, erosion, damage to the revetment mattress, and other visible factors that could affect performance. The underdrain and settling basin located at the toe of the dam will be inspected	• Inspections conducted quarterly throughout postremediation care period • Dam and spillway will also be inspected following any rainfall event equivalent to a 25-y, 24-h intensity

Table 5.4. Other LTS Requirements for Chestnut Ridge (cont.)

Other LTS requirements for Completed Actions in Chestnut Ridge[a]			
Specific Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
		for any blockage or impediment to flow. In addition, the settling basin will be inspected for excessive sediment accumulation. The wetlands located down gradient of the settling basin will be monitored for viability of vegetation, and plants will be checked for stability and growth. • The permanent benchmarks will be inspected to determine if they have been damaged. Also, to prevent unauthorized access to the site, the inspector will ensure that the gate at the entrance to the facility is locked and in good condition and that signs restricting unauthorized access are legible and in good condition. During each quarterly inspection, the inspector will also note any evidence of unauthorized access and the need for additional security measures. • Following each inspection, the inspector will complete an inspection checklist, noting any items that require maintenance or repair. Inspection records will be maintained for a minimum of three years from the date of inspection. • Site maintenance will include repair of any damage observed during the site inspection. Any erosion damage will be repaired by restoring the area to its original grade and replacing cover material. Excessive sediment accumulation in the settling basin will be removed, characterized for potential contaminants of concern, and disposed of accordingly. Any blockage or impediment to proper drainage will be removed or repaired. Wetland vegetation will be replaced or replenished, and, if feasible, hydraulic characteristics will be adjusted as necessary to maintain the viability of the wetlands.	

[a]LTS for specific areas is determined by each remediation project and listed in the project specific completion report.
[b]*Record of Decision for Kerr Hollow Quarry at the Oak Ridge Y-12 Plant* (DOE/OR/02-1398&D2) defers all LTS requirements to the RCRA post-closure permits.
[c]*Post-Closure Permit Chestnut Ridge Hydrogeologic Regime U.S. Department of Energy, Y-12 National Security Complex Oak Ridge, Tennessee* (TNHW-128).

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act of 1980
FCAP = Filled Coal Ash Pond
KHQ = Kerr Hollow Quarry
LTS = long-term stewardship
ORR = Oak Ridge Reservation
PCP = Post-Closure Permit
PCR = Post-Completion Report
RAR = Remedial Action Report
RCRA = Resource Conservation and Recovery Act of 1976
ROD = Record of Decision
UNC = United Nuclear Corporation
Y-12 = Y-12 National Security Complex

5.3 KERR HOLLOW QUARRY

5.3.1 Performance Monitoring

5.3.1.1 Performance Monitoring Goals and Objectives

The *Record of Decision for Kerr Hollow Quarry* (DOE/OR/02-1398&D2) (Figure 5.1 and Figure 5.4) presents the decision for No Further Action (NFA) at the site, deferring all monitoring, reporting, and maintenance requirements to the *Post-Closure Permit for the Chestnut Ridge Hydrogeologic Regime* (TNHW-088), as modified. Because the RCRA closure left contaminated material in place, the permit requires monitoring of groundwater. RCRA-required monitoring is described in this section. The *Post-Closure Permit for Chestnut Ridge Hydrogeologic Regime* (TNHW-088) was reissued in September 2006 (TNHW-128), changing monitoring requirements from semiannual to annual beginning in January 2007.

The objective of the RCRA 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 *Record of Decision for Kerr Hollow Quarry* (DOE/OR/02-1398&D2). The *RCRA Post-Closure Permit for Chestnut Ridge Hydrogeologic Regime* (TNHW-128) specifies annual detection monitoring, alternating between seasonally high and low flow conditions, to identify any potential future releases to groundwater. Statistical analysis for groundwater target list compounds is conducted for each annual sampling event. The statistical procedure included in the RCRA Post-Closure Permit (PCP) 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) verification sampling if the results fail the trend analysis. If statistically significant contamination is detected in groundwater 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 *Record of Decision for Kerr Hollow Quarry* (DOE/OR/02-1398&D2) states that monitoring of the surface water discharge point (Outfall 301) from the quarry will be performed as a best management practice. Because the outfall was typically dry, the DOE obtained approval to discontinue monitoring of Outfall 301 at the quarry in 2002.

5.3.1.2 Evaluation of Performance Monitoring Data

During FY 2014, annual groundwater monitoring was conducted in upgradient/background well GW-231 and in downgradient/point-of-compliance (POC) wells GW-143, GW-144, and GW-145 (Figure 5.4) for metals, VOCs, gross alpha, and gross beta. Statistical analyses of target constituents were conducted in accordance with the PCP. Site-specific background values were determined for each inorganic target list constituent using historical data for upgradient wells along Chestnut Ridge 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 2014 with the exception of a detection of carbon tetrachloride from downgradient POC well GW-144 at a concentration of 1.3 µg/L on July 10, 2014. No other VOCs were detected in the sample. The well was redeveloped in accordance with the permit and a verification sample was collected on August 28, 2014. Results of the laboratory analysis showed a slightly higher level of carbon tetrachloride (3.6 µg/L) than evident in July. Again, no other VOCs were detected in the sample.

After allowing sufficient time for full recovery of the water level in well GW-144, confirmation sampling/analysis in accordance with the Chestnut Ridge PCP was conducted on September 29, 2014. Analytical results showed detection of carbon tetrachloride at a concentration of 1.18 µg/L. Again, no other VOCs were detected. Validation of the official laboratory report was completed on October 14, 2014, and a 7-day notification was prepared and sent to the Division of Solid Waste Management of the TDEC, as required by the Chestnut Ridge PCP.

Previous groundwater sampling and analysis results from nearly 30 years of uninterrupted RCRA interim status detection monitoring and RCRA post-closure detection monitoring at Kerr Hollow Quarry (KHQ) show that carbon tetrachloride was detected in 19 of the groundwater samples collected from well GW-144 before July 2014. Sixteen of the detected carbon tetrachloride results, including the historical maximum concentration (6 µg/L in September 1990), were reported for groundwater samples collected during the early and mid-1990s. Sporadic detection of carbon tetrachloride in the groundwater collected from well GW-144 over such an extended period suggests a continued low-level source at KHQ, presumably the dissolution of carbon tetrachloride present in the wastes that remain in the quarry and/or residual in the fractured bedrock or sediment on the quarry floor. The persistent long-term presence of carbon tetrachloride suggests minimal biodegradation in the groundwater and reflects the very slow advective groundwater transport possible under the nearly flat horizontal hydraulic gradient indicated by static water-level elevations in the wells at KHQ.

5.3.1.3 Performance Summary

The July 2014 and subsequent verification and confirmation sampling/analysis results for RCRA POC well GW-144 show carbon tetrachloride concentrations similar to the levels sporadically detected in previous groundwater samples from the well. Although this continues to represent a long-term decreasing trend of carbon tetrachloride at the KHQ, the DOE and UCOR, Operator and Co-operator, respectively, of the unit have proposed to increase monitoring in GW-144 to semiannually for the same VOCs required by the RCRA PCP and to add semiannual monitoring at the downgradient surface-water exit pathway (S17) for the watershed that includes KHQ. These changes in monitoring requirements will continue until four consecutive non-detect samples are obtained from well GW-144.

5.3.2 Other LTS Requirements

5.3.2.1 Requirements

The *Record of Decision for Kerr Hollow Quarry* (DOE/OR/02-1398&D2) does not specify any requirements; however, the *RCRA Post-Closure Permit for Chestnut Ridge Hydrogeologic Regime* (TNHW-128) 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. Final closure certification for the site was February 22, 1995. As a RCRA closure, deed restrictions were required to be filed at the County Register of Deeds Office.

5.3.2.2 Status of Requirements

KHQ was inspected quarterly in FY 2014 by the Y-12 S&M Program for proper signage, integrity of benchmarks and monitoring wells including downhole condition, condition of the fences, gates, and locks, and condition of the access road. Maintenance in FY 2014 included routine mowing, and removing a downed tree across the fence and road.

Additionally, the KHQ is located outside the 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 of Deeds Office and remain in place.

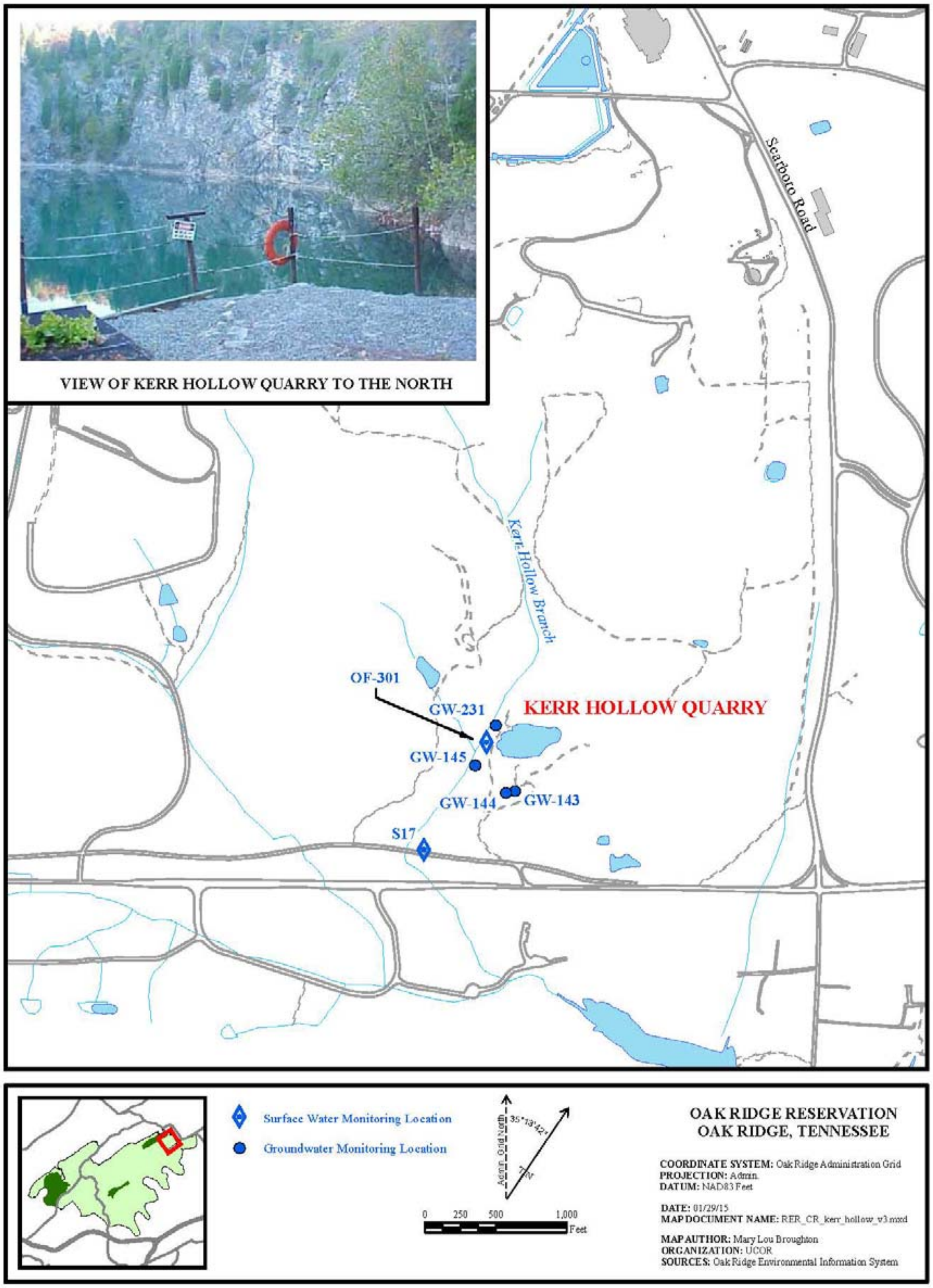


Figure 5.4. KHQ.

5.3.3 KHQ Issues and Recommendations

There are no recommendations.

5.4 FILLED COAL ASH POND/UPPER MCCOY BRANCH

5.4.1 Performance Monitoring

5.4.1.1 Performance Monitoring Goals and Objectives

The Filled Coal Ash Pond (FCAP) is situated south of Y-12 along the southern slope of Chestnut Ridge (Figure 5.1 and Figure 5.5). The scope of the *Record of Decision for Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity)* (DOE/OR/02-1410&D3) was to remediate the FCAP and vicinity. The *Remedial Action Report on Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity)* (DOE/OR/01-1596&D1) documents 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.

The goal of the RA specified in the ROD (DOE/OR/02-1410&D3) 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 (DOE/OR/02-1410&D3) are to:

- *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 *Record of Decision for Chestnut Ridge Operable Unit 2* (DOE/OR/02-1410&D3) 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 *Remedial Action Report on Chestnut Ridge Operable Unit 2* (DOE/OR/01-1596&D1) specifies that surface water samples "be collected and analyzed for the primary contaminants of concern (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 other 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 ARARs for protection of aquatic resources specified in the *Record of Decision for Chestnut Ridge Operable Unit 2* (DOE/OR/02-1410&D3). The *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) identified that the ROD does not specify compliance with AWQC; however, they are used as comparative criteria to track reduction in "contaminant migration to surface water" and "risk to ecological receptors." 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 collected from Rogers Quarry for contaminant analysis on an annual basis.

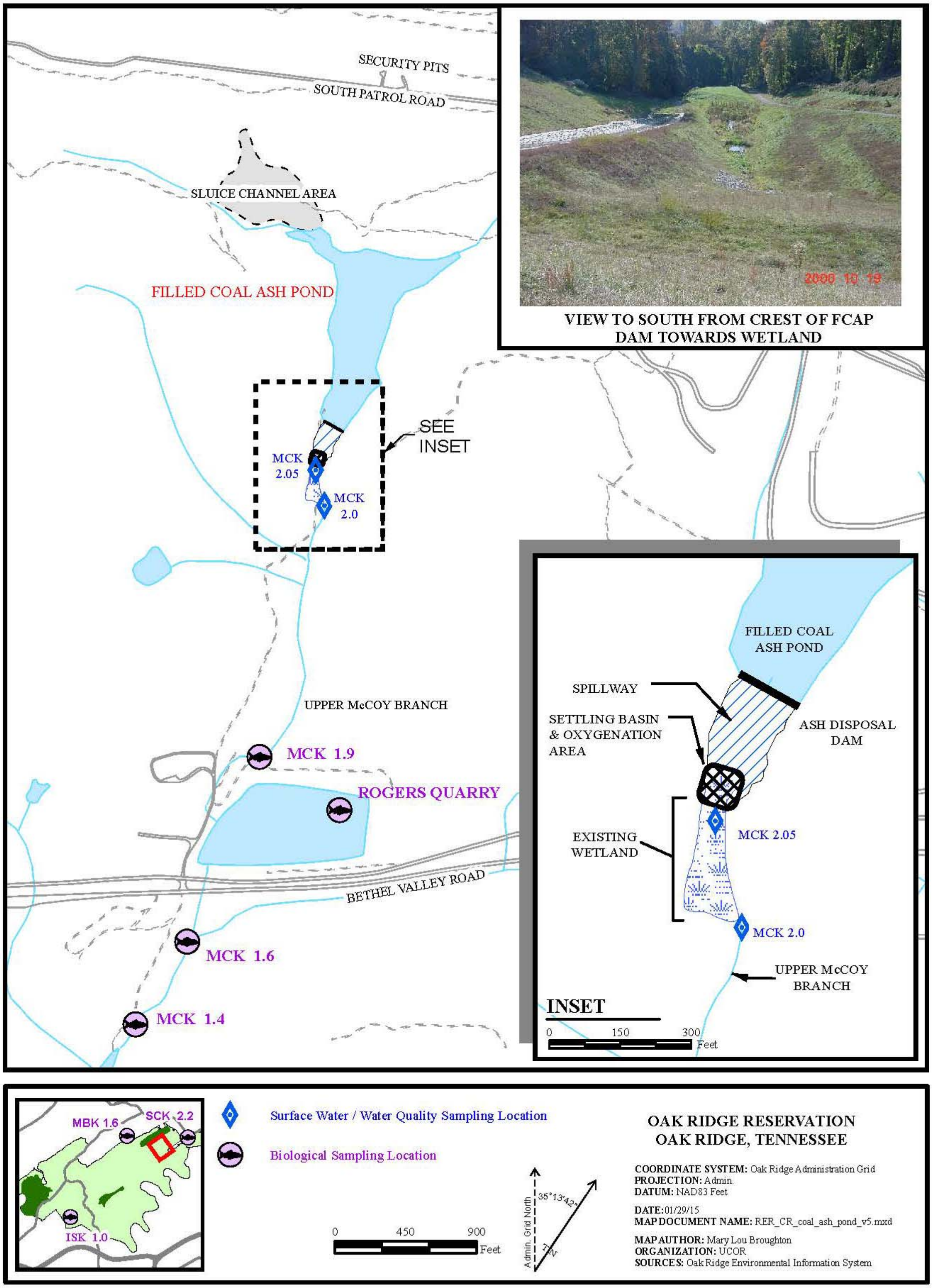


Figure 5.5. FCAP.

5.4.1.2 Evaluation of Performance Monitoring Data

5.4.1.2.1 Surface Water

Monitoring data evaluation for the FCAP RA focuses on reduction of metals between the inlet and outlet sampling locations at the wetland. Data are presented below for the metals arsenic, zinc, aluminum, iron, and manganese. Past monitoring results show that arsenic is the most significant metal present in the site discharge. Iron and manganese are common and abundant metals present in coal ash leachate. These elements form solid metal oxide precipitates when the leachate water comes in contact with free oxygen such as when leachate contacts air or other water rich in dissolved oxygen. AWQC for arsenic and zinc are used as screening criteria for evaluating the performance of the remedy.

Table 5.5 summarizes monitoring data from FY 1996 prior to the RA while Table 5.6 summarizes the FY 2014 monitoring results. The upstream (before flow through the wetland) sampling location is MCK 2.05 and the downstream (after flow through the wetland) is MCK 2.0. For the baseline event the data summary is based on both filtered and unfiltered sample results for which four replicate samples were collected on the same date. During FY 2014, the monitoring results summarize the results from single unfiltered and field-filtered samples collected at the downstream site under wet season (March) and dry season (September) conditions and regular plus duplicate samples collected at the upstream location. The FY 2014 results for zinc show no screening criterion exceedances. Arsenic levels in unfiltered water both upstream and downstream of the wetland exceeded the screening criterion during the dry season sampling event. Arsenic levels exceeded the AWQC in all of the unfiltered samples although the downstream arsenic levels were reduced about 45% from upstream levels. Arsenic exceeded the AWQC level in the filtered aliquot from the upstream location during the dry season sampling event.

Table 5.5. Summary of FCAP pre-remediation monitoring results, FY 1996

Analyte	Units	MCK 2.05[a] (filtered)			MCK 2.05[a] (unfiltered)			MCK 2.0[b] (filtered)			MCK 2.0[b] (unfiltered)		
		Avg	Max	Stdev	Avg	Max	Stdev	Avg	Max	Stdev	Avg	Max	Stdev
Arsenic[c]	mg/L	0.007	**0.011**	0.004	**0.484**	**1.4**	0.623	**0.014**	**0.017**	0.003	**0.572**	**1.2**	0.606
Iron	mg/L	--[d]	0.014	--[d]	20.1	48	23.1	0.091	0.26	0.114	16.7	43	17.7
Manganese	mg/L	0.089	0.17	0.087	1.94	3.8	1.48	0.079	0.15	0.077	13.8	39	17.9
Zinc[e]	mg/L	0.022	0.052	0.022	0.035	0.056	0.023	--[d]	0.009	--[d]	0.072	0.2	0.091

[a]Dam effluent/wetland influent.
[b]Wetland effluent.
[c]AWQC screening criterion for arsenic is 0.01 mg/L.
[d]Value not determined because only one valid result was available.
[e]AWQC screening criterion for zinc is 0.12 mg/L.

Avg = average
AWQC = ambient water quality criteria
FCAP = Filled Coal Ash Pond
FY = fiscal year
Max = maximum
MCK = McCoy Branch kilometer
Stdev = standard deviation

Comparison of the pre-remediation to FY 2014 results for iron and manganese shows that there are much lower concentrations of those constituents entering the wetland recently than there were before site remediation. Comparison of the pre-remediation average unfiltered arsenic concentration to FY 2014 influent (MCK 2.05) unfiltered arsenic maximum concentration shows that although the levels continued to exceed the screening criterion, the levels have diminished by more than 90% compared to the average of pre-remediation values. Although the FY 2014 effluent (MCK 2.0) arsenic unfiltered maximum concentration exceeded the screening criterion, the result was about 98% less than the average pre-remediation concentration. During FY 2014 sampling events, arsenic was detected in both the dry and wet season filtered wetland effluent sample.

Table 5.6. Summary of FY 2014 post-remediation data from MCK 2.05 and 2.0

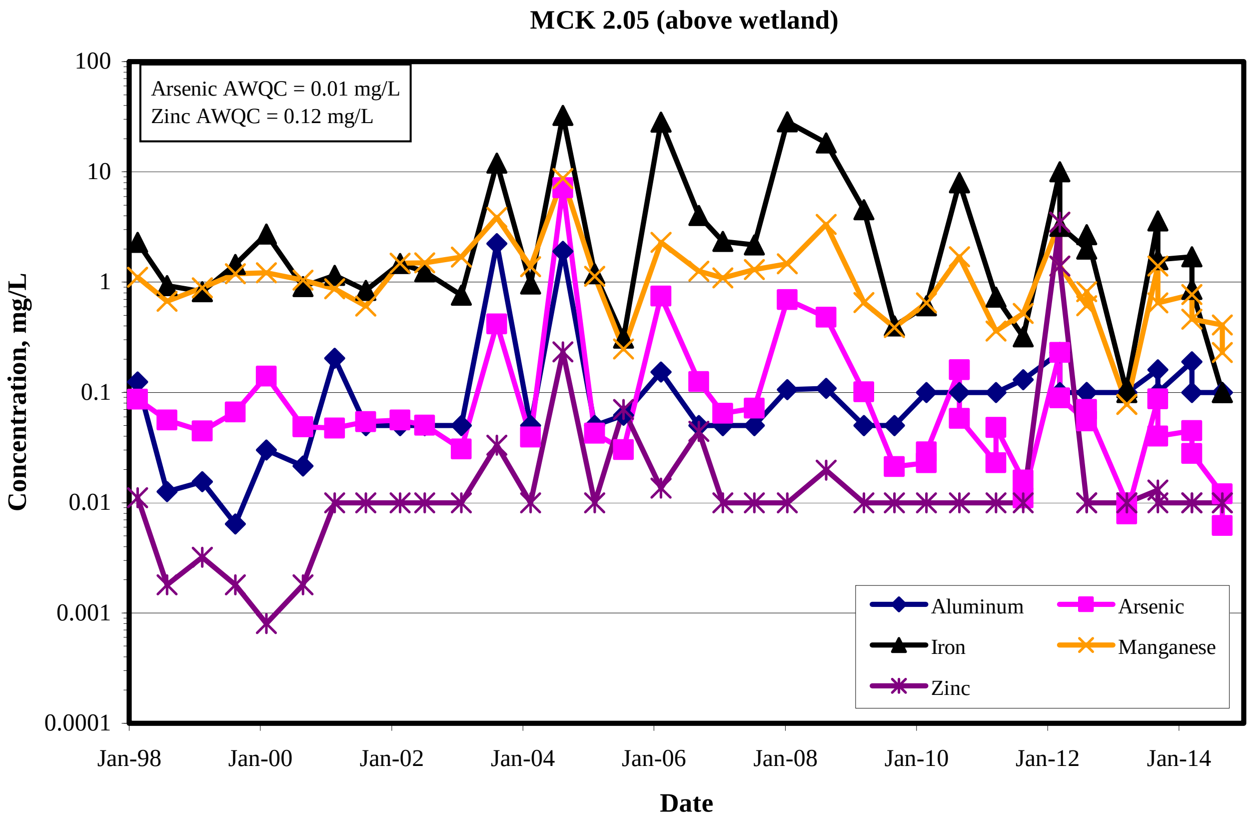
Analyte	Units	Wet-season sample		Dry-season sample		AWQC
		MCK 2.05[a] Mar-18 Unfiltered/Filtered	MCK 2.0[b] Mar-18 Unfiltered/Filtered	MCK 2.05[a] Sep-4 Unfiltered/Filtered	MCK 2.0[b] Sep-4 Unfiltered/Filtered	
Arsenic[c]	mg/L	**0.045** / 0.0093	**0.02 /** 0.0059	**0.029 / 0.012**	**0.013** / 0.0066	0.01[d]
Iron	mg/L	1.7 / <0.1 U	0.74 / <0.1 U	0.94 / <0.1 U	0.16 / <0.1 U	N/A
Manganese	mg/L	0.77 / 0.33	0.53 / <0.005 U	0.41 / 0.28	0.16 / 0.012	N/A
Zinc[e]	mg/L	<0.01 U / <0.01 U	0.011 / <0.01 U	<0.01 U / <0.01 U	<0.01 U / <0.01 U	0.12[f]

[a]Dam effluent/wetland influent.
[b]Wetland effluent.
[c]AWQC screening criterion for arsenic is 0.01 mg/L.
[d]Source: TDEC 0400-40-3-.03(4) recreational criteria - organisms only.
[e]AWQC screening criterion for zinc is 0.12 mg/L.
[f]Source: TDEC 0400-40-3-.03(3) criteria continuous concentration for protection of fish and aquatic life. AWQC for zinc are hardness dependent. The 0.12 mg/L ambient water quality criterion for zinc is based on the most conservative criterion for hardness.

Bold value indicates sample concentration exceeds AWQC.

AWQC = ambient water quality criteria
FY = fiscal year
MCK = McCoy Branch kilometer
N/A = not applicable
TDEC = Tennessee Department of Environment and Conservation
U = not detected

The historic data presented in Figure 5.6 show that elevated measurements in the upstream location (MCK 2.05) are almost ten times higher for iron than observed downstream of the wetland and for arsenic the upstream locations average 15 times higher than downstream. Since FY 2011 field filtered and unfiltered aliquots from both the upstream and downstream sample sites have been analyzed for metals. The arsenic concentrations at the upstream (pre-treatment) site have averaged 0.225 mg/L total and 0.009 mg/L dissolved (n = 13 with 4 non-detect results at 0.005 mg/L in the filtered aliquots). The arsenic concentrations at the downstream (post-treatment) site have averaged 0.015 mg/L total and 0.007 mg/L dissolved (n = 7 with 2 non-detect results at 0.005 mg/L in the filtered aliquots). Based on the sampling for the FY 2011 through FY 2014 period, the passive wetland treatment area reduces total arsenic concentrations by about 93% with associated reductions of dissolved arsenic of about 19%. Over the five year sampling period, approximately 70% of the arsenic is associated with filterable solids at the upstream sample site and approximately 48% is associated with filterable solids at the downstream site.



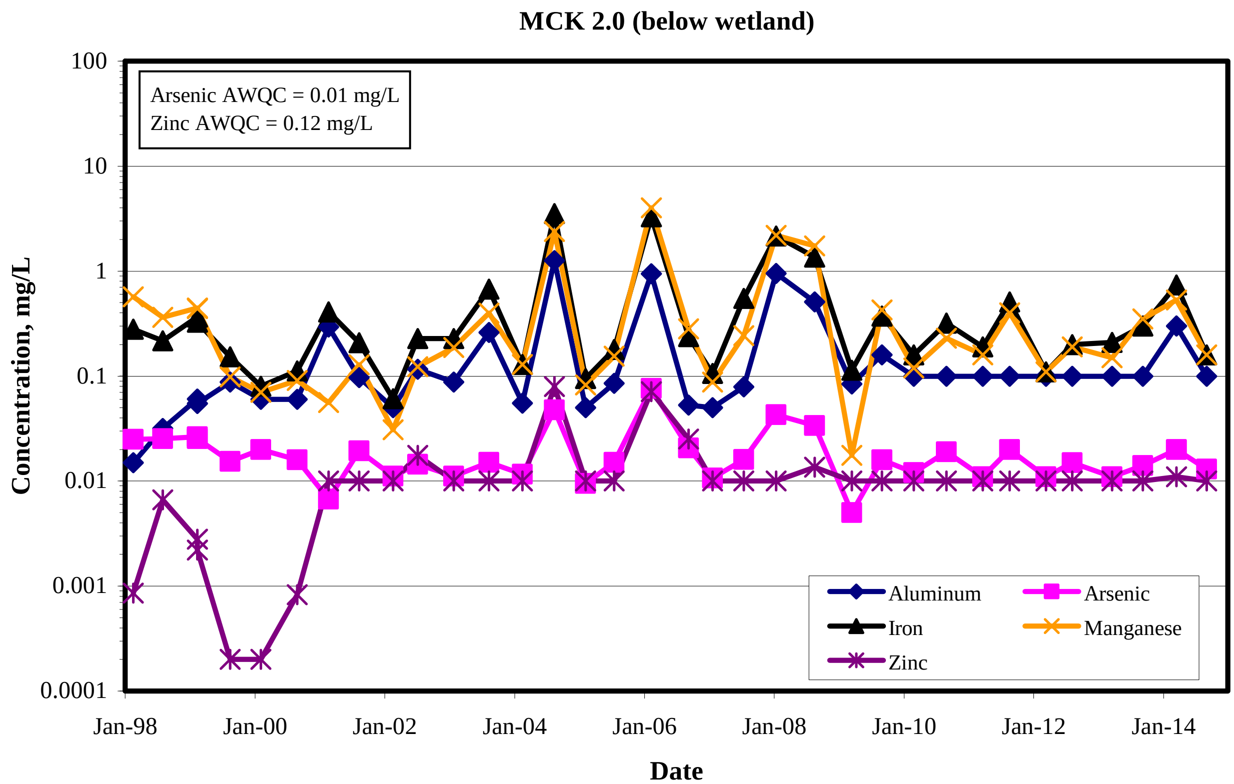


Figure 5.6. Historic data at MCK 2.0 and 2.05 between FY 1998 – FY 2014 (unfiltered samples).

5.4.1.2.2 Biota

Fly-ash disposal from Y-12 into the FCAP, as well as direct disposals of ash into Rogers Quarry (Figure 5.5), 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 were collected from Rogers Quarry and analyzed for concentrations of key contaminants of concern. An evaluation of overall ecological health in the stream was conducted by monitoring the fish and benthic macroinvertebrate communities.

Average mercury and selenium concentrations in largemouth bass collected from Rogers Quarry increased slightly in 2014, but remained in the range of concentrations seen in recent years (1.25 µg/g for selenium and 0.82 µg/g for mercury). Selenium concentrations in this species remain above typical background concentrations (~0.5 µg/g), and mercury concentrations are above EPA's recommended AWQC (0.3 µg/g mercury in fish fillet), suggesting continuing low level inputs from the FCAP (Figure 5.7). Arsenic concentrations continued to be near background levels since 2007 (Figure 5.7).

The species richness (number of species) of the fish community at MCK 1.6 in McCoy Branch has shown a wide range of variation since sampling began in the late 1980s (Figure 5.8). The wide variation at MCK 1.6 may be related to the proximity of the site to Melton Hill Reservoir which serves as a source for many species, including those not expected in a smaller stream, for example threadfin shad (*Dorosoma petenense*). This variation is also influenced by the presence of beaver activity which can sometimes inhibit species migration. The species richness at MCK 1.9 remained stable, where introduction of the western blacknose dace appears to be successful, and the recently introduced creek chub were still present in 2014 samples increasing total richness to three (Figure 5.8). A significant number of creek chub were collected in the fall of 2013 and spring 2014 suggesting that stream conditions may be sufficient for a reproducing population to persist. Both sites were below mean reference stream values for 2014 and had far fewer sensitive species such as darters.

The number of pollution-intolerant benthic macroinvertebrate taxa (EPT taxa richness) continued to show a strong seasonal trend at MCK 1.4, with the highest values consistently occurring in April (Figure 5.9). There continues, however, to be no such strong seasonal trends at MCK 1.9. EPT richness continues to be lower than the reference range at both McCoy Branch sites. Drought conditions may have contributed to a reduction in EPT richness at MCK 1.9 in 2007, and there appears to be some evidence that the drought likely had a negative effect at some reference sites as well. However, EPT richness at reference sites appeared to rebound after 2007, while the rebound at MCK 1.9 appeared to be more limited. Since the drought in 2007, annual rainfalls have generally been near or above normal. The structure of the stream channel and substrate at MCK 1.9 have shown strong evidence of significant scouring, down-cutting, and bank erosion since 2008. This suggests that this site may be negatively affected by periodic strong and rapid changes in stream-flow (i.e., flashy stream flow) during periods of heavy rain. Even with a reduction in the number of pollution-intolerant taxa at MCK 1.9, the site still supports several taxa that are generally intolerant of poor water quality and are typically found predominantly at reference sites (e.g., the stoneflies *Leuctra* and *Tallaperla*). MCK 1.4, on the other hand, generally has higher densities of taxa that typically dominate sites with mildly to moderately poor water quality (e.g., filter-feeding caddisflies and Orthocladiinae midges).

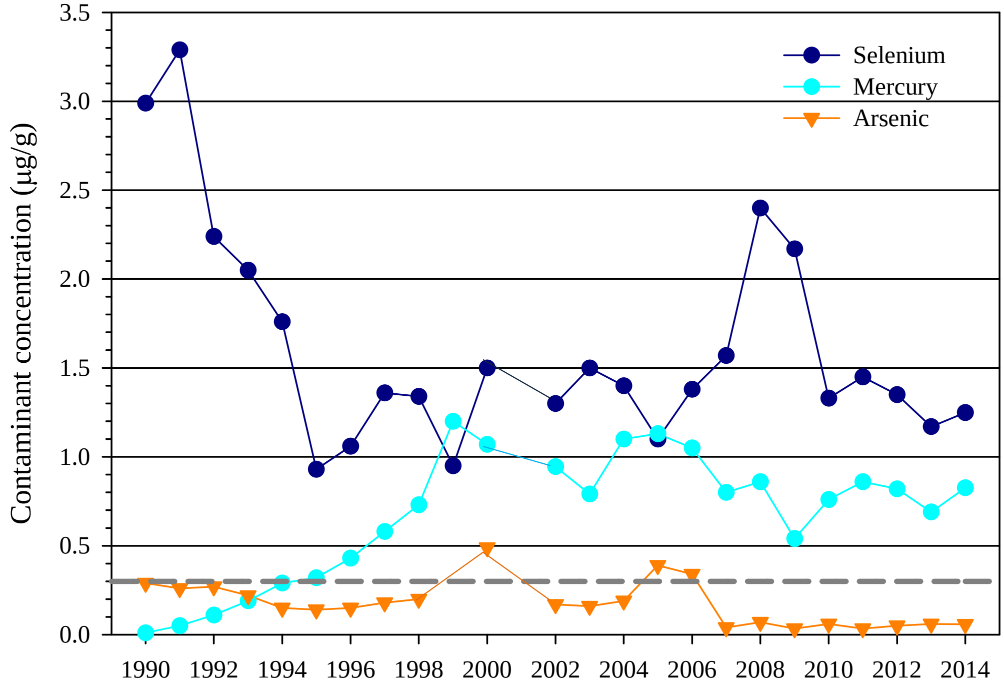


Figure 5.7. Mean concentrations of selenium, mercury, and arsenic in fillets of largemouth bass from Rogers Quarry (1990 – 2014; n=6 fish/yr).

Dashed gray line indicates federal recommended AWQC for mercury in fish fillets (0.3 µg/g).

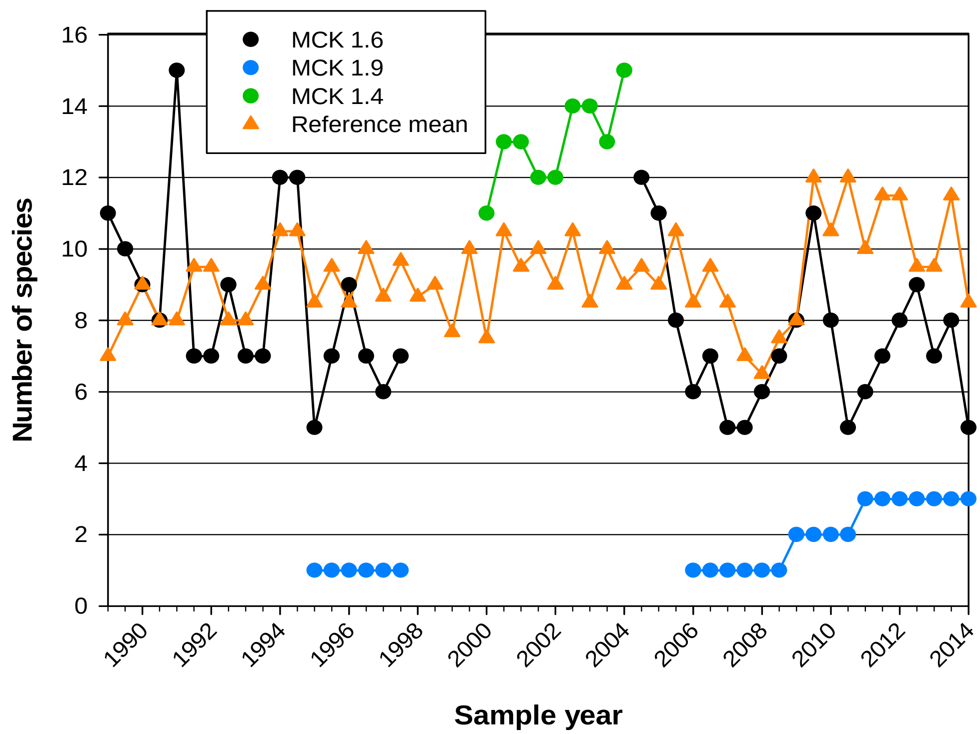


Figure 5.8. Species richness (number of species) in samples of the fish community in McCoy Branch (MCK) and the mean value of two-three reference streams, Scarboro Creek, Mill Creek, and Ish Creek, 1989 – 2014.

See Figure 5.5 for locations of reference sampling sites. Interruptions in data lines for MCK sites indicate no results available for those periods.

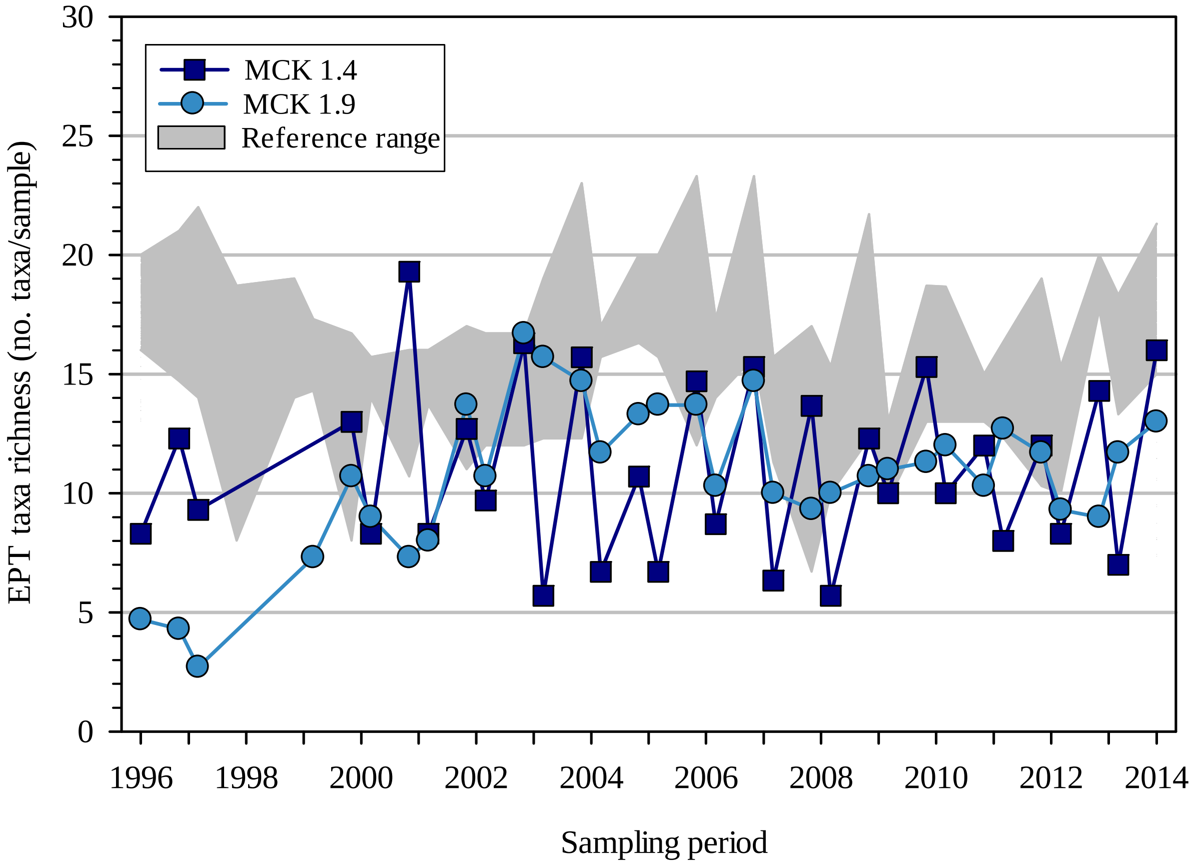


Figure 5.9. Taxonomic richness of pollution-intolerant taxa in the benthic macroinvertebrate community at sites in McCoy Branch, and the range of mean values at reference streams (First Creek, Fifth Creek, Gum Hollow Branch, Mill Branch, Walker Branch, and WOC), 1996 – 2014 (FY 2014).

Each symbol represents the mean of 3 samples for April and October sampling periods beginning with October 1996. Tick marks for the x-axis are centered between results for the April and October sampling periods in a given year.

The gray shading is the range of mean values for reference sites.

5.4.1.3 Performance Summary

The monitoring results since the RA indicate that the remedy is minimizing the migration of contaminants into surface water as it exits the wetland. Although concentrations have decreased significantly since implementation of the RA, total arsenic concentrations generally exceed the screening criteria in both the upgradient and downgradient locations at the FCAP wetland. Based on the sampling for the FY 2011 through FY 2014 period, the passive wetland treatment area reduces total arsenic concentrations by about 93% with associated reductions of dissolved arsenic of about 19%. Arsenic levels in Rogers Quarry fish have been near background. However, selenium and mercury concentrations remain higher in fish relative to typical background concentrations for selenium and relative to federal AWQC guidelines for mercury, suggesting continuing low level inputs from the FCAP. Stream community measures show that McCoy Branch remains below, or at the lower end, of values observed in reference streams.

5.4.2 Other LTS Requirements

5.4.2.1 Requirements

The *Remedial Action Report on Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity)* (DOE/OR/01-1596&D1) 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 dependent on adequate inspection and maintenance of the dam, spillway channel, adjacent slopes, settling basin, and wetlands. Because erosion damage is of great concern, the dam and spillway will also be inspected following any rainfall event equivalent to a 25-y, 24-h intensity.

5.4.2.2 Status of Requirements

All components of the FCAP were inspected quarterly in FY 2014 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. Maintenance in FY 2014 included removing vegetation growing in the spillway, as well as removing a cedar tree growing at the corner of the dam and spillway.

5.4.3 FCAP/Upper McCoy Branch Issues and Recommendations

There are no issues or recommendations.

5.5 CHESTNUT RIDGE ISSUES AND RECOMMENDATIONS

The issues and recommendations for Chestnut Ridge are in Table 5.7.

Table 5.7. Chestnut Ridge issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issue Carried Forward			
None			
Completed/Resolved Issues[b]			
None			

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the 2015 RER. An "Issue Carried Forward" is an issue identified in a previous year's RER for FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.

[b]The year in which the issue originated is provided in parentheses, e.g., (2013 RER).

FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report

5.6 REFERENCES

65 FR 76708 – 76753, *National Primary Drinking Water Regulations; Radionuclides; Final Rule*, December 7, 2000, Environmental Protection Agency.

DOE 1991. *Record of Decision United Nuclear Corporation Disposal Site Declaration, Y-12 Plant, Oak Ridge, Tennessee*, U.S. Department of Energy, Oak Ridge Field Office, Oak Ridge, TN.

DOE/OR/01-1128&D1. *Post-Construction Report for the United Nuclear Corporation Disposal Site at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 1993, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1596&D1. *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*, 1997, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1398&D2. *Record of Decision for Kerr Hollow Quarry at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 1995, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR/02-1410&D3. *Record of Decision for Chestnut Ridge Operable Unit 2 (Filled Coal Ash Pond and Vicinity), Oak Ridge, Tennessee*, 1996, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for the Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

ES/ER-15&D1. *Feasibility Study for the United Nuclear Corporation Disposal Site at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 1991, Y/ER/Sub-90/VK168/3&D1, U.S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

TNHW-088. *Post-Closure Permit for the Chestnut Ridge Hydrogeologic Regime, 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.

TNHW-128. *RCRA Post-Closure Permit for Chestnut Ridge Hydrogeologic Regime, 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.

6. UPPER EAST FORK POPLAR CREEK WATERSHED

6.1 INTRODUCTION AND STATUS

6.1.1 Introduction

The UEFPC watershed contains most of the active facilities and a considerable fraction of the CERCLA facilities and contaminated sites at Y-12. Table 6.1 lists the CERCLA actions within the watershed and identifies those with monitoring or other LTS requirements. Figure 6.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action will be assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Only sites that have LTS requirements (Table 6.1) are included in these performance evaluations. End uses of a site form the basis of RAOs and determine access restrictions and allowable activities at the site. Figure 6.2 shows ROD-designated end uses within the watershed and interim controls requiring LTS.

Completed CERCLA actions in the UEFPC 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 a complete description of background information and performance metrics for each remedy, a compendium of all CERCLA decisions in the watershed within the context of a contaminant release conceptual model is provided in Chapter 7 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

6.1.2 Status Update

<u>Watershed-Scale Actions</u>

In FY 2014, documentation for four completed mercury projects was approved as follows:

- **Mercury Recovery.** The *Removal Action Report for the Mercury Reduction Project at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2595&D1) approved in February 2014 documents the installation of mercury recovery traps at locations upstream of Outfalls 150, 160, 163, and 169. The traps collect elemental mercury and mercury-contaminated sediment. Y-12 personnel remove that mercury and sediment from the traps and other storm drain locations. A decanting facility was installed to separate mercury from co-collected sediment and water. Trapping and removing elemental mercury from the storm drain system will be of benefit by removing some mercury before it reaches UEFPC at Outfall 200. Ongoing collection and disposition of elemental mercury and associated contaminated sediments in the traps and monitoring of the outfalls will continue to be summarized in the annual RER (Section 6.2.1.2.1.2).

Table 6.1. CERCLA actions in UEFPC watershed

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
Watershed-scale actions			
Phase I Interim Source Control Actions	ROD (DOE/OR/01-1951&D3): 05/02/02 NSC: 10/05/06, mercury monitoring NSC: 05/17/07, 9201-5 sumpwater Erratum to the 10/05/06 NSC: 06/09/08, sampling at Outfall 163 NSC: 09/30/09; sumpwater ESD (DOE/OR/01-1539&D2): 08/29/12, updates to selected remedy NSC: submitted 03/14/14; UEFPC monitoring to be managed in RAR CMP	**Actions complete**	
		PCCR for BSWTS for Building 9201-2 (DOE/OR/01-2218&D1) approved 07/01/05	Yes/Yes
		PCCR WEMA storm sewer remediation (DOE/OR/01-2526&D2) approved 08/31/12	Yes/No
Phase II Interim RA for Contaminated Soils and Scrapyard	ROD (DOE/OR/01-2229&D3): 04/21/06	**Actions complete**	
		PCCR for Y-12 Salvage Yard – Scrap Removal (DOE/OR/01-2481& D1) approved 10/11/11	No/No
		PCCR for Y-12 Salvage Yard Soil (DOE/OR/01-2564&D1) approved 11/01/12	No/No
		(DOE/OR/01/-2481&D1/A1) addendum for removal and disposal of five tanks approved 02/11/14	No/No
Single-project actions			
		Actions complete	
Y-12 EEVOC Plume	AM (DOE/OR/01-1819&D2): 06/25/99 NSC: 03/06/13	RmAR (DOE/OR/01-2297&D1) approved 06/07/06 • Erratum to establish monitoring POC: submitted 03/05/13 (no approval required)	Yes/Yes
Union Valley	IROD (DOE/OR/02-1545&D2): 07/10/97	--[c]	No/Yes
Mercury Tanks (Tanks 2100-U, 2101-U, 2104-U)	IROD (DOE/OR/02-1164): 09/26/91	RAR (DOE/OR/01-1169&D1) approved 03/02/94	No/No
Plating Shop Container Areas	ROD (DOE/OR-1049&D3): 09/30/92	NFA	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/ Other LTS required[b]
Abandoned Nitric Acid Pipeline (UEFPC Operable Unit 2)	ROD (DOE/OR/02-1265&D2): 09/12/94	NFA	No/No
Building 9201-4 Exterior Process Piping	AM (DOE/OR/02-1571&D2): 04/22/97	RmAR (DOE/OR/02-1650&D1) approved 09/30/99	No/No
Lead Source Removal of Former YS-860, Firing Range Removal Action	AM (DOE/OR/02-1622&D1): 03/10/98	RmAR (DOE/OR/01-1774&D2) approved 02/24/99	No/No
9822 Sediment Basin and 81-10 Sump Removal Action	AM (DOE/OR/01-1716&D2): 06/19/98	RmAR (DOE/OR/01-1763&D2) approved 02/24/99	No/No
Removal of Mercury from Storm Sewer System	Time-critical AM (DOE/OR/01-2574&D1): 07/19/12	RmAR for Mercury Reduction Project (DOE/OR/01-2595&D1) approved 02/11/14	No/Yes
		Actions in progress	
Removal of Debris and Soil from the Haul Road Ravine Disposal Area	Time-Critical AM (DOE/OR/01-2662&D1): 10/06/14	RmAR in progress	TBD[d]
Demolition Projects			
		Actions complete	
Removal of legacy materials from Buildings 9201-5 and 9204-4	Time critical AM (DOE/OR/01-2404&D1): 05/04/09 Addendum (DOE/OR/01-2404&D1/A1): 10/03/11	RmAR (DOE/OR/01-2519&D2) approved 02/27/12	No/No
Demolition of Buildings 9735 and 9206 filterhouse	Time critical AM (DOE/OR/01-2405&D1): 05/04/09	RmAR (DOE/OR/01-2502&D1) approved 02/15/12	No/No
Demolition of Buildings 9211, 9220, 9224, and 9769 (Biology Complex)	Time critical AM (DOE/OR/01-2406&D1): 05/04/09	RmAR (DOE/OR/01-2508&D2) approved 02/13/12	No/No
Y-12 Facilities D&D	AM (DOE/OR/01-2462&D2): 09/29/10	Project Completion Report (Beta-3 Legacy Material) (DOE/OR/01-2570&D1) approved 11/05/12	No/No
		RmAR Just In Case Yard (DOE/OR/01-2532&D1) approved 11/05/12	No/No
		PCCR for Secondary Pathways Project (DOE/OR/01-2596&D1) approved 02/11/14	No/Yes

Table 6.1 CERCLA actions in UEFPC watershed (cont.)

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required[b]
		PCCR for Building 9206 Duct and Fan Removal (DOE/OR/01-2613&D1) approved 07/21/14	No/No

[a]Detailed information of the status of ongoing actions is from Appendix E of the *Federal Facility Agreement* (DOE/OR-1014) and is available at <http://www.ucor.com/ettp_ffa_appendices.html>.

[b]"No/No" indicates no monitoring/other LTS requirements are identified in the CERCLA action completion document beyond those identified in the watershed RODs. Refer to Table 6.2 for watershed-scale monitoring requirements and Figure 6.2 and Table 6.6 for watershed-scale LUCs and other LTS requirements.

[c]This action was completed prior to uniform adherence to the RAR process; hence, no RAR exists for this decision.

[d]The completion document was not approved during the FY 2014 reporting period.

AM = Action Memorandum
BSWTS = Big Spring Water Treatment System
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMP = Comprehensive Monitoring Plan
D&D = decommissioning & demolition
ESD = Explanation of Significant Differences
EEVOC = East End Volatile Organic Compound
FY = fiscal year
IROD = Interim Record of Decision
LTS = long-term stewardship
LUC = land use control
NFA = No Further Action
NSC = Non-Significant Change
PCCR = Phased Construction Completion Report
POC = point of compliance
RA = remedial action
RAR = Remedial Action Report
RmAR = Removal Action Report
ROD = Record of Decision
TBD = to be determined
UEFPC = Upper East Fork Poplar Creek
WEMA = West End Mercury Area
Y-12 = Y-12 National Security Complex

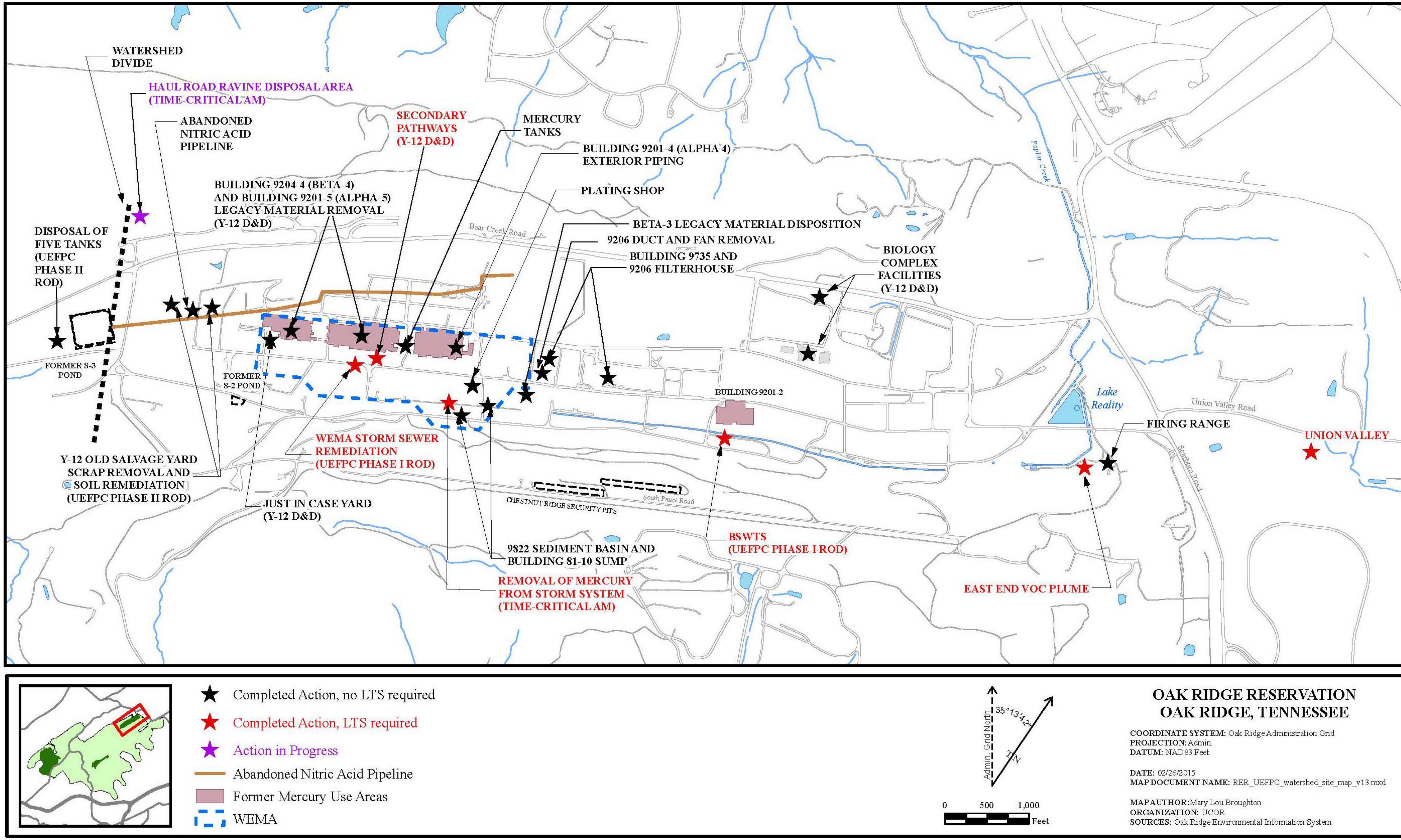


Figure 6.1. UEFPC watershed.

This page intentionally left blank.

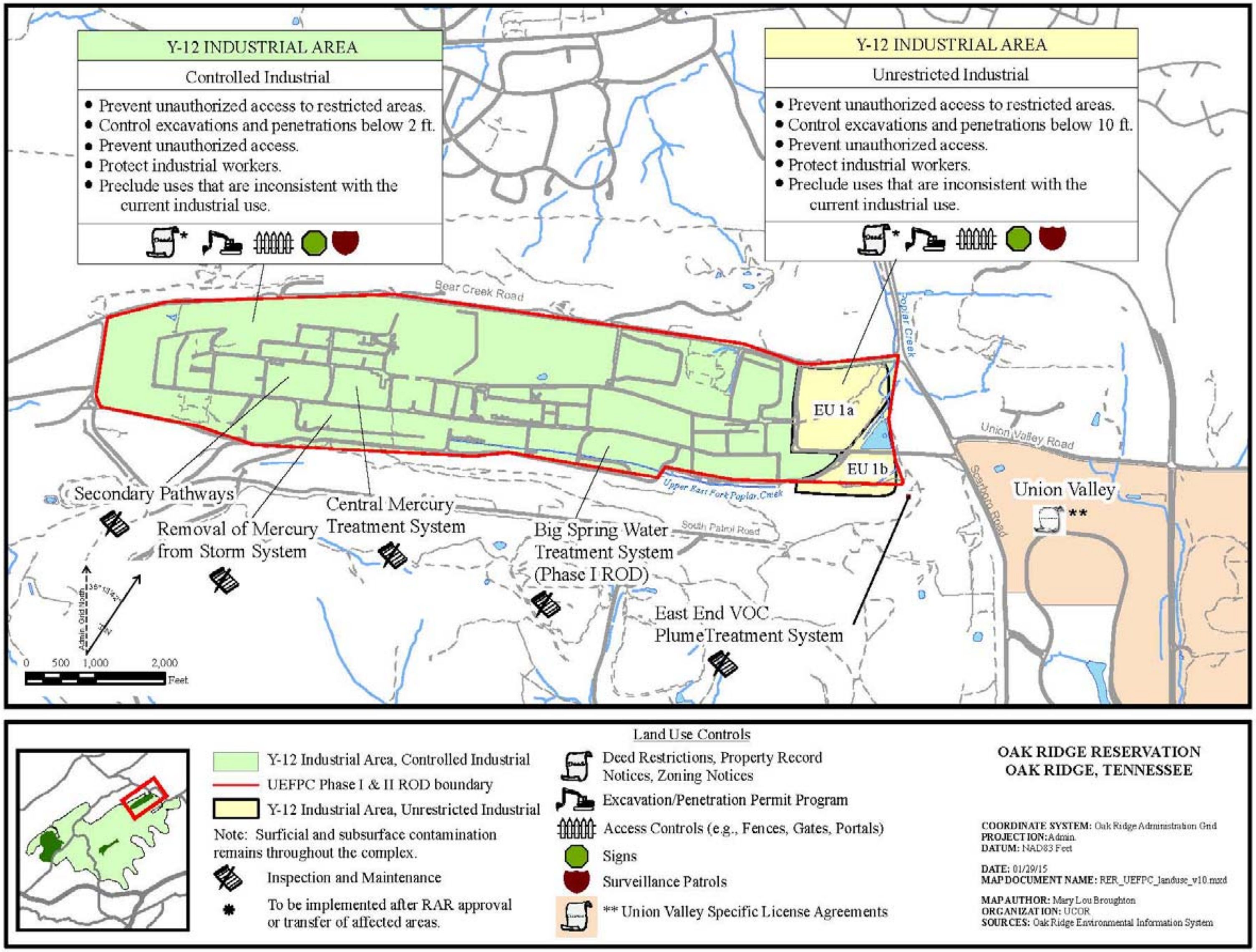


Figure 6.2. UEFPC Phase I and II ROD-designated end use and interim controls requiring LTS.

- **Mercury Soils Treatability Study.** A *Treatability Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge, Tennessee* (UCOR-4323) completed in FY 2013 was approved in February 2014. The report details the results of treatability studies conducted under the UEFPC Phase I ROD and provides treatment and disposal options for mercury contaminated soils.
- **Secondary Pathways.** Actions to reduce or eliminate secondary mercury infiltration around Alpha 4 (9201-4) and Alpha 5 (9201-5), and identification and confirmation of open drains inside Alpha 5 and Beta 4 (9204-4) were completed in FY 2013. The actions are documented in the *Phased Construction Completion Report for the Secondary Pathways Complex, Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2596&D1) approved in February 2014. The PCCR identified no monitoring requirements; however the status of other LTS requirements specified in the PCCR is reported in Section 6.2.2.
- **Disposal of Five Tanks.** A tank removal project to characterize and dispose of five tanks used for mercury-related activities at Y-12 that were removed from service in the 1980s was completed in FY 2013 under the UEFPC Phase II ROD. The tank removal project is documented in the *Addendum to the Phased Construction Completion Report for Scrap Metal Removal at the Y-12 Old Salvage Yard, Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2481&D1/A1) approved in February 2014. No monitoring or other LTS requirements are specified in the report.

A revised *Strategic Plan for Mercury Remediation at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2605&D2) incorporating regulator comments and suggestions was submitted in FY 2014. A phased, adaptive management approach is proposed to first address mercury contamination in surface water. A key component is construction of a water treatment facility, Outfall 200 Mercury Treatment Facility (MTF), that will help to further reduce the amount of mercury entering UEFPC. Other actions proposed in the plan will advance cleanup of mercury in the site and in the creek, including diversion of water sources to avert contact with contaminated soils and sediments, technology development efforts, and mercury source removal through building demolition and soil remediation.

- **Outfall 200 MTF Conceptual Design.** *A Remedial Design Work Plan for the Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2599&D2), which includes a conceptual design report for the Outfall 200 MTF, was submitted to the regulators in April 2014. The *Focused Feasibility Study for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-2660&D1) and *Proposed Plan for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-2661&D1) were submitted to the regulators in August 2014. These documents support a planned modification of the UEFPC Phase I ROD to include the Outfall 200 MTF and other supplemental mercury abatement actions. Also in FY 2014, work progressed in areas of further study to identify information and data that are needed for the Outfall 200 MTF preliminary and final design (Figure 6.3).

Figure 6.3. Sampling equipment at Outfall 200.

<u>Single-Project Actions</u>

Time-critical Removal Action for Haul Road Ravine Disposal Area. A haul road construction project was underway in FY 2014 to support construction of the Uranium Processing Facility at Y-12. During haul road excavation, uncontaminated debris, radioactive debris, and mercury-contaminated debris were encountered in an area at the western end of Y-12 just northeast of the Bear Creek Road-Old Bear Creek Road intersection. EPA and TDEC were notified and work and waste management were re-evaluated.

The FFA parties agreed that the removal of contaminated debris from the road corridor and subsequent treatment and disposal would be conducted pursuant to a time critical action memorandum (Figure 6.4). The *Action Memorandum for Time-Critical Removal Action for the Removal of Debris and Soil from the Haul Road Ravine Disposal Area, at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2662&D1) was approved in October 2014. Uncontaminated debris was disposed at the ORR landfill; radioactively contaminated debris was disposed at Nevada National Security Site (NNSS); and mercury contaminated debris was treated and disposed at Energy Solutions – Utah. Preparation of a RmAR to document completion of the action is planned for FY 2015.

Figure 6.4. Excavated haul road debris.

Demolition Projects

Building 9206 Duct and Fan Removal. Removal of two deteriorated and radiologically contaminated fans and duct systems located on the roof of Building 9206 was completed in FY 2013 and waste disposition was completed in November 2013. The *Phased Construction Completion Report for Non-Time Critical Removal Action Building 9206 Duct and Fan Removal at the Y-12 National Security Complex Oak Ridge*, *Tennessee* (DOE/OR/01-2613&D1) was approved in July 2014. No monitoring or other LTS requirements are specified in the report.

6.2 PHASE I INTERIM SOURCE CONTROL ACTIONS IN THE UEFPC CHARACTERIZATION AREA

The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) addresses principal threat source material control remedies designed to reduce mercury loading within UEFPC. The RAO for the selected remedy is to restore surface water to human health recreational risk-based values at Station 17. Principal components of the decision include:

- hydraulic isolation (e.g., capping contaminated soils) of the West End Mercury Area (WEMA)[1];
- removal of contaminated sediments in storm sewers, UEFPC, and Lake Reality;
- treatment of discharge from Outfall 51 (including a large-volume spring) and Building 9201-2 sumps;
- temporary water treatment using existing facilities East End Mercury Treatment System 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 Building 9201-2 sumps. Mercury contaminated water was rerouted from Building 9201-2 sumps and the East End Mercury Treatment System to the BSWTS in December 2006. The East End Mercury Treatment System and Outfall 550 are no longer in operation.

6.2.1 Performance Monitoring

6.2.1.1 Performance Monitoring Goals and Objectives

Performance measures and monitoring requirements for watershed-scale and single-project actions in UEFPC are summarized in Table 6.2, and monitoring locations are shown in Figure 6.5.

6.2.1.2 Evaluation of Performance Monitoring Data

6.2.1.2.1 Surface Water

6.2.1.2.1.1 Surface Water Quality Goals and Monitoring Requirements

The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) includes a 200 ppt performance metric for mercury in surface water at the UEFPC integration point (Station 17) based on an adult recreator consuming only fish. Surface water monitoring at Station 17, including analysis for uranium and zinc, is conducted to

[1]Capping of contaminated soils in the West End Mercury Area (WEMA) was never implemented. An *Explanation of Significant Differences for 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/01-2539&D2) was approved in August 2012 to remove the action from the selected remedy in the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3).

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 East Fork kilometer (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.

In November 2011 the TDEC issued a new NPDES Permit applicable to the Y-12 site. In that permit the state of Tennessee included a target average mercury concentration of 87.5 ng/L and a median annual daily mercury load of 2.42 g/d in water at Station 17 that was expected to allow mercury in fish tissue to decrease to the EPA-recommended AWQC (0.3 µg/g mercury in fish). This target mercury concentration in surface water at Station 17 is significantly less than the 200 ng/L goal set in the approved *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3). The 2011 Permit also included requirements for the DOE to perform several activities that were deemed appropriate to reduce the site mercury discharges to the permit-specified level. Some of the activities required by the permit were consistent with modification of actions required in previous permits (e.g. modification of location and amount of supplemental flows to the creek) while others were enforcement of CERCLA actions. In November 2011 the DOE filed an appeal to remove the performance of CERCLA actions, most of which were already subject to implementation under the EM Program under the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014). DOE and TDEC continue to negotiate over a potential settlement of the permit appeal.

Table 6.2. Performance measures for UEFPC watershed

Site	ROD goal	Performance standard	Monitoring location	Schedule and parameters
		Watershed-scale actions (Section 6.2)		
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 Uranium or Zinc 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
East End Mercury Treatment System no longer operational	Treatment of effluents from Building 9201-2 sumps was tied-in to BSWTS December 2006	200 ppt mercury	Outfall 550 flow piped to the BSWTS in December 2006	Discontinued

Table 6.2. Performance measures for UEFPC watershed (cont.)

Site	ROD goal	Performance standard	Monitoring location	Schedule and parameters
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.
		Single – Project actions (Section 6.3.1)		
EEVOC Plume	Reduce risk from exposure in off-site areas and mitigate off-site migration of contamination.	No specific numeric performance standards established System performance: trend VOC concentrations downgradient of extraction well Treatment system discharge at downstream POC (LRBP-1) must not exceed AWQC recreational (for organism only) 16 µg/L carbon tetrachloride	Treatment system influent and effluent and LRBP-1 GW-722, GW-169 and GW-170	Quarterly grab samples of system influent/effluent for metals, VOCs, nitrate, and uranium Quarterly grab samples at LRBP-1 for VOCs Semiannual grab samples of downgradient wells for VOCs

[a]Baseline monitoring re-instated FY 2010.

AWQC = ambient water quality criteria
BSWTS = Big Spring Water Treatment System
CMTS = Central Mercury Treatment System
EEVOC = East End Volatile Organic Compound
FY = fiscal year
GW = groundwater well
LRBP = Lake Reality By-Pass
POC = point of compliance
ROD = Record of Decision
UEFPC = Upper East Fork Poplar Creek
VOCs = volatile organic compounds
WEMA = West End Mercury Area
WTS = Water Treatment System

This page intentionally left blank.

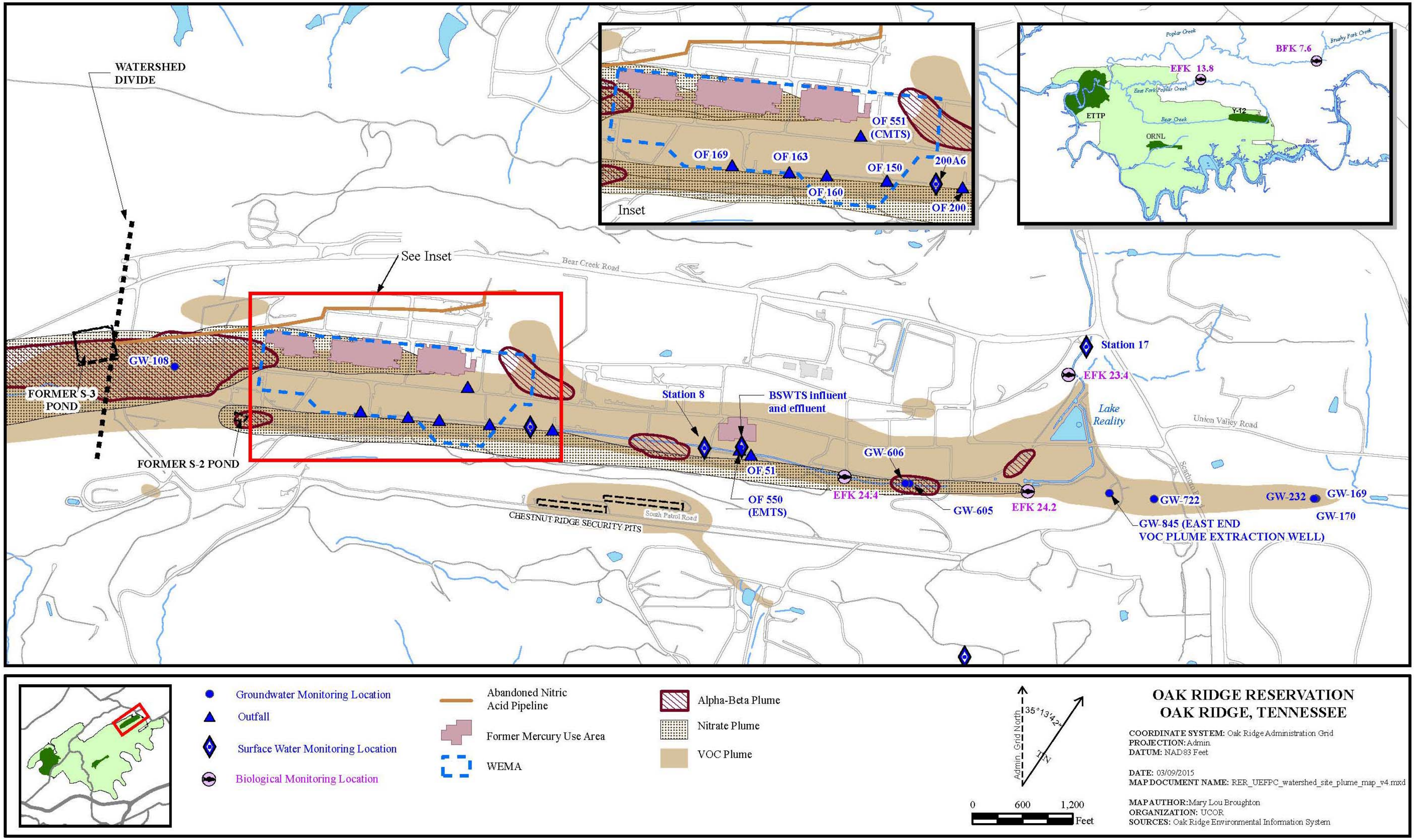


Figure 6.5. Monitoring locations in UEFPC watershed.

This page intentionally left blank.

6.2.1.2.1.2 Surface Water Monitoring Results

Mercury Treatment and Capture Systems Performance

DOE operates two mercury wastewater treatment systems in the UEFPC watershed (CMTS or Outfall 551) and BSWTS. Locations of these systems are shown on Figure 6.5. In addition to treatment of mercury in contaminated water, elemental mercury is captured from locations in the storm drain network in the WEMA. The collection of elemental mercury is an important activity in managing principal threat waste in the environment.

Continued monitoring of effluent from the CMTS, which treats building sump discharges from the WEMA, is specified in the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) pending demonstration of the effectiveness of actions (e.g., hydraulic controls, storm sewer relining/replacement).

The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) states that the mercury limit for the 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 2014 was 2,595,595 gal. During FY 2014, none of the effluent samples exceeded the 200 ppt UEFPC goal for total mercury in surface water, and the total mercury discharge was less than 2 mg. Because of a 2005 accidental introduction of methanol from a leaking Alpha 5 cooling (brine) system that interfered with mercury treatment, a *Non-Significant Change to the Record of Decision for Phase 1 Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3/R2) was approved in May 2007 so that the CMTS no longer receives water from sump pumps located in the basement of Building 9201-5. The CMTS continues treatment of Building 9201-4 sump water (a much larger source of mercury). The CMTS experienced no downtime during FY 2014.

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 seeps into the subsurface storm drains through cracks and open joints. Once in the storm drains, the mercury accumulates in low points and moves with the current of storm water. An estimated 3 kg (6.5 lb) of elemental mercury was removed from storm drains during FY 2014 by using a suction pump to remove visible mercury from manholes.

The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) states that approximately 25% of the mercury discharged from the site via the UEFPC originated from Outfall 51. The ROD further stipulated construction of a mercury water treatment system with a 300 gpm capacity and an effluent mercury concentration limit of 200 ppt. The main source of flow at Outfall 51 was Big Spring, located near the southeast corner of Building 9201-2. Mercury contamination within shallow groundwater beneath and adjacent to Building 9201-2 discharges at this spring. The source area extent that feeds Big Spring is not well understood and much of the flow and contamination is thought to originate from source areas to the west in the WEMA. At the time of Building 9201-2 construction in 1943 the spring discharge was captured within a brick enclosure (spring box) and directed to UEFPC via a drainpipe. In the latter part of FY 2005, Big Spring flow was routed to the new BSWTS during test and start-up operations. As a result, the flow at Outfall 51 decreased significantly. 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 *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) specifies a 0.2 µg/L (200 ppt) goal for mercury in BSWTS effluent. Outfall 51 and BSWTS effluent are separate monitoring locations. The BSWTS influent is grab sampled on a monthly frequency inside the treatment facility upstream of any treatment processes. BSWTS effluent is sampled using a continuous, flow-paced autosampler to obtain representative samples of the total effluent on a 7-day integration basis. At Outfall 51 flow rate is monitored continuously and under baseflow conditions grab samples are collected monthly from the end of pipe. During prolonged rainy periods, often observed in winter, when the Outfall 51 flow rate is greater than 60 gpm, grab samples are collected on a weekly frequency from end of pipe to provide more data for mercury mass discharge from this area.

Figure 6.6 provides a comparison of mercury concentrations at Outfall 51 and the BSWTS effluent. During FY 2014, the average BSWTS influent concentration was about 4.2 µg/L. In FY 2014, the BSWTS treated approximately 377,555 m^3 (99 million gal) of contaminated water. 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 2014 was 0.026 µg/L, which is nearly an order of magnitude less than the 0.2 µg/L goal specified in the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3). Although one of the weekly composite samples exceeded the 0.2 µg/L effluent goal during FY 2014, the result is thought to be a result of either a sampling or laboratory problem since operational monitoring during the same week revealed no elevated mercury concentrations downstream of the carbon treatment media. The FY 2014 total mercury flux discharged in the treated BSWTS effluent was approximately 6.4 g. Based on comparison of the average influent and effluent mercury concentrations for FY 2014, the treatment effectiveness was 98% inclusive of the one outlier datapoint.

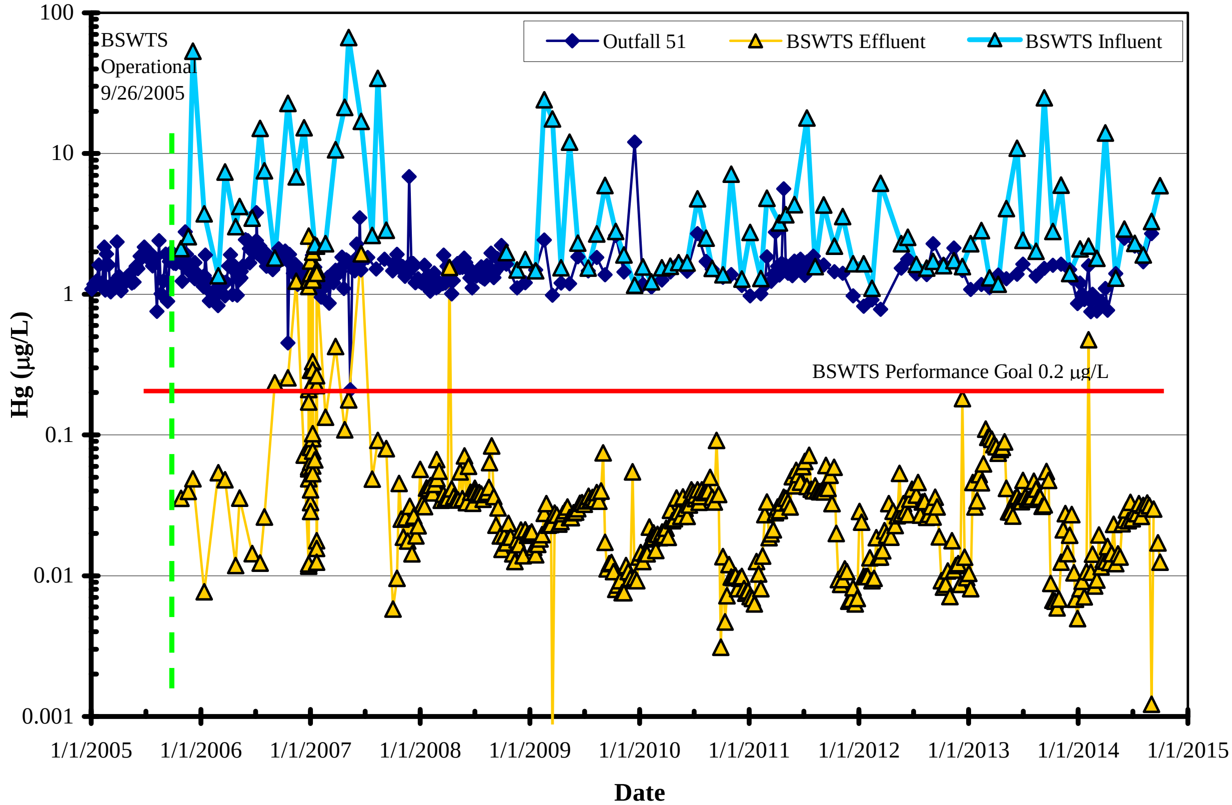


Figure 6.6. Mercury concentrations at Outfall 51 and BSWTS.

Since the BSWTS was designed to operate at a maxi6mum capacity of 300 gpm, there are times during prolonged rainy periods when the system receives more inflow volume than can be treated. At those times there is treatment system bypass flow. Although such conditions can occur in any season, the majority of bypass flows occur during the winter and spring months when groundwater recharge amounts are greatest. During FY 2014 the annual rainfall total was about 5 in. below the long term average in Oak Ridge. The amount of inflow exceeded the system design treatment capacity during portions of FY 2014, which necessitated allowing bypass flows to occur during 30 weeks out of the year. Ninety-eight percent of the 901,000 gal of bypass discharge occurred between November 27, 2013 and March 5, 2014. The total measured bypass mercury discharge was about 10 g during the year.

During FY 2014, flow monitoring continued at Outfall 51 to measure wet season flows discharging from the outfall. Baseflow from Outfall 51 ranged from about 14 gpm in early September 2014 to about 90 gpm during early February. The total estimated mercury discharge from Outfall 51 during FY 2014 is estimated to be approximately 0.125 kg. The average mercury concentration from Outfall 51 was 1.4 µg/L during FY 2014, which is about the same as the average concentration during FY 2013.

UEFPC Mercury Mass Balance

DOE operates continuous mercury monitoring systems at multiple locations in the UEFPC watershed including mercury treatment facility discharges, several manhole locations within the WEMA, and at instream locations in UEFPC (Figure 6.5). High level summary results of the mercury monitoring are provided in Table 6.3 which includes daily total mercury flux and total annual flux summaries.

Table 6.3. Summary statistics for daily mercury discharge from monitored locations in UEFPC watershed, FY 2014

Outfall	Median[a]	Mean[a]	Maximum[a]	Mercury flux[b]
150	0.6	0.99	16.4	274
160	0.32	0.4	3.0	145
163	2.8	5.0	43.3	1,845
169[c]	1.6	1.9	13.9	614
Sum of WEMA Outfalls				2,878
200A6	4.5	6.5	75.9	2,373
Station 8	9.8	11.9	58.8	4,353
51	0.34	0.34	0.78	125
BSWTS	0.016	0.018	0.116[d]	6.4
BSWTS bypass flow (intermittent)	-	-	-	~10
Station 17[e]	11.9	39.4	681	14,392

[a]Values are g/d.
[b]Mercury flux is total g measured/estimated for FY 2014.
[c]OF169 experienced 54 days of flow meter outage during June and July. This causes a low bias in the estimate of mercury discharge at that location.
[d]Maximum daily load from BSWTS based on exclusion of one spurious lab result.
[e]EM operates continuous flow-paced sampling at a mid-channel location at Station 17.

BSWTS = Big Spring Water Treatment System
EM = Environmental Management
FY = fiscal year
UEFPC = Upper East Fork Poplar Creek
WEMA = West End Mercury Area

Since January 2010, flow-paced continuous sampling has been operated at five locations in the WEMA. In early January 2010, flow-paced continuous sampling devices became operational at Outfalls 150, 160, 163, and 169. These outfalls carry the principal WEMA drainages into the main storm drain pipes that discharge at Outfall 200 and make up the headwater 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 6.5). Outfall 200A6 serves as an integration point for contamination leaving the WEMA.

During FY 2011, a major storm drain sediment removal and drain pipe repair project was conducted to remove accumulated sediment and repair deteriorated pipe sections in portions of the WEMA. The project field work occurred between late February and the end of September 2011. Coincident with work in the storm drains there were increases in mercury concentration and flux at the WEMA manholes (Outfalls 150, 160, 163, and 169), at Outfall 200A6, and at Station 17. Monitoring conducted during FY 2014 showed that the daily mercury load decreased to the lowest level measured since the continuous monitoring at Outfall 200A6 started in FY 2007. Table 6.4 tabulates the median daily mercury load measured at Outfall 200A6 for the time period FY 2007 through FY 2014. The elevated mercury discharge during FY 2011 stands out in Table 6.4 as does the subsequent decrease. The lower than average annual rainfall during FY 2014 may have contributed to the very low daily mercury load as well.

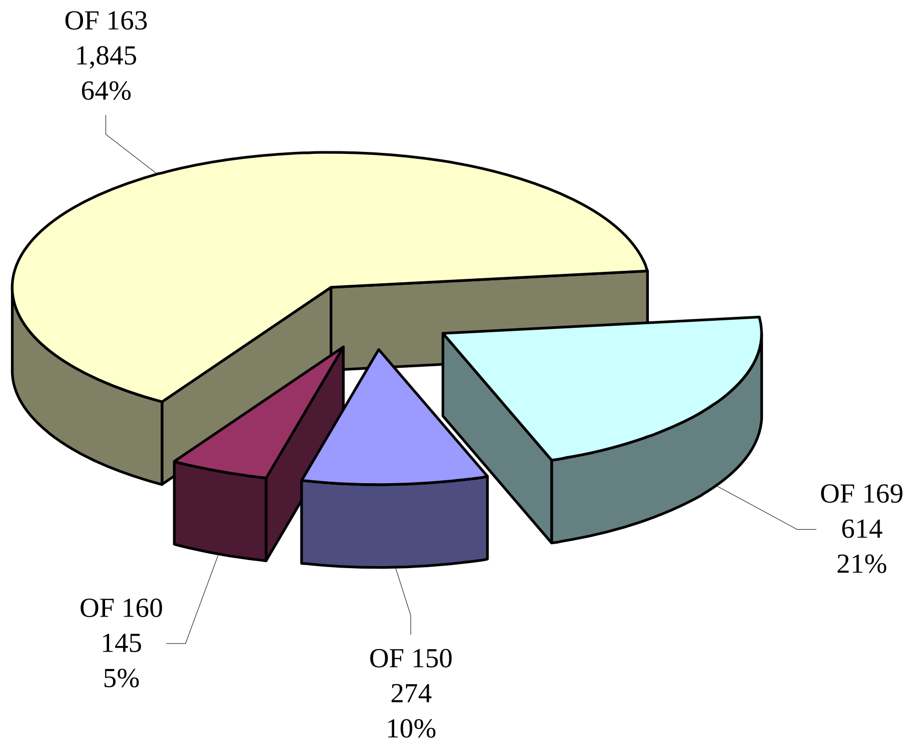
Table 6.4. Median Daily Mercury Flux measured at Outfall 200A6

FY	Median Daily Mercury Discharge (g/d)
2007	4.7
2008	6.2
2009	7.3
2010	6.9
2011	13.8
2012	5.4
2013	5.9
2014	4.5

FY = fiscal year

Table 6.3 includes summary statistical data for the amount of mercury measured at the four WEMA outfalls, Station 200A6, Station 8, and Station 17. Median, mean, and maximum calculated daily mercury discharge masses are included as is the measured total mercury flux measured at each location during FY 2014. There is an obvious imbalance in the mercury discharge fluxes measured at Outfall 200A6 compared to the sum of discharges from the upstream locations (Outfalls 150, 160, 163, and 169). There are multiple causes for the imbalance. Position of sampler intakes within the storm drain pipes is suspected to cause low efficiency in collecting sediment loads travelling in the base of the pipe. Experience shows that sampler intakes located at the very base of pipes become clogged with sediment and/or buried under gravel bars which prevents sample collection. Therefore, the sampler intakes are positioned toward the edge of flows where they remain submerged to minimize fouling of the intakes. The under-representation of mercury associated with the particulate load in the much larger diameter pipe at Outfall 200A6 compared to the smaller diameter pipes upstream is thought to be a factor in the flux estimate imbalance.

Figure 6.7 shows the relative contributions of mercury from WEMA Outfalls 150, 160, 163, and 169 to the sum of their mercury discharges.



FY 2014 WEMA Storm Drain Area Contributions
(grams total mercury and percent contribution to sum of sites upstream of OF200A6)

Figure 6.7. Relative contributions of mercury from WEMA storm drain outfalls.

Figure 6.8 shows the FY 2014 weekly mercury concentration, daily rainfall and average flow rate, along with the calculated daily mercury discharge at Outfall 200A6. Total mercury concentration hovered in the range of 800 – 1,000 ppt with concentration spikes typically coinciding with intense rainfall periods. The mercury discharge behavior exhibited during FY 2014 was typical of pre-storm drain cleanout conditions.

An important factor in the Y-12 mercury discharges and in downstream areas is the physicochemical behavior of mercury in different regions of the East Fork Poplar Creek. Under baseflow conditions at Outfall 200 the majority (> 80%) of mercury is dissolved. However during storm discharge conditions mercury contaminated sediment is discharged, causing pulses of solids-associated mercury (mostly chemically adsorbed Hg^{+2}). During storm discharge periods a great deal of scatter is observed in the percentage of dissolved mercury however values tend to lie below the 50th percentile with some results in the 10% range. The presence of chlorine in the storm drain upstream of Outfall 200 (where chlorine is removed by addition of a dechlorinating chemical) contributes to the dominance of dissolved mercury at the headwater. As the mostly dissolved mercury discharged from Outfall 200 travels downstream it is rapidly adsorbed to solid surfaces in the stream channel. These surfaces include stream bottom sediments and organic materials such as biofilms on rocks and other channel surfaces. Variations in flow velocity over these channel and streambank surfaces and disturbances by biota dislodges some of the contaminated material which is transported further downstream as suspended particulates. Stormflow scour suspends large amounts of channel bottom and bank material.

Outfall 200A6 Mercury Data FY 2014

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Hg Flux (grams)	105	188	359	207	332	142	266	121	183	214	145	110	2,373

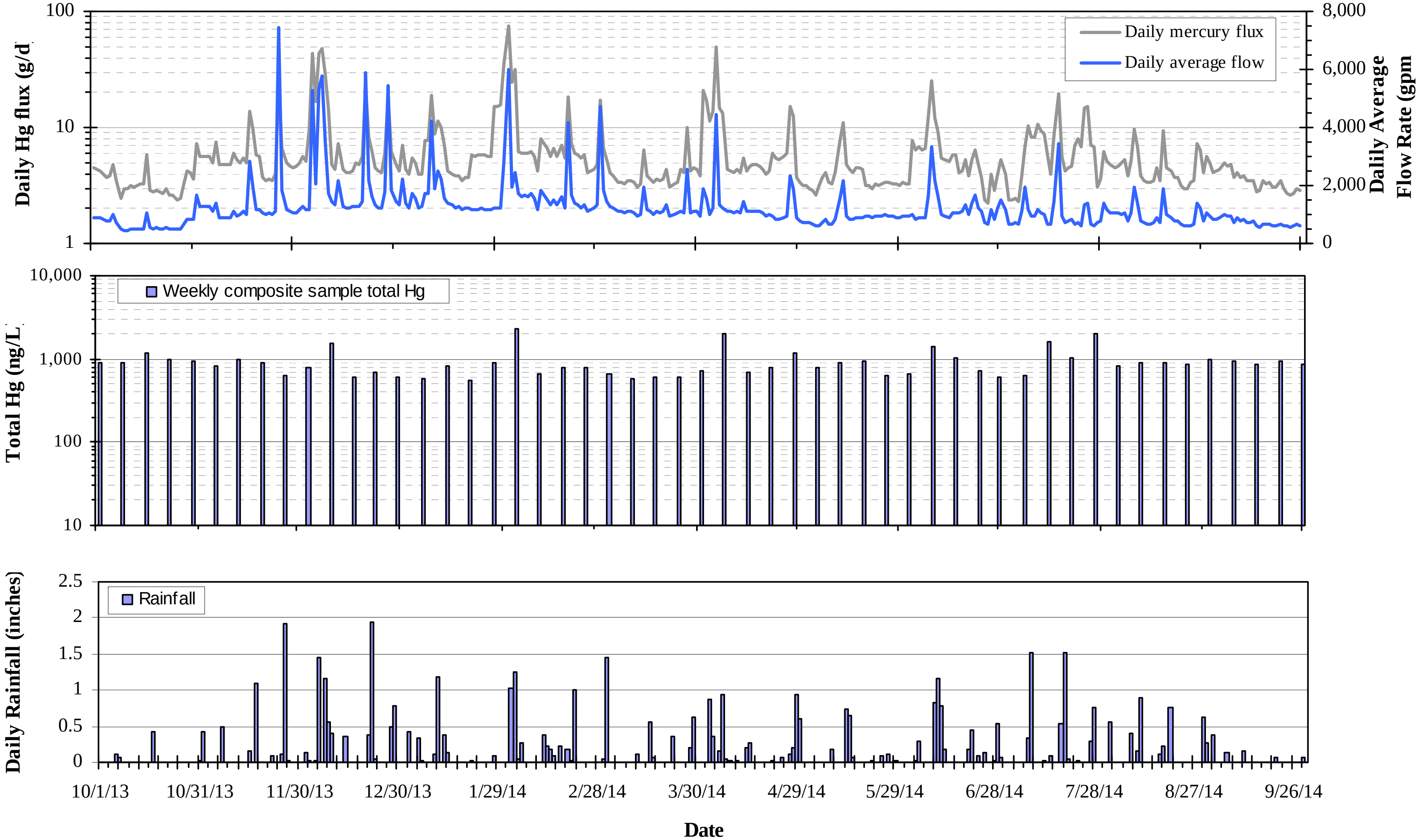


Figure 6.8. OF200A6 mercury discharges during FY 2014.

On May 1, 2014, the addition of augmentation flow to UEFPC just downstream of Outfall 200 was discontinued under terms of the new NPDES Permit for the Y-12 site. This cessation of flow augmentation had a significant effect on downstream flow volumes as shown on Figure 6.9. Flows at Outfall 200 were not affected by this change, however baseflow rates at Station 8 and Station 17 were diminished by a factor of approximately two-thirds. The revised NPDES Permit deferred mercury discharge monitoring at Station 17 to the CERCLA Program with reporting in the annual RER.

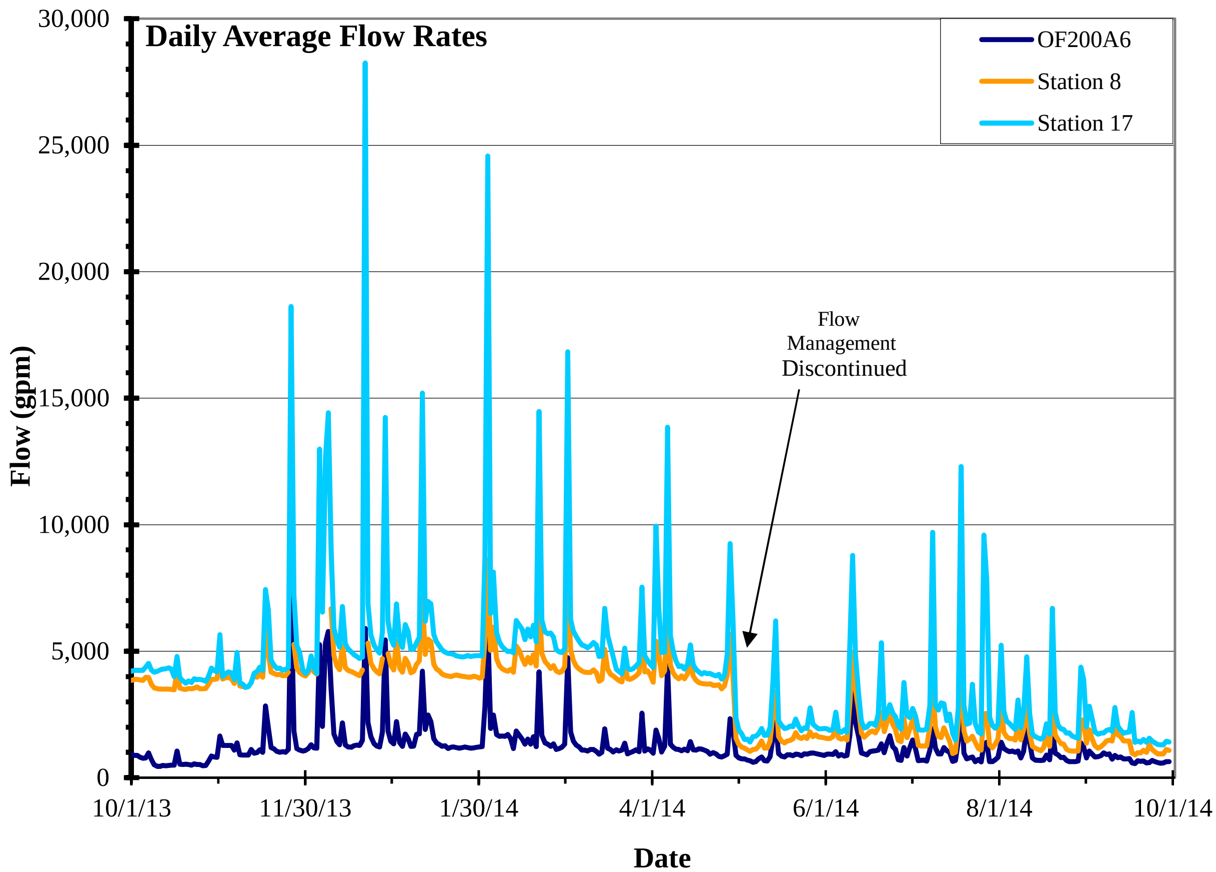


Figure 6.9. Daily average flow rates at OF200A6, Station 8, and Station 17.

Since the winter of 2013 DOE has collected and analyzed filtered and unfiltered splits from each weekly flow-paced composite sample from Outfall 200A6, Station 8, and Station 17 to allow assessment of the dissolved vs particle-associated mercury flux. Figure 6.10 shows the results of these analyses. For this figure the daily mercury flux was calculated as the simple weekly flux divided by the number of days in the sampling period (no flow weighting was considered). The generally higher mercury load measured at Stations 8 and 17 than those measured at Outfall 200A6 is apparent in the top graph panel. The progressive downstream decrease in dissolved mercury fraction is apparent in the middle panel. The bottom panel in the figure shows the total suspended solids (TSSs) measured in the weekly composite samples. Comparison of the calculated median daily total mercury fluxes for Outfall 200A6 and Station 8 suggests that on an annual basis, approximately 5 g/d of total mercury is being released from the contaminated sediment reach downstream of Outfall 200. This value is higher than previous estimates and is thought to be related to the more intermittent nature of streambed scour that occurs following the approximately two-thirds reduction of baseflow in that reach following termination of flow management. Station 17 generally has the highest suspended solids concentration although five weekly sample sets Outfall 200A6 had the highest level. Both dissolved and particle-associated mercury have been found to be susceptible to conversion to the bioavailable methylmercury in the environment. This topic is discussed in Section 6.2.1.2.3.

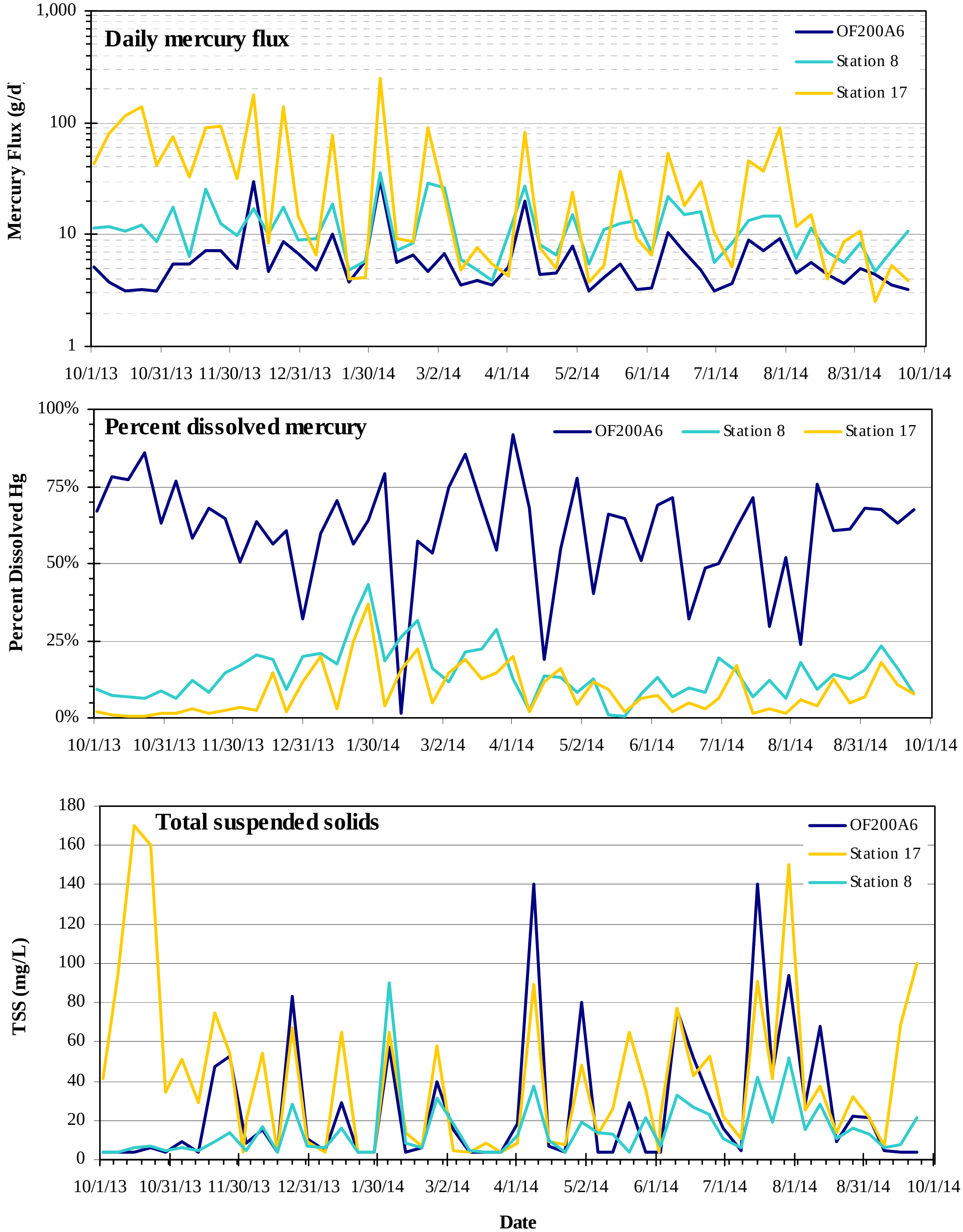


Figure 6.10. Mercury associated with suspended solids in UEFPC.

Just as there is an increasing particle association of mercury from Outfall 200 downstream to Station 17, there is an increase in flow volume attributable to both facility discharges and groundwater influx to the stream. The combined effects of the increased flow volume along with greater particle association of mercury and generally higher suspended solids load downstream is an increasing total mercury load in the UEFPC at Station 17 than at upstream monitoring locations. Inspection of the annual mercury flux column in Table 6.3 clearly shows this.

Integration Point Monitoring Results at Station 17

Station 17 is the integration point where the stream leaves Y-12 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 contaminants of concern in the UEFPC surface water.

Figure 6.11 shows the Station 17, daily average flow and mercury flux calculated as the flow-weighted fraction of the weekly total mercury concentration (top graph), weekly total mercury concentration (middle graph), and daily rainfall (bottom graph) for FY 2014. Also noted on the center graph panel is the 200 ppt ROD goal for total mercury concentration at this location. Several of the weekly composite samples had total mercury concentrations less than the 200 ppt ROD goal level although the annual average concentration from the composite samples was 1,490 ppt. The reduction of flow previously noted that occurred on May 1 is visible in the daily flow rate graph. Total mercury concentrations and calculated daily fluxes decreased through FY 2014.

Annual fluxes and average concentrations of uranium and mercury at Station 17 from FY 2000 through FY 2014 are listed in Table 6.5. Figure 6.12 is a graph of annual average mercury concentrations and fluxes and uranium fluxes at Station 17. The decrease in annual average total mercury concentration at Station 17 from 2012 through 2014 in the EM Program data suggests that the effects of the FY 2011 mercury discharges from Outfall 200 associated with the storm drain cleanout work are subsiding.

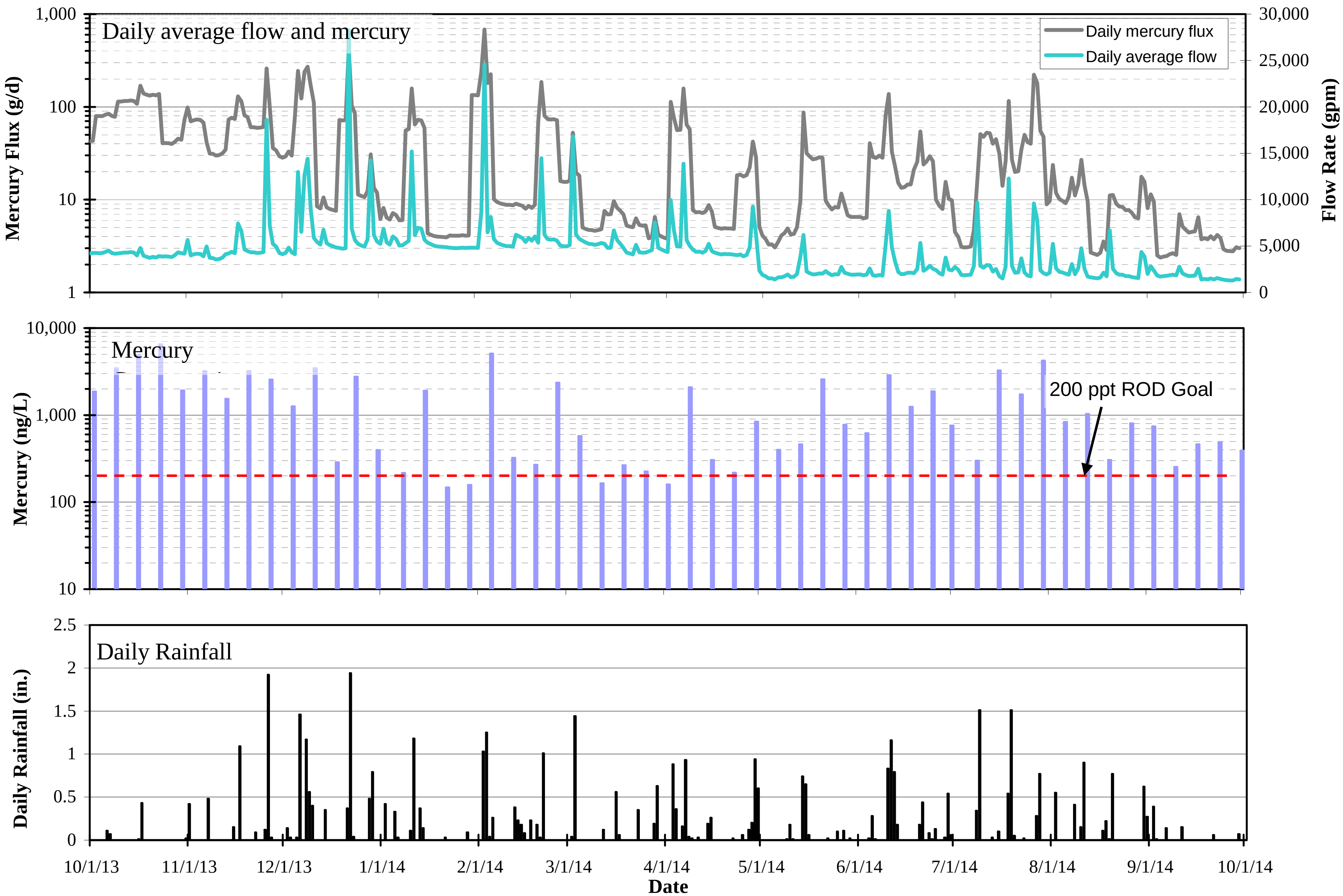


Figure 6.11. Summary of FY 2014 mercury discharge data for Station 17.

Table 6.5. Annual uranium and mercury fluxes[a] and average concentrations at Station 17

Date	Mercury flux (kg)[b]	Average mercury (µg/L)[b, c]	Uranium flux (kg)[d]	Average uranium (mg/L)[d]	Annual rainfall (in.)[e]
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
2011	12.2 / 24[d]	**0.817 / 1.66**[d]	173	0.013	60.4
2012	11.1 / 21.5[d]	**0.880 / 1.78**[d]	161	0.014	61.8
2013	5.2 / 20[d]	**0.413 / 1.71**[d]	181	0.015	63.7
2014	14.4 [d]	**1.49** [d]	120	0.012	48.8

[a]*Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) flux goals for uranium and mercury at Station 17 do not exist.
[b]Reported value is for NPDES reported 7-day continuous flow-paced samples unless indicated otherwise.
[c]**Bold** values exceed *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) mercury concentration goal of 200 ppt (0.2 µg/L) for Station 17.
[d]Reported mercury and uranium results are from composite samples collected and analyzed by EM Program.
[e]Average annual rainfall = 54 in.

EM = Environmental Management
NPDES = National Pollutant Discharge Elimination System

The daily mercury flux measured at Station 17 from FY 2000 through FY 2014 has been examined to determine the differences between the years pre- and post-startup of the BSWTS and to show the changed conditions during and after the FY 2011 storm drain cleanout project. All the calculated daily mercury flux results were ranked and cumulative distribution datasets were created. Figure 6.13 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 along with the FY 2011 through FY 2013 NPDES and EM daily flux data. The NPDES data set shows median daily mercury flux at Station 17 from FY 2000 through FY 2005 was 11.4 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. The FY 2011 through FY 2013 NPDES data show the increase in mercury flux with a median value similar to the pre-BSWTS median value and maximum values at the upper end of the distributions measured during FY 2000. The FY 2011 through FY 2013 EM data also show the effects of higher concentrations measured in the EM samples. The current NPDES Permit for the Y-12 facility does not require continuous mercury monitoring by the Y-12 Environmental Compliance Program and therefore the EM monitoring data is used to assess site conditions. From January 2013 through FY 2014 field filtered and unfiltered splits of the EM weekly composite samples were analyzed for samples collected between mid-January and the end of September. Those analyses showed that on average 92% of the mercury passing Station 17 is associated with filterable (> 0.45 µm) particulates. Similar sampling and analysis conducted at Outfall 200A6 and Station 8 showed that about 38% of the Outfall 200A6 mercury is particle associated and about 82% of mercury passing Station 8 is particle associated.

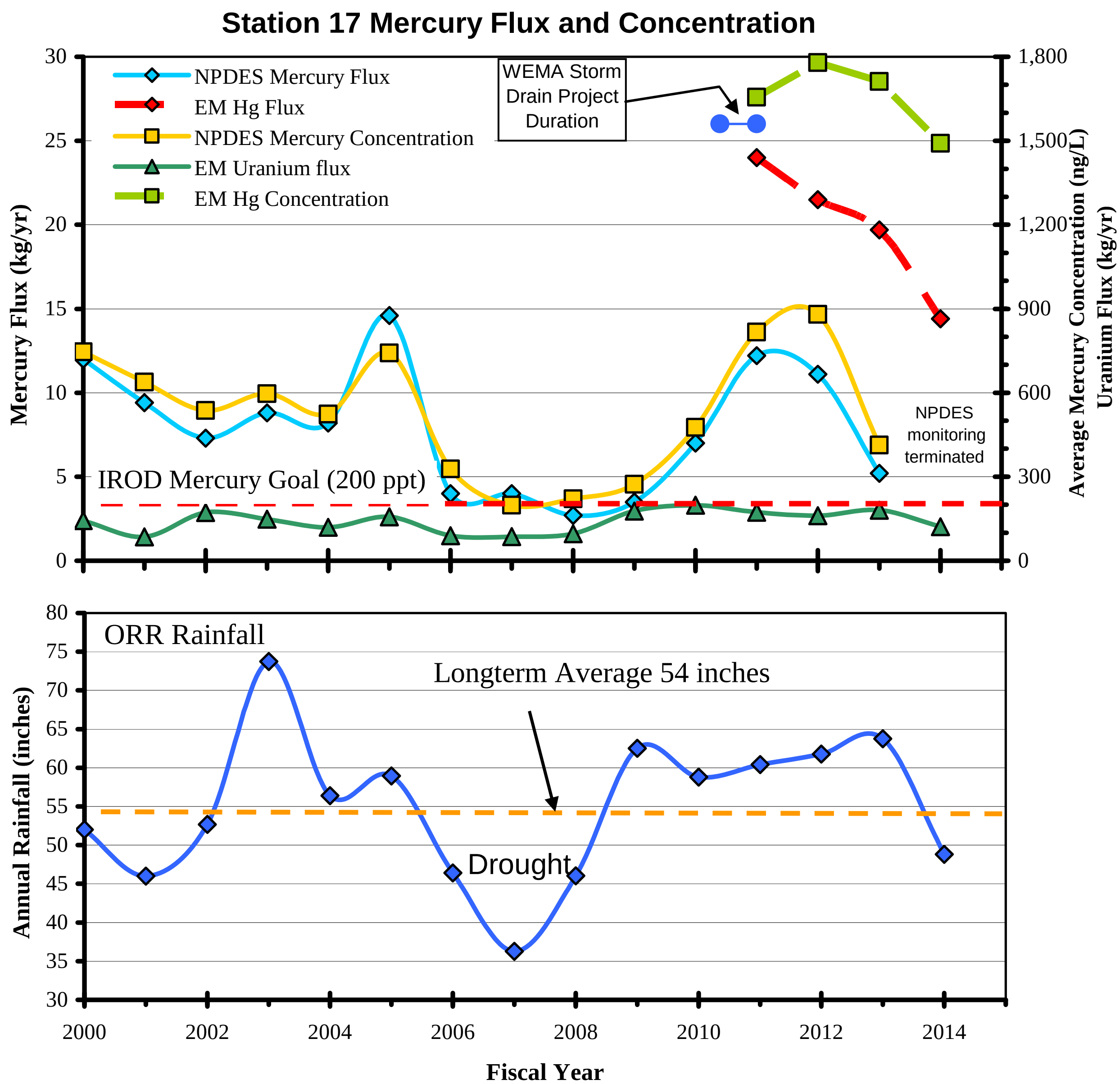


Figure 6.12. Annual mercury and uranium fluxes at Station 17 and annual rainfall.

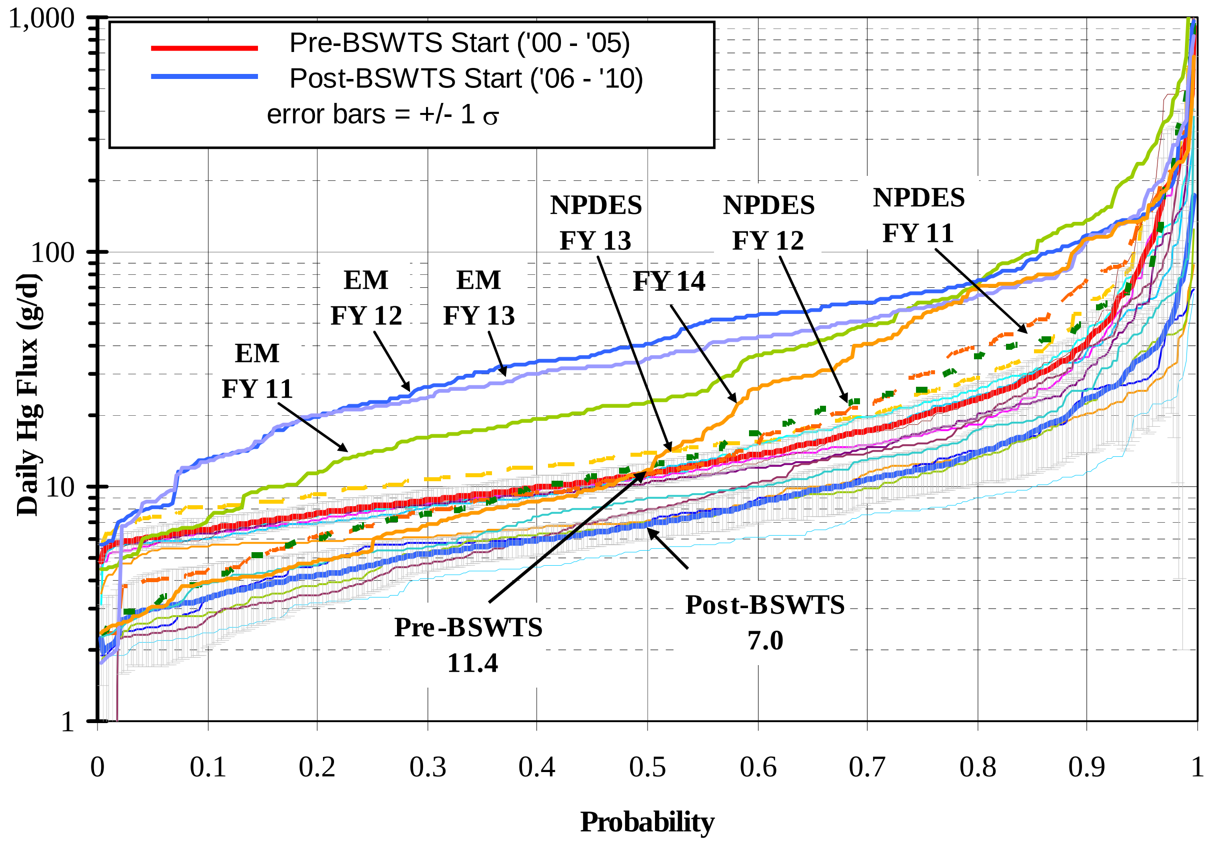


Figure 6.13. Pre- and post-BSWTS startup mercury daily flux at Station 17.

Contaminants of concern in the UEFPC watershed also include zinc and uranium. Areas of radiologically contaminated groundwater in the UEFPC Watershed are shown on Figure 6.5. 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 uranium flux at Outfall 200A6. Other significant source of uranium located in the eastern end of Y-12 that may enter UEFPC are the former Oil Skimmer Basin located adjacent to the original UEFPC channel in the eastern end of the plant area, an unknown source adjacent to wells GW-605/606, and the Uranium Oxide Vault/Building 9418-3. As shown in Table 6.5 and Figure 6.12, the uranium flux and average concentrations measured at Station 17 during FY 2014 decreased somewhat in comparison to the previous several years of above-average annual rainfall. 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 in FY 2014 was about 12 µg/L. During FY 2014 none of the uranium concentration in the weekly composite samples exceeded the 30 µg/L MCL (for UEFPC surface water, the uranium MCL is used only as a screening level). The maximum detected uranium concentration was 25.5 µg/L.

Zinc was analyzed in weekly grab samples collected at Station 17 during FY 2014 for comparison to the AWQC (120 µg/L). Zinc was not detected in 13 of the 52 weekly samples. The average detected zinc concentration during FY 2014 was 15.0 µg/L, the maximum detected zinc concentration was 41 µg/L and none of the zinc samples exceeded the AWQC.

6.2.1.2.2 Groundwater

The *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant* (DOE/OR/01-1641/V1-V4&D1) 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 6.5 shows the UEFPC 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 MCL or MCL-DC (10 mg/L MCL for nitrate and 900 pCi/L MCL-DC for ^{99}Tc), originate from the S-3 Ponds in a low pH plume finger that seeps eastward into the UEFPC watershed. The nitrate concentrations are undergoing a long term decreasing trend with one obvious outlier datapoint in 2005. The ^{99}Tc activities are also showing a decreasing trend since the summer of 2010.

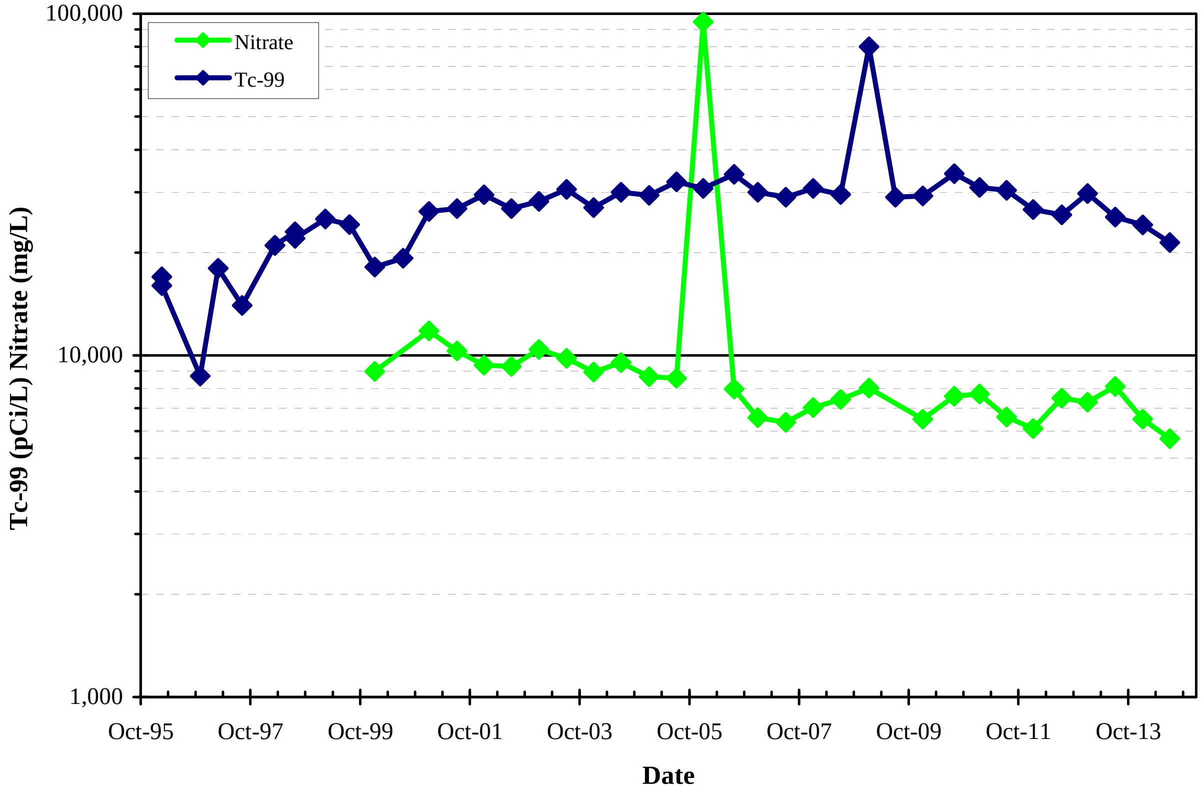
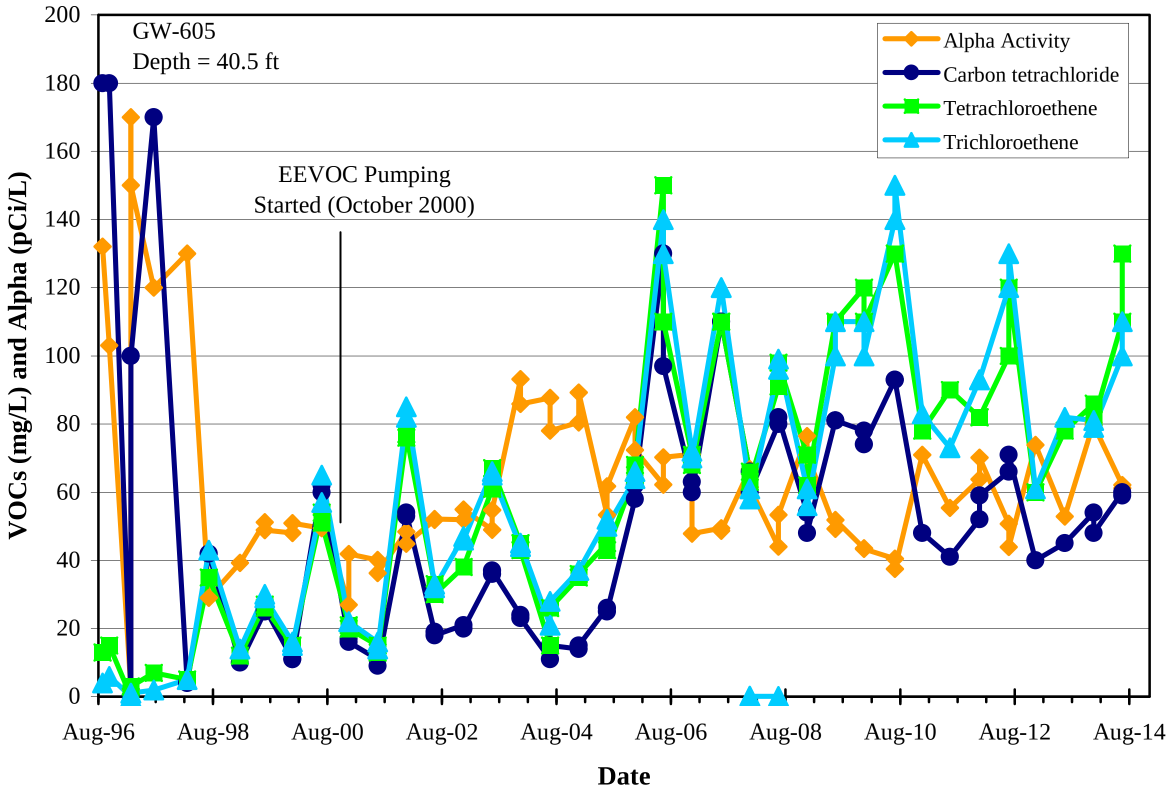


Figure 6.14. Well GW-108 nitrate concentration and ^{99}Tc activity.

Wells GW-605 and GW-606 are located in the Maynardville Limestone exit pathway upgradient of the EEVOC plume interception and treatment system (Figure 6.5). 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. These wells are located near the upgradient edge of the capture zone for the EEVOC pump and treat system and the date of startup of that groundwater remediation system is shown on Figure 6.15. Although cause and effect of variations in contaminant levels in the wells is not positively confirmed, some of the contaminant signatures appear to be influenced by possible changes in groundwater flow paths associated with establishment of the pump and treat system capture zone.



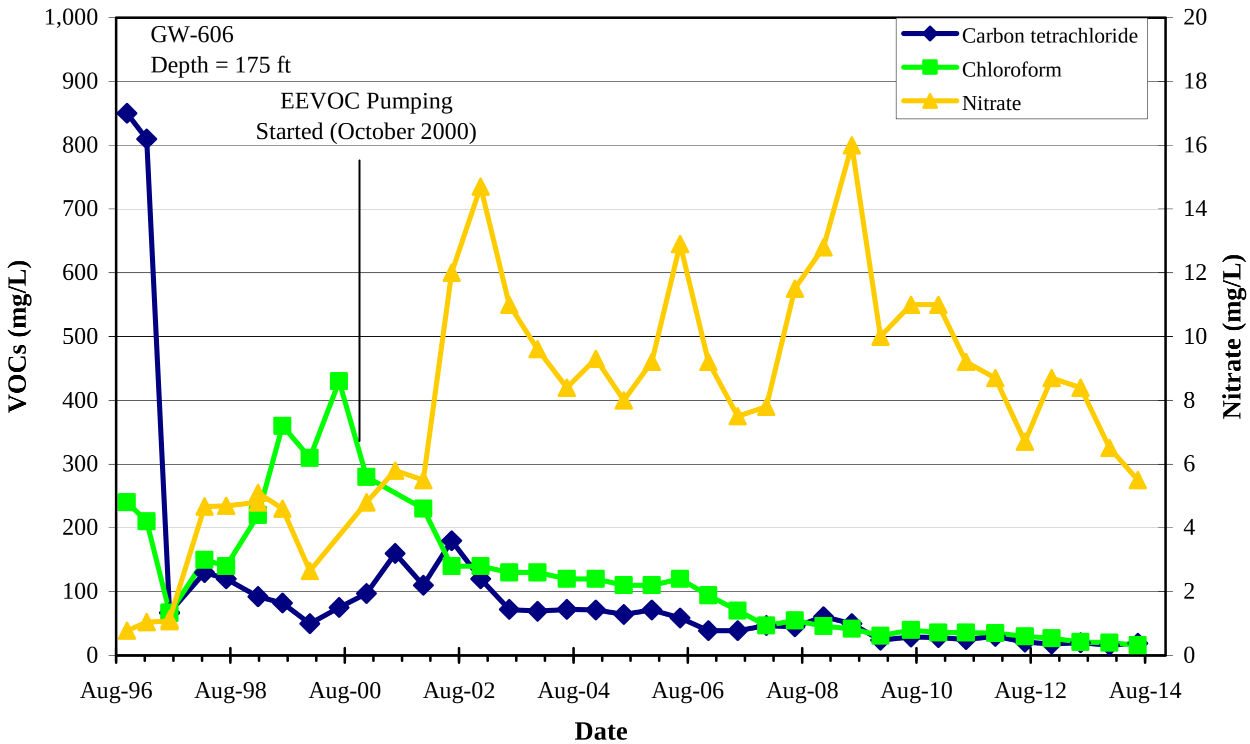


Figure 6.15. Wells GW-605 and GW-606 signature contaminant concentrations.

The alpha activity in well GW-605 is attributed to uranium which was present in the well at concentrations of approximately 150 µg/L in FY 2014. The concentration behavior of three chlorinated VOCs, carbon tetrachloride, PCE, and TCE in well GW-605 show that a significant increase occurred in the summer of 2006 followed by somewhat erratic concentration fluctuation. The cause of the significant increase in 2006 is not known although deactivation and demolition of facilities in the area may be related to a change in groundwater conditions. Well GW-605 is sampled semiannually with samples typically collected in January and July. Samples collected during the summer typically have higher VOC concentrations than those collected during the winter. Four fairly prominent July peaks of concentration have been observed in 2006, 2010, 2012, and 2014. This pattern of higher vs lower concentrations suggests winter season dilution of groundwater in the vicinity of this well. Since the alpha and VOC concentration fluctuation patterns are opposite one another in the seasonal sense it is probable that the uranium, which causes the alpha signal originates from shallower contamination that is mobilized during winter groundwater recharge events, while the VOCs originate from a different groundwater source that exhibits a dilutional response during the winter higher groundwater recharge season.

At well GW-606, concentrations of carbon tetrachloride and its degradation product chloroform have decreased since the EEVOC plume collection and treatment started operation in FY 2000. 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 concentration between 8 and 16 mg/L. Since January 2011 nitrate in GW-606 has been measured at concentrations less than the 10 mg/L MCL, and concentrations have decreased to less than 6 mg/L as of the summer of 2014. During FY 2014 well GW-606 contained 5 to 6 µg/L of uranium and PCE was present at 4.5-4.8 µg/L. TCE was not detected during FY 2014 although it has been present historically. Like the VOCs detected in well GW-605, the nitrate contamination represented by the GW-606 data 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 that includes annual nitrate and uranium data.

The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) did not specify target groundwater contaminant levels or other ARAR-based performance criteria for groundwater. SDWA MCLs are used as screening criteria to evaluate performance.

6.2.1.2.3 Aquatic Biology

Bioaccumulation of contaminants of concern in fish and stream ecological health has been monitored in UEFPC 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 (Peterson et al., 2011). For the last 10 years, the bioaccumulation studies have been augmented by twice yearly monitoring of aqueous mercury concentrations and speciation at sites throughout the length of UEFPC.

Aqueous mercury concentrations at Station 17 have fluctuated significantly in recent years. During the 1990's, concentrations decreased drastically, eventually leveling off at ~0.4 µg/L by the early 2000's. After the implementation of the BSWTS in 2007 aqueous concentrations dropped again, reaching a new "baseline" of ~0.30 µg/L that lasted until 2010. Following WEMA storm drain clean-out activities beginning in 2010, average aqueous mercury concentrations increased sharply, peaking at ~0.93 µg/L in the spring of 2011. For the past three years, concentrations at this site have significantly decreased, approaching concentrations comparable to those prior to the storm drain clean out activities (Figure 6.16). Mean concentrations in the spring of 2014 were ~0.27 µg/L, approaching the 0.2 µg/L performance goal (DOE/OR/01-1951&D3).

Despite the substantial fluctuations in aqueous mercury concentrations seen at Station 17 in recent years, mercury concentrations in rock bass collected at this site (i.e., EFK 23.4) have not fluctuated accordingly, but remained comparable to concentrations seen in recent years (Figure 6.16). However, redbreast collected from EFK 23.4 and at the EFK 24.2 sampling site, approximately 1 km upstream of Station 17, appear to have responded to the recent peak and decline in aqueous mercury concentrations. Mean concentrations at EFK 24.2 increased from ~0.6 µg/g in 2011 to above 1 µg/g in 2012, and then decreased back down to ~0.74 µg/g in 2014 (Figure 6.17). That this species appears to have responded to changes in water mercury concentrations in the upper reaches of the creek is interesting, given they have not responded to decreases in aqueous total mercury concentrations at downstream sites throughout East Fork Poplar Creek in the past 20 years.

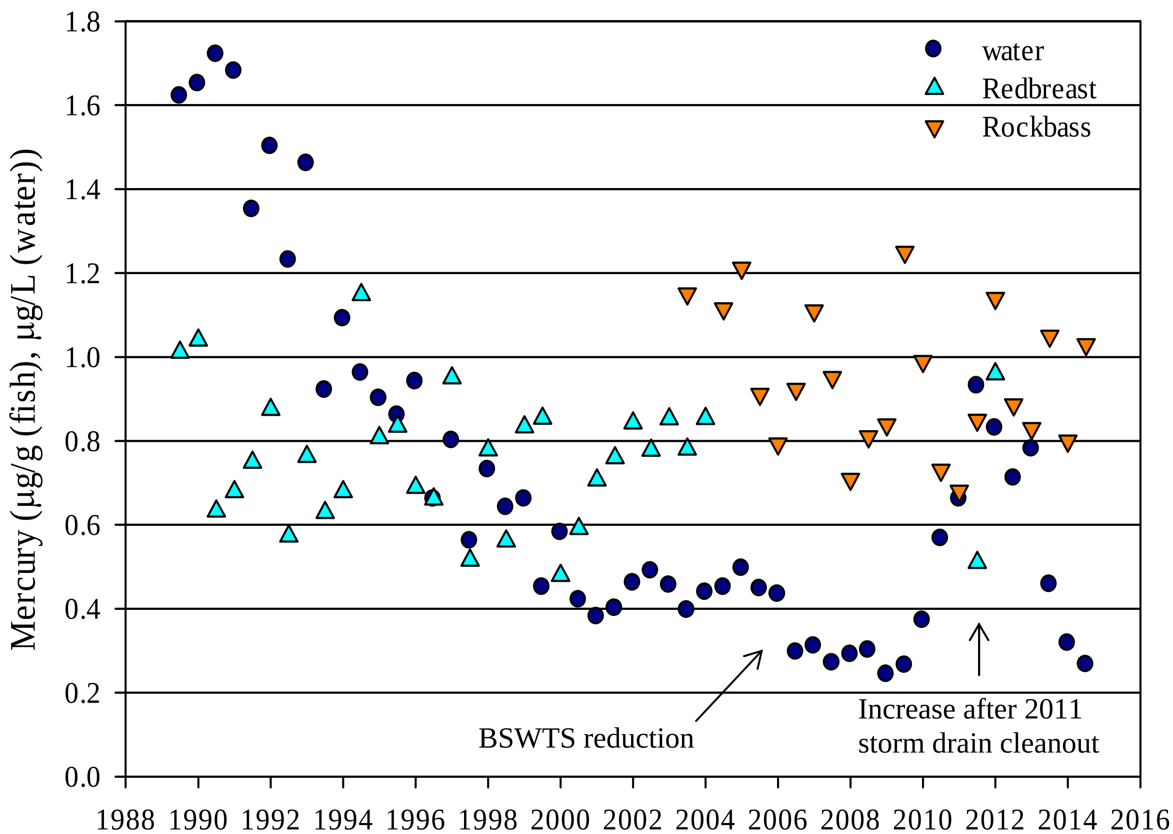


Figure 6.16. Mean concentration of mercury in redbreast sunfish and rockbass at EFK 23.4 vs trailing 6-mo. mean concentration of mercury in water.

BSWTS = Big Spring Water Treatment System

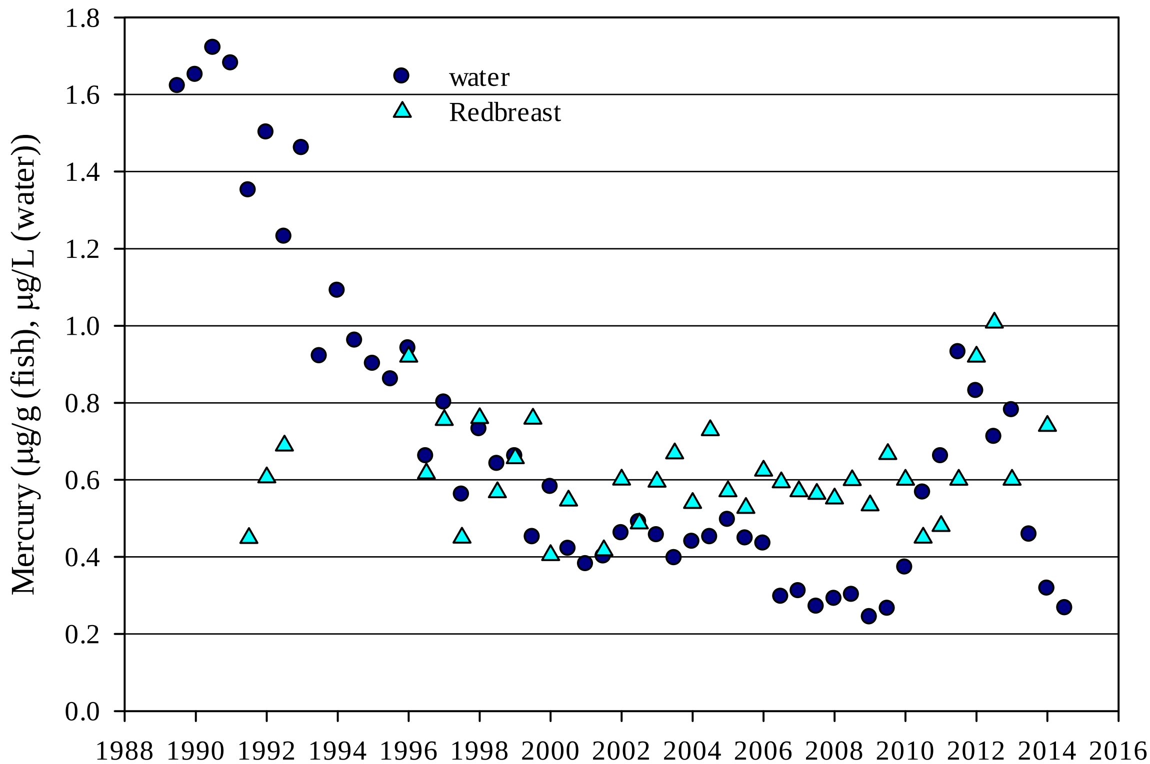


Figure 6.17. Mean concentration of mercury in redbreast sunfish at EFK 24.2 vs trailing 6-mo. mean concentration of mercury in water at Station 17 (EFK 23.4).

The relationship between aqueous total mercury concentrations and fish tissue concentrations is complex. A recent study examined the relationship between aqueous total mercury and mercury in fish from three mercury contaminated streams on the ORR (East Fork Poplar Creek, WOC, and Mitchell Branch) and one reference site (Hinds Creek) (Mathews et al., 2013). This study reported a non-linear relationship between water and fish tissue concentrations, and suggested a threshold aqueous mercury concentration above which fish do not respond. However, because mercury is predominantly accumulated through the food chain rather than through aqueous exposure, understanding food web structures and transfer pathways for mercury to fish is a key component critical to identifying strategies to mitigate mercury bioaccumulation. Uptake at the base of the aquatic food chain (algae/periphyton, invertebrates) is the most important concentration step for mercury into the aquatic food chain (with mercury concentrating over 10,000-fold between water and algae) but, while the relationship between mercury concentrations in water and fish has been characterized, the transfer pathways from the base of the food chain remain largely unknown. Future work will focus on quantifying the trophic transfer efficiency of mercury through the EFPC food chain and identifying the critical linkages for mercury transfer to fish.

Mean PCB concentrations in whole body composites of stoneroller minnows at EFK 24.4 decreased from 3.77 $\pm$ 0.15 µg/g in 2013 to 2.76 $\pm$ 0.12 µg/g in 2014. The mean whole-body concentration in 2014 approaches the EPA and TDEC agreed-to whole fish remediation goal of 2.3 µg/g established for ETTP's K-1007-P1 Pond (DOE/OR/01-2456&D1/R1). Total PCB concentrations in sunfish fillets at EFK 23.4 increased significantly in 2014 (0.86 µg/g), but remain much lower than the peak levels observed in the mid-1990s (Figure 6.18). Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Criterion Continuous Concentration (CCC) under the Tennessee water quality criteria for total PCBs is 0.00064 µg/L under the recreation designated use classification and is the target for PCB-focused TMDLs, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon; TDEC 2010a,b,c). In the state of Tennessee, assessments of impairment for water body segments as well as public fishing advisories are based on fish tissue concentrations. Historically, the FDA threshold limit of 2 µg/g PCBs in fish fillet was used for advisories, and then for many years an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. The remediation goal for fish fillet at the ETTP K-1007-P1 Pond is 1 µg/g PCBs. Most recently, the water quality criterion has been used to calculate the fish tissue concentration triggering impairment and a TMDL (TDEC 2007), and this concentration is 0.02 mg/kg PCBs in fish fillet (TDEC 2010a,b,c). TMDLs are used by TDEC to develop controls for reducing pollution from both point and non-point sources in order to restore or maintain the quality of a water body and ensure it meets the applicable water quality standards. The fish PCB concentrations in UEFPC, at approximately 0.9 mg/kg in fish fillet, are well above this concentration.

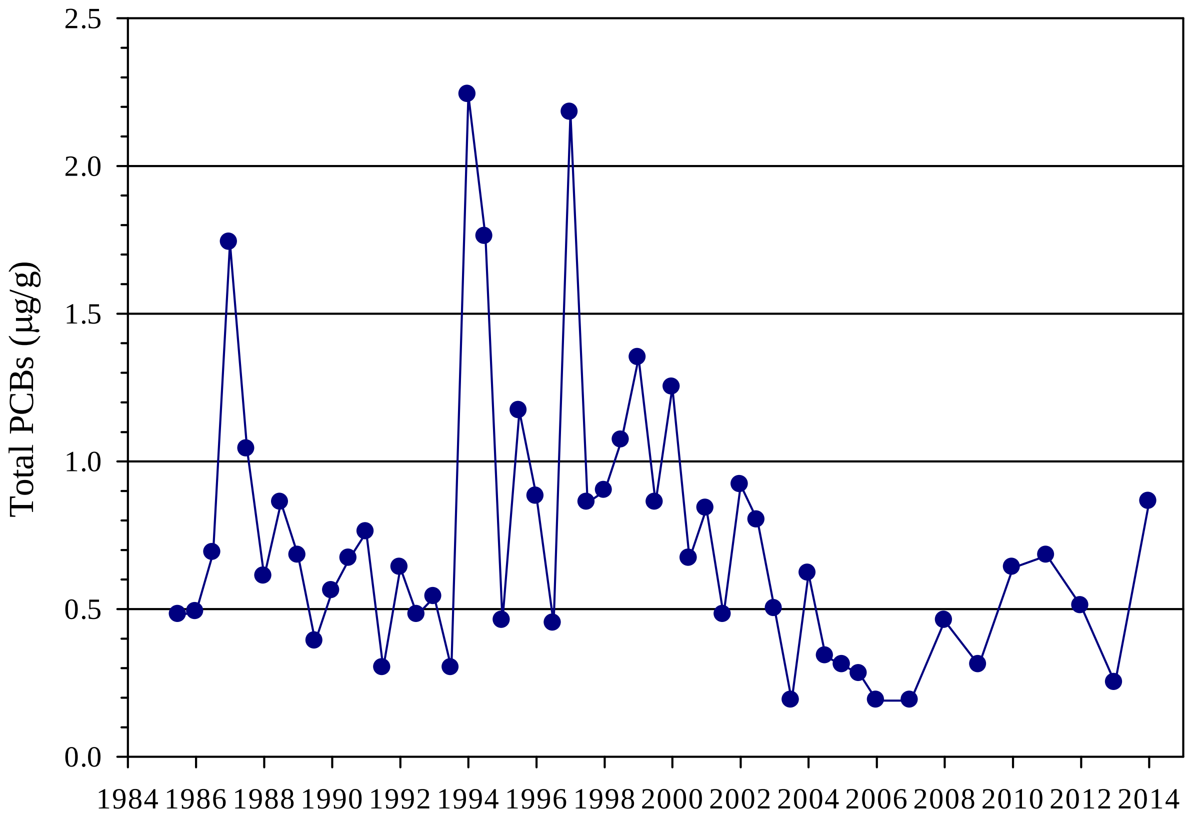


Figure 6.18. Mean concentrations of PCBs in redbreast sunfish and rockbass at EFK 23.4, 1985 – 2014.

After substantial increases in fish species richness (number of species) at EFK 23.4 in the late 1980s and early to mid-1990s, the number of fish species leveled out for an extended period. In recent years, there has been a slight increase in fish richness values at EFK 23.4, however, the species richness remains below comparable reference fish communities like BFK 7.6 (Figure 6.19). UEFPC has experienced multiple fish kills since 2011, which could be influencing the ability of new species to colonize this area. In contrast, the species richness of the fish community further downstream at EFK 13.8 has continued to improve since the late 1980s, and now routinely meets or exceeds richness at the reference site. The improvement at EFK 13.8 includes more sensitive species, such as darters and suckers, but the density of these sensitive species is still below reference values while the density of more tolerant species remains high. Recent collections (since 2012) appear to be on a decreasing trend, which may be more reflective of natural variability in species composition in a watershed this size than current impacts. These trends will need to be monitored as additional changes in the watershed (such as the removal of flow augmentation in the spring of 2014) may have influences on fish communities.

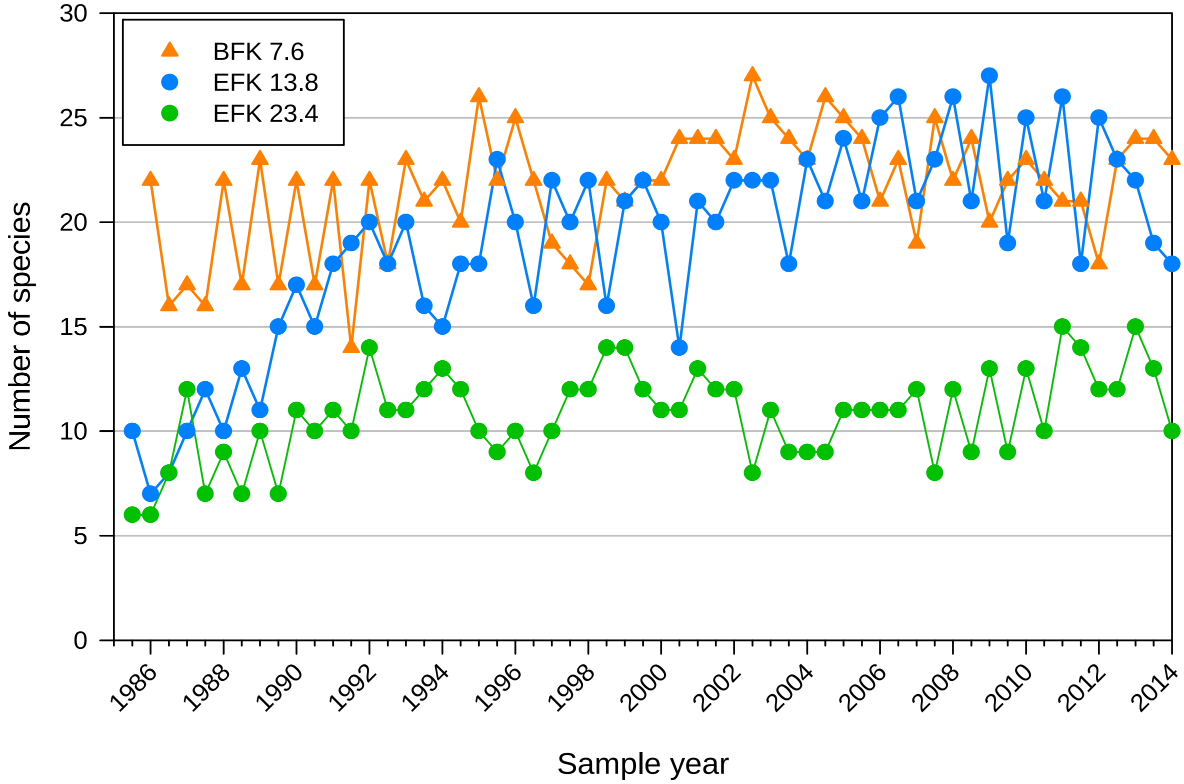


Figure 6.19. Species richness (number of species) in samples of the fish community at two sites in East Fork Poplar Creek and a reference stream, Brushy Fork, 1985 – 2014.

No unusual change was observed in taxonomic richness of the pollution-intolerant benthic macroinvertebrates (i.e., EPT taxa richness) at EFK 24.4 in 2014 relative to results from 1999 – 2013 (Figure 6.20), demonstrating that conditions at this site have been relatively stable during this period. Since 2007, the number of EPT taxa/sample at EFK 23.4 has generally increased. For example, from 1999 – 2006, EPT richness averaged three EPT taxa/sample, and from 2007 – 2014, the average was five EPT taxa/sample. A notable decrease in the number of EPT taxa/sample was evident at the reference site BFK 7.6 after 2008, likely a result of higher discharge caused by increased rainfall in early 2009. In contrast to EFK 23.4, however, EPT richness at BFK 7.6 had not yet returned to the pre-2009 levels by April 2014 (i.e., ~10 EPT taxa/sample), while at EFK 23.4 EPT richness had experienced a slight overall increase during this same period. This suggests that further recovery has likely occurred in the invertebrate community at EFK 23.4 since 2006.

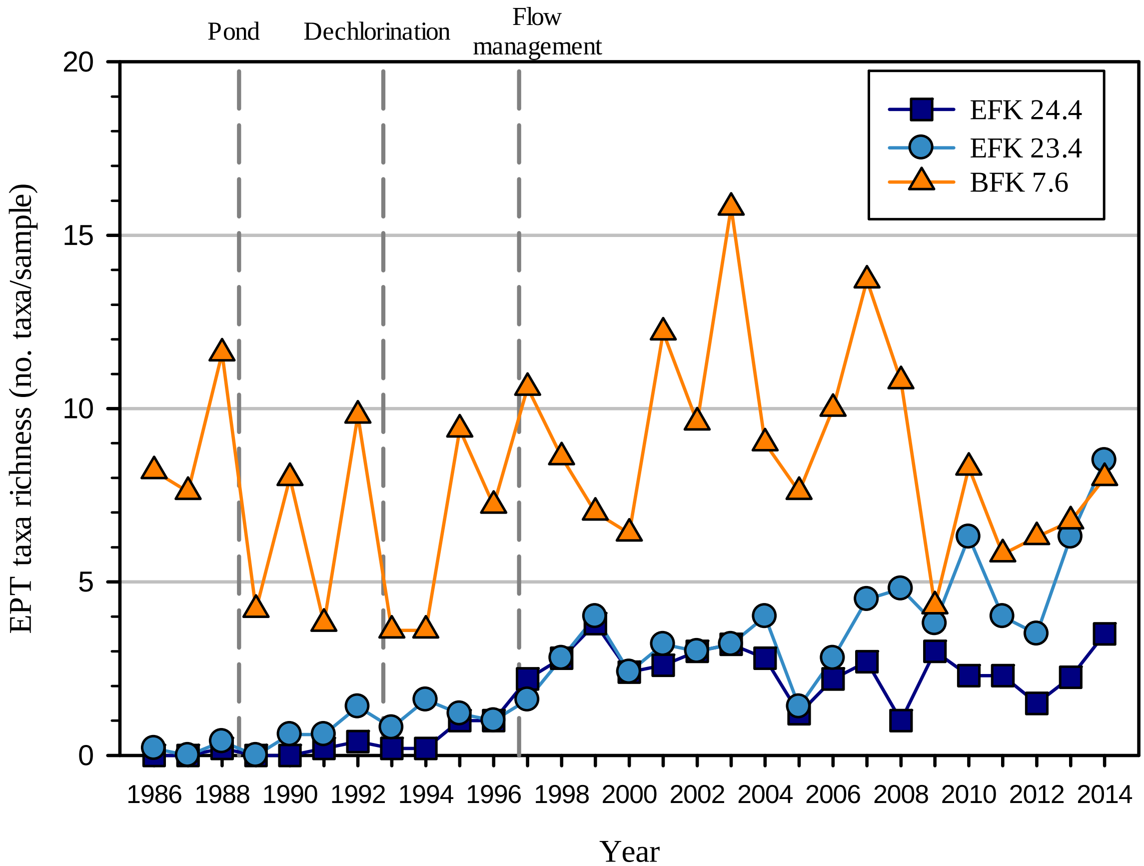


Figure 6.20. Mean (n = 5; n = 4 after 2006) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in UEFPC and Brushy Fork, April sampling periods, 1986 – 2014.[a,b]

[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, stoneflies and caddisflies.

6.2.1.3 Performance Summary

Following is a summary of the FY 2014 UEFPC watershed performance monitoring:

- The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) goal for mercury in surface water at Station 17 is 200 ng/L. The average flow-paced composite mercury concentration during FY 2014 was 1,490 ng/L, down from 1,710 ng/L in FY 2013. Total mercury concentrations in several of the weekly composite samples collected at Station 17 during FY 2014 were less than the 200 ng/L ROD goal.
- The BSWTS was fully operational during FY 2014. Although no significant downtime or operational problems occurred, winter and early spring seasonal rainfall caused the influent to BSWTS groundwater collection system to exceed the treatment system's design capacity. This necessitated bypassing the system during 30 weeks. Approximately 98% of the bypass discharge occurred between late November 2013 and early March 2014 with a mercury discharge from the bypass of approximately 10 g during the year (less than 0.1% of measured flux at Station 17).

- The performance standard for uranium at Station 17 is to monitor the trend. The uranium flux at Station 17 in FY 2014 decreased relative to levels measured during the previous several years of above-average rainfall.
- Aquatic biological monitoring shows that mercury concentrations in rock bass at Station 17 generally remain stable. However, at upstream locations EFK 23.4 and EFK 24.2, mercury concentrations in redbreast appear to have declined in response to the reduction in aqueous mercury concentrations in FY 2013. While redbreast mercury concentrations in water at upper reaches of the creek have declined, they have not responded to decreases in aqueous total mercury concentrations at downstream sites in East Fork Poplar Creek.

6.2.2 Other LTS Requirements

Other LTS requirements for UEFPC are listed in Table 6.6 and described below.

6.2.2.1 Requirements

The *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3) specifies maintenance and LUCs to reduce the risk of human exposure to contaminants. 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.

6.2.2.2 Status of Requirements

LUCs in UEFPC were maintained, including signs to control access, surveillance patrols, and an ongoing EPP program. Operation and maintenance of water treatment systems (CMTS and BSWTS) are discussed in Section 6.2.1.2.1.2.

6.3 SINGLE-PROJECT ACTIONS IN THE UEFPC WATERSHED

6.3.1 EEVOC Plume

The EEVOC plume (DOE/OR/01-1819&D2) extraction/treatment system began operation in 2000 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 to evaluate performance before preparation and approval of the *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-2297&D1). The *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-2297&D1) recommended continuation of the current plume interception system and specified evaluation of the system performance in the annual RER.

6.3.1.1 Performance Monitoring

6.3.1.1.1 Performance Monitoring Goals and Objectives

The goals of the removal action (DOE/OR/01-1819&D2) are to reduce health and environmental risks associated with the migration of VOC-contaminated groundwater from the east end of Y-12, to reduce the potential risk from exposure to this contamination in off-site areas, and to mitigate off-site migration of contaminants. No specific numeric performance standards were established. Existing human health or ecological risks specific to groundwater were evaluated during the *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant*

(DOE/OR/01-1641/V1-V4&D1), and a *Union Valley Interim Study Remedial Site Evaluation* (Y/ER-206/R1) 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.

System performance is measured by evaluating reductions in VOC concentrations downgradient of the extraction well (GW-845) (DOE/OR/01-1819&D2). The *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-2297&D1) identified changes to monitoring frequencies and analysis, which were implemented in the FY 2007 monitoring. As shown in Table 6.2, 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 treatment system discharge measured at the downstream POC, monitoring location LRBP-1, must not exceed the applicable AWQC (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 VOC analysis.

Table 6.6. Other LTS requirements for the UEFPC watershed

Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area (DOE/OR/01-1951&D3)[a]					
Type of control	***Affected areas***	***Purposes of control***	***Duration***	***Implementation***	**Frequency/ Implementation**
1. Property Record Restrictions[b] *A. Land use* *B. Groundwater*	*WEMA mercury-contaminated areas*	*Restrict use of property by imposing limitations.* *Prohibit uses of groundwater*	*Indefinitely*	*Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office*	DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s)
2. Property Record Notices[c]	*WEMA mercury-contaminated areas*	*Provide notice to anyone searching records about the existence and location of contaminated areas*	*Indefinitely*	*Initial Notice recorded by DOE in accordance with state law at County Register of Deeds office: 1) as soon as practicable after signing of the ROD; 2) upon transfer of affected areas; 3) final Notice upon completion of all other remedial actions*	DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s)
3. Zoning Notices[d]	*WEMA mercury-contaminated areas*	*Provide notice to city about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes*	*Indefinitely*	*Copy of initial Property Notice filed with County Register of Deed office to be filed by DOE with City Planning Commission as soon as practicable after signing of the ROD; survey plat upon completion of all remedial actions.*	DOE official (or its contractors) will verify no less than annually that information is properly maintained with the City Planning Commission
4. Excavation/Penetration Permit Program[e]	*WEMA mercury-contaminated areas*	*Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity*	*As long as property remains under DOE control*	• *Implemented by DOE and its contractors* • *Initiated by permit request*	DOE official (or its contractors) will verify no less than annually the functioning of permit program against existing procedures

Table 6.6. Other LTS requirements for the UEFPC watershed (cont.)

***Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3)**[a]					
Type of control	***Affected areas***	***Purposes of control***	***Duration***	***Implementation***	**Frequency/ Implementation**
5. Signs[f]	*UEFPC surface water*[g]	*Provide notice or warning to prevent unauthorized access*	*Indefinitely*	*Signage maintained by DOE*	DOE official (or its contractors) will conduct field survey no less than annually of all signs to assess condition (i.e., remain erect, intact, and legible)
6. Surveillance Patrols	*UEFPC surface water*[g]	*Control and monitor access by workers/public*	*Indefinitely*	• *Established and maintained by DOE* • *Necessity of patrols evaluated upon completion of remedial actions*	DOE official (or its contractors) will verify no less than annually against procedures/plans that routine patrols conducted
***Record of Decision for Phase II Interim Remedial Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek* (DOE/OR/01-2229&D3)**[h]					
Type of control	***Affected areas***	***Purposes of control***	***Duration***	***Implementation***	**Frequency/ Implementation**
1. DOE land notation (Property record restrictions)[b]	*Throughout entire Y-12 industrial area*	*Restrict use of property consistent with LUC objectives*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure*	*Drafted and implemented by DOE upon completion of remediation activities per this ROD or transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.*	DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s)
2. Property record notices[c]	*Throughout entire Y-12 industrial area*	*Provide notice to anyone searching records about the existence and location of contaminated areas*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure*	*Notice provided by DOE EM to the public as soon as practicable, but no later than 90 days after approval of the LUCIP.*	DOE official (or its contractors) will verify no less than annually that information is properly recorded at County Register of Deeds office(s)

Table 6.6. Other LTS requirements for the UEFPC watershed (cont.)

Record of Decision for Phase II Interim Remedial Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek **(DOE/OR/01-2229&D3)**[h]					
Type of control	***Affected areas***	***Purposes of control***	***Duration***	***Implementation***	**Frequency/ Implementation**
3. Zoning notices[d]	*Throughout entire Y-12 industrial area*	*Provide notice to city about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure*	*Initial Zoning Notice (same as Property Record Notice) filed with City Planning Commission as soon as practicable after approval of the LUCIP; final Zoning Notice and survey plat files with City Planning Commission upon completion of all remedial actions*	DOE official (or its contractors) will verify no less than annually that information is properly maintained with the City Planning Commission
4. Excavation/penetration permit program[e]	*Throughout entire Y-12 industrial area*	*Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity*	*As long as property remains under DOE control, including transferred property remaining subject to the excavation/penetration permit program*	*Implemented by DOE and its contractors; initiated by permit request*	DOE official (or its contractors) will verify no less than annually the functioning of permit program against existing procedures
5. Security guards/surveillance patrols	*Patrol of selected areas throughout Y-12, as necessary*	*Control and monitor access by workers/public*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure as well as established programmatic needs*	*Established and maintained by DOE; necessity of patrols evaluated upon completion of remedial actions. Existing routine patrols continued.*	DOE official (or its contractors) will verify no less than annually against procedures/plans that routine patrols conducted

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/ Implementation**
Mercury Storm Sewer Traps	RmAR (DOE/OR/01-2595&D1)	• Collect, store, treat, and dispose of elemental mercury and associated contaminated sediments from specified storm drain locations • Periodically visually inspect nine trap locations for material accumulated in the traps	The results of the removals are to be summarized in the annual RER
Secondary Pathways	PCCR (DOE/OR/01-2596&D1)	• Long-term operation and maintenance requirements associated with the drainage improvements • Clean out and other maintenance work will be performed as needed	As needed

Table 6.6. Other LTS requirements for the UEFPC watershed (cont.)

Other LTS requirements for Specific Areas			
Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/ Implementation**
BSWTS	PCCR (DOE/OR/01-2218&D1)	• Operate and maintain in accordance with the developed procedure to address startup, operation, and shutdown • General and routine maintenance will be performed in accordance with the Preventative Maintenance, Calibrations and Inspection Plan	Not stated
Y-12 EEVOC Plume	RmAR (DOE/OR/01-2297&D1)	• O&M parameters, such as influent/effluent concentrations, system uptime versus downtime, unusual occurrences, average pumping rate, and total volume treated, are recorded, and an evaluation of system performance is performed annually • The cartridge filters are changed out as fine particles and grit collect on the filter media • The air-stripper trays are removed and cleaned as scale builds up on the surface. The scale is removed to prevent plugging of the holes in the trays resulting in reduced stripper efficiency.	Annual evaluation of system performance documented in the RER
CMTS	Phase I ROD (DOE/OR/01-1951&D3)	• The existing sump collection and treatment systems (pumps, valves, piping, and treatment components) will continue to be inspected and maintained in accordance with current NPDES Permit Compliance Program requirements	Until implementation and effectiveness evaluation of the remaining hydraulic isolation components (e.g., horizontal well) are complete
Union Valley	IROD (DOE/OR/02-1545&D2)	• License agreements with property owners notifying them of the potential contamination and requiring them to notify DOE of any changes in use of groundwater or surface water in certain areas • Appropriate verification by DOE of compliance with the agreements and notification of state and local agencies • The DOE Real Estate Office and DOE's management and operations contractor's real estate office are responsible for (1) completing the annual title search by the anniversary date of this ROD to determine whether any affected property has changed hands; (2) notifying property owners, the Oak Ridge city manager, and the TDEC/DOE Oversight Division (now called the TDEC/DOE Oversight Office) of their obligations under the agreements and updating them on the status of the environmental investigations; (3) surveying owners by telephone to determine whether any new groundwater wells have been constructed or planned of there are any new uses for surface water; and (4) notifying licensed well drillers in Tennessee of the license agreements and their terms.	The DOE Real Estate Office shall report search results to the DOE Program Office annually

[a]Source for LUCs: *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).

[b]*Property Record Restrictions—Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with original property acquisition records of DOE and its predecessor agencies.*

[c]*Property Record Notices—Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination/waste disposal areas on the property.*

[d]*Zoning Notices—Includes information on the location of waste disposal areas and residual contamination depicted on a survey plat, which is provided to a zoning authority (i.e., City Planning Commission) for consideration in appropriate zoning decisions for non-DOE property.*

[e]*Excavation/Penetration Permit Program—Refers to the internal DOE/DOE contractor administrative program(s) that requires permit requester to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case of contaminated soil or groundwater, will not disturb the affected area without the appropriate precautions and safeguards.*

[f]*Signs—Posted command, warning, or direction*

[g]To prevent consumption of fish from UEFPC.

[h]Source for LUCs: *Record of Decision for Phase II Interim Remedial Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek* (DOE/OR/01-2229&D3).

BSWTS = Big Spring Water Treatment System
CMTS = Central Mercury Treatment System
DOE = U.S. Department of Energy
EEVOC = East End Volatile Organic Compound
EM = Environmental Management
IROD = Interim Record of Decision
LTS = long-term stewardship
LUC = land use control
LUCIP = Land Use Control Implementation Plan
NPDES = National Pollutant Discharge Elimination System
O&M = operations and maintenance
PCCR = Phased Construction Completion Report
RER = Remediation Effectiveness Report
RmAR = Removal Action Report
ROD = Record of Decision
TDEC = Tennessee Department of Environment and Conservation
UEFPC = Upper East Fork Poplar Creek
WEMA = West End Mercury Area
Y-12 = Y-12 National Security Complex

6.3.1.1.2 Evaluation of Performance Monitoring Data

6.3.1.1.2.1 Groundwater

Figures 6.21 and 6.22 show the EEVOC chlorinated hydrocarbon concentrations before pumping at well GW-845 was started in FY 2000, and in FY 2014 showing the region of maximum contaminant removal, respectively. Concentrations represent the sum of chlorinated VOCs. 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 chlorinated VOC 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 its contact with the Nolichucky Shale. The groundwater extraction system has effectively withdrawn contaminant mass from the more permeable limestone strata, but the contaminated groundwater is not as effectively withdrawn from the shale 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 6.23 shows the drawdown feature created by pumping of well GW-845 in plain 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 6.23, 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 *Action Memorandum for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-1819&D2), system performance is measured by evaluating reductions in VOC concentrations downgradient of the extraction well (GW-845). The *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-2297&D1) 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 (Figures 6.21 and 6.22). 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 (Figures 6.21 and 6.22). Consistent with recommendations in the approved *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2289&D3) and *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-2297&D1), sampling of well GW-232 in Union Valley has been discontinued and sampling frequency and target analytes at other specified (DOE/OR/01-1819&D2) wells have been modified.

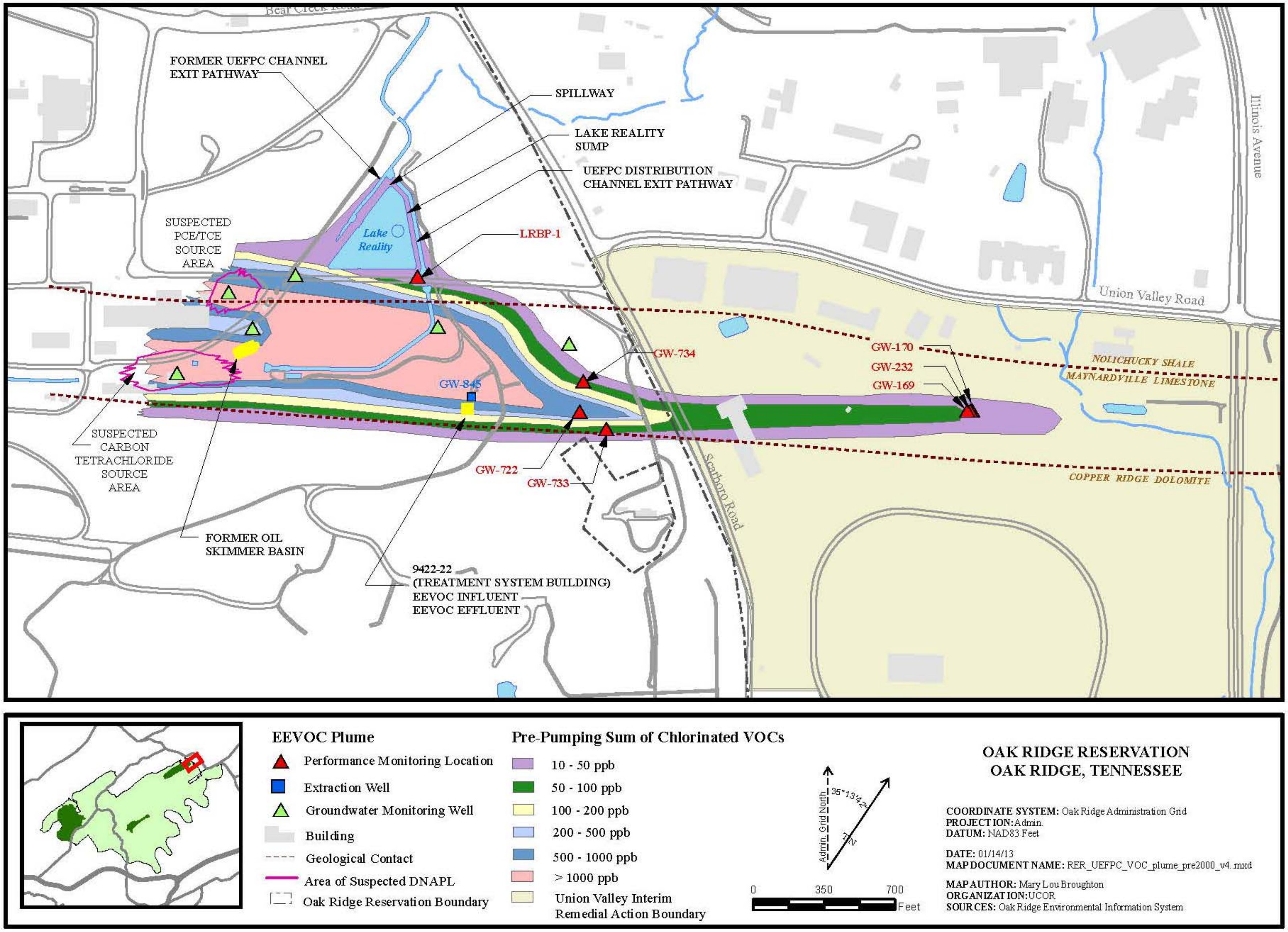


Figure 6.21. EEVOC Plume before pump and treatment system startup (1998 – 2000).

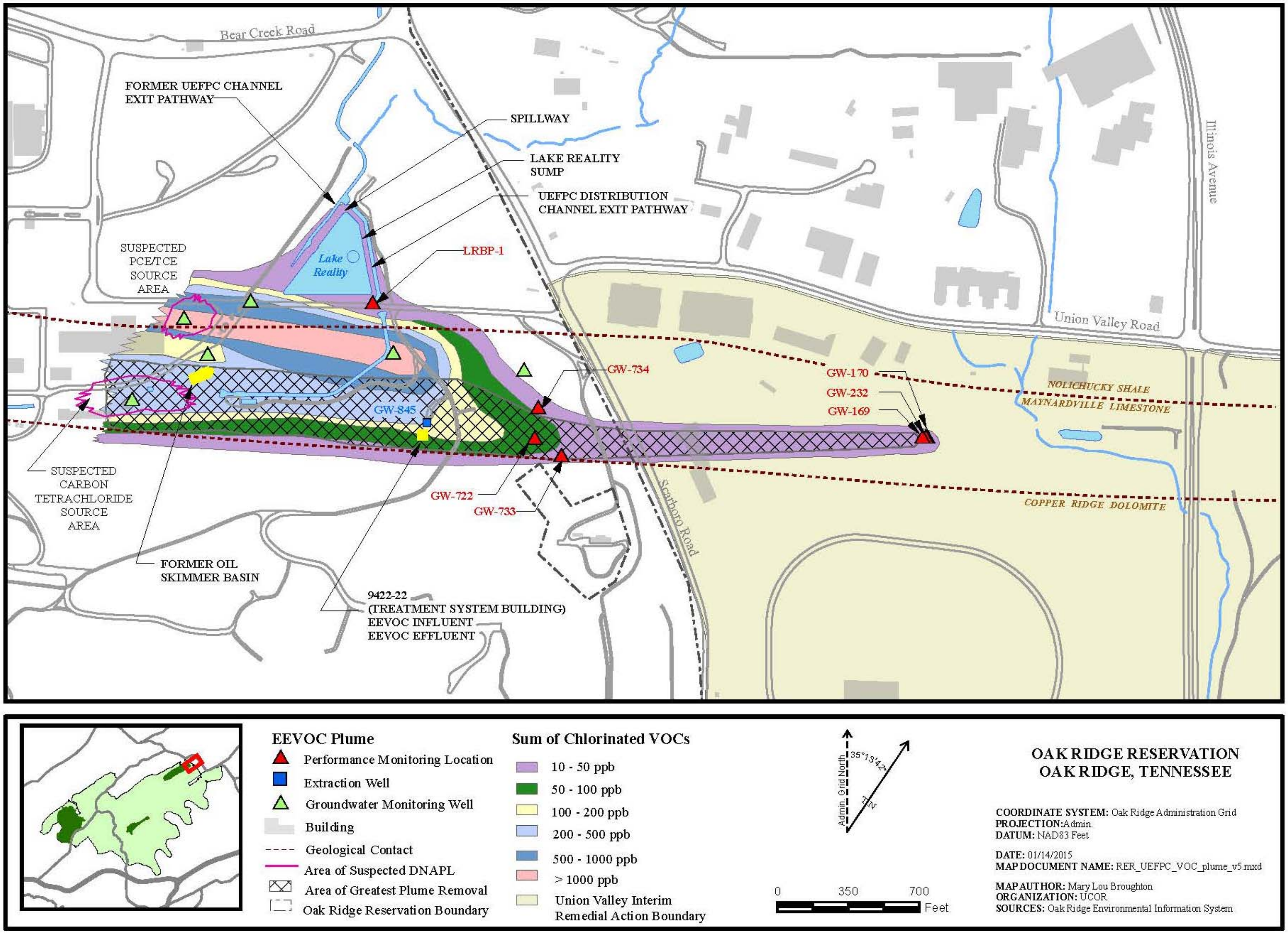


Figure 6.22. EEVOC plume in FY 2014 showing region of maximum chlorinated VOC removal.

Treated groundwater is continuously discharged into UEFPC. The *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-2297&D1) requires at least quarterly sampling and analysis of influent and effluent for VOCs, metal, nitrate, and uranium. The AWQC for carbon tetrachloride (currently 16 µg/L) is the ARAR for the treated discharge monitored at LRBP-1, the downstream POC.

6.3.1.1.2.1.1 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 an average concentration of about 140 µg/L (Figure 6.24). Likewise, chloroform concentrations have stabilized at about 9 µg/L.

Signature VOCs within the intermediate and deep intervals of the Maynardville Limestone directly downgradient of the pumping well (Figure 6.23) 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 GWPP. 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 2014 analytical results for several signature VOCs in well GW-722, Port 14 and Port 17, are in Table 6.7. 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 6.24). Since operation of the extraction system, carbon tetrachloride concentrations have 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.

In Union Valley east of Scarboro Road (Figures 6.21 and 6.22), signature VOCs (Table 6.7) 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. 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. Since EEVOC operation started in 2000, carbon tetrachloride concentrations have stabilized at about 5 µg/L or less. A sharp 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.

This page intentionally left blank.

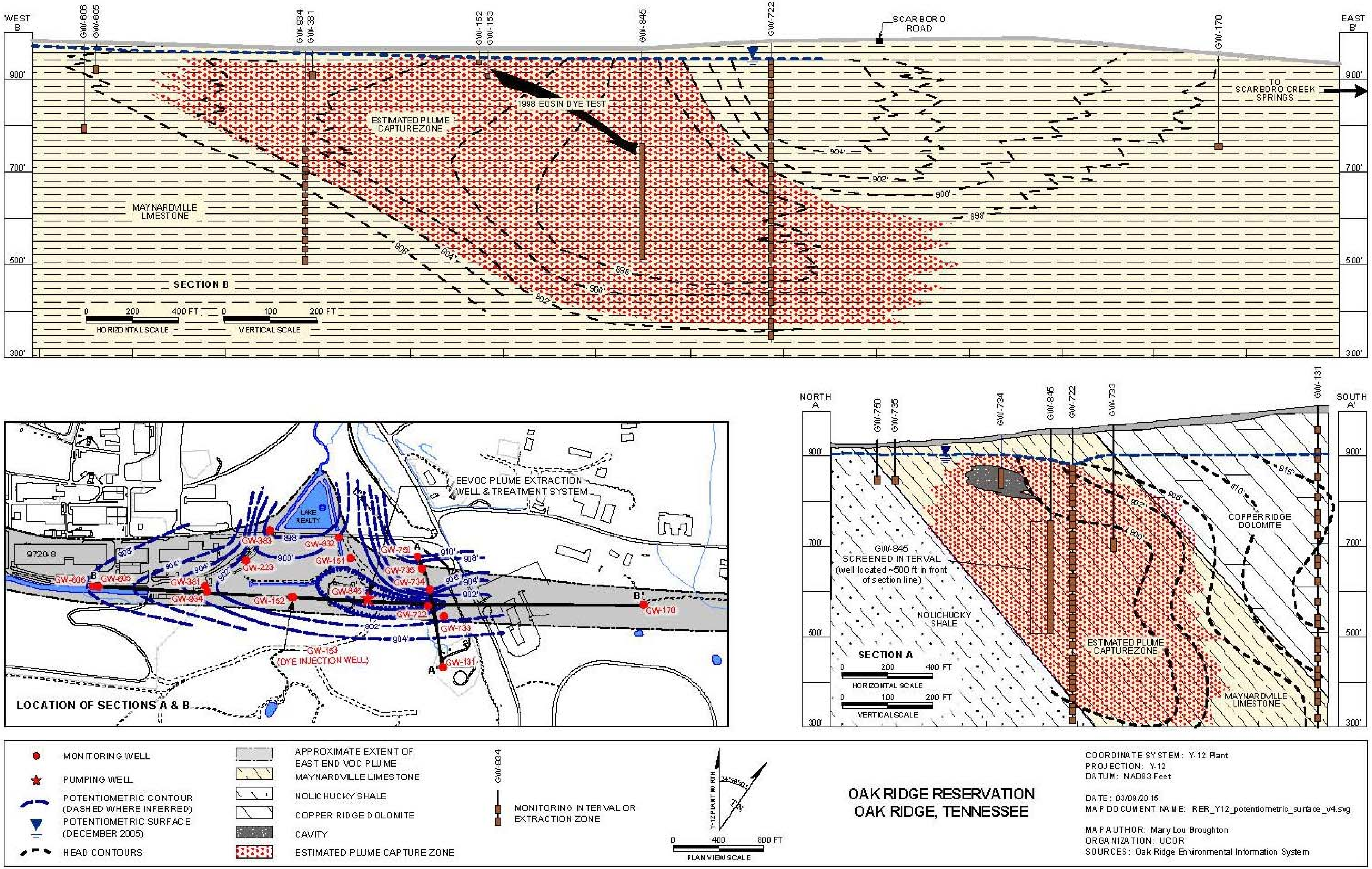


Figure 6.23. Potentiometric data and subsurface plume distribution at the eastern Y-12 Administrative site.

This page is intentionally left blank.

6.3.1.1.2.1.2 Treatment System Performance

Treatment system performance monitoring began in November 2000, following startup. During FY 2014, the treatment system performed well after correction of a mechanical problem in October 2013. Figure 6.25 shows the cumulative actual EEVOC treated water volume which varied between about 0.6 and 1.14 million gal/mo. and totaled about 11.3 million gal. In September 2014 the variable frequency drive on the pump motor failed and required replacement resulting in a 4-d system outage. This event had a minimal effect on the annual performance.

To evaluate the effectiveness of the treatment system, influent and corresponding effluent samples have been collected since operations began. In FY 2014, concentrations of carbon tetrachloride in treatment system influent (from well GW-845) ranged from 120 μg/L to 150 μg/L and averaged 142 μg/L for the year (Table 6.8). The concentration range for carbon tetrachloride in the effluent stream was 1 μg/L to 120 μg/L and averaged 26 μg/L. Removal efficiency for carbon tetrachloride ranged from about 8% to 99% and averaged about 81% in FY 2014 while removal efficiency for chloroform ranged from 8% to greater than 90% and averaged about 56%. Table 6.9 summarizes total mass removals for the principal VOCs since operations began in 2000. Inspection of Table 6.9 shows that there was a gradual deterioration in treatment system efficiency over the FY 2009 through FY 2011 period, better performance during FY 2012 and deteriorated performance during FY 2013. Facility operators investigated a performance issue in the autumn of 2013 and corrected a problem in the air stripper ducting which dramatically improved performance in the November 2013 sample results and for the remainder of FY 2014.

Table 6.7. Selected FY 2014 data for Y-12 EEVOC Plume performance

Chemical	**Station Name Sample Date Units**	**GW-169 2/26/2014**	**GW-169 8/4/2014**	**GW-170 2/26/2014**	**GW-170 8/2/2014**
Alpha activity (MCL = 15 pCi/L)	pCi/L	0.237 (U)	0.99 (U)	1.25 (U)	0.438 (U)
Beta activity (MCL screen = 50 pCi/L)	pCi/L	4.01 ± 1.44	3.91 ± 1.16	10.9 ± 2.31	8.82 ± 1.35
Carbon tetrachloride (MCL = 2 μg/L)	μg/L	< 1 (U)	< 1 (U)	1.3	1 (U)
Chloroform (MCL = 70 μg/L)	μg/L	< 1 (U)	< 1 (U)	< 1 (U)	< 1 (U)
PCE (MCL = 5 μg/L)	μg/L	1.5	1.5	< 1 (U)	< 1 (U)
TCE (MCL = 5 μg/L)	μg/L	< 1 (U)	< 1 (U)	1.1	< 1 (U)
Nitrate (MCL = 10 mg/L)	mg/L	1	0.94	0.47	0.45
Chemical	**Station Name Sample Date Units**	**GW-722-17 2/25/2014**	**GW-722-17 7/16/2014**	**GW-722-14 2/5/2014**	**GW-722-14 7/16/2014**
Carbon tetrachloride (MCL = 2 μg/L)	μg/L	27	34	16	17
Chloroform (MCL = 70 μg/L)	μg/L	4.8	4 (J)	1.6	5 (U)
PCE (MCL = 5 μg/L)	μg/L	5	3 (J)	2.2	2 (J)
TCE (MCL = 5 μg/L)	μg/L	1.3	5 (U)	1.2	5 (U)

EEVOC = East End Volatile Organic Compound
FY = fiscal year
GW = groundwater well
J = estimated value
MCL = maximum contaminant level
PCE = tetrachloroethene
TCE = trichloroethene
U = Not detected or result less than minimum detectable
Y-12 = Y-12 National Security Complex

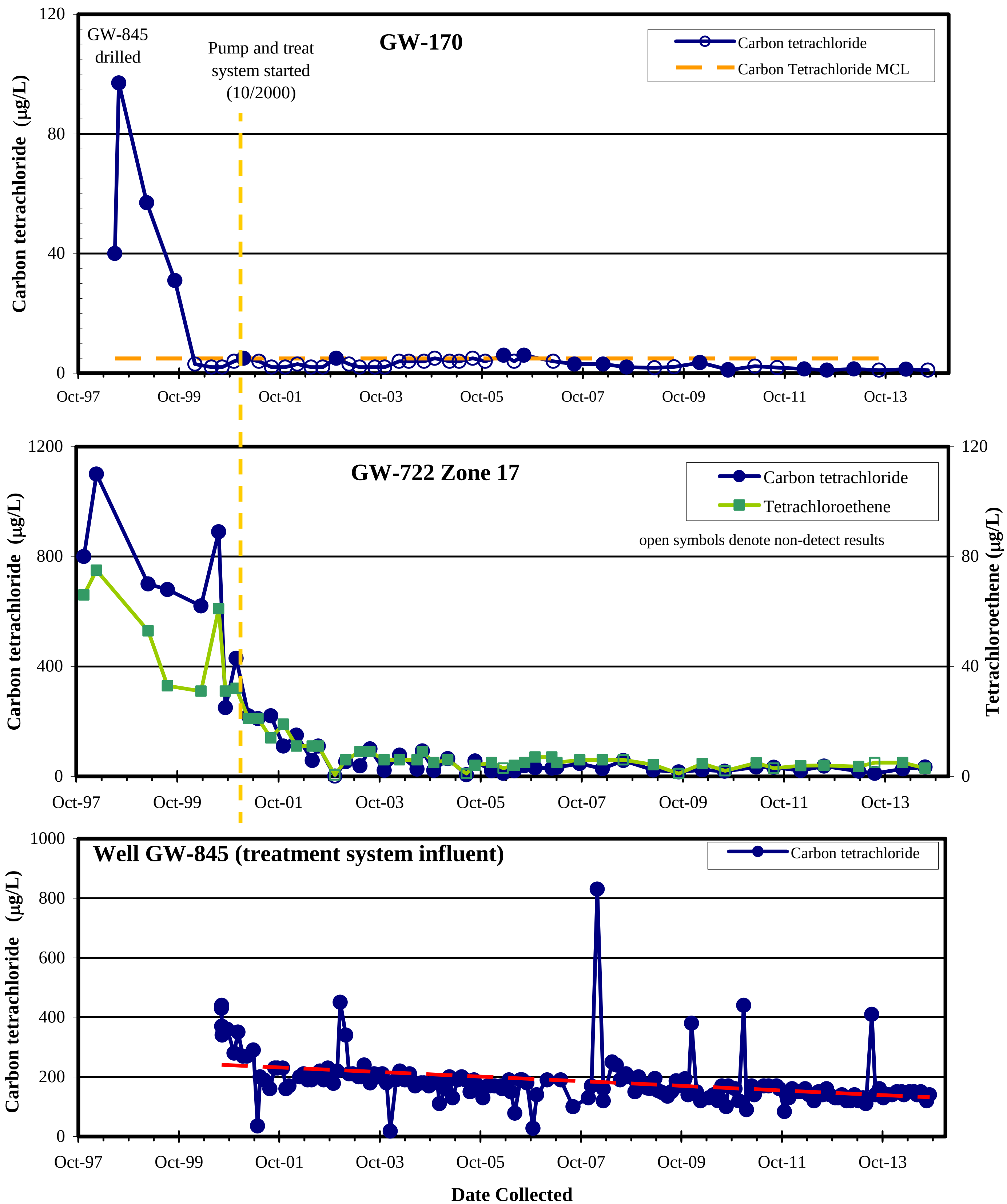


Figure 6.24. Selected VOC trends in the Maynardville Limestone exit pathway.

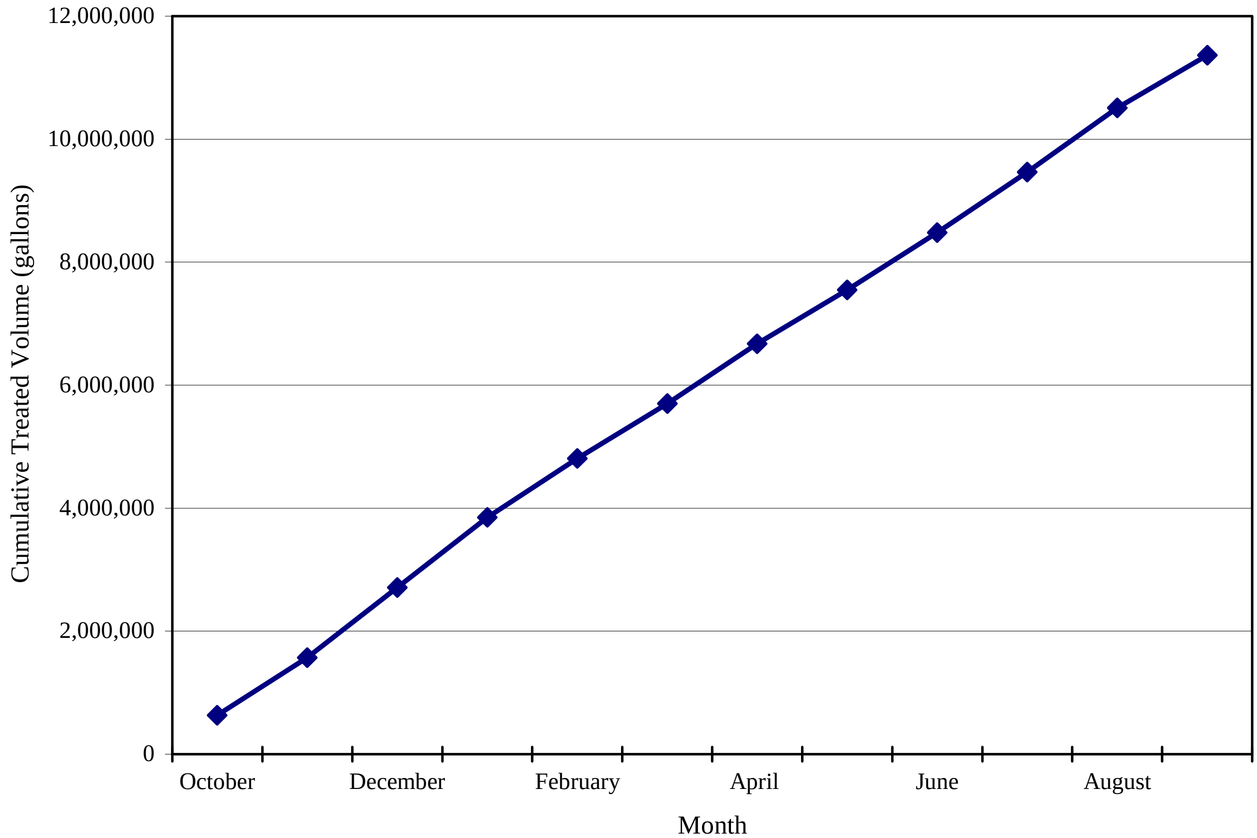


Figure 6.25. EEVOC treatment system cumulative water treated during FY 2014.

Effluent concentration limits were 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. Six of the monthly grab samples contained carbon tetrachloride at concentrations greater than the recreational – organisms only AWQC value of 16 µg/L. To evaluate potential impacts in surface water in the UEFPC grab samples were collected at LRBP-1, the POC in the receiving stream downstream of the location where treated water is discharged. No AWQC exceedances were measured for carbon tetrachloride in the stream. Regular and duplicate samples are collected at this location and during February 2014 carbon tetrachloride was detected in the regular sample at 1 µg/L and in the duplicate at 1.4 µg/L. During September carbon tetrachloride was not detected in the regular sample but was detected at 1 µg/L in the duplicate sample.

Maximum FY 2014 results of selected organic and radiological constituents in both influent and effluent samples are in Table 6.10. Reductions observed for other signature VOCs detected in the influent stream (Table 6.8 and Table 6.10) are consistent with the relative ranking of their volatility, as indicated by their respective Henry's Law constants (i.e., carbon tetrachloride > PCE > chloroform).

Table 6.8. EEVOC plume treatment system performance data, FY 2014

Chemical	Date	Influent result (μg/L)	Effluent result (μg/L)	Percent reduction	Estimated net mass removal (kg)[a]
Carbon tetrachloride	10/8/2013	130	120	7.7%	0.024
	11/12/2013	140	1	84%	0.493
	12/10/2013	140	4.9	99%	0.584
	1/14/2014	150	28	81%	0.527
	2/19/2014	150	54	64%	0.348
	3/6/2014	140	2.5	98%	0.464
	4/15/2014	150	14	91%	0.501
	5/19/2014	150	11	93%	0.459
	6/10/2014	140	20	86%	0.423
	7/8/2014	150	18	88%	0.493
	8/19/2014	120	23	81%	0.383
	9/8/2014	140	13	91%	0.411
FY 2014 annual average:		**142**	**26**	**81%**	
FY 2014 annual mass removal:					**5.1 kg**
Chloroform	10/8/2013	8.7	9.4	- 8%	-0.002
	11/12/2013	9.9	<1 U	> 90%	0.032
	12/10/2013	9.2	1.5	84%	0.033
	1/14/2014	9.6	5.3	45%	0.019
	2/19/2014	9	7.4	18%	0.006
	3/6/2014	6.8	1.3	81%	0.019
	4/15/2014	9.3	3.6	61%	0.021
	5/19/2014	9.3	3	68%	0.021
	6/10/2014	10	4.4	56%	0.020
	7/8/2014	9.7	3.7	62%	0.022
	8/19/2014	8.6	4.5	48%	0.016
	9/8/2014	9.4	2.9	69%	0.021
FY 2014 annual average:		**9.1**	**4.0**	**56%**	
FY 2014 annual mass removal:					**0.23 kg**
PCE	10/8/2013	28	26	7%	0.005
	11/12/2013	23	< 1 U	> 96%	0.078
	12/10/2013	21	< 1 U	> 95%	0.086
	1/14/2014	20	4.9	76%	0.065
	2/19/2014	20	9.7	52%	0.037
	3/6/2014	15	< 1 U	> 93%	0.047
	4/15/2014	19	2.8	85%	0.060

Table 6.8. EEVOC plume treatment system performance data, FY 2014 (cont.)

Chemical	Date	Influent result (μg/L)	Effluent result (μg/L)	Percent reduction	Estimated net mass removal (kg)[a]
	5/19/2014	23	2.4	90%	0.068
	6/10/2014	24	4.6	81%	0.068
	7/8/2014	25	4	84%	0.078
	8/19/2014	21	5	76%	0.063
	9/8/2014	21	2.7	87%	0.059
FY 2014 annual average:		**22**	**5.4**	**77%**	
FY 2014 annual mass removal:					**0.72 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.

EEVOC = East End Volatile Organic Compound
FY = fiscal year
PCE = tetrachloroethene
U = Not detected or result less than minimum detectable

Table 6.9. Estimated mass removals for key EEVOC plume constituents since inception of treatment operations

FY	Carbon tetrachloride (kg)	Chloroform (kg)	PCE (kg)
2001	9.2	0.81	0.74
2002	7.7	0.39	0.81
2003	9.9	0.44	1.03
2004	7.4	0.27	0.83
2005	6.3	0.29	0.86
2006	6.7	0.34	0.86
2007	5.7	0.22	0.63
2008	7.2	0.37	1.1
2009	6.8	0.20	0.88
2010	4.9	0.21	0.68
2011	2.7	0.04	0.31
2012	5.5	0.22	0.73
2013	3.9	0.19	0.64
2014	5.1	0.23	0.72
Totals	89	4.2	11

EEVOC = East End Volatile Organic Compound
FY = fiscal year
PCE = tetrachloroethene

Table 6.10. Summary of EEVOC plume groundwater treatment system performance results, FY 2014

Analyte[a]	Units	Maximum influent detect (GW-845)	Maximum effluent detect
2-Butanone	µg/L	10 (U)	10 (U)
Carbon tetrachloride	µg/L	150	120
Chloroform	µg/L	10	9.4
1,1-DCA	µg/L	< 1 (U)	1.2
1,1,1-TCA	µg/L	< 1 (U)	< 1 (U)
Cis-1,2-DCE	µg/L	4.3	3.1
Trans-1,2-DCE	µg/L	< 1 (U)	< 1 (U)
PCE	µg/L	28	26
TCE	µg/L	4.5	3.8
Nitrate[b]	mg/L	1.3	1.4
Total uranium[b]	mg/L	0.0071	0.0065
^{234}U[b]	pCi/L	8.24 ± 0.915	8.77 ± 1.02
^{235}U[b]	pCi/L	0.643 ± 0.267	0.608 ± 0.288
^{238}U[b]	pCi/L	6.23 ± 0.789	6.53 ± 0.873

[a]All VOCs detected are listed.
[b]Note system design and remedy is targeted for VOCs.

DCA = dichloroethane
DCE = dichloroethene
EEVOC = East End Volatile Organic Compound
FY = fiscal year
GW = groundwater well
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene
U = Result less than method reporting limits or minimum detectable activity
VOC = volatile organic compound

During FY 2014, monitoring data for treatment system influent show that ^{234}U and ^{238}U reached their highest activities for the year in December. Figure 6.26 is a graph of the measured activities of ^{234}U and ^{238}U throughout the EEVOC treatment system operations through FY 2014. Table 6.10 includes the maximum EEVOC treatment system influent and effluent uranium isotopic activities. The uranium concentration calculated from the isotopic activities in influent and effluent ranged from about 1 to 20 µg/L and averaged 4.6 µg/L during FY 2014. These levels are less than the 30 µg/L MCL reference concentration. Based on the average groundwater withdrawal rate throughout FY 2014, the uranium mass discharged from the EEVOC system was approximately 0.19 kg for the year. This mass is a minor contribution to the yearly uranium mass measured at Station 17 (Section 6.2.1.2.1.2). During FY 2014 the strong seasonal fluctuations of uranium concentrations noted in FY 2012 and FY 2013 continued, with higher activities measured during winter and spring than during summer and early autumn. This cyclic contaminant concentration signature is indicative of the role of dynamic groundwater plume transport in response to seasonal climatic drivers.

The *Action Memorandum for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-1819&D2) 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 can be modified to accommodate treatment of other contaminants, as warranted.

6.3.1.1.3 Performance Summary

The EEVOC plume removal action is measured through two metrics. The first metric is the effectiveness of the groundwater withdrawals at reducing VOC concentrations in the plume off DOE property to the northeast in Union Valley. The second metric is the performance of the air stripper at removing the signature VOCs from the water discharged to UEFPC. FY 2014 data indicate that the groundwater pump and treatment system has effectively withdrawn groundwater and has limited off-site plume migration. Evidence of that performance is the below drinking water limit concentrations of carbon tetrachloride in off-site monitoring wells in Union Valley. During FY 2014 the air stripper system performed well after a mechanical problem noted in October 2013 was corrected. The variable frequency drive on the well pump motor required replacement during September 2014. A brief (4-day) system outage occurred at that time.

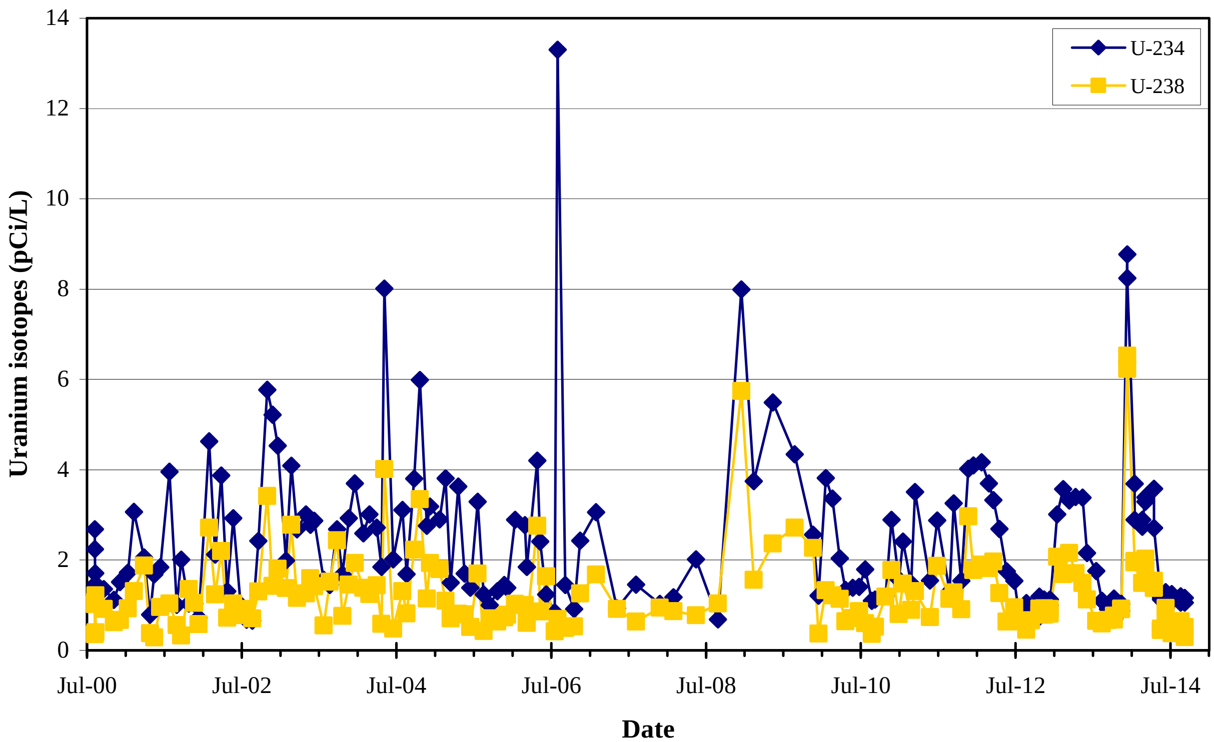


Figure 6.26. Activities of ^{234}U and ^{238}U in EEVOC treatment system influent.

6.3.1.2 Other LTS Requirements

Other LTS requirements for EEVOC plume treatment system are listed in Table 6.6 and described below.

6.3.1.2.1 Requirements

Other than operation and maintenance of the EEVOC plume treatment system discussed above in Section 6.3.1, no requirements were specified in the *Action Memorandum for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume* (DOE/OR/01-1819&D2).

6.3.1.2.2 Status of Requirements

Although no requirements are specified other than operation and maintenance of the EEVOC plume treatment system, the site remained protected by the DOE 229 Boundary access controls (this security boundary is designated pursuant to Section 229 of the Atomic Energy Act of 1954 which prohibits unauthorized entry) and was regularly patrolled by security personnel. In addition, groundwater use remained restricted within Y-12 and Union Valley.

6.3.2 Union Valley

Location of the Union Valley Interim Action (DOE/OR/02-1545&D2) 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.

6.3.2.1 Performance Monitoring

Institutional controls were selected as the interim remedy to ensure that public health is protected while final actions are being developed and implemented and to identify and prohibit, if necessary, future activities with a potential to accelerate the rate of contaminant migration from the contaminated area or increase the extent of the contaminant plume.

No surface water or groundwater monitoring is required as part of this interim action. 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 Section 6.3.1.1.1.

6.3.2.2 Other LTS Requirements

Other LTS requirements for Union Valley are listed in Table 6.6 and described below.

6.3.2.2.1 Requirements

The *Record of Decision for an Interim Action for Union Valley, Upper East Fork Poplar Creek Characterization Area* (DOE/OR/02-1545&D2) requires that DOE ensure that the required property title searches and appropriate notifications are made until a final ROD is issued for the UEFPC contaminated area. DOE 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 Office 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.

6.3.2.2.2 Status of Requirements

Compliance with all requirements was verified in FY 2014. The DOE ORO Realty Officer provided documentation that property owners, the Oak Ridge City Manager, and TDEC/DOE Oversight Office 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 and that property owners were surveyed by telephone, as required, was provided by the DOE Property Management Office. LUC verification information used to document these results was compiled by the DOE Property Management Office in conjunction with DOE Realty Office. A copy of the documentation is submitted to the WRRP for use in the annual RER. Original documents are maintained by the Project Document Control Center.

6.3.2.3 Removal of Mercury from Storm Sewer System

Location of the action addressed in the *Action Memorandum for Time-Critical Removal Action for the Removal of Mercury from the Storm Sewer System at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2574&D1) is shown on Figure 6.1. The goal of the removal action was to reduce the release of mercury to UEFPC by capturing ongoing releases of mercury to the storm drain system, upstream of Outfalls 150, 160, 163, and 169. The project included reworking selected manholes; reworking selected storm drain junction boxes; installing mercury collection sumps (traps); installing mercury removal mechanisms; and collecting mercury from those features and other locations.

6.3.2.3.1 Other LTS Requirements

Other LTS requirements for the removal action are listed in Table 6.6 and described below.

6.3.2.3.2 Requirements

The *Removal Action Report for the Mercury Reduction Project* (DOE/OR/01-2595&D1) requires that the storm drain locations identified in the RmAR will continue to be monitored and maintained. Elemental mercury and associated contaminated sediments will continue to be collected, stored, treated, and disposed as described in the RmAR. The results of the removals are to be summarized in the annual RER.

6.3.2.3.3 Status of Requirements

Compliance with the requirements of the RmAR were verified in FY 2014. The nine trap locations are visually inspected periodically and material accumulated in the traps, including elemental mercury and associated sediments, is removed as needed for waste storage, treatment, and disposal. The amount of mercury removed in FY 2014 is reported in Section 6.2.1.2.1.2.

6.3.2.4 Secondary Pathways Project

The purpose of the Secondary Pathways Project was to identify and/or correct potential mercury infiltration and migration points at each of the three major mercury use facilities at Y-12. Scope included completion of mercury reduction actions outside Buildings 9201-5 (Alpha 5) and 9201-4 (Alpha 4). Additional actions included the investigation, identification and confirmation of potential mercury source points inside both facilities and Building 9204-4 (Beta 4) using available drawings of piping systems and floor drains. The project consisted of work to improve and control storm water runoff from the north and south sides of Alpha 5 and the south side of Alpha 4. The work included modifying drains, drainage systems and installing graded impervious surfaces to route runoff to storm drains, reducing percolation through mercury contaminated soil. Work inside Alpha 5 and Beta 4 identified and confirmed the location of existing open drains inside each building. Prior activities in Alpha 4 have already been completed to eliminate potential mercury migration pathways.

6.3.2.4.1 Other LTS Requirements

Other LTS requirements for the Secondary Pathways Project are listed in Table 6.6 and described below.

6.3.2.4.1.1 Status of Requirements

The *Phased Construction Completion Report for the Secondary Pathways Project* (DOE/OR/01-2596&D1) states that the Y-12 Utilities Management Division is responsible for long-term operation and maintenance requirements associated with the drainage improvements. Clean out and other maintenance work will be performed as needed.

6.3.2.4.1.2 Status of Requirements

Compliance with the requirements of the PCCR were verified in FY 2014. The drainage improvements were maintained as needed.

6.4 UEFPC WATERSHED ISSUES AND RECOMMENDATIONS

The issues and recommendations for the UEFPC watershed are in Table 6.11.

Table 6.11. UEFPC watershed issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issues Carried Forward[b]			
None			
Completed/Resolved Issues			
None			

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the 2015 RER. An "Issue Carried Forward" is an issue identified in a previous year's RER or FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.
[b]The year of the RER or the FYR in which the issue originated is provided in parentheses, e.g., (2013 RER).

FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report
UEFPC = Upper East Fork Poplar Creek

6.5 REFERENCES

DOE/OR/01-1641/V1-V4&D1. *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 1998, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1819&D2. *Action Memorandum for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume, Oak Ridge, Tennessee*, 1999, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1951&D3. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1951&D3/R2. *Non-Significant Change to the Record of Decision for Phase 1 Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2229&D3. *Record of Decision for Phase II Interim Remedial Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek, Oak Ridge, Tennessee,* 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2289&D3. *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2297&D1. *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume, Oak Ridge, Tennessee*, 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2456&D1/R1. *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, Oak Ridge, Tennessee*, 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2481&D1/A1. *Addendum to the Phased Construction Completion Report for Scrap Metal Removal at the Y-12 Old Salvage Yard, Y-12 National Security Complex, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee, Volumes 1 and 2*, 2012, U.S. Department of Energy, Oak Ridge, TN.

DOE/OR/01-2539&D2. *Explanation of Significant Differences for the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2574&D1. *Action Memorandum for Time-Critical Removal Action for the Removal of Mercury from the Storm Sewer System at they-12 National Security Complex, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2595&D1. *Removal Action Report for the Mercury Reduction Project at the Y-12 National Security Complex, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2596&D1. *Phased Construction Completion Report for the Secondary Pathways Project Y-12 National Security Complex, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2599&D2. *Remedial Design Work Plan for the Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2605&D2. *Strategic Plan for Mercury Remediation at the Y-12 National Security Complex, Oak Ridge, Tennessee,* 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2613&D1. *Phased Construction Completion Report for the Non-Time-Critical Removal Action for Building 9206 Duct and Fan Removal Project at the Y-12 National Security Complex, Oak Ridge, Tennessee,* 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2660&D1. *Focused Feasibility Study for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee,* 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2661&D1. *Proposed Plan for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee,* 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2662&D1. *Action Memorandum for Time-Critical Removal Action for the Removal of Debris and Soil from the Haul Road Ravine Disposal Area at the Y-12 National Security Complex, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1545&D2. *Record of Decision for an Interim Action for Union Valley, Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 1997, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for the Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Mathews, T., G. Southworth, M. Peterson, W. Roy, R. Ketelle, C. Valentine, S. Gregory. Decreasing aqueous mercury concentrations to achieve safe levels in fish: examining the water-fish relationship in two point-source contaminated streams. *Science of the Total Environment* 2013. 443:836-843.

Peterson, M. J., R. A. Efroymson, and S. M. Adams. 2011. *Long-Term Biological Monitoring of an Impaired Stream: Synthesis and Environmental Management Implications*. Environmental Management 47:6: 1125-1140.

TDEC 2007. State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October 2007. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Approved March 2008.

TDEC 2010a. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Melton Hill Reservoir: Lower Clinch River Watershed (HUC 06010207), Anderson, Knox, Loudon, and Roane Counties, Tennessee.

TDEC 2010b. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Watts Bar Reservoir: Watts Bar Lake Watershed (HUC 06010201), Lower Clinch River Watershed (HUC 06010207), and Emory River Watershed (HUC 06010208), Loudon, Meigs, Morgan, Rhea, and Roane Counties, Tennessee.

TDEC 2010c. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Fort Loudon Reservoir: Fort Loudon Lake Watershed (HUC 06010201), Blount, Knox, and Loudon Counties, Tennessee.

UCOR-4323. *Treatability Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge, Tennessee* 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Y/ER-206/R1. *Union Valley Interim Study Remedial Site Evaluation, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, 1995, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge TN.

This page intentionally left blank.

7. OFF-SITE ACTIONS

7.1 INTRODUCTION AND STATUS

7.1.1 Introduction

Table 7.1 lists the CERCLA actions outside of the ORR and identifies those with monitoring or other LTS requirements. Figure 7.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Figure 7.2 shows interim controls requiring LTS.

Poplar Creek, the Clinch River, and Watts Bar Reservoir comprise a single, hydrologically connected system through which contaminants originating on the ORR are transported. In September 1999, the monitoring plans for the Clinch River/Poplar Creek and LWBR were combined in the *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&D2), now referred to as the *Lower Watts Bar Reservoir and Clinch River Poplar/Creek Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee (*DOE/OR/01-1820&D3), to better identify and evaluate changes in contaminants of concern concentrations in fish. However, the CERCLA decisions and evaluations of effectiveness are discussed separately (Sections 7.3 and 7.4).

For a complete discussion of background information and performance metrics for each remedy, a compendium of all CERCLA decisions for off-site actions is provided in Chapter 4 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

7.1.2 Status Update

A Non-Significant Change (NSC) to the *Record of Decision for the Lower Watts Bar Reservoir* (DOE/OR/02-1373&D3) was approved in November 2014. The NSC clarifies that the CERCLA decision included ecological protection and that the basis of the monitoring being performed is to detect changes in LWBR. If the annual RER or FYR process results in an agreement for additional monitoring, DOE will submit an Erratum to the *Lower Watts Bar Reservoir and Clinch River Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-1820&D3) to EPA and TDEC requesting formal approval of the change.

Table 7.1. CERCLA actions at off-site locations

CERCLA action	Decision document, date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/ Other LTS required
Completed actions			
LEFPC	ROD (DOE/OR/02-1370&D2): 08/17/95 ESD (DOE/OR/02-1443&D2): 11/15/96, increase in soil excavation volume	RAR (DOE/OR/01-1680&D5) approved 08/15/00	Yes/Yes
Clinch River/Poplar Creek	ROD (DOE/OR/02-1547&D3): 09/23/97	RAR (DOE/OR/02-1627&D3) approved 06/14/99 • LWBR and Clinch River/Poplar Creek Watershed RAR CMP (DOE/OR/01-1820&D3)	Yes/Yes
LWBR	ROD (DOE/OR/02-1373&D3): 09/29/95 NSC: approved 11/04/14, ecological protection clarification	RAWP[b] (DOE/OR/02-1376&D3) approved 05/25/96 • LWBR and Clinch River/Poplar Creek Watershed RAR CMP (DOE/OR/01-1820&D3)	Yes/Yes

[a]Detailed information of the status of ongoing actions is from Appendix E of the FFA and is available at <http://www.ucor.com/ettp_ffa_appendices.html>.
[b]This action was completed prior to uniform adherence to the RAR process; hence, no RAR exists for this decision.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMP = Comprehensive Monitoring Plan
ESD = Explanation of Significant Differences
FFA = Federal Facility Agreement
LEFPC = Lower East Fork Poplar Creek
LTS = long-term stewardship
LWBR = Lower Watts Bar Reservoir
NSC = Non-Significant Change
RAR = Remedial Action Report
RAWP = Remedial Action Work Plan
ROD = Record of Decision

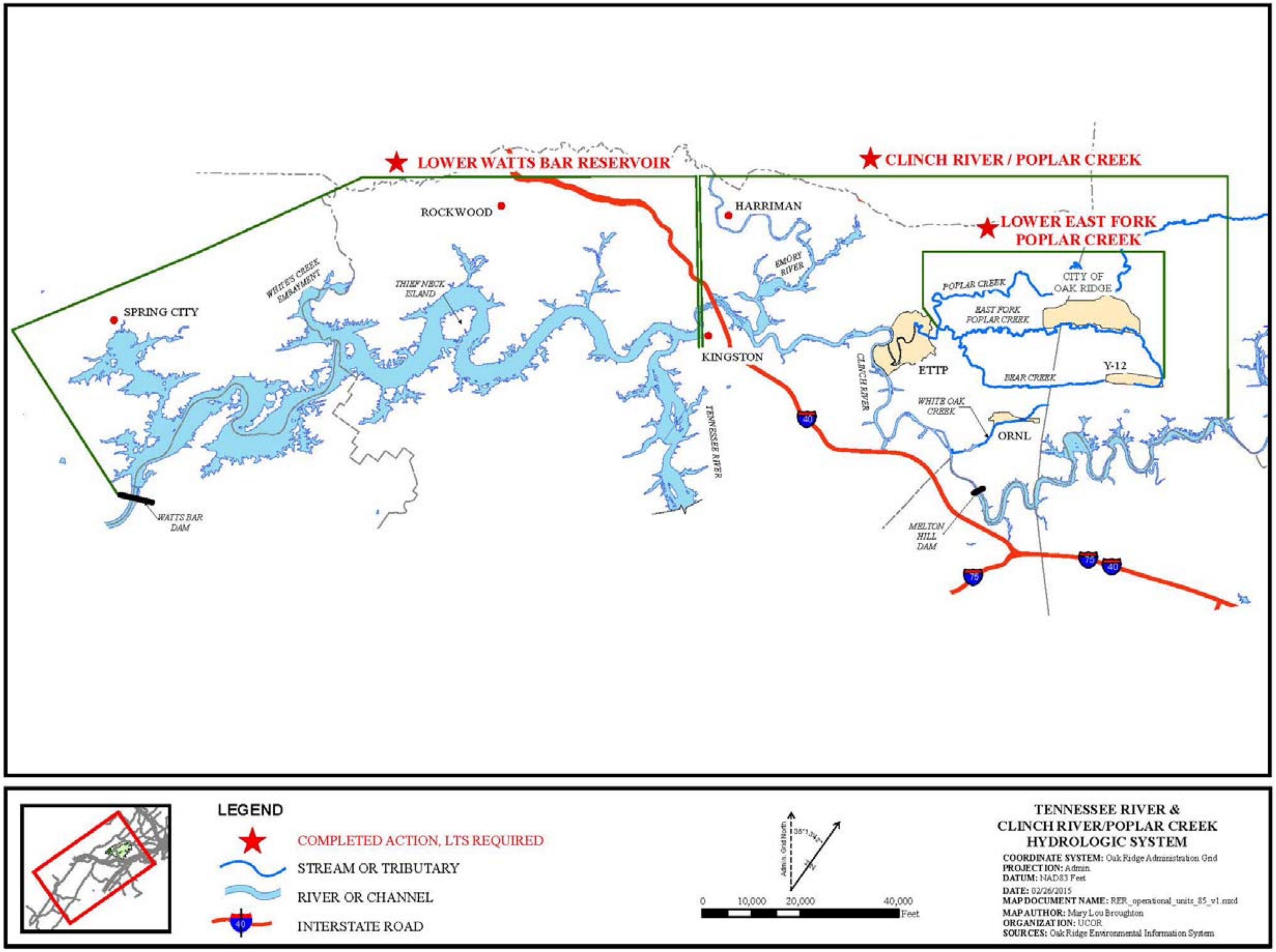


Figure 7.1. CERCLA actions at off-site locations.

This page intentionally left blank.

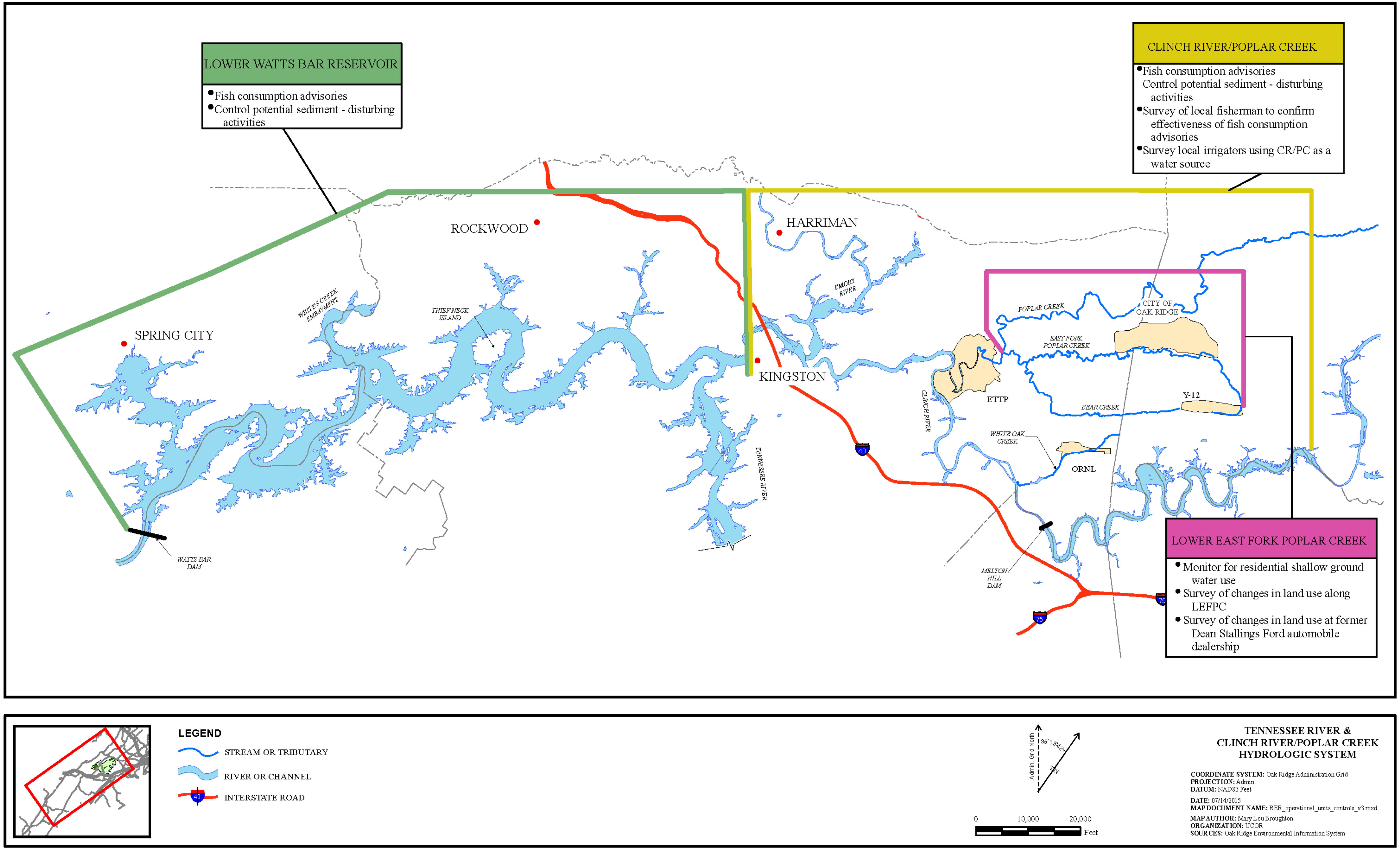


Figure 7.2. Interim controls requiring LTS at off-site locations.

This page intentionally left blank.

7.2 LEFPC

7.2.1 Performance Monitoring

7.2.1.1 Performance Monitoring Goals and Objectives

The *Record of Decision for Lower East Fork Poplar Creek* (DOE/OR/02-1370&D2) 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 7.3).

A major component of the selected remedy for LEFPC was to perform appropriate monitoring to ensure effectiveness. The *Remedial Action Report on the Lower East Fork Poplar Creek Project* (DOE/OR/01-1680&D5) provides a description of all measures taken during the remedial activities to comply with ARARs and supplemental monitoring activities. During FY 2014 mercury inputs from UEFPC to LEFPC were monitored at Station 17. This requirement is covered by the mercury monitoring at Station 17 required by the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area* (DOE/OR/01-1951&D3).

7.2.1.2 Evaluation of Performance Monitoring Data

7.2.1.2.1 Watershed Data

As a requirement of the *Remedial Action Report on the Lower East Fork Poplar Creek Project*, (DOE/OR/01-1680&D5) 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 LEFPC (Figure 7.3). A full discussion of the historical and current trends in mercury releases at Station 17 is presented in Section 6.2.

The effect of the upstream mercury source on LEFPC and downstream spatial trends in mercury bioaccumulation in various sunfish species (rock bass, redbreast, and bluegill) are depicted in Figure 7.4. Different species of fish are encountered at different sites, and these species can vary in their mercury content. In contrast to aqueous mercury concentrations which tend to decrease with increasing distance downstream, there is a general trend of increasing mercury concentrations in fish with increasing distance downstream within LEFPC. Although there is variability in mercury concentrations between sites and species of fish, mercury concentrations are highest in fish that feed at higher trophic levels such that concentrations in rock bass > redbreast > bluegill collected at the same site and season. In 2014, similar to trends seen in recent years, the highest concentrations in LEFPC were seen at EFK 13.8 (0.87 and 1.37 µg/g for redbreast and rock bass, respectively), but concentrations in redbreast in Poplar Creek just downstream of the confluence with East Fork Poplar Creek (Poplar Creek mile [PCM] 5.1) were even higher than within East Fork Poplar Creek (1.09 µg/g). Regardless of the sunfish species, it is evident that the mercury content in fillets of sunfish is above EPA's recommended AWQC of 0.3 µg/g mercury in fish throughout LEFPC and at the mouth of Poplar Creek, but decreases below this threshold within a few kilometers downstream in lower Poplar Creek and the Clinch River.

At EFK 6.3, the long-term trend since the 1980s is of increasing mercury concentrations in fish (Southworth et al., 2011; Figure 7.5). However, trend analysis is again complicated by the change in fish species availability. If considering redbreast or rock bass temporal trends only, there is no clear evidence of an increasing or decreasing trend in recent years (especially over the 2003 – 2014 time period).

This page intentionally left blank.

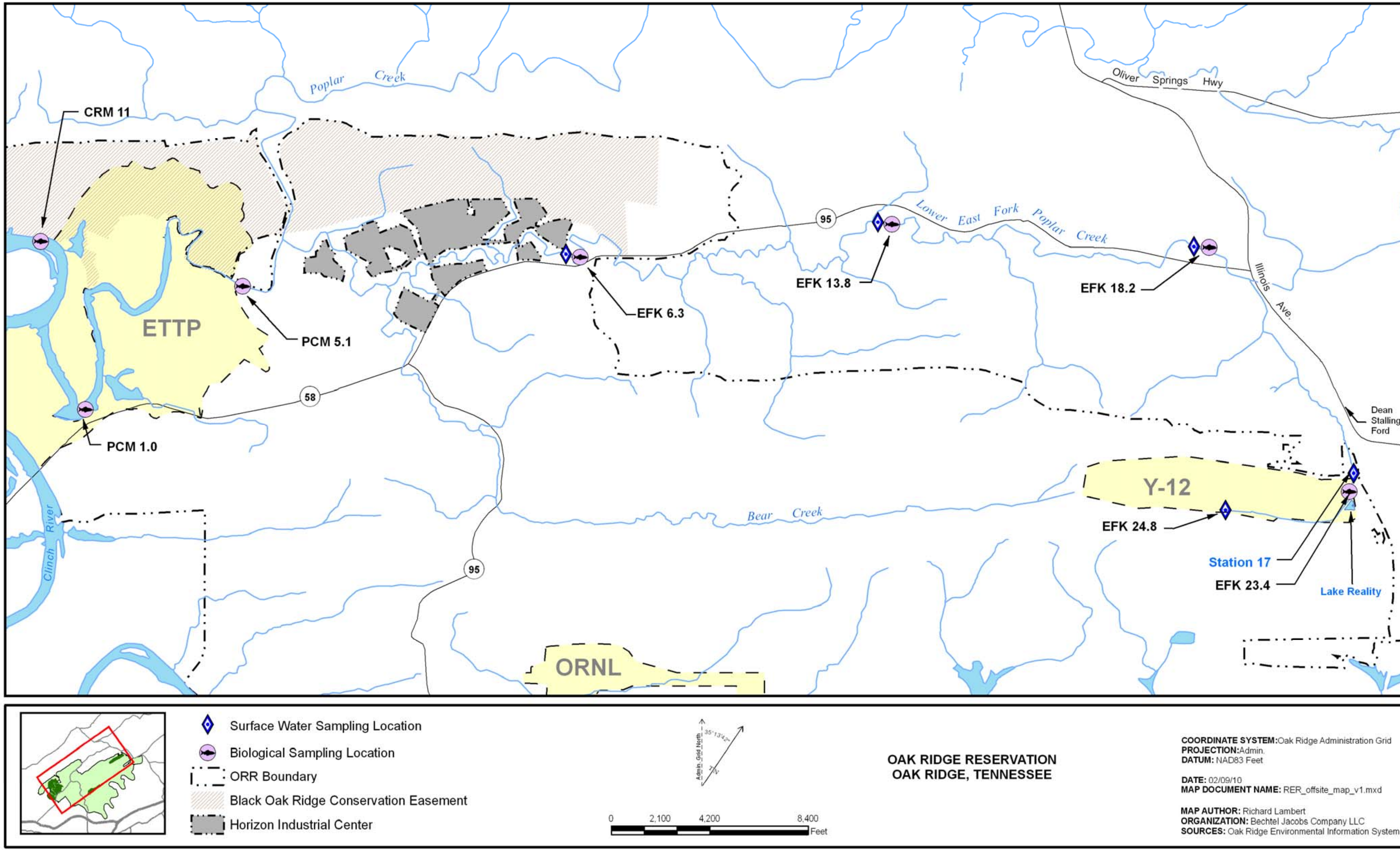


Figure 7.3. LEFPC.

This page intentionally left blank.

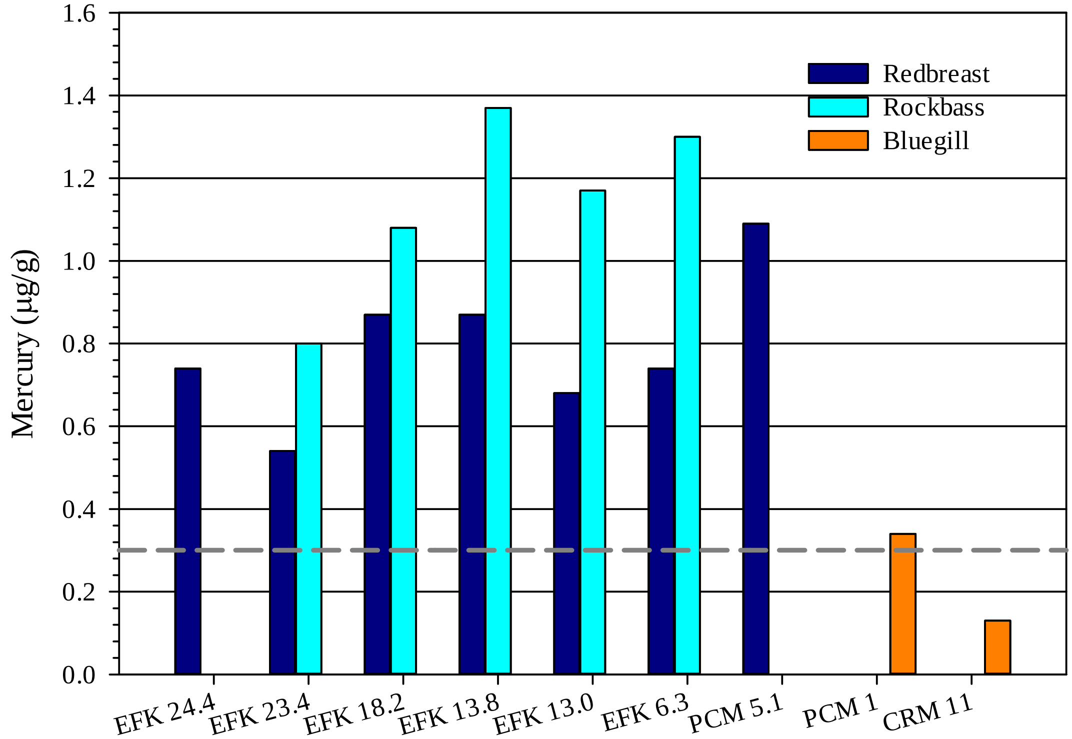


Figure 7.4. Spatial pattern of mercury bioaccumulation in various fish species in LEFPC (EFK), Poplar Creek (PCM) and the Clinch River (CRM) in spring/summer 2014.

Dashed line indicates EPA recommended AWQC for mercury (0.3 µg/g in fish).

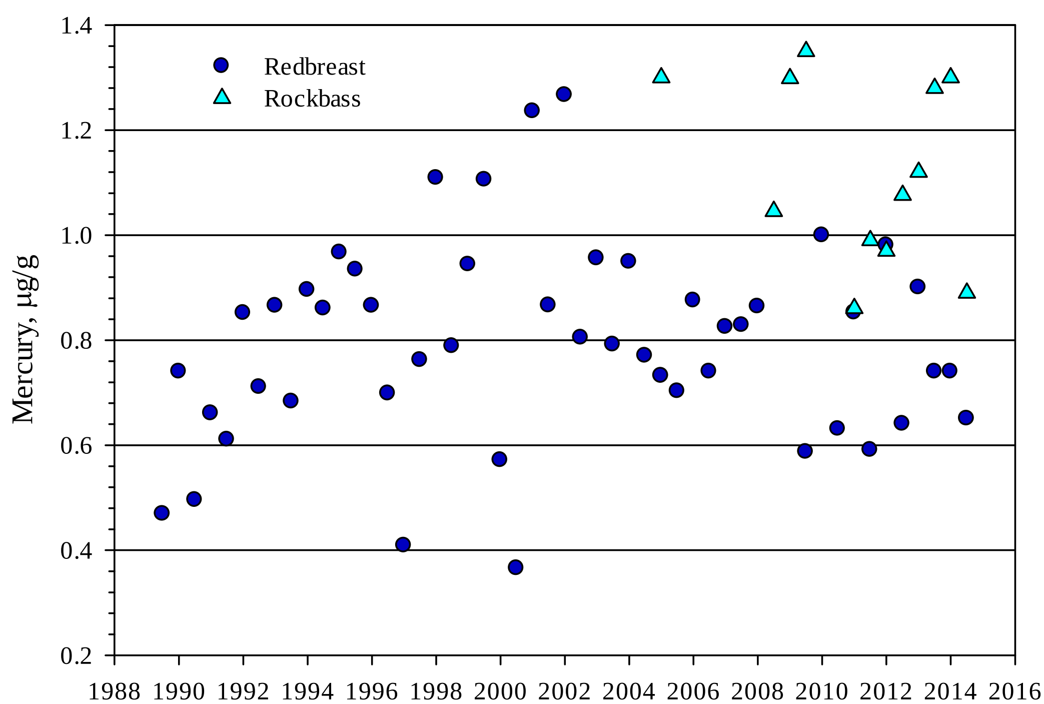


Figure 7.5. Mean mercury concentration in muscle tissue of redbreast sunfish at EFK 6.3.[a]

[a]When redbreast sunfish could not be found, rock bass (light blue triangles) were collected instead.

7.2.1.3 Performance Summary

Monitoring at Station 17 is conducted to measure the concentration and mass flux of mercury that is discharged from the UEFPC watershed into LEFPC. During FY 2014, the flow-paced continuous monitoring detected an average concentration of 1,490 ng/L and a mass flux of 14.4 kg mercury (Section 6.2.1). The levels of mercury in fish tissue in the LEFPC have remained elevated.

7.2.2 Other LTS Requirements

Other LTS requirements for LEFPC are listed in Table 7.2 and described below.

7.2.2.1 Requirements

The *Record of Decision for Lower East Fork Poplar Creek, Oak Ridge, Tennessee* (DOE/OR/02-1370&D2) states that although residential use of soil horizon (shallow) groundwater is not realistic, as a safeguard, DOE will periodically perform a survey to determine if shallow groundwater is being used as a potable water supply by residents along LEFPC.

The *Remedial Action Report on the Lower East Fork Poplar Creek* (DOE/OR/01-1680&D5) 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 ROD (DOE/OR/02-1370&D2) and exposure pathways remain protected. Additionally, the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) identified that the property is for sale and that could result in a change in land use. It was stated that if changes occur DOE will evaluate the need for additional institutional controls and other response activities. The verification of this LUC is institutionalized as part of a LUC program.

7.2.2.2 Status of Requirements

A periodic survey to detect residential use of shallow groundwater was last performed in FY 2012. There were no new wells identified for residential use along LEFPC.

Visual inspections in FY 2014 confirmed that land use of the property of the former Dean Stallings Ford automobile dealership has not changed. The area is now leased to Ole Ben Franklin Motors used car dealership which opened for business in January 2014.

Table 7.2. Other LTS requirements for Off-Site

Other LTS requirements for Completed Actions Off-Site[a]			
Specific Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
LEFPC	ROD (DOE/OR/02-1370&D2) RAR (DOE/OR/01-1680&D5)	• DOE will monitor to detect any future residential use of the shallow soil horizon groundwater • A survey to determine any changes in land use patterns along LEFPC • Annual survey to verify land use in the area of the Dean Stallings Ford automobile dealership parking lot shall be performed to verify that the land use has not changed since the issuance of the EFPC RIR	• A 5-yr review will be required to evaluate whether the selected remedy remains protective • Before 5-yr review, a survey will be performed to re-evaluate land-use patterns along LEFPC to ensure that the land-use assumption used to develop the 400 ppm mercury cleanup level remains valid
Clinch River/Poplar Creek	RAR (DOE/OR/02-1627&D3) CMP (DOE/OR/01-1820&D3)	• Survey of local fisherman to confirm the effectiveness of fish consumption advisories • Irrigation survey – identify and survey local irrigators using Clinch River or Poplar Creek as a water source for irrigating crops, fields, or gardens • Fish consumption advisories to reduce exposure to contaminants in fish tissue • Existing institutional controls to control potential sediment-disturbing activities	• Fish advisory survey conducted one time only in 2000. Results reported in 2001 RER. • Conduct irrigation survey before preparation of the decision document for the surface water OU • Fish consumption advisories are issued by the TDEC Division of Water Pollution Control • DOE participates in the WBIWG to review permitting and use activities that could result in disturbance of sediments
LWBR	RAWP (DOE/OR/02-1376&D3) CMP (DOE/OR/01-1820&D3)	• Fish consumption advisories to reduce exposure to contaminants in fish tissue • Existing institutional controls to control potential sediment-disturbing activities	• Fish consumption advisories are issued by the TDEC Division of Water Pollution Control • DOE participates in the WBIWG to review permitting and use activities that could result in disturbance of sediments

[a]LTS for specific areas is determined by each remediation project and listed in the project specific completion report.

CMP = Comprehensive Monitoring Plan
DOE = U.S. Department of Energy
EFPC RIR = East Fork Poplar Creek-Sewer Line Beltway Remedial Investigation Report
LEFPC = Lower East Fork Poplar Creek
LTS = long-term stewardship
LWBR = Lower Watts Bar Reservoir
OU = operable unit
RAR = Remedial Action Report
RAWP = Remedial Action Work Plan
RER = Remediation Effectiveness Report
ROD = Record of Decision
TDEC = Tennessee Department of Environment and Conservation
WBIWG = Watts Bar Interagency Working Group

7.2.3 LEFPC Issues and Recommendations

In response to EPA comments on the draft *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2), two LEFPC action plans were developed and agreed to that focused on issues and uncertainties in the FYR protectiveness determination. The Action Plans are included in Appendix C of this document. The action plans center on two identified issues:

1) New information suggests mobilization of mercury from East Fork Poplar Creek streambed and stream banks is a major source of mercury exposure during high-flow conditions. The current *Record of Decision for Lower East Fork Poplar Creek, Oak Ridge, Tennessee* (DOE/OR/02-1370&D2) did not fully consider the entire hydrologic system and did not explicitly address creek bank or creek bed sediments.

The agreed-to action plan to evaluate the contributions of downstream sources and mobilization of mercury at a watershed scale includes field and laboratory investigations to close data gaps. Newly collected data will be used to develop conceptual and systems-based models that can be used as tools to refine source estimates. The evaluations will be conducted over the period leading to the *2016 Five-Year Review*, and progress reported annually in the RER (See Action Plan #1 in Appendix C).

2) New mercury bioaccumulation studies show mercury uptake in spiders along LEFPC.

To address the issue of elevated mercury concentrations in spiders, literature reviews and risk calculations were performed using estimates of key parameters from the literature. It was determined, after results were attained, that more conclusive site-specific floodplain information is needed to decrease uncertainty. The results of analysis to date and DOE's planned path forward to determine an LEFPC protectiveness statement are described in Action Plan #2 in Appendix C.

No changes for LEFPC are recommended.

7.3 CLINCH RIVER/POPLAR CREEK

7.3.1 Performance Monitoring

7.3.1.1 Performance Monitoring Goals and Objectives

The Clinch River/Poplar Creek Operable Unit 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 7.6). The Clinch River/Poplar Creek Operable Unit 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 LEFPC at PCM 5.5 (Figure 7.3).

A major component of the *Record of Decision for the Clinch River/Poplar Creek Operable Unit* (DOE/OR/02-1547&D3) is appropriate monitoring to ensure the institutional controls remain protective against the risk of potential exposure to contaminants of concern in sediments and fish tissue.

The original monitoring plans for the action are in the *Remedial Action Report for Clinch River/Poplar Creek* (DOE/OR/02-1627&D3). However, in September 1999, DOE recommended two broad changes to the monitoring plans. The first was to combine the two operable units into a single entity for monitoring purposes. The second was to change the number and locations of monitoring stations and sampling techniques in both operable units. Based on these recommendations, which were based on the hydrological connection of Poplar Creek, Clinch River, and Watts Bar Reservoir, a *Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River Poplar Creek Operable Units* (DOE/OR/01-1820&D2) was prepared.

Based on sampling results from 1999 – 2004, the combined monitoring plan was revised in FY 2004. This monitoring plan is now referred to as the *Lower Watts Bar Reservoir and Clinch River Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1820&D3) and consists of two components for the Clinch River/Poplar Creek – annual monitoring of major contaminants of concern in fish and additional monitoring for Clinch River/Poplar Creek (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 contaminants of concern 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/OR/01-1820&D3). 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 contaminants of concern concentrations would support the evaluation of the need for continuing the fish advisory.

The ROD requirements for the Clinch River/Poplar Creek hydrologic unit is satisfied by conducting annual sampling of contaminant concentrations in fish. Sites sampled in FY 2014 include four sites in the Clinch and Tennessee Rivers between Melton Hill Dam and the Watts Bar Dam, a site in Poplar Creek, and two Clinch River reference sites (upstream of Melton Hill Dam) that are sampled for comparison purposes (Figure 7.6). 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/OR/01-2058&D2). 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. Historically, striped bass were monitored below the Bull Run and Kingston steam plants (CRM 48 and CRM 3, respectively), but since 2008 Tennessee Valley Authority (TVA) steam plant generators have not been running on regular schedules and so striped bass have rarely been available at Bull Run steam plant. In 2014, striped bass were collected in Norris Lake as the upstream reference site.

Starting in FY 2013, largemouth bass were no longer collected annually in the summer. Largemouth will now be collected for mercury bioaccumulation on an annual cycle in the fall. Channel catfish will continue to be collected annually in the summer.

Fish consumption advisories are issued by the TDEC http://www.tn.gov/twra/fish/contaminants.html. The advisories are based on a calculation of fish concentration thresholds from the aqueous PCB AWQC, and also TDEC interpretation of site-specific risks. TDEC has issued the following advisories:

- 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]

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.

Table 7.3. Monitoring locations in Clinch River/Poplar Creek

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, PCM 1, CRM 11, and CRM 20 (catfish and largemouth bass), annually. As of FY 2013, largemouth bass are collected in the fall and channel catfish in summer Downstream Clinch River (CRM 3, or as needed from downstream of DOE facilities), and upstream Clinch River (CRM 48, or Norris Lake reference site (NORRIS) (striped bass), winter only	Catfish: PCBs , total mercury, ^{137}Cs (CRM 20 only), and total lipid Largemouth bass: total mercury Striped Bass: PCBs and total lipid
Turtles: CRM 23, CRM 20, and CRM 11, once every five years in summer	PCBs, total mercury, ^{137}Cs, and total lipid

[a]Analyses listed are those required to monitor action effectiveness.

CRM = Clinch River mile
DOE = U.S. Department of Energy
FY = fiscal year
PCB = polychlorinated biphenyl
PCM = Poplar Creek mile
TAL = target analyte list
WOCE = White Oak Creek Embayment

[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/mo.

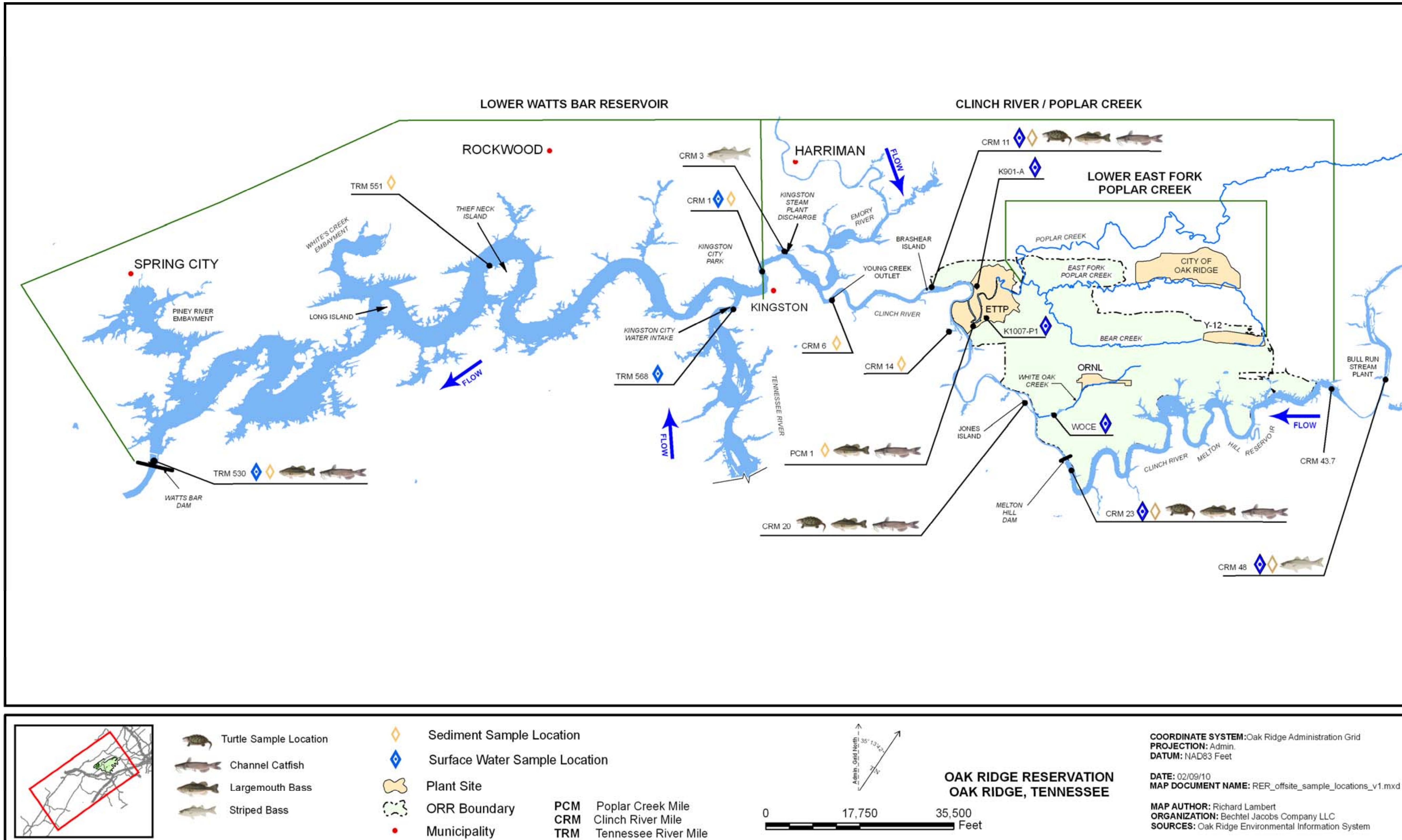


Figure 7.6. Monitoring locations in the Clinch River/Poplar Creek and LWBR operable units.

This page intentionally left blank.

7.3.1.2 Evaluation of Performance Monitoring Data

The selected remedy identified in the *Record of Decision for the Clinch River/Poplar Creek Operable Unit* (DOE/OR/02-1547&D3) is still in place and effective. Institutional controls prevent exposure to contaminated sediment (via the Watts Bar Interagency Working Group [WBIWG]); fish consumption advisories are issued by TDEC; and annual monitoring is conducted to evaluate changes in contaminant levels. Performance monitoring for the Clinch River/Poplar Creek has primarily focused on contaminant trending in fish to address the requirement for annual monitoring to detect changes in contaminant levels or mobility.

Results of FY 2014 monitoring for Poplar Creek and the Clinch River arm of Watts Bar Reservoir are provided in Table 7.4. PCB concentrations in Clinch River channel catfish were slightly lower in 2014 than in the past few years and have been trending downward for more than a decade, although there is substantial year-to-year variability (Figure 7.7). PCBs in channel catfish from Poplar Creek are similarly variable (Figure 7.7). The highest mean PCB concentrations in catfish have historically been found in Poplar Creek, but the concentrations at this site have been decreasing steadily for the past four years, such that concentrations in these fish have been approaching those in fish from the Clinch River. PCB concentrations in striped bass collected from CRM 2.6 were significantly higher than those seen at the Norris Lake reference site (Table 7.4). These concentrations were comparable to values seen in recent years, and within the range of normal inter-annual variation observed at these sites.

How do the current PCB results in fish compare to the latest fish consumption guidelines? Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criterion for total PCBs is 0.00064 µg/L under the recreation designated use classification and is the target for PCB-focused TMDLs, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon; TDEC 2010a,b,c). In the state of Tennessee, assessments of impairment for water body segments as well as public fishing advisories are based on fish tissue concentrations. Historically, the FDA threshold limit of 2 µg/g in fish fillet was used for advisories, and then for many years an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. The remediation goal for fish fillet at the ETTP K-1007-P1 Pond is 1 µg/g. Most recently, the water quality criterion (0.00064 µg/L for total PCBs) has been used by TDEC to calculate the fish tissue concentration triggering impairment and a TMDL (TDEC 2007) under its TMDL Program, and this concentration is 0.02 mg/kg in fish fillet (TDEC 2010a,b,c). TMDLs are used to develop controls for reducing pollution from both point and non-point sources in order to restore or maintain the quality of a water body and ensure it meets the applicable water quality standards. The fish PCB concentrations in the Clinch River and Watts Bar are still well above the calculated TMDL concentration.

Temporal trends in mean mercury concentrations in largemouth bass from Poplar Creek, the Clinch River, and lower Watts Bar are shown in Figure 7.8. Although there is some inter-annual variability, concentrations have remained fairly constant over the time period studied at all sites monitored. Of all the sites monitored, mercury concentrations in largemouth bass have been highest in Poplar Creek (PCM 1, just downstream of where the K-1007-P1 Pond exchanges with Poplar Creek).

Bluegill and redbreast sunfish have also been collected for mercury analysis from PCM 1 and PCM 5. The PCM 5 sampling location is centered at the confluence of EFPC and Poplar Creek and has been monitored since 2006 (Figure 7.9). Mercury concentrations at the PCM 5 site have consistently been higher than at PCM 1, consistent both with the pattern of downstream dilution of mercury within Poplar Creek and also with the difference in species collected at the two sites. Previous studies have shown that redbreast sunfish accumulate 25 – 50% more mercury than similarly sized bluegill sunfish collected from the same sites

(Southworth et al. 1994). Regardless, mercury concentrations in sunfish at both of these sites have been slowly but steadily increasing since 2006, with a significant increase seen in redbreast collected at the upper site from 2012 – 2014. This time period is just after significant increases were observed in both aqueous mercury and sunfish mercury concentrations in UEFPC which have been attributed to storm drain cleanout activities from 2010 – 2011. The concentrations in redbreast continue to exceed the AWQC and were higher than concentrations seen for this species in EFPC in 2014. Mean mercury concentrations in bluegill collected from PCM 1 have been fluctuating around the AWQC, slightly exceeding this limit in 2014.

Mercury concentrations in catfish were below the EPA fish tissue criterion at all sites monitored in 2014 (Table 7.4). Levels of cesium were below analytical detection limits in all fish collected from the Clinch River sample site immediately downstream of WOC (which flows from ORNL).

7.3.1.3 Performance Summary

Performance monitoring of the Clinch River and Poplar Creek continues to indicate an overall downward trend in fish PCB concentrations. The decreasing PCB trends in fish are some of the most dramatic observed by the long-running Oak Ridge biological monitoring programs (Figure 7.7). However, striped bass are routinely above PCB advisory limits, especially larger fish. Mercury concentrations in fish at monitored sites continue to indicate the influence of mercury sources from East Fork Poplar Creek, 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.

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 2014

Monitoring location		Total PCBs (mg/kg)		Mercury (mg/kg)		^{137}Cs (pCi/g)
Site	**Description**	**Channel catfish**	**Striped bass**	**Largemouth bass**	**Channel catfish**	**Channel catfish**
		Clinch River				
CRM 20	Jones Island downstream of WOC	0.12 ± 0.03		0.21 ± 0.04	0.05 ± 0.01	< 0.1
CRM 11	Brashear Island downstream of Poplar Creek	0.13 ± 0.01		0.54 ± 0.04	0.16 ± 0.05	
CRM 3	Kingston Steam Plant discharge					
		Poplar Creek				
PCM 1	Near K-1007-P1 outlet	0.19 ± 0.04		0.73 ± 0.18	0.18 ± 0.05	
		LWBR				
TRM 530	Watts Bar Reservoir forebay	0.13 ± 0.03		0.16 ± 0.02	0.07 ± 0.01	
		Reference sites (upstream of Clinch River/Poplar Creek-LWBR)				
CRM 23	Melton Hill Reservoir forebay	0.07 ± 0.01		0.14 ± 0.03	0.06 ± 0.02	
CRM 2.6	Kingston Fossil Plant		0.42 ± 0.05			
CRM 95	Norris Lake		0.08 ± 0.02			

CRM = Clinch River mile
FY = fiscal year
LWBR = Lower Watts Bar Reservoir
PCB = polychlorinated biphenyl
PCM = Poplar Creek mile
TRM = Tennessee River mile
WOC = White Oak Creek

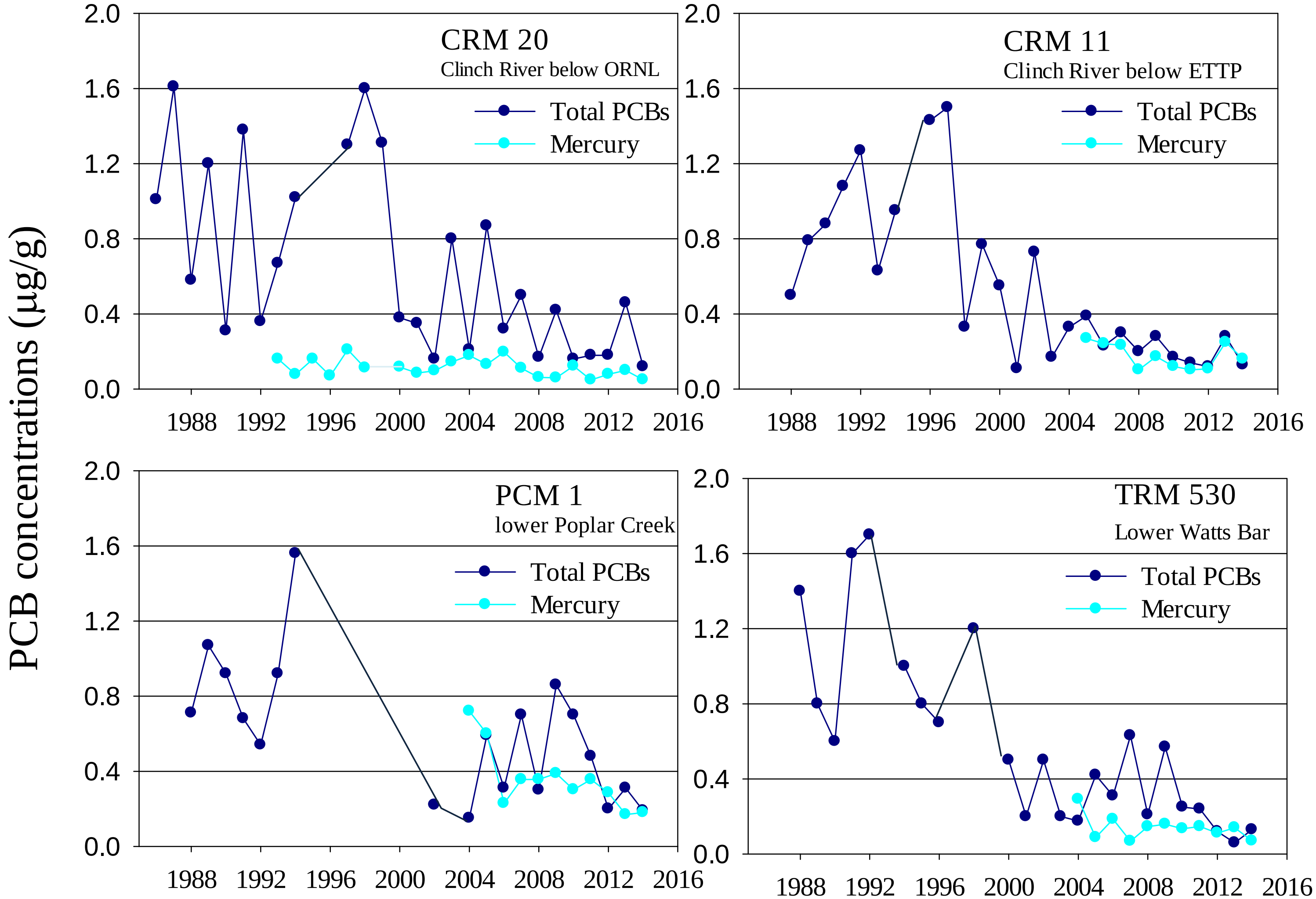


Figure 7.7. Average PCB concentrations in channel catfish from Clinch River/Poplar Creek and LWBR sites, 1986 – 2014.

(Courtesy of multiple programs in the early years, including Biological Monitoring and Abatement program, Annual Site Environmental Report, and TVA, 1986 – 2003).

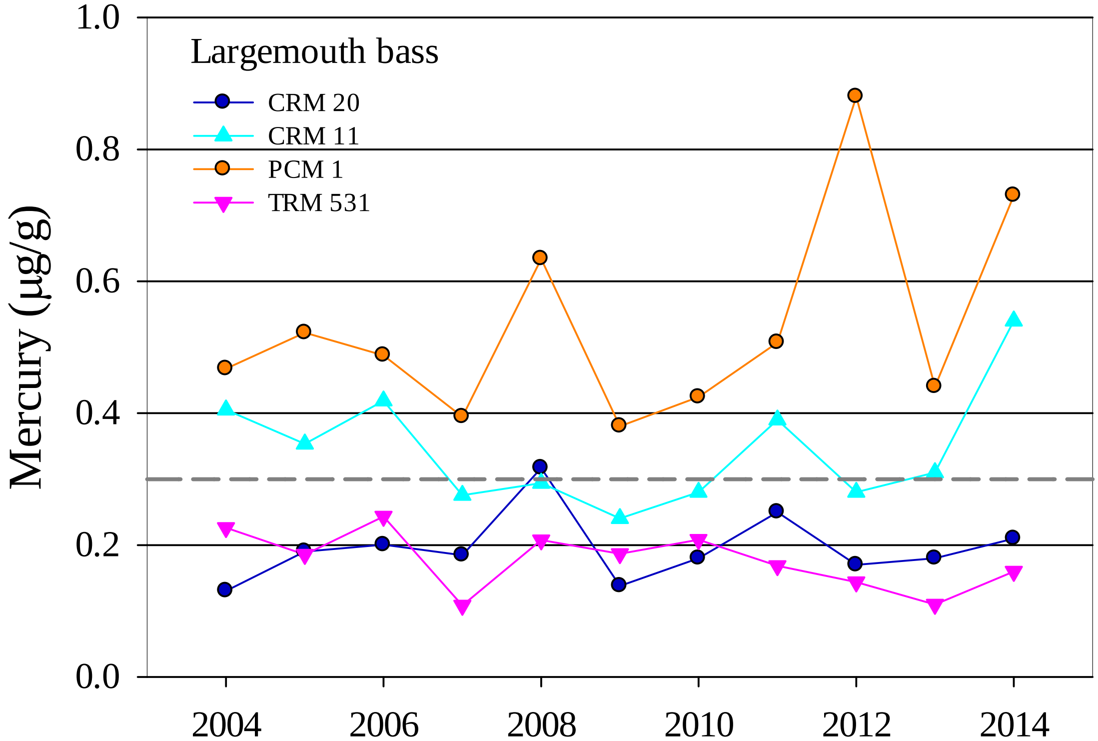


Figure 7.8. Mean mercury concentrations in largemouth bass from Clinch River/Poplar Creek and LWBR sites, 2004 – 2014.

Dashed gray line indicates EPA recommended AWQC for mercury (0.3 µg/g in fish).

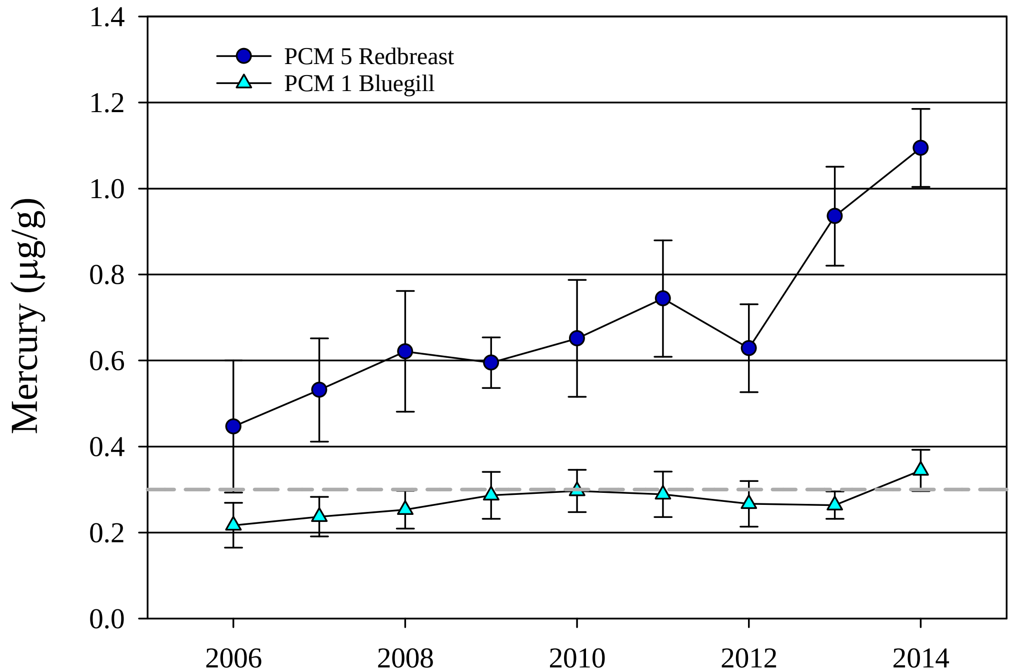


Figure 7.9. Mean mercury concentrations in sunfish from Poplar Creek, 2006 – 2014.

Dashed gray line indicates EPA recommended AWQC for mercury (0.3 µg/g in fish).

7.3.2 Other LTS Requirements

Other LTS requirements for Clinch River/Poplar Creek are listed in Table 7.2 and described below.

7.3.2.1 Requirements

Requirements specified in the *Remedial Action Report for Clinch River/Poplar Creek* (DOE/OR/02-1627&D3) include institutional controls for the Clinch River/Poplar Creek and LWBR:

- continued use of TDEC's fish consumption advisories to limit exposure to contaminated fish.
- continued scrutiny of sediment-disturbing activities in LWBR by the WBIWG, comprised of TDEC, TVA, Army Corps of Engineers, and DOE, to prevent exposure to potentially contaminated dredged soil.
- conduct of a survey of irrigation practices.
- determination of the effectiveness, i.e., awareness, of fish consumption advisories.

7.3.2.2 Status of Requirements

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 April 2014. These same advisories are included in the TWRA's 2014 – 2015 Tennessee Fishing Guide that is available on-line and where fishing licenses are sold.

The WBIWG provided continued controls on sediment-disturbing activity in the deep-water channel. In FY 2014, seven dredging permit applications were received and approved for Clinch River/Poplar Creek and LWBR.

A review of the efficacy of institutional controls preventing sediment exposure and the effectiveness of the fish consumption advisory was provided in the *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2289&D3) and referenced again in the *2011 Third Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2516&D2). 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 fishermen who do not follow advisories. The state of Tennessee is responsible for issuing fish consumption advisories and communicating relevant health information to the public.

7.3.3 Clinch River/Poplar Creek Issues and Recommendations

There are no issues or recommendations.

7.4 LWBR

7.4.1 Performance Monitoring

7.4.1.1 Performance Monitoring Goals and Objectives

The LWBR operable unit 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 7.6).

The original post-ROD monitoring plans for the action are in the *Remedial Action Work Plan for Lower Watts Bar Reservoir* (DOE/OR/02-1376&D3). As discussed in Section 7.3.1, monitoring requirements for the LWBR are included with requirements for Clinch River/Poplar Creek in the *Lower Watts Bar Reservoir and Clinch River Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1820&D3).

The overall goal of the remedy for LWBR is to protect human health and the environment by reducing exposure to contaminated sediment in the main river channel and contaminants in fish. The monitoring strategy is provided in the *Lower Watts Bar Reservoir and Clinch River Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1820&D3) and summarized in Table 7.5.

Table 7.5. Monitoring locations in LWBR

Monitoring stations	Analyses[a]
Surface water: TRM 568.4 and TRM 530–532, once every five years[b]	Surface water—isotopic uranium, total mercury, TAL metals, and hydrolab profile
Sediment: TRM 551–556 and TRM 530–532, once every five years[b]	Total metals, total mercury, and ^{137}Cs
Fish: TRM 530 (catfish and largemouth bass), annually. As of FY 2013, largemouth bass are collected in the fall and channel catfish in summer.	Catfish: PCBs, total mercury, and total lipid Largemouth bass: total mercury

[a]Analyses listed are those required to monitor effectiveness.
[b]Sampling takes place the year before the FYR, e.g., FY 2010 for the 2011 FYR.

FY = fiscal year
FYR = Five-Year Review
LWBR = Lower Watts Bar Reservoir
PCB = polychlorinated biphenyl
TAL = target analyte list
TRM = Tennessee River mile

Fish consumption advisories are issued by the TDEC at the web site http://www.tn.gov/twra/fish/contaminants.html. The advisories are based on a calculation of fish concentration thresholds from the aqueous PCB AWQC, and also TDEC interpretation of site-specific risks. TDEC has issued the following advisories:

- 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.

7.4.1.2 Evaluation of Performance Monitoring Data

Performance monitoring in LWBR has primarily focused on the *Lower Watts Bar Reservoir and Clinch River Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-1820&D3) 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 concentration at TRM 530 in 2014 averaged 0.13 µg/g in channel catfish (Table 7.4), which is slightly higher than the concentration observed at this site in FY 2013. As was previously discussed, regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. Although historically fish advisories were considered when fish fillets were in the 0.8 to 1 µg/g range, the current target concentration for Watts Bar Reservoir is 0.02 mg/kg in fish fillet (TDEC 2010a,b,c). The fish PCB concentrations in LWBR are still above this concentration. The good news is that the current levels are substantially lower than the concentrations observed in the 1980s and 1990s when the advisories were first issued (Figure 7.7).

Mercury concentrations in fish from LWBR are also low, averaging equal to or less than 0.16 µg/g depending on species (Table 7.4). This level is less than the EPA recommended AWQC of 0.3 µg/g mercury in fish. Mercury concentrations in the 0.2 µg/g range are typical of largemouth bass and channel catfish in Tennessee reservoirs.

7.4.1.3 Performance Summary

Performance monitoring results from LWBR obtained during FY 2014 continue to indicate that mercury and PCB levels in fish are decreasing from historical levels.

7.4.2 Other LTS Requirements

Other LTS requirements for LWBR are listed in Table 7.2 and described below.

7.4.2.1 Requirements

The Remedial Action Work Plan for Lower Watts Bar Reservoir (DOE/OR/02-1376&D3) requires institutional controls, including continued use of TDEC’s fish consumption advisories to limit exposure to contaminated fish and continued scrutiny of sediment-disturbing activities in LWBR by the WBIWG to prevent exposure to potentially contaminated dredged soil.

7.4.2.2 Status of Requirements

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 April 2014. These same advisories are also published in the TWRA’s 2014 – 2015 Tennessee Fishing Guide that are available online and where fishing licenses are sold.

The WBIWG provided continued controls on sediment-disturbing activity in the deep-water channel. In FY 2014, seven dredging permit applications were received and approved for Clinch River/Poplar Creek and LWBR.

A review of the efficacy of institutional controls preventing sediment exposure and the effectiveness of the fish consumption advisory was provided in the *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2289&D3) and referenced again in the *2011 Third Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2516&D2). 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.

7.4.3 LWBR Issues and Recommendations

There are no issues or recommendations.

7.5 OFF-SITE ISSUES AND RECOMMENDATIONS

The issues and recommendations for the Off-Site areas are in Table 7.6.

Table 7.6. Summary of technical issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issue Carried Forward			
None			
Completed/Resolved Issues[b]			
None			

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the 2015 RER. An "Issue Carried Forward" is an issue identified in a previous year's RER or FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.
[b]The year in which the issue originated is in parentheses, e.g. (2013 RER).

FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report

7.6 REFERENCES

DOE/OR/01-1680&D5. *Remedial Action Report on the Lower East Fork Poplar Creek Project, Oak Ridge, Tennessee*, 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1820&D2. *Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River/Poplar Creek Operable Units at the Oak Ridge Reservation, Oak Ridge, Tennessee*, 1999, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1820&D3 and Erratum. *Lower Watts Bar Reservoir and Clinch River Poplar Creek Watershed Remedial Action Report Comprehensive Monitoring Plan* , *Oak Ridge, Tennessee*, 2004 and 2013 Erratum, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1951&D3. *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2058&D2. *2003 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, 2003, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2289&D3. *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1370&D2. *Record of Decision for Lower East Fork Poplar Creek, Oak Ridge, Tennessee*, 1995, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR/02-1373&D3. *Record of Decision for the Lower Watts Bar Reservoir*, 1995, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR/02-1376&D3. *Remedial Action Work Plan for Lower Watts Bar Reservoir in Tennessee*, 1996, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR/02-1547&D3. *Record of Decision for the Clinch River/Poplar Creek Operable Unit, Oak Ridge, Tennessee*, 1997, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1627&D3. *Remedial Action Report for Clinch River/Poplar Creek in East Tennessee*, 1999, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Southworth, G. R., et al. 1994, "Estimation of appropriate background concentrations for assessing mercury contamination in fish." Bull. Environ. Contam. Toxicol. **53**: 211-218.

Southworth, G. R., M. J. Peterson, W. K. Roy, and T. J. Mathews. 2011, *Monitoring Fish Contaminant Responses to Abatement Actions: Factors that Affect Recovery*, Environmental Management 47:6:1064-1076.

TDEC 2007. State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October 2007. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Approved March 2008.

TDEC 2010a. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Melton Hill Reservoir: Lower Clinch River Watershed (HUC 06010207), Anderson, Knox, Loudon, and Roane Counties, Tennessee.

TDEC 2010b. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Watts Bar Reservoir: Watts Bar Lake Watershed (HUC 06010201), Lower Clinch River Watershed (HUC 06010207), and Emory River Watershed (HUC 06010208), Loudon, Meigs, Morgan, Rhea, and Roane Counties, Tennessee.

TDEC 2010c. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Fort Loudon Reservoir: Fort Loudon Lake Watershed (HUC 06010201), Blount, Knox, and Loudon Counties, Tennessee.

This page intentionally left blank.

8. EAST TENNESSEE TECHNOLOGY PARK

8.1 INTRODUCTION AND STATUS

8.1.1 Introduction

ETTP contains contaminated facilities and media from the operation of the gaseous diffusion process. Table 8.1 lists the CERCLA actions at ETTP and identifies those with monitoring or other LTS requirements. Figure 8.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Only sites that have LTS requirements (Table 8.1) are included in these performance evaluations. End uses of a site form the basis of RAOs and determine access restrictions and allowable activities at the site. Figure 8.2 shows ROD-designated end uses at ETTP and interim controls requiring LTS.

Completed CERCLA actions at ETTP are gauged against their respective action specific goals. However, CERCLA actions have yet to be fully implemented at ETTP. 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 for each subwatershed.

For a complete discussion of background information and performance metrics for each remedy, a compendium of all CERCLA decisions at ETTP within the context of a contaminant release conceptual model is provided in Chapter 10 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the annual RER and republished every fifth year in the CERCLA FYR.

8.1.2 Status Update

To date, most of the completed actions at ETTP have been single-project actions to address primary sources of contamination or primary release mechanisms. Concurrent with these actions, demolition of buildings at ETTP is occurring under CERCLA removal authority. While these actions ultimately help to reduce contaminant loading or minimize the potential for future contaminant releases, the goals of many of these actions have not included specific, measurable performance objectives for reductions in flux or risk in surface water and groundwater at the watershed scale. More recent watershed-scale decisions for Zone 1 and Zone 2 (*Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* [DOE/OR/01-1997&D2], referred to as the Zone 1 ROD, and *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], referred to as the Zone 2 ROD), 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 and sediments, and ecological receptors will be evaluated and addressed by future CERCLA decision(s).

Table 8.1. CERCLA actions at the ETTP

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
Watershed-scale actions			
		Actions complete	
Zone 1 Interim Actions	ROD (DOE/OR/01-1997&D2): 11/08/02	Duct Island/K-901 Area PCCR (DOE/OR/01-2261&D2) approved 04/03/06	No/No
		• Duct Island/K-901 Area PCCR Addendum (DOE/OR/01-2261&D2/A1/R2) approved 02/28/11	No/No
		K-1007 Ponds/Powerhouse PCCR (DOE/OR/01-2294&D2) approved 10/04/06	No/No
		• K-1007 Ponds/Powerhouse PCCR Addendum (DOE/OR/01-2294&D2/A1/R1) approved 12/31/11	No/No
		• K-1007 Ponds/Powerhouse PCCR Addendum (DOE/OR/01-2294&D2/A2) submitted 06/20/11	No/No
		K-770 Scrap Removal PCCR (DOE/OR/01-2348&D1) approved 05/30/07	No/No
		• K-770 Scrap Removal PCCR Addendum (DOE/OR/01-2348&D1/A1) approved 12/03/10	No/TBD[c,j]
		FY 2008 PCCR for Units Z1-01, Z1-03, Z1-38, Z1-49 (DOE/OR/01-2367&D2) approved 04/23/08	No/No
Zone 2 Soil, Buried Waste, and Subsurface Structure Interim Actions	ROD (DOE/OR/01-2161&D2): 04/19/05	**Actions complete or in progress**	
		FY 2006 PCCR for EUs 2, 7, 9, 10, 27, and 42 (DOE/OR/01-2317&D2) approved 02/08/07	No/No
		FY 2007 PCCR for EUs 1, 3, 8, 23, 24, 28, 33, 34, 35, 36, 37, 41, 43, and 44 (partial) (DOE/OR/01-2723&D2) approved 06/09/08	No/No
		• FY 2007 PCCR Addendum for EU 44 (DOE/OR/01-2723&D2/A1) approved 10/07/14 with submission of Erratum	No/No
		FY 2008 PCCR for EU Z2-33 (DOE/OR/01-2368&D2/R1) approved 09/28/09	No/No

Table 8.1. CERCLA actions at the ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
		• FY 2008 PCCR for EU Z2-33 – Erratum (DOE/OR/01-2368&D2/R2 approved 12/16/09	No/No
		FY 2009 PCCR for EU Z2-36 (DOE/OR/01-2399&D1) approved 06/03/09	No/No
		FY 2009 PCCR for EUs 11, 12, 17, 18, 29, 38 (DOE/OR/01-2415&D2) approved 04/02/10	No/No
		FY 2010 PCCR for EU Z2-31 (DOE/OR/01-2443&D2) approved 10/22/10	No/No
		FY 2010 PCCR for EU Z2-32 (DOE/OR/01-2452&D1) approved 04/08/10	No/No
		PCCR for EU Z2-30 (K-1070-B Burial Ground) (DOE/OR/01-2521&D2) approved 03/15/13	No/No
		• PCCR for EU Z2-30 – Erratum (K-1070-B Burial Ground) (DOE/OR/01-2521&D2) submitted 5/16/13 (no approval required)	No/No
		PCCR for EUs 4 and 5 (K-33 slab) (DOE/OR/01-2590&D1) approved 02/11/13	No/No
		PCCR for EU 35 Sumps (DOE/OR/O1-2618&D2) approved 05/07/14	No/No
Single-project actions			
		Actions complete	
K-1417-A/B Drum Storage Yards	ROD (DOE/OR-991&D1): 09/19/91	RAR (Letter) approved 03/02/95	No/No
K-1070-C/D SW-31 Spring	IROD (DOE/OR-1050&D2): 09/30/92 ESD (DOE/OR/02-1132&D2): 07/08/93	RAER (DOE/OR/01-1520&D1/R1) approved 12/11/96	Superseded by RAER Addendum – Erratum (DOE/OR/01-1520&D1/R1/A1) to eliminate monitoring[k]
		• RAER Addendum (DOE/OR/01-1520&D1/R1/A1) to terminate action approved 02/28/07	
		• RAER Addendum – Erratum (DOE/OR/01-1520&D1/R1/A1) to eliminate monitoring approved 10/03/13	No/No

Table 8.1. CERCLA actions at the ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
K-1407-B/C Ponds	ROD (DOE/OR/02-1125&D3): 09/30/93 (Also, closed under RCRA)	RAR (DOE/OR/01-1371&D1) approved 08/16/95	Superseded by RAR Erratum[k]
		• RAR Erratum (DOE/OR/01-1371 submitted 02/06/15	Yes/Yes
K-1401 and K-1420 Sumps	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)	RmAR (DOE/OR/01-1754&D2) approved 02/01/99	Terminated by RmAR Addendum (DOE/OR/01-1754&D2/A1)
		• RmAR Addendum (DOE/OR/01-1754&D2/A1) to terminate operation approved 04/21/06	
K-1070-C/D and Mitchell Branch	AM (DOE/OR/02-1611&D2): 08/25/97	RmAR (DOE/OR/01-1728&D3) approved 03/02/99	Terminated[d]
		• Approval to terminate operation of non-cost effective system 12/17/04	
K-901-A and K-1007-P Pond	AM (DOE/OR/02-1550&D2): 10/15/97 (superseded by AM (DOE/OR/01-2314&D2)	RmAR (DOE/OR/01-1767&D2) approved 11/12/99	Superseded by RmAR (DOE/OR/01-2456&D1/R1)[k]
K-1070-C/D G-Pit and Concrete Pad	ROD (DOE/OR/02-1486&D4): 01/23/98	RAR (DOE/OR/01-1964&D2) approved 10/15/03	Superseded by RAR Erratum[k]
		• Completion letter (waste) approved 10/29/03	No/No
		• RAR Erratum (DOE/OR/01-1964&D2) submitted 02/06/15	No/Yes[e]
K-1070-A Burial Ground	ROD (DOE/OR/01-1734&D3): 01/13/00	RAR (DOE/OR/01-2090&D1) approved 11/28/03	Superseded by Duct Island/K-901 Area PCCR (DOE/OR/01-2261&D2) approved 04/03/06[k]
K-1085 Old Firehouse Burn Area Drum Burial Site Removal Action	AM (DOE/OR/01-1938&D1): 03/27/01	RmAR (DOE/OR/01-2050&D1) conditionally approved 02/18/03	No/No
		Completion Letter approved 01/19/07	
Outdoor LLW Removal	AM (DOE/OR/01-2109&D1): 11/14/03	RmAR (DOE/OR/01-2225&D2) approved 08/24/05	No/No
ETTP Ponds removal action	AM (DOE/OR/01-2314&D2): 03/12/07 (K-1007-P and K-901-A holding ponds, K-720 Slough, and 770 Embayment) (supersedes DOE/OR/01-1550&D2)	RmAR (DOE/OR/01-2456&D1/R1) approved 03/10/11 (supersedes DOE/OR/01-1767&D2)	Yes/Yes

Table 8.1. CERCLA actions at the ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
Mitchell Branch Chrome Reduction	AM (DOE/OR/01-2369&D1): 12/20/07 (Reduction of Hexavalent Chromium Releases to Mitchell Branch Time-Critical)	RmAR (DOE/OR/01-2384&D1) submitted 07/30/08; review and approval suspended 10/09/08	Superseded by RmAR (DOE/OR/01-2598&D2)[k]
	AM (DOE/OR/01-2448&D1) (Long Term Reduction of Hexavalent Chromium Releases to Mitchell Branch) approved 04/13/10 (supersedes DOE/OR/01-2369&D1)	RmAR (DOE/OR/01-2598&D2) approved 04/04/13	Yes/Yes
Demolition projects			
		Actions complete	
K-25 Auxiliary Facilities Group I Building Demolition removal action	AM (DOE/OR/02-1507&D2): 01/17/97	RmAR (DOE/OR/01-1829&D1) issued August 1999	No/TBD[j]
		• RmAR Addendum I (DOE/OR/01-1829&D1/A1) approved 06/02/05	No/No
		• RmAR 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 Decontamination removal action	AM (DOE/OR/02-1646&D1): 09/30/97	RmAR (DOE/OR/01-2290&D3) approved 06/08/07	No/No
		• RmAR Addendum (DOE/OR/01-2290&D3/A2) approved 03/16/09	No/No
K-25 Auxiliary Facilities Group II, Phase I Building Demolition, Main Plant removal action	AM (DOE/OR/01-1868&D2): 08/03/00	RmAR (DOE/OR/01-2116&D2) approved 09/24/04	No/TBD[j]
K-25 Auxiliary Facilities Group II, Phase II Building Demolition, K-1064 Peninsula Area removal action	AM (DOE/OR/01-1947&D2): 07/31/02	RmAR (DOE/OR/01-2339&D1) approved 06/27/07	No/TBD[j]
		• PCCR (DOE/OR/01-2183&D1) approved 01/31/06	Superseded by RmAR (DOE/OR/01-2339&D1)[k]
		• PCCR Addendum (DOE/OR/01-2183&D1/A1) approved 04/10/06	
		• PCCR Addendum (DOE/OR/01-2184&D1/A2) approved 10/03/06	

Table 8.1. CERCLA actions at the ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
		Action in progress	
K-25 and K-27 Buildings Demolition removal action	AM (DOE/OR/01-1988&D2): 02/13/02 NSC (DOE/OR/01-2259&D1): 12/16/05 NSC (DOE/OR/01-2582&D1): 08/09/12	PCCR for Hazardous Materials Abatement conditionally (DOE/OR/01-2275&D1) approved 12/19/05	No/No
		Completion of mercury ampoules disposal in accordance with the PCCR (DOE/OR/01-2275&D1) approved 03/17/06	No/No
		Completion Letter, Disposition of Centrifuge and Y-12 Materials, Excess Materials Removal, K-25/K-27 D&D 06/30/08	No/No
		PCCR for FY 2008 Earned Value (DOE/OR/01-2396&D2) approved 09/17/09	No/No
		• PCCR for FY 2008 Earned Value – Erratum (DOE/OR/01-2396&D2) submitted 10/30/09 (no response required)	No/No
		PCCR for FY 2009 Earned Value (DOE/OR/01-2436&D2) approved 06/29/10	No/No
		PCCR for Excess Material Removal (DOE/OR/01-2392&D4) approved 04/23/12	No/No
		PCCR for FY 2010 Earned Value (DOE/OR/01-2494&D2) approved 08/03/11	No/No
		PCCR (K-25 East Wing Characterization, Foaming, NE Bridge) (DOE/OR/01-2538&D2) approved 04/28/12	No/No
		PCCR for FY 2012 (DOE/OR/01-2577&D2) approved 08/27/14	No/No
		PCCR for FY 2013 (DOE/OR/01-2624&D2) submitted 03/06/14	TBD[f]
		• PCCR for FY 2013 – Erratum (DOE/OR/01-2624&D2) submitted 06/16/14	TBD[f]
		K-25 Completion Report (DOE/OR/01-2651&D1) submitted 07/02/14	TBD[f]

Table 8.1. CERCLA actions at the ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
		Action in progress	
K-25 Group II, Phase 3 Building Demolition, Remaining Facilities removal action	AM (DOE/OR/01-2049&D2): 09/30/03	FY 2004 PCCR PUF (DOE/OR/01-2193&D2) approved 03/28/05	No/No
		FY 2005 PCCR PUF (DOE/OR/01-2269&D2) approved 02/15/06	No/No
		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/TBD[g,j]
		Balance of Site-Laboratory Area Facilities PCCR (DOE/OR/01-2309&D2) approved 08/30/07	No/TBD[h,j]
		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/TBD[j]
		K-29 PCCR (DOE/OR/01-2336&D2) approved 10/18/07	No/TBD[j]
		K-1420 PCCR (DOE/OR/01-2341&D2) approved 10/26/07	No/TBD[j]
		Building K-1401 PCCR (DOE/OR/01-2365&D2) approved 02/27/09	No/No[i]
		• Building K-1401 PCCR erratum (DOE/OR/01-2365&D2/A1) approved 04/08/09	No/No
		FY 2008 PCCR LR/LC Facilities (DOE/OR/01-2394&D1) approved 03/13/09	No/TBD[j]
		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) approved 09/14/11	No/TBD[j]
		FY 2009 PCCR for PUF (DOE/OR/01-2435&D2)	No/No

Table 8.1. CERCLA actions at the ETTP (cont.)

CERCLA action	Decision document: date signed (mm/dd/yy)	Action/Document status[a]	Monitoring/Other LTS required[b]
		approved 04/12/10	
		PCCR for Poplar Creek 3 High Risk Facilities (DOE/OR/01-2444&D2) approved 07/28/10	No/TBD[j]
		PCCR (SW-31 Spring Transfer Line) (DOE/OR/01-2520&D1) approved 02/10/12	No/No
		PCCR for K-33 (DOE/OR/01-2541&D1) approved 02/06/12	No/No
		• PCCR for K-33 above-ground utility piping (DOE/OR/01-2541&D2 approved 07/03/13	No/No
		FY 2011 PCCR for Poplar Creek – four tie lines (DOE/OR/01-2524&D3) approved 12/28/12	No/No
		FY 2011 PCCR for LR/LC Facilities (DOE/OR/01-2547&D2) approved 07/09/12	No/TBD[j]
		FY 2011 PCCR PUF (DOE/OR/01-2554&D2) approved 05/31/12	No/No
		Building K-33 PCCR (DOE/OR/01-2541&D2) approved 07/03/13	No/No
		PCCR for K-33/K-31 Process Tie Line (DOE/OR/01-2620&D1) submitted 10/08/13	TBD[f]
		PCCR for Decommissioning Central Neutralization Facility (DOE/OR/01-2619&D2) submitted 05/23/14	TBD[f]
		PCCR for Decommissioning Central Neutralization Facility – Erratum (DOE/OR/01-2619&D2) submitted 10/23/14	TBD[f]

[a]Information on the enforceable agreement milestones for ongoing actions is in Appendix E of the FFA for the ORR (DOE/OR-1014) and is available at <http://www.ucor.com/ettp_ffa_appendices.html >.

[b]"No/No" indicates no monitoring/other LTS requirements are identified in the CERCLA action completion document beyond those identified in the watershed RODs. Refer to Table 8.3 for watershed-scale monitoring requirements and Figure 8.2 and Table 8.2 for watershed-scale LUCs and other LTS requirements.

[c]The *Addendum II 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/A2) documents the characterization and remediation of the associated EUs and recommends NFA because all remediation levels were met. The EPA and TDEC have not approved the *Addendum* but have no technical disagreement with the conclusions. Therefore, the interim LTS requirements in 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) are no longer required for areas in these Zone 1 EUs.

[d]In a letter dated December 1, 2004, DOE proposed to EPA and TDEC to discontinue operation of the groundwater collection system because it was not cost-effectively reducing contaminant flux. TDEC and EPA approved the proposal on December 15, 2004 and December 17, 2004, respectively, and the groundwater collection system was terminated.

Table 8.1. CERCLA actions at the ETTP (cont.)

[e]The action for the K-1071 concrete pad is an interim action, and a final RA will be performed under the *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).

[f]Completion document not approved during FY 2014 reporting period.

[g]Controls were removed because the slab was removed as documented in the *Addendum to the Phased Construction Completion Report for the K-1007 Ponds Area and North Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2294&D2/A1).

[h]The *Phased Construction Completion Report for the Laboratory Area Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park* (DOE/OR/01-2309&D2) 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 LTS of these sites is no longer reported in the RER.

[i]Although the Building K-1401 PCCR documents the building demolition and prescribes LTS requirements 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 *Fiscal Year 2010 Phased Construction Completion Report for EU Z2-31 in Zone 2* (DOE/OR/01-2443&D2).

[j]This completion document includes "Other LTS" requirements for potentially contaminated slabs, e.g., slab monitoring, access controls, inspection, etc. Interim LTS requirements for potentially contaminated slabs following building demolition are the subject of an open issue identified in Table 8.9. Until this issue is resolved, the "Other LTS" requirements for potentially contaminated slabs are not known and are TBD.

[k]The "Monitoring/Other LTS" requirements in a completion document have been superseded, or replaced, by the requirements in the subsequent, referenced completion document.

AM = Action Memorandum
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D = decontamination and decommissioning
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ESD = Explanation of Significant Difference
ETTP = East Tennessee Technology Park
EU = exposure unit
FFA = Federal Facility Agreement
FY = fiscal year
IROD = Interim Record of Decision
LLW = low-level waste
LR/LC = Low Risk/Low Complexity
LTS = long-term stewardship
LUC = land use control
NE = northeast
NFA = no further action
NSC = Non-Significant Change
ORR = Oak Ridge Reservation
PCCR = Phased Construction Completion Report
PUF = Predominantly Uncontaminated Facilities
RA = remedial action
RAER = Remedial Action/Effectiveness Report
RAR = Remedial Action Report
RCRA = Resource Conservation and Recovery Act of 1976
RER = Remediation Effectiveness Report
RmAR = Removal Action Report
ROD = Record of Decision
TBD = to be determined
TDEC = Tennessee Department of Environment and Conservation
Y-12 = Y-12 National Security Complex

This page intentionally left blank.

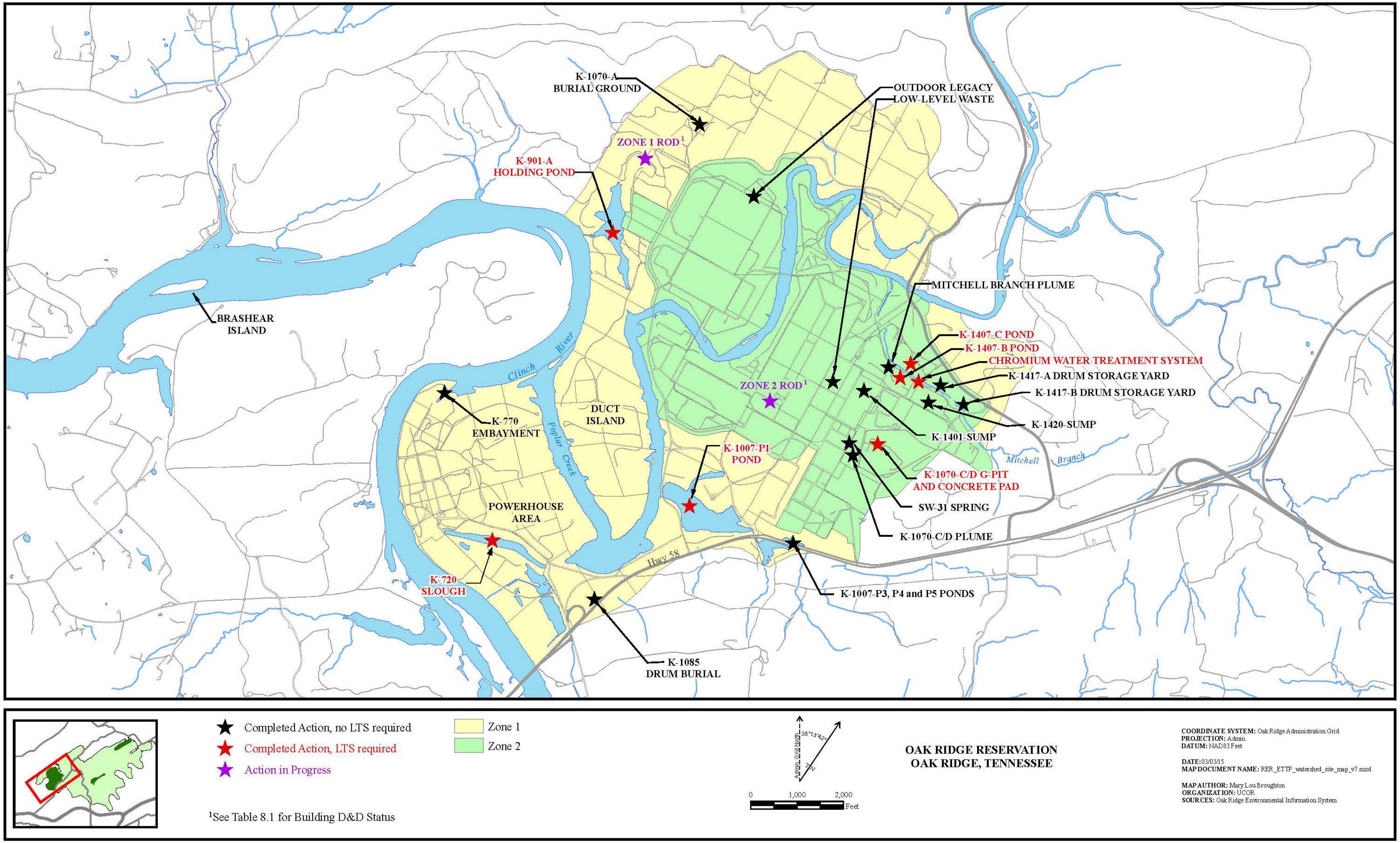


Figure 8.1. ETTP.

This page intentionally left blank.

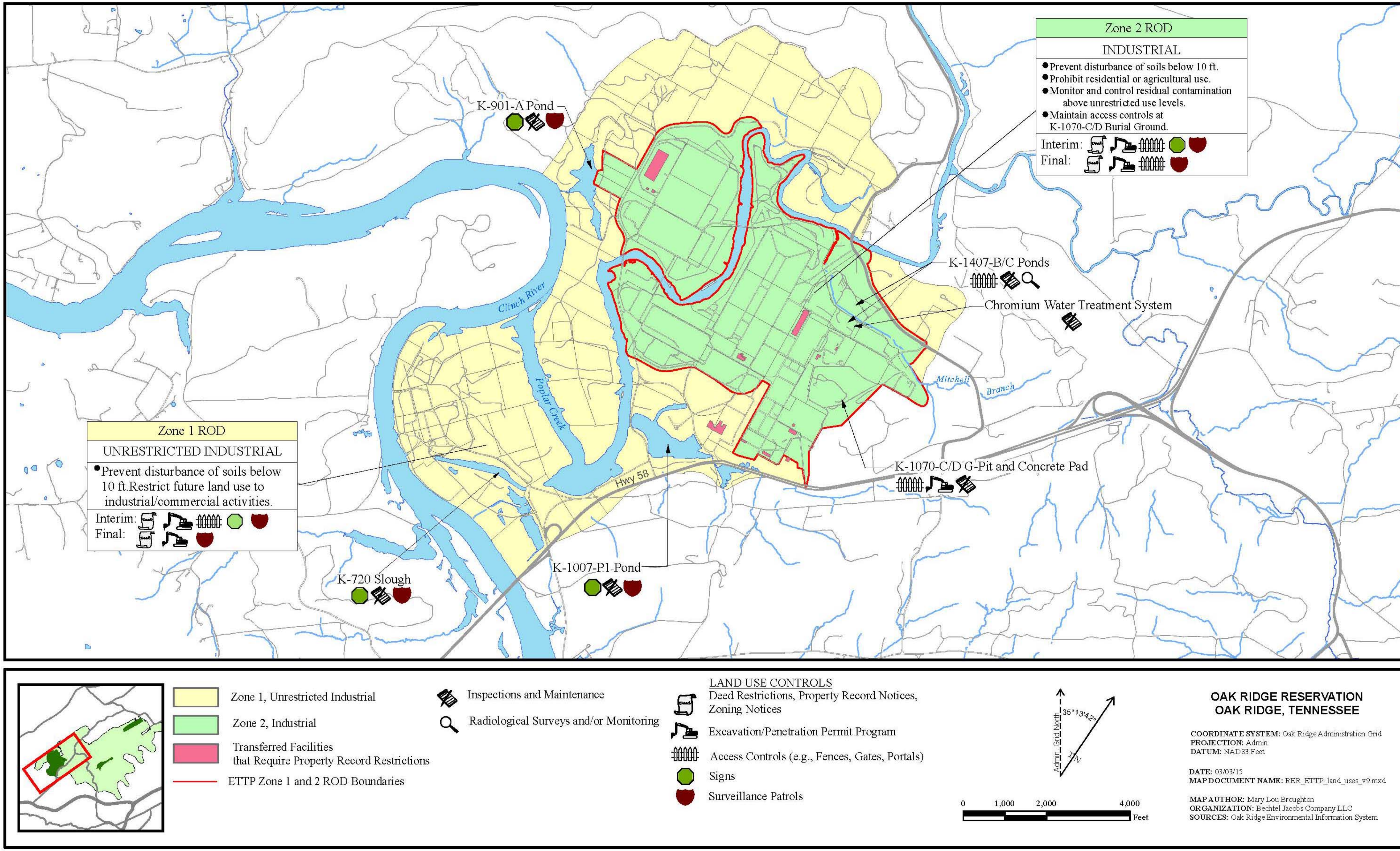


Figure 8.2. ETTP Zones 1 and 2 ROD-designated end uses and interim controls requiring LTS.

This page intentionally left blank.

Watershed-Scale Actions

For RA purposes, ETTP is divided into zones. Zone 1 comprises approximately 1,400 acres outside the main plant area, and Zone 2 comprises approximately 800 acres of the main plant area (Figure 8.1). The remainder of the site, which encompasses approximately 2,800 acres surrounding Zones 1 and 2, is primarily uncontaminated and is part of DOE's NPL Boundary Definition effort (Section 1.4).

Zone 1

The remediation required by the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2) for unrestricted industrial use to a depth of 10 ft and for sources of groundwater contamination has been completed. Zone 1 was divided into 80 exposure units (EUs) for evaluation purposes. The status of Zone 1 is summarized in Figure 8.3.

Work continued in FY 2014 on a final Zone 1 ROD addressing soil and ecological protection. The *Final Zone 1 Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2561&D3) was submitted to the regulators, and TDEC approved the document. The *Final Proposed Plan for Soils in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2648&D1) was submitted to the regulators for review.

Zone 2

The *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) includes RAs for unrestricted industrial use to a depth of 10 ft and for sources of groundwater contamination. Zone 2 was divided into 44 EUs for evaluation purposes. The status of Zone 2 is summarized in Figure 8.4 and discussed below:

- In FY 2014 characterization of the footprints of Building K-25 (EUs Z2-20, -21, and -22) and Building K-31 (EU Z2-6) was initiated (Figure 8.5). The 40 acre footprint of Building K-25 (EUs 20, 21, and 22 shown on Figure 8.4) has been declared the K-25 Preservation footprint that is dedicated for historical commemoration and interpretation activities. In order to determine how to preserve this footprint, the characterization to determine if remediation is required was initiated, and a study to evaluate potential end states of the slab was initiated. Pre-demolition activities were performed on Building K-31 during FY 2014, so characterization of the surrounding land was initiated to determine if remediation will be required.

- The *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) documented characterization in 11 EUs (Z2-01, Z2-03, Z2-08, Z2-23, Z2-24, Z2-28, Z2-34, Z2-37, Z2-41, Z2-43, and Z2-44) and RAs in EUs Z2-33, Z2-35, and Z2-36. However, the footprint of the Toxic Substances Control Act of 1976 (TSCA) Incinerator in EU Z2-44 was excluded from characterization at that time because the facility was still active. Since that time, characterization of the TSCA Incinerator footprint has been completed, and two RAs have been conducted. The results and conclusions of the characterization and a description of the RAs were reported in the *Addendum to the 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/A1) that was submitted to the regulators in March 2013. Since the TSCA Incinerator has not been demolished, there is a possibility that the surrounding soil will be contaminated during demolition. Therefore, an erratum was prepared in 2014 stating the Addendum is interim, and EU Z2-44 will be reevaluated following demolition. EPA and TDEC approved the Addendum in October 2014.

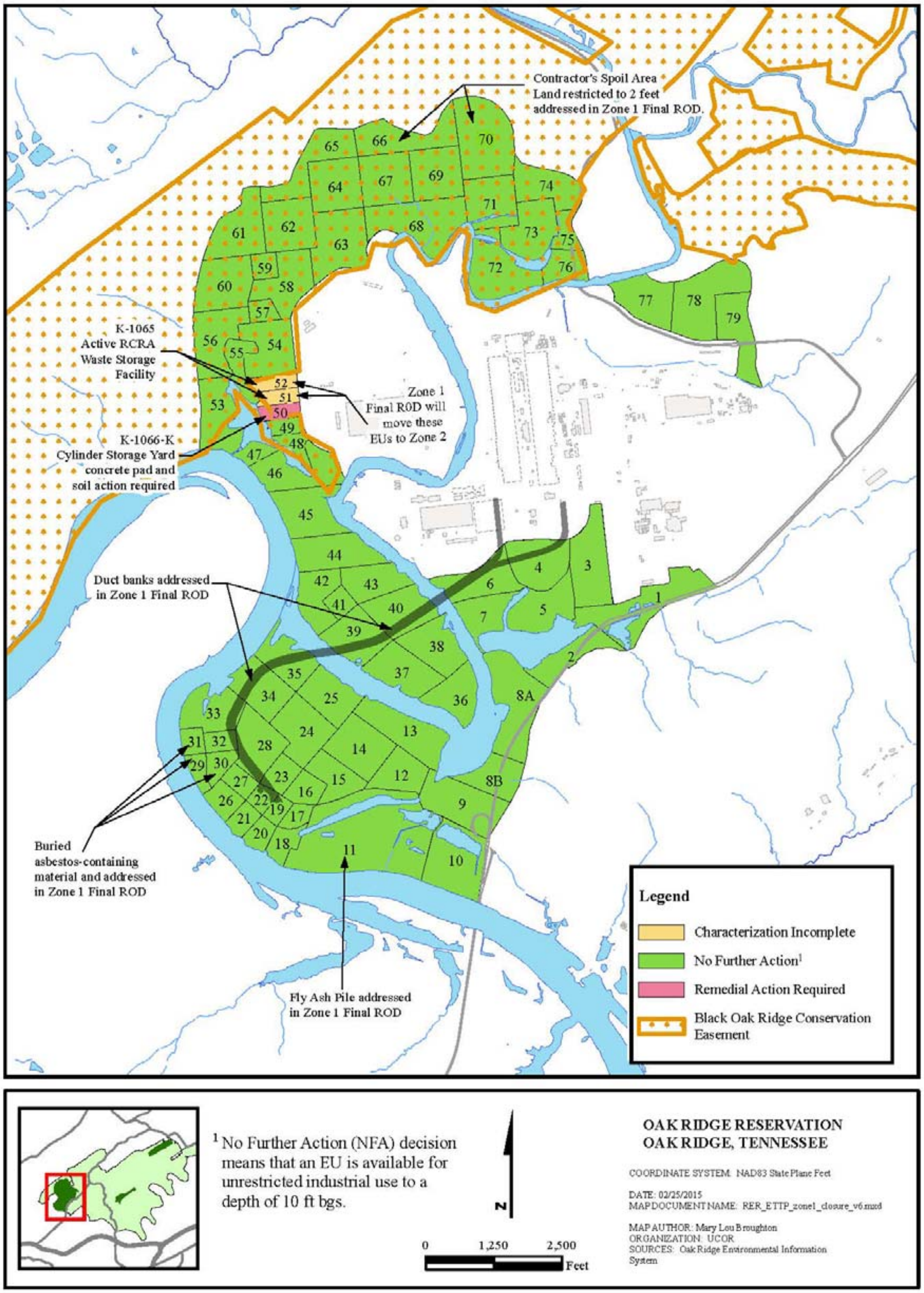


Figure 8.3. ETTP Zone 1 status.

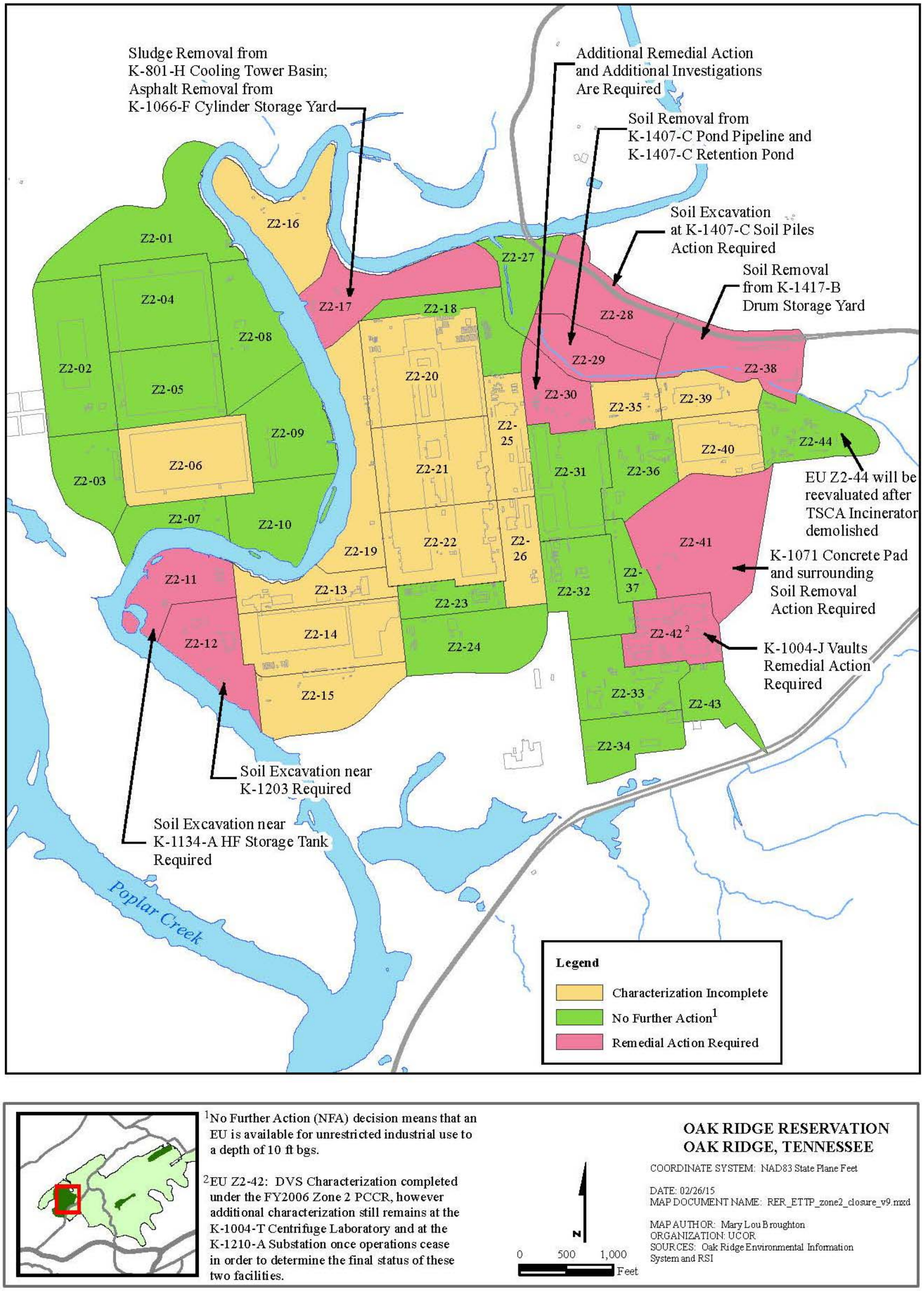


Figure 8.4. ETTP Zone 2 closure document and action status.

Figure 8.5. Workers sample soil under the K-31 slab as part of characterization.

- Characterization of several subsurface facilities at the Central Neutralization Facility (CNF) was completed to determine if remediation was required prior to backfill. Based on the results, the subsurface facilities were backfilled to eliminate safety hazards and the management of storm water. The *Phased Construction Completion Report for Exposure Unit Z2-35 Sumps in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2618&D2) documenting the NFA decisions for the subsurface facilities was approved in FY 2014.

- The *Remedial Design Report/Remedial Action Work Plan for Zone 2 Soils, Slabs, and Subsurface Structures, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2224&D3/R1) was revised in FY 2014 to update the QAPP, include alternate remediation levels for the Building K-25 preservation footprint, include a groundwater soil screening level for ^{99}Tc, and include the Dynamic Work Plan and was submitted to EPA and TDEC for review and approval. TDEC approved the document, and EPA provided comments.

Demolition Projects

The *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; DOE/OR/01-2259&D1; DOE/OR/01-2582&D1) requires the buildings be demolished to slab. Completion of demolition progress has been documented by several PCCRs (Table 8.1). The FY 2014 status of the demolition of Buildings K-25 and K-27 follows:

- Demolition of Building K-25, one of the original Manhattan Project facilities, was completed in December 2013 (Figure 8.6), and disposal of all demolition debris was completed in June 2014. The *Completion Report for Building K-25 at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2651&D1) was submitted to EPA and TDEC in July 2014. Following demolition, ^{99}Tc, which is extremely mobile, was found in storm water and underground utilities associated with Building K-25. Following an extensive investigation of storm water sewers, underground electrical duct banks, sanitary sewers, and groundwater, the conclusion was that the concentrations of ^{99}Tc were in compliance with applicable regulatory requirements and DOE Orders and did not pose a threat to human health and the environment. A *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1) was prepared that documents the findings.

- Pre-demolition work continued in Building K-27 (Figure 8.7), a former gaseous diffusion building similar in structure to Building K-25. In FY 2014, inventory management and nondestructive assay (NDA) measurements were completed; the building structure and process equipment were characterized; vent, purge, and drain operations were performed on process equipment; and the *Addendum to Waste Handling Plan for Demolition of the K-25 and K-27 Building Structures and Remaining Components Located at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2167&D1/A5) and the *Waste Handling Plan for Building K-27 Process Equipment and Piping at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2652&D1) were submitted to EPA and TDEC for approval.

The *Action Memorandum for the Remaining Facilities Demolition Project at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2049&D2) requires approximately 500 facilities be demolished to slab. Demolition progress has been documented by several PCCRs (Table 8.1). The FY 2014 status of demolition follows:

- Demolition of Building K-33, one of the major uranium enrichment facilities at ETTP, was completed in FY 2011. The 1.4 million ft^2, partially decontaminated, multi-story building spanned 32 acres. The *Phased Construction Completion Report for Building K-33 of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2541&D1) was approved in February 2012. Following removal of above ground utility piping, the revised *Phased Construction Completion Report for Building K-33 of the Remaining Facilities Demolition Project* (DOE/OR/01-2541&D2) was approved in July 2013. The process tie-line that connected Building K-33 with Building K-31 was demolished in FY 2013, and the *Phased Construction Completion Report for the K-33/K-31 Process Tie Line Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2620&D1) was submitted to EPA and TDEC for review and approval in FY 2014.

Figure 8.6. Building K-25 before and after demolition.

Figure 8.7. Workers remove process piping inside Building K-27.

- Pre-demolition work was started in FY 2014 for Building K-31, another of the five gaseous diffusion buildings at ETTP. The *Waste Handling Plan – Part 2 for Building K-31 at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2644&D2) was approved by EPA and TDEC in FY 2014.

- The CNF was decommissioned in FY 2014. The decommissioning resulted in all RCRA hazardous waste being removed and disposed and all facility components being decontaminated to the point where RCRA-listed waste codes are no longer associated with any items, i.e., equipment, sumps, pipelines or structures. The *Phased Construction Completion Report for Decommissioning the Central Neutralization Facility at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2619&D2) was submitted to EPA and TDEC for approval in FY 2014, and EPA approved the document.

8.2 ZONE 1 ROD

Major components of the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2) are:

- excavation of Blair quarry and associated contaminated soil,
- excavation of contaminated soil in the K-895 Cylinder Destruct Facility and the Powerhouse Area,
- removal of scrap metal and debris from the K-770 Area,
- removal of sludge and demolition of the K-710 sludge beds and Imhoff tanks,
- implementation of LUCs, and
- characterization of the soil and removal of soil up to 10 ft in depth that exceeds remediation levels set to protect a future industrial worker; removal of soil to bedrock, water table, or acceptable levels of contamination to protect underlying groundwater to meet drinking water MCLs.

Completion of these Zone 1 ROD actions is documented in PCCRs listed in Table 8.1. No performance monitoring is required under the Zone 1 ROD (DOE/OR/01-1997&D2).

8.2.1 Other LTS Requirements

Other LTS requirements for the Zone 1 ROD are listed in Table 8.2 and described below.

8.2.1.1 Requirements

This ROD (DOE/OR/01-1997&D2) establishes "unrestricted industrial" as the end 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 are in accordance with this land use and to restrict access to this area until that land use has been achieved, seven LUCs will be implemented.

Table 8.2. Other LTS requirements for the ETTP

Type of control	Affected areas[a]	Purposes of control	Duration	Implementation	Frequency
***Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park* (Zone 1 ROD) (DOE/OR/01-1997&D2)**					
1. Property Record Restrictions[b] *A. Land use* *B. Groundwater*	*Throughout all of Zone 1.*	*Restrict use of property by imposing limitations.* *Prohibit uses of groundwater.*	*Indefinitely*	*Drafted and implemented by DOE upon transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.*	*Verify annually that information is being maintained properly.*
2. Property Record Notices[c]	*Throughout all of Zone 1.*	*Provide notice to anyone searching records about the existence and location of contaminated areas and limitations on their use.*	*Indefinitely*	*Notice recorded by DOE in accordance with state law at County Register of Deeds office: 1) as soon as practicable after signing of the ROD; 2) upon transfer of affected areas; 3) upon completion of all remedial actions.*	*Verify annually that information is being maintained properly.*
3. Zoning Notices[d]	*Throughout all of Zone 1.*	*Provide notice to city about the existence and location of waste disposal and residual contamination areas for zoning/planning purposes.*	*Indefinitely*	*Initial Zoning Notice (same as Property Record Notice) filed with City Planning Commission as soon as practicable after signing of the ROD; final Zoning Notice and survey plat filed with City Planning Commission upon completion of all remedial actions*	*Verify annually that information is being maintained properly.*
4. Excavation/ Penetration Permit Program[e]	*All areas where hazardous substances are left in the subsurface below 10 ft or that are not yet discovered in areas with more limited characterization requiring land use and/or groundwater restrictions.*	*Provide notice to worker/ developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/ penetration activity.*	*As long as property remains under DOE control.*	*Implemented by DOE and its contractors. Initiated by permit request. Provide permits program with contamination information as soon as practicable after signing of the ROD, and update information regularly while remediation proceeds.*	*Monitor annually to ensure it is functioning properly.*
5. Access Controls[f] (e.g., fences, gates, and portals)	*Specific locations will, if necessary, be determined by each remediation project.*	*Control and restrict access to workers and the public to prevent unauthorized uses.*	*Indefinitely*	*Controls maintained by DOE.*	*Inspect no less than annually.*
6. Signs[g]	*At select locations throughout Zone 1.*	*Provide notice or warning to prevent unauthorized access.*	*Indefinitely*	*Signage maintained by DOE.*	*Inspect no less than annually.*
7. Surveillance Patrols	*Patrol of selected areas throughout Zone 1, as necessary.*	*Control and monitor access by workers/public.*	*Indefinitely*	*Established and maintained by DOE. Necessity of patrols evaluated upon completion of remedial actions.*	*Adequacy of necessary patrols assessed no less than annually.*

Table 8.2. Other LTS requirements for the ETTP (cont.)

Type of control	Affected areas[a]	Purposes of control	Duration	Implementation	Frequency
***Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park* (Zone 2 ROD) (DOE/OR/01-2161&D2)**					
1. Property Record Restrictions[b]	*Throughout all of Zone 2.*	*Restrict use of property by limiting penetrations deeper than 10 ft bgs and all uses involving exposures to human receptors greater than industrial use exposures.*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure.*	*Drafted and implemented by DOE upon completion of all remediation activities or transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.*	*Verify annually that information is being maintained properly.*
2. Property Record Notices[c]	*Throughout all of Zone 2.*	*Provide information to the public about the existence and location of contaminated areas and limitations on their use.*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure.*	*Notice recorded by DOE EM in accordance with state law at County Register of Deeds office: 1) as soon as practicable after signing of the ROD but no later than 90 days after approval of the LUCIP, 2) upon transfer of affected areas; 3) upon completion of all remedial actions.*	*Verify annually that information is being maintained properly.*
3. Zoning Notices[d]	*Throughout all of Zone 2.*	*Provide notice to city and county about the existence and location of waste disposal and residual contamination areas and limitations on their use for zoning/planning purposes.*	*Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure.*	*Initial Zoning Notice (same as Property Record Notice) filed with City Planning Commission as soon as practicable after signing of the ROD; final Zoning Notice and survey plat filed with City Planning Commission upon completion of all remedial actions.*	*Verify annually that information is being maintained properly.*
4. Excavation/ Penetration Permit Program[e]	*All areas where hazardous substances are left in the subsurface below 10 ft or where hazardous substances may be present but have not been detected because of the limits on characterization performed.*	*Provide notice to worker/ developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity.*	*As long as property remains under DOE control, including transferred property remaining subject to excavation/ penetration permit program.*	*Implemented by DOE and its contractors. Initiated by permit request. Provide permits program with contamination information as soon as practicable after signing of the ROD, and update information regularly while remediation proceeds.*	*Monitor annually to ensure it is functioning properly.*
5. Access Controls[f] *(e.g., fences, gates, and portals)*	*Specific locations will, if necessary, be determined by each remediation project in the near term. At K-1070-C/D until security is no longer an issue.*	*Control and restrict access to workers and the public to prevent unauthorized uses.*	*Until remediation is complete or until security is no longer an issue at K-1070-C/D.*	*Controls maintained by DOE.*	*Inspect no less than annually.*

Table 8.2. Other LTS requirements for the ETTP (cont.)

Type of control	Affected areas[a]	Purposes of control	Duration	Implementation	Frequency
6. Signs[g]	*At select locations throughout Zone 2. At K-1070-C/D until security is no longer an issue.*	*Provide notice or warning to prevent unauthorized access.*	*Until the concentrations of hazardous substances left beneath 10 feet allow for industrial use and for K-1070-C/D until security is no longer an issue.*	*Signage maintained by DOE.*	*Inspect no less than annually.*
7. Surveillance Patrols	*Patrol of selected areas throughout Zone 2, as necessary until remediation is complete. Then at K-1070-C/D until security is no longer an issue.*	*Control and monitor access by workers/public.*	*Until remediation is complete or until security is no longer an issue at K-1070-C/D.*	*Established and maintained by DOE.*	*Adequacy of necessary patrols assessed no less than annually.*

Areas	Project Documents	Other LTS Requirements	Implementation/ Frequency
		Other LTS requirements for Specific Areas at ETTP	
Single Actions:			
K-1070-C/D OU K-1071 Concrete Pad soil cover	K-1070-C/D G-Pit and Concrete Pad RA • ROD (DOE/OR/02-1486&D4) • RAR (DOE/OR/01-1964&D2) • RAR Erratum (DOE/OR/01-1964&D2)	From RAR Erratum: • To maintain the effectiveness of the soil cover over the pad, the cover is inspected annually • Any needed maintenance of the K-1071 Concrete Pad soil cover is provided through the S&M program • The grass on the cover will be mowed as needed but not less than annually • If erosion of the cover is found, soil is used to repair the eroded area, and the area is re-seeded, if necessary • A radiological walkover on the concrete pad cover will occur only if there is activity within the area • The interim LUCs include the fence that is present and the excavation permits system that is in place under DOE's control • The existing fence is evaluated for its integrity as needed, but no less than annually	Annual inspection of soil cover Grass on the cover will be mowed as needed but no less than annually Radiological walkover on the concrete pad cover will occur only if there is activity within the area Fence will be evaluated for its integrity as needed, but no less than annually

Table 8.2. Other LTS requirements for the ETTP (cont.)

Areas	Project Documents	Other LTS Requirements	Implementation/ Frequency
K-1407-B/C Ponds	K-1407-B/C Ponds RA • ROD (DOE/OR/02-1125&D3) • RAR (DOE/OR/01-1371&D1) • RAR Erratum (DOE/OR/01-1371&D1)	From RAR and Erratum: • Conduct annual inspections and annual inspections and perform radiological and industrial hygiene surveillance and other assessment activities only as needed if activities are conducted at the site that are necessary to keep the remediated ponds in compliance with environmental, safety, and health requirements and maintain records of all related activities • Maintenance activities required as a result of inspections are implemented • Access and activity controls have been established and are maintained, as required • DOE (or its successor) will conduct a review of the remedy and current site conditions prior to transfer of the K-25 Site from DOE (or its successor) to another person or entity. Any property transfer will follow the procedure outlined in the FFA (DOE/OR-1014), Section XLIII, Property Transfer.	Annual inspections Verify annually that controls are being implemented
		Other LTS Activities for Specific Removal Actions	
CWTS	Mitchell Branch Chromium Reduction Removal Action • RmAR (DOE/OR/01-2598&D2)	• The groundwater interception wells require ongoing operation and maintenance • The CWTS will be operated and maintained in accordance with a contractor procedure	Verify system operation monthly
K-1007-P1 Holding Pond K-901-A Holding Pond K-720 Slough	ETTP Ponds Removal Action • AM (DOE/OR/01-2314&D2) • RmAR (DOE/OR/01-2456&D1/R1)	1. DOE land notation (property record restrictions)[b] 2. Property record notices[c] 3. Zoning notices[d] 4. EPP program[e] • As long as property remains under DOE control, including transferred property remaining subject to EPP program 5. Signs[g,h] • All ponds: Provide notice or warning to prevent unauthorized access by fishermen • K-1007-P1: Provide notice or warning that prohibits mowing in the buffer zone 6. Surveillance patrols to control and monitor access by fishermen	1-3. Until the concentration of PCBs in fish are at such levels to allow for unrestricted use and exposure *5-6. Until PCB fish advisories are lifted in the Clinch River and PCB concentrations in fish are protective for the recreation user*

[a]*Affected areas – Specific locations identified in the Zone 1 LUCIP, subsequent post-ROD documents, or the Zone 2 LUCIP as part of a remedial design report/remedial action work plan.*
[b]*Property Record Restrictions – Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with original property acquisition records of DOE and its predecessor agencies.*
[c]*Property Record Notices – Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination/waste disposal areas on the property.*
[d]*Zoning Notices – Includes information on the location of waste disposal areas and residual contamination depicted on a survey plat, which is provided to a zoning authority (i.e., City Planning Commission) for consideration in appropriate zoning decisions for non-DOE property.*

Table 8.2. Other LTS requirements for the ETTP (cont.)

[e]*Excavation/Penetration Permit Program – Refers to the internal DOE/DOE contractor administrative program(s) that require the permit requestor to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case of contaminated soil or groundwater, will not disturb the affected area without the appropriate precautions and safeguards.*

[f]*Access Controls – Physical barriers or restrictions to entry.*

[g]*Signs – Posted command, warning, or direction.*

[h]Specific sign requirements at the K-1007-P1 Holding Pond, K-901-A Holding Pond, and K-720 Slough to provide notice or warning to prevent unauthorized access by fisherman, and specific signs at the K-1007-P1 Holding Pond to provide notice or warning that prohibits mowing in the buffer zone.

AM = Action Memorandum
bgs = below ground surface
CWTS = Chromium Water Treatment System
DOE = U.S. Department of Energy
EM = Environmental Management
EPP = excavation/penetration permit
ETTP = East Tennessee Technology Park
FFA = Federal Facility Agreement
LTS = long-term stewardship
LUC = land use control
LUCIP = Land Use Controls Implementation Plan
OU = operable unit
PCB = polychlorinated biphenyls
RA = remedial action
RAR = Remedial Action Report
RmAR = Removal Action Report
ROD = Record of Decision
S&M = surveillance and maintenance

The objectives of these Zone 1 LUCs follow:

- 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.

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. These controls and their implementation are summarized in Table 8.2.

The PCCRs completed under the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2) state that the NFA decision means that an EU is available for unrestricted industrial use to a depth of 10 ft bgs and NFA is required beyond the LUCs specified in the Zone 1 Interim ROD. All Zone 1 EUs have been cleared for industrial use to a depth of 10 ft. However, the following areas (Figure 8.3) have issues with unrestricted industrial use that are not addressed in the Zone 1 Interim ROD but will be addressed in the Zone 1 Final ROD.

- The Black Oak Ridge Conservation Easement (BORCE) is managed by the state of Tennessee as a Wildlife Management Area and State Natural Area. Two EUs in the northern section of Zone 1 (EU 66 and EU 70) are located in the BORCE. A large portion of these two EUs (15.6 acres) comprises the Contractors Spoil Area construction debris and fly-ash landfill. The recreational end use of these EUs in the BORCE is different from the end use identified in the Zone 1 Interim ROD. This is being addressed in the Zone 1 Final ROD.
- EU 11 is considered NFA; however, groundwater beneath the K-720 Fly Ash Pile is contaminated with semivolatile organic compounds, metals, and radionuclides. The K-720 Fly Ash Pile is included in the *Addendum to the Phased Construction Completion Report for the K-1007 Ponds Area and Powerhouse North Area in Zone 1* (DOE/OR/01-2294&D2/A1). No site-specific controls are recommended, but the Addendum recommends the K-720 Fly Ash Pile be reevaluated in conjunction with a groundwater decision so that all media can be addressed. A soil cap was constructed over the fly-ash pile in anticipation of a final Zone 1 ROD to address the fly ash pile and the impact on groundwater. The soil cap is in place but requires controls to maintain the cap to prevent possible releases of fly ash.

- EUs 27 – 33 are addressed in the second *Addendum to the Phased Construction Completion Report for the K-1007 Ponds Area and Powerhouse North Area* (DOE/OR/01-2294&D2/A2). Observations made during confirmatory radiological walkover and geophysical surveys indicated that asbestos-containing material and metal debris may remain buried. While meeting the Zone 1 criteria for a NFA determination, an end use change is proposed for EUs 29, 30, and 31 due to the asbestos-containing material and metal debris that remain buried on site. This is being addressed in the Zone 1 Final ROD.

- Active RCRA waste storage facilities are located on EUs Z1-50, -51, and -52. Therefore, these EUs are being transferred to the Zone 2 ROD for remediation.

8.2.1.2 Status of Requirements

General LUCs for Zone 1 remained in place during FY 2014. Restrictions were maintained for government-controlled industrial land use. The EPP functioned according to established procedures and plans for the site. Additionally, signs were maintained to control access and surveillance patrols were conducted as part of routine S&M inspections.

The northern section of Zone 1 was identified as a conservation easement, the BORCE, on March 14, 2005 (Figure 8.3). The BORCE is utilized for recreational use, e.g., hiking, bicycling, and select controlled deer hunts. The trailhead is posted with a sign which designates the trails that are available for use in the conservation easement. Additionally, trail maps are located within the conservation easement 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 Zone 1 Interim ROD (DOE/OR/01-1997&D2) is unrestricted industrial, i.e., recreational use was not designated. This is an issue that was identified in the 2010 RER and carried forward in subsequent RERs. The Zone 1 Final ROD will address this issue (Table 8.9).

8.3 ZONE 2 ROD

8.3.1 Performance Monitoring

8.3.1.1 Performance Monitoring Goals and Objectives

Major components of the *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) (Figure 8.4) selected remedy are:

- Assess data sufficiency for each EU and supplement data as necessary to determine if remediation levels are exceeded.

- Remove soil up to 10 ft in depth that exceeds remediation levels set to protect a future industrial worker.

- Remove soil to water table, bedrock, or acceptable levels of contamination, whichever is the shallowest, to protect underlying groundwater to MCLs and to protect human health and the environment.

- Remove or decontaminate the contaminated portions of slabs, vaults, basements, pits, tanks, pipelines, or any other subsurface structure that exceed the remediation levels to protect a future industrial worker to a depth no more than 10 ft. Use soil or concrete debris that meets Zone 2 remediation levels as backfill material in basements and deep excavations.

- Remove the debris in the K-1070-B Burial Ground, regardless of depth to minimize potential future impact to surface water and soil that exceeds remediation levels for protection of workers (upper 10 ft) or protection of groundwater (water table or bedrock surface).

- Remove the debris and soil in the K-1070-C/D Burial Ground that exceeds remediation levels for the protection of workers (upper 10 ft) or protection of groundwater (water table or bedrock surface).

- Verify all acreage in Zone 2 as compliant with soil remediation levels established by the ROD.

- Implement LUCs to prevent exposure to residual solid 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 (Figure 8.4). Final status assessments and associated data gap sampling efforts for EUs in Zone 2 are being conducted using a Dynamic Verification Strategy (DVS) in accordance with the *Remedial Design Report/Remedial Action Work Plan for the Zone 2 Soils, Slabs, and Subsurface Structures, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2618&D2). Successful completion of the Zone 2 cleanup requires that each of these 44 EUs be characterized, evaluated against the Zone 2 risk criteria, and remediated if necessary.

The RAOs for Zone 2 are to:

- *Protect human health under an industrial land use to an excess cancer risk level at or below 1 x* 10^{-4} *and non-cancer risk levels at or below an HI [Hazard Index] of 1, and*

- *Protect groundwater to levels at or below MCLs.*

Drinking water MCLs are used as screening criteria for evaluating the effectiveness of soil, buried waste, and subsurface structure cleanup. The ROD, however, specifically defers groundwater and surface water cleanup to a later CERCLA action and does not include ARAR-based performance objectives for groundwater cleanup.

The monitoring requirements are monitoring of groundwater adjacent to potential sources of groundwater contamination, including the K-1070-C/D Burial Ground (DOE/OR/01-2161&D2). This monitoring will continue until the Sitewide ROD is approved.

Table 8.3 lists performance monitoring conducted for the Zone 2 ROD and other CERCLA actions at ETTP. Figure 8.8 shows watershed scale and CERCLA performance monitoring locations at ETTP (groundwater monitoring locations are shown on separate figures as indicated). ETTP does not have a sole surface water integration point at which all upstream contaminant releases converge to exit the watershed but has several subwatersheds. Therefore, there are several surface water integration points.

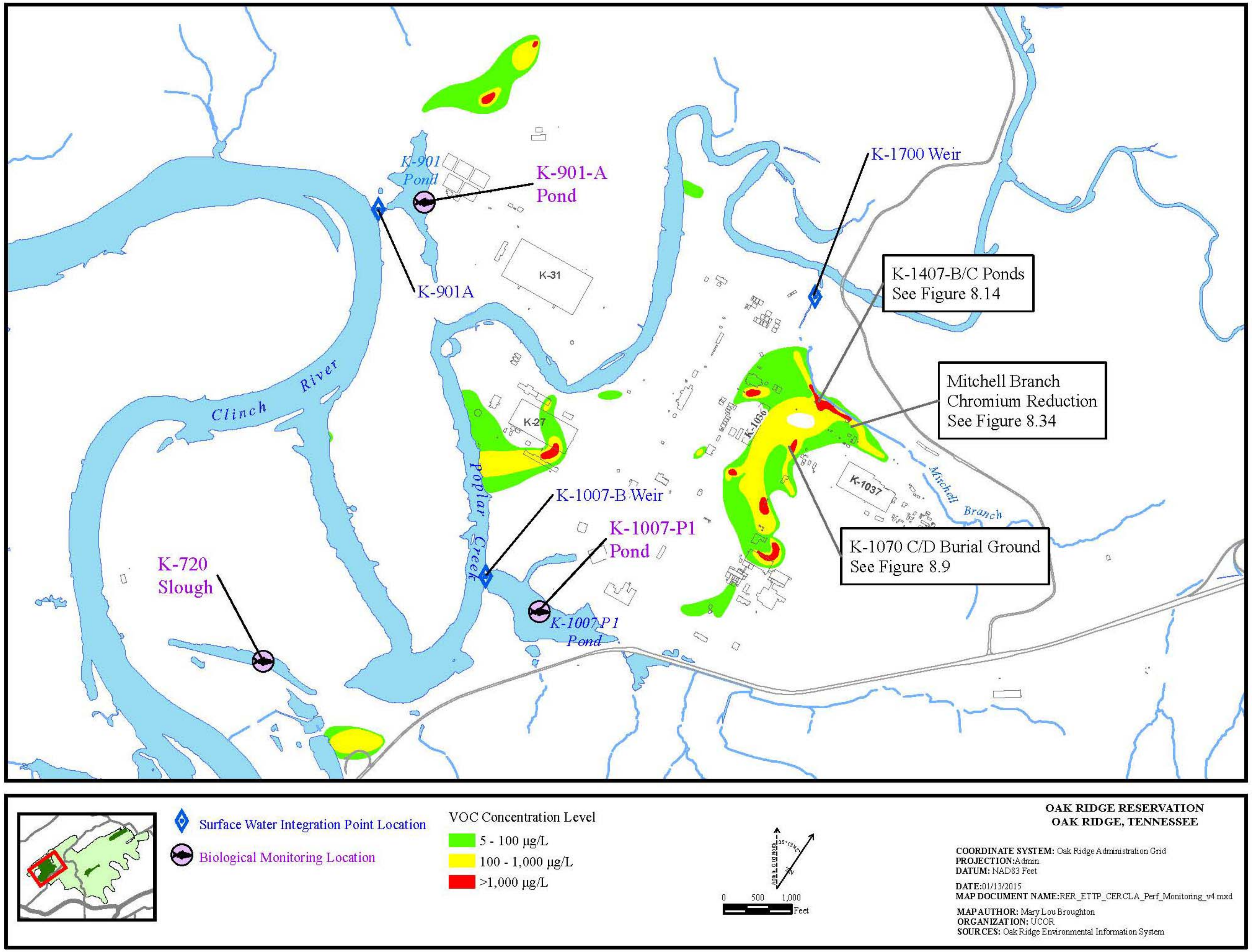


Figure 8.8.Watershed scale and CERCLA performance monitoring locations at ETTP.

This page intentionally left blank.

Table 8.3. CERCLA action performance monitoring in the ETTP Administrative watershed[a]

CERCLA action	Performance goal	Performance standard	Monitoring location(s)	General schedule and monitored parameters
		Performance Monitoring		
Zone 2 Soil, Buried Waste, and Subsurface Structure RAs (includes K-1070-C/D Burial Ground)	Protect human health under an industrial land use to an ELCR at or below 1 x 10^{-4} and non-cancer risk levels at or below a HI of 1 Protect groundwater to levels at or below MCLs for drinking water	Drinking water MCLs	*Groundwater* TMW-011 UNW-064 UNW-114	Semiannual sampling (seasonally wet and dry conditions) Laboratory analyses for VOCs and water quality parameters
Long-term Reduction of Hexavalent Chromium Releases to Mitchell Branch (Non-TC RmA)	Collect and treat hexavalent chromium-contaminated groundwater to reduce its toxicity prior to discharge into Mitchell Branch Protect water quality in Mitchell Branch at levels consistent with AWQC	Hexavalent chromium concentrations below 0.011 mg/L AWQC in Mitchell Branch immediately downstream of SD-170 discharge	*Surface water* MIK-0.79 SD-170 *Groundwater* TP-289 IW-416 and IW-417 *Treatment System Discharge*	Quarterly sampling of all monitoring locations Laboratory analyses (unfiltered samples) for total and hexavalent chromium in surface water, groundwater, and treatment system discharge samples Treatment system discharge samples also analyzed for pH, total uranium, VOCs, gross alpha and beta, and select radionuclides
K-1407-B/C Ponds RA	Reduce potential threats to human health and the environment posed by residual contamination in pond soils by providing isolation and shielding with rock fill and intact soil cover	Remediation target concentrations were not established in the CERCLA decision or post-decision documents	*Surface water* K-1700 Weir *Groundwater* UNW-003 UNW-009	Semiannual sampling Laboratory analyses for nitrate, field parameters, VOCs, metals, gross alpha and beta, ^{99}Tc, ^{90}Sr, ^{137}Cs, ^{230,232}Th, and $^{234/238}$U

Table 8.3. CERCLA action performance monitoring in the ETTP Administrative watershed[a] (cont.)

CERCLA action	Performance goal	Performance standard	Monitoring location(s)	General schedule and monitored parameters
K-901-A and K-1007-P1 Holding Ponds and K-720 Slough RA	The goal of the ecological enhancement performed at the K-1007-P1 Holding Pond 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, which will reduce risks to human and piscivorous wildlife by interdicting contaminant exposure pathways associated with these receptors	PCB concentration of 1 mg/kg in fish fillets (2.3 mg/kg whole body)	Operational Monitoring at K-1007-P1 Pond only:	
			1. Presence of original fish	1. Once, after fish removal
			2. PCBs in fish	2. Annually
			3. Condition of vegetation	3. 2x/yr during growing season
			4. Species of fish	4. Annually
			5. Water quality	5. 3x/yr during growing season
			6. PCBs in clams	6. 4 locations annually for a 4-week exposure
			7. Geese/waterfowl population	7. Monthly identification and enumeration of all waterfowl in and around pond
			Performance Monitoring at K-1007-P1 & K-901-A Holding Ponds, and K-720 Slough:	
			1. PCBs in fish	1. Annually for 4 years, then reassess for every other year until acceptable risk documented for each pond
			2. Species of fish in K-1007-P1 only	2. Annually for 4 years (reassess after 4 years, as above)
			3. PCBs in clams in K-1007-P1 only	3. Four locations annually for a 4-week exposure (reassessed after 4 years, as above)

[a]Changes to performance monitoring for RAs require prior approval from the EPA and TDEC.

AWQC = ambient water quality criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
ELCR = excess lifetime cancer risk
EPA = U.S. Environmental Protection Agency
ETTP = East Tennessee Technology Park
HI = hazard index
MCL = maximum contaminant level
MIK = Mitchell Branch kilometer
PCB = polychlorinated biphenyl
RA = remedial action
RmA = Removal Action
TDEC = Tennessee Department of Environment and Conservation
TC = time critical
VOC = volatile organic compound

8.3.1.2 Evaluation of Performance Monitoring Data

Monitoring locations, analytical parameters, and clean-up levels were not specified for groundwater monitoring at the K-1070-C/D Burial Ground (Figure 8.9), although the primary COCs in that area are VOCs. Semiannual samples are analyzed for VOCs and general water quality parameters in wells and surface water locations outside the perimeter of the K-1070-C/D Burial Ground. 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. Approximately 9,000 gal of mixed volatile organic liquids were disposed in G-Pit. Historic data showed that 1,1,1-TCA was present at very high concentrations in wells monitored near the site. 1,1,1-TCA is amenable to biodegradation to 1,1-DCA by microbes in the *Dehalobacter* genus. Although 1,1-DCA is also amenable to degradation by some species of *Dehalobacter*, the presence of cis-1,2-DCE and VC tend to inhibit the biodegradation of 1,1-DCA. Cis-1,2-DCE and VC are common biodegradation products of PCE and TCE which are also present in groundwater at the site along with 1,1-DCE, another biodegradation product of PCE and TCE.

Following remediation of G-Pit, monitoring wells UNW-114, TMW-011, and UNW-064 (Figure 8.9) were selected to monitor the VOC plume leaving the K-1070-C/D Burial Grounds because they were located in the principal known downgradient groundwater pathway. 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) and continue to decrease. Although 1,1,1-TCA was formerly present at concentrations far greater than its 200 µg/L MCL, natural biodegradation has reduced its concentrations to less than the drinking water standard. Several direct push monitoring points were installed to the west of UNW-114 during investigations conducted in support of a Sitewide Groundwater Remedial Investigation in 2005. The purpose of these monitoring points was to investigate groundwater contamination in an area along potential geologically controlled seepage pathways that may have connected the G-Pit contaminant source to the former SW-31 Spring. DOE continues to monitor two of these points (DPT-K1070-5 and DPT-K1070-6) to measure VOC concentrations and their fluctuations.

Of the three wells monitored at this site, well UNW-114 is closest to the source area. Monitoring data for well UNW-114 (Figure 8.10) show that concentrations of most VOCs have been variable since 2005 and exhibit no trend or a stable trend. Concentrations of 1,1-DCA have gradually increased from a minimum of about 140 µg/L in 2007 to a recent concentration of 680 µg/L. 1,1,1-TCA was not detected in samples from well UNW-114 during FY 2014 but its former presence is reflected in the lingering 1,1-DCA residuals in groundwater. Recent concentrations of most chlorinated VOCs in well UNW-114 are within factors of about two to five times their MCLs.

Well UNW-064 is located slightly further downgradient from the contaminant source area than UNW-114 and its monitoring data exhibit a slightly different behavior. Similar to the overall trend observed at UNW-114, the majority of VOC concentrations at UNW-064 (Figure 8.11) decreased from about 2002 through 2005. Concentrations remained relatively low through the drought years of 2006 into 2008 and increased between 2008 and 2010. Since 2010 VOCs in well UNW-064 have exhibited gradual decreases with strong seasonal fluctuations. At UNW-064 the 1,1-DCA, 1,1-DCE, cis-1,2-DCE, and TCE show a seasonal concentration fluctuation with higher concentration during winter than during summer. This seasonal fluctuation suggests that contaminant mass transport responds to increased groundwater recharge and seepage through the plume. DOE suspects that increased seasonal recharge drives mass transfer in the plume through two combined mechanisms. One mechanism is a rise in groundwater elevation in the source area (residual liquid waste beneath “G-Pit”) which allows groundwater seepage through fractures of higher permeability at a somewhat shallower depth. The second mechanism is simply a higher flow volume through the source area and downgradient fractures caused by the higher head imposed on the whole saturated zone. Cis-1,2-DCE and PCE have decreased to concentrations less than their respective

MCLs in well UNW-064 and the most recent results for TCE and VC have decreased to concentrations below their respective MCLs. The most recent result for 1,1-DCE was approximately 1.5 times its MCL.

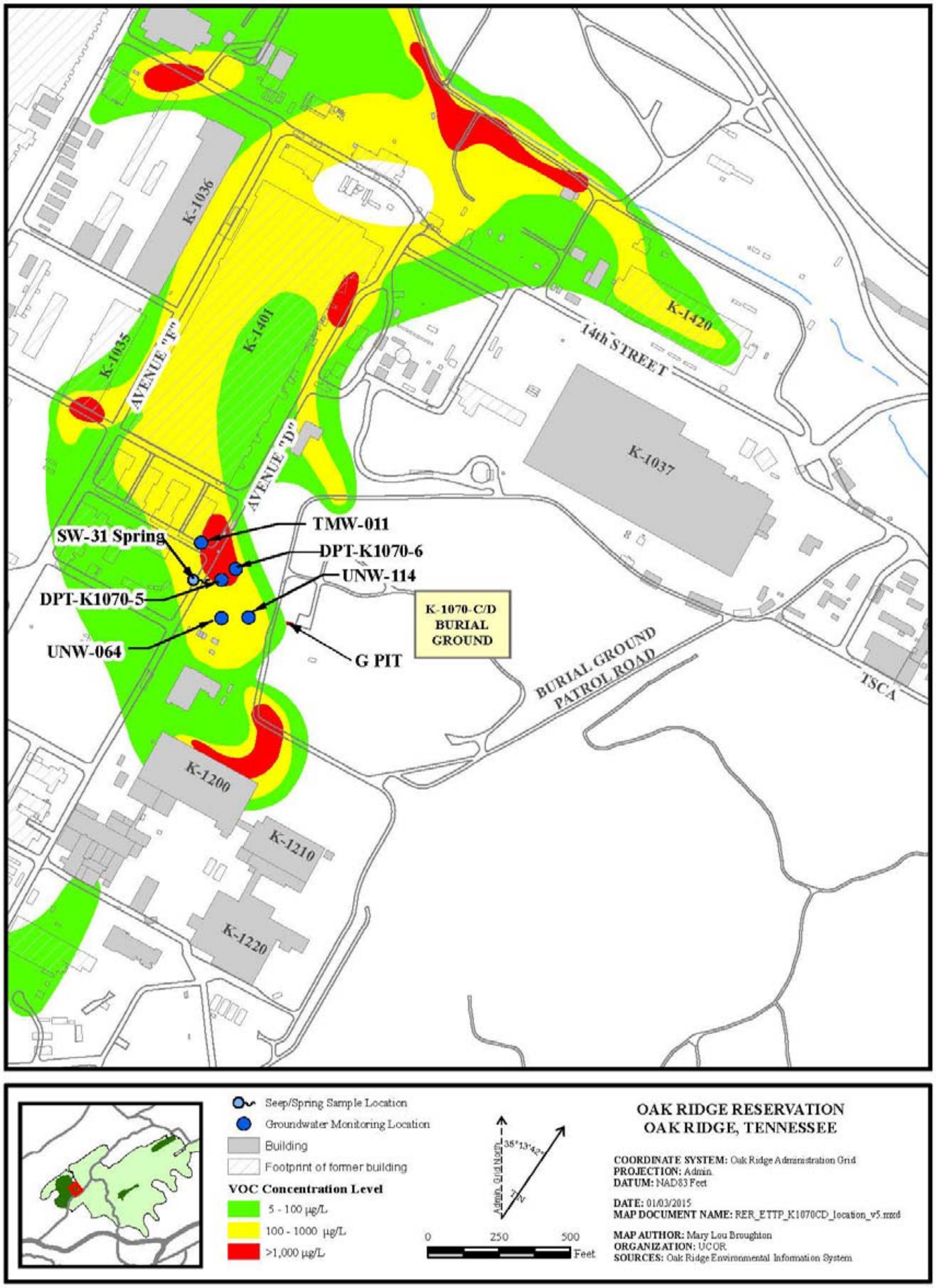


Figure 8.9. Location map for K-1070-C/D Burial Ground.

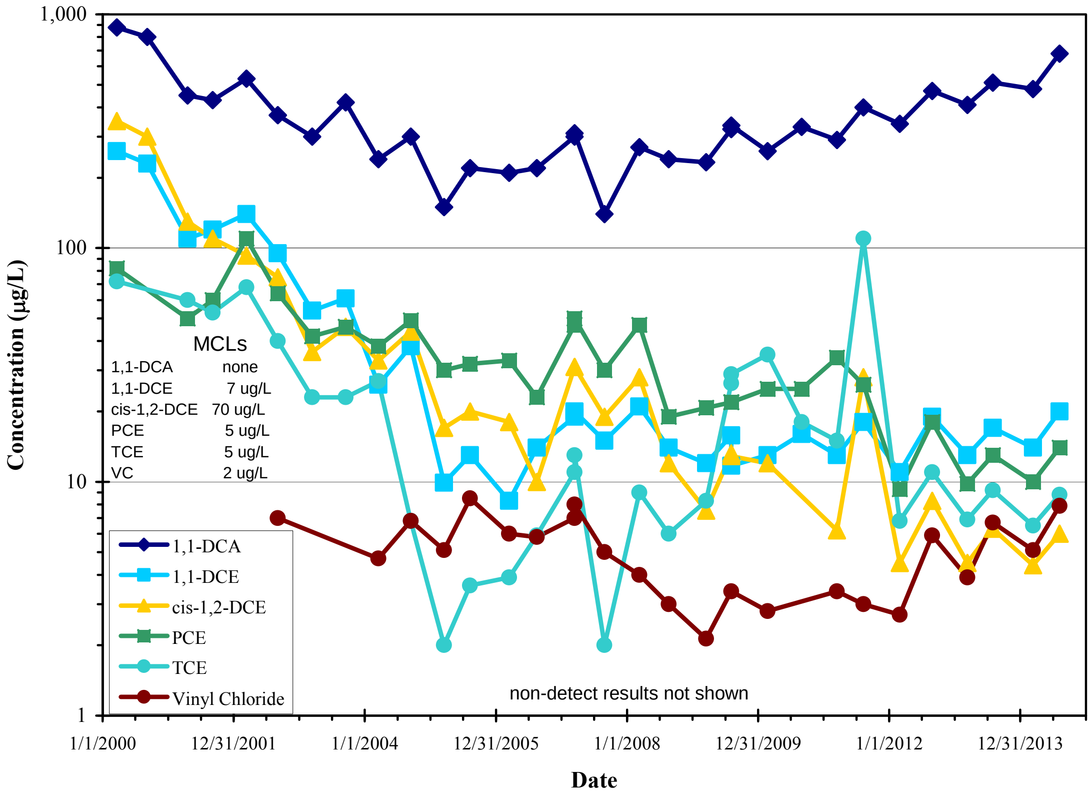


Figure 8.10. VOC concentrations in well UNW-114 for FY 2002 – FY 2014.

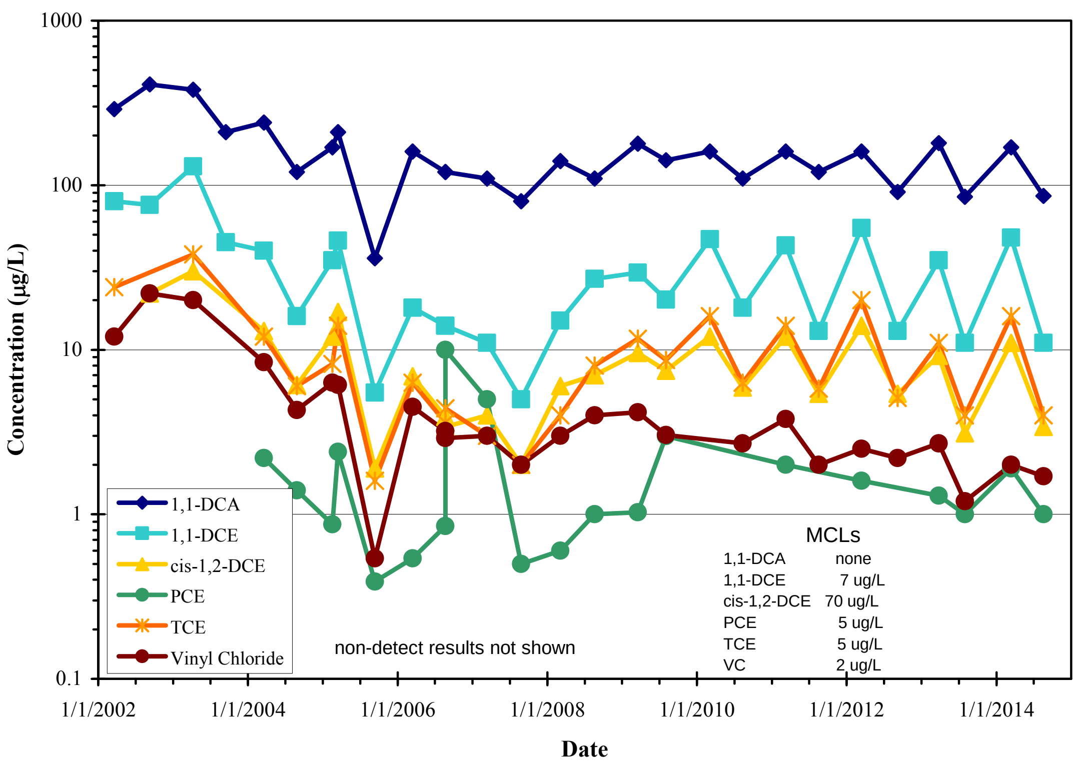


Figure 8.11. VOC concentrations in well UNW-064 for FY 2000 – FY 2014.

Well TMW-011 is located furthest from the contaminant source area near the base of the hill below K-1070-C/D. VOC concentrations at TMW-011 tend to fluctuate in a fashion similar to those at UNW-064 except that the seasonal signature is reversed with higher concentration in summer than during winter. This relationship suggests that groundwater recharge during winter tends to dilute the VOCs near TMW-011 rather than cause a pulse of higher concentration groundwater as was observed at the mid-slope location near UNW-064. Like the other two wells, VOC concentrations (Figure 8.12) decreased from 2000 until early 2005 after which concentrations have fluctuated seasonally within a gradual downward trend through about 2011. During FY 2012 through FY 2014 concentrations have experienced another step-like decrease. Cis-1,2-DCE and PCE have remained below their respective MCLs since winter of 2012. Since the winter sampling event in 2012 VC concentrations have fluctuated with winter concentrations being below the MCL and summer concentrations exceeding the MCL by factors of two to three. TCE and 1,1-DCE concentrations fluctuate at concentrations about five to 15 times their respective MCLs.

Monitoring locations DPT-K1070-5 and DPT-K1070-6 (Figure 8.9) were installed using direct-push technology and therefore they sample groundwater just at, and somewhat above the top of bedrock. At these locations very high concentrations of 1,1,1-TCA, 1,1-DCE, and TCE persist (Figure 8.13). Overall decreasing trends for TCE, 1,1,1-TCA and its degradation product 1,1-DCE are apparent at well DPT-K1070-5 while 1,1,1-TCA in DPT K-1070-6 fluctuates in a concentration range well above its MCL. High concentration (500 – 1,000 μg/L) of cis-1,2-DCE are present in addition to some values for 1,1,1-TCA, 1,1-DCA, 1,1-DCE, and TCE in this concentration range. Other VOCs that were found in the excavated material from G-Pit, such as 1,1,2-TCA, 1,2-dimethylbenzene, and chloroform continue to be detected in these monitoring points.

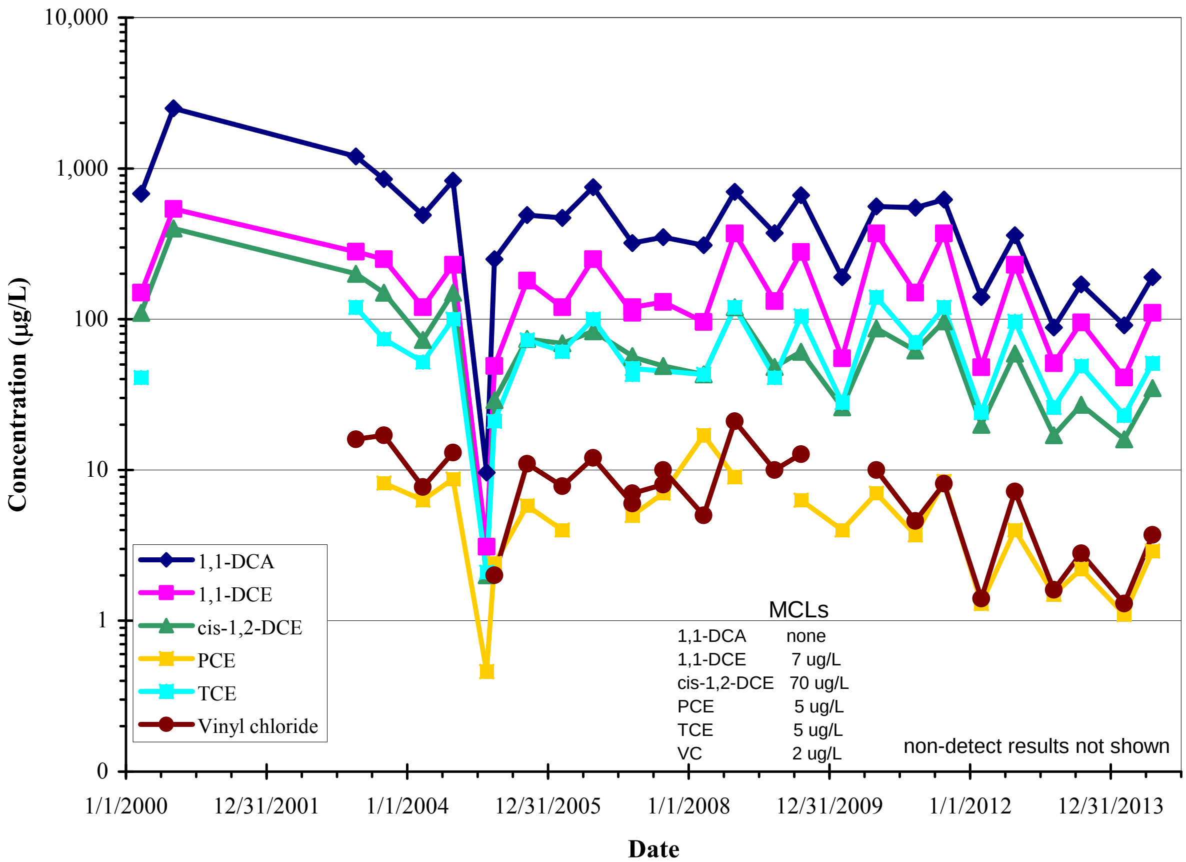


Figure 8.12. VOC concentrations in well TMW-011 for FY 2000 – FY 2014.

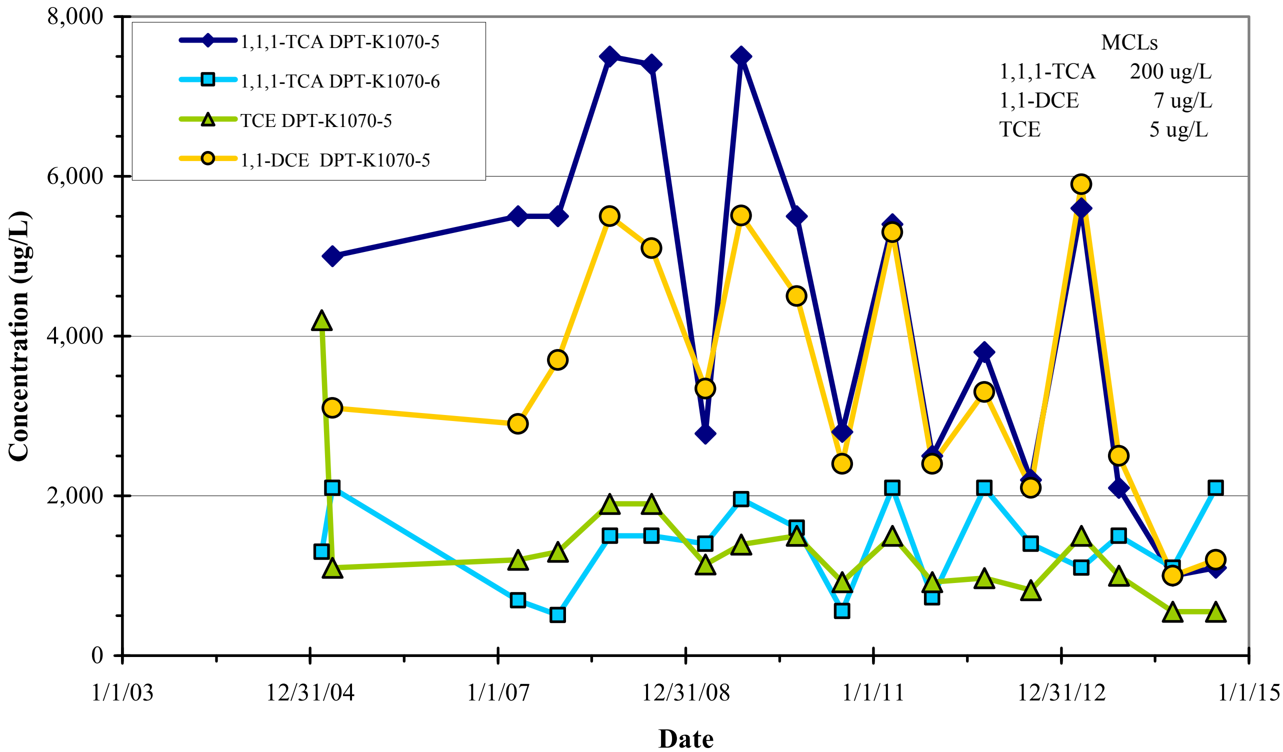


Figure 8.13. Concentrations of selected VOCs in DPT-K1070-5 and DPT-K1070-6.

8.3.1.3 Performance Summary

VOC concentrations in wells monitored downgradient of K-1070-C/D show that a broad area is affected by the releases from the G-Pit liquid VOC disposals. While concentrations along one portion of the impacted area continue to decrease, there remains a known area with very high concentrations of the contaminants disposed at the site. The persistent, very high concentrations of these VOCs suggests that a DNAPL source beneath, and/or downgradient of the G-Pit continues to release mass into the plume.

8.3.2 Other LTS Requirements

Other LTS requirements for the Zone 2 ROD are listed in Table 8.2 and described below.

8.3.2.1 Requirements

The *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) 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 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 program, (5) access controls, (6) signs, and (7) surveillance patrols. The objectives of these Zone 2 LUCs follow:

- 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 reestablish 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. These controls and their implementation are summarized in Table 8.2.

The PCCRs completed under the *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) state that the NFA decision means that an EU is available for unrestricted industrial use to a depth of 10 ft bgs and NFA is required beyond the LUCs specified in the Zone 2 ROD. Figure 8.4 illustrates EUs that have NFA decisions, EUs that have characterization yet to be completed, and EUs that will require RA.

8.3.2.2 Status of Requirements

General LUCs for Zone 2 remained in place during FY 2014. Signs were maintained to control access and surveillance patrols were conducted as part of routine S&M inspections. The EPP program functioned according to established procedures and plans for the site. Required mowing was performed. Additionally, signs and access controls at the K-1070-C/D Burial Ground were inspected annually by the ETTP S&M Program.

8.4 SINGLE-PROJECT ACTIONS

8.4.1 K-1407-B/C Ponds

The *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) 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 Figures 8.1 and 8.14.

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 Monitoring

8.4.1.1.1 Performance Monitoring Goals and Objectives

The objective of the K-1407-B/C Ponds remediation was to reduce potential threats to human health and the environment posed by residual metal, radiological, and VOC contamination within the pond soils (DOE/OR/01-1125&D3).

The *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) 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. Target concentrations for these parameters were not established in the CERCLA documents (DOE/OR/01-1125&D3; DOE/OR/01-1371&D1) for use in post-remediation monitoring to evaluate effectiveness. Performance monitoring is conducted in wells UNW-003, UNW-009, and the Mitchell Branch weir (K-1700 Weir), shown on Figure 8.14.

8.4.1.1.2 Evaluation of Performance Monitoring Data

The primary groundwater contaminants in the K-1407-B and -C ponds area are VOCs. VOCs are widespread in this portion of ETTP, including contaminant sources upgradient of the ponds. Groundwater samples were collected at UNW-003 and UNW-009 in March and August/September 2014. VOCs are not detected in shallow groundwater north of Mitchell Branch in well UNW-009. VOC concentration data for well UNW-003 for the time span 2001 through 2014 are shown on Figure 8.15. Monitoring results for FY 2014 at the wells are generally consistent with results from previous years. The detection of VOCs at concentrations well above 1,000 µg/L and the steady concentrations over recent years suggest the presence of DNAPLs in the vicinity of well UNW-003. The sitewide ROD will address groundwater contamination present in the area of the former ponds.

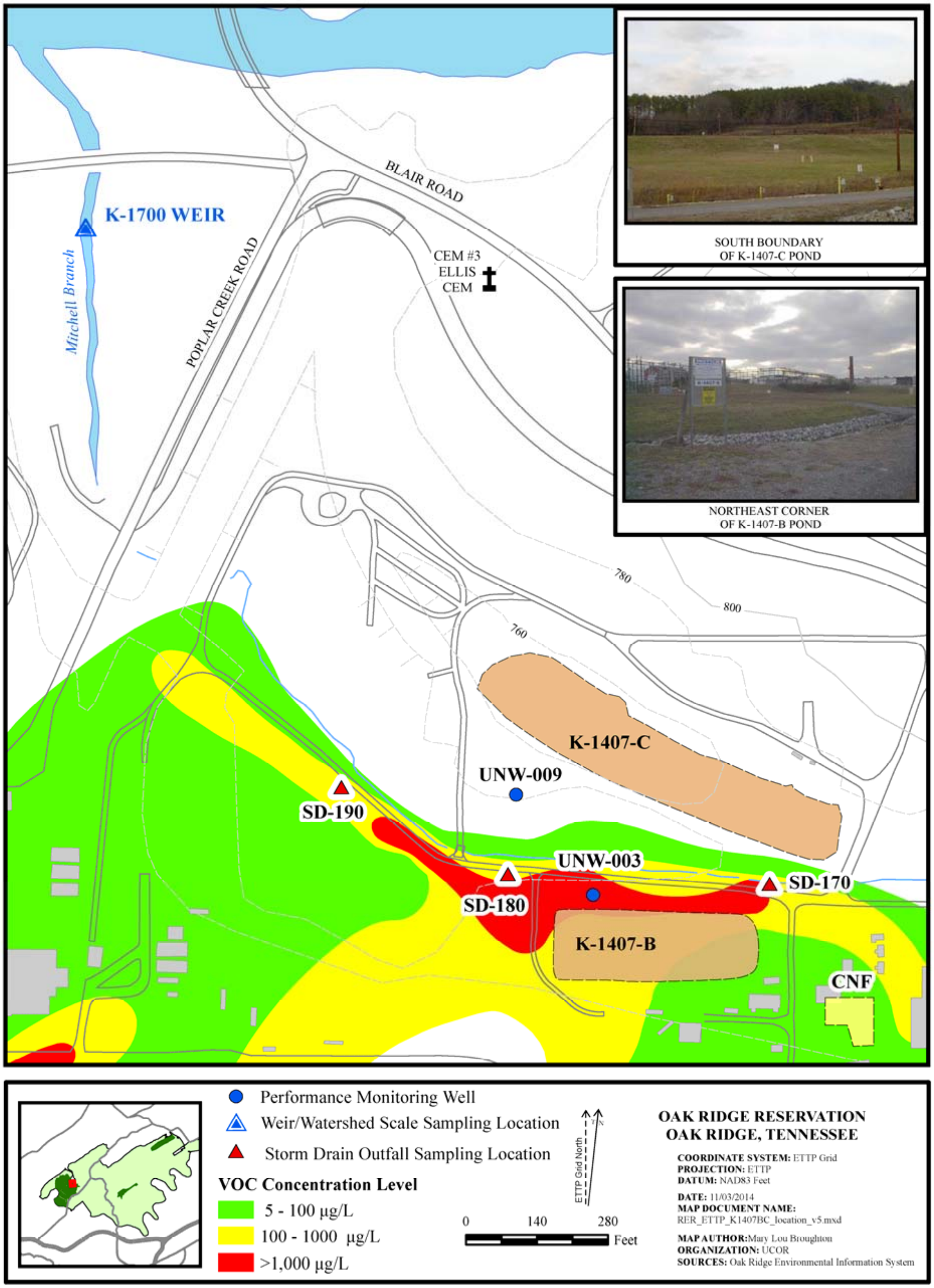


Figure 8.14. Location of K-1407-B/C Ponds.

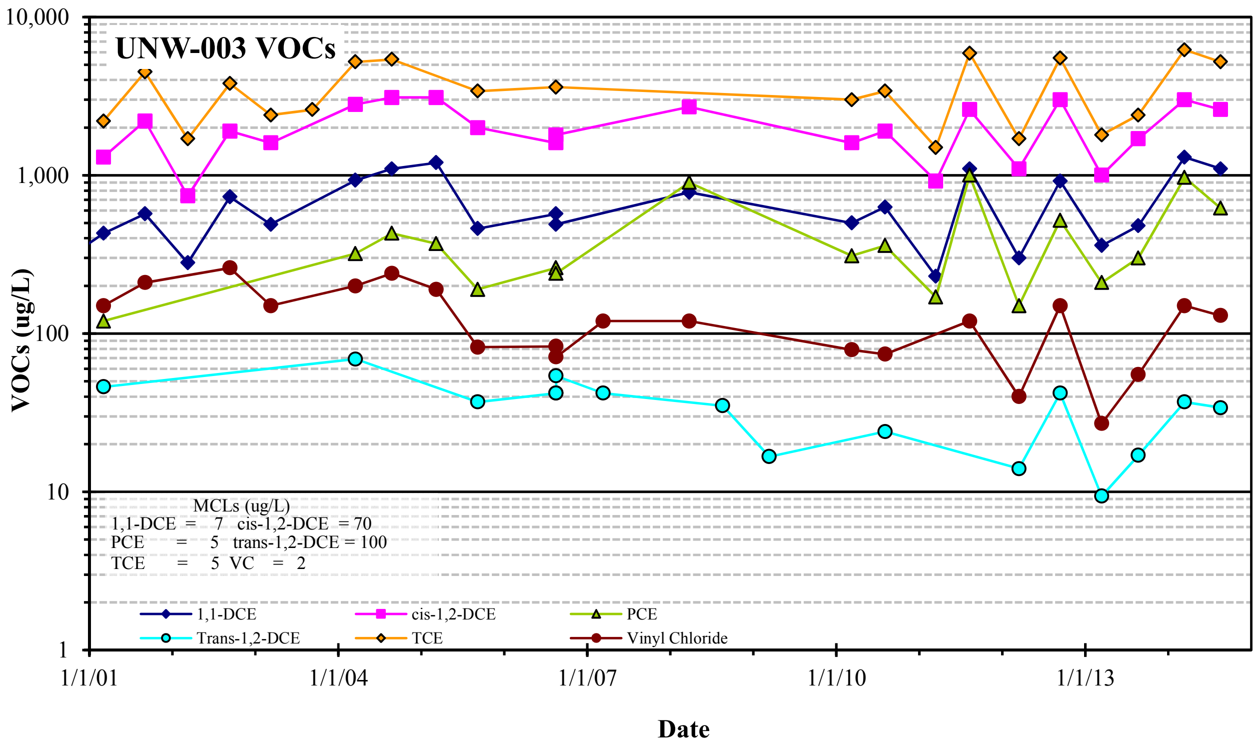


Figure 8.15. VOC concentrations in well UNW-003, 2001 – 2014.

8.4.1.2 Other LTS Requirements

8.4.1.2.1 Requirements

LTS requirements specified in the *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin* (DOE/OR/01-1371&D1) 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.

A recommendation was made in the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) site visit to clarify the LTS requirements and frequencies and the ETTP RA Core Team accepted the recommendation. An erratum to the RAR (DOE/OR/01-1371&D1) submitted in February 2015 contains the following clarification: *"Conduct annual inspections and perform radiological and industrial hygiene surveillance and other assessment activities only as needed if activities are conducted at the site that are necessary to keep the remediated ponds in compliance with environmental, safety, and health requirements and maintain records of all related activities"*. This resolves the issue in Table 8.9.

8.4.1.2.2 Status of Requirements

All components of the K-1407-B/C Ponds site were inspected in FY 2014 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. The site underwent routine mowing; no additional maintenance was required.

8.4.2 ETTP Ponds

8.4.2.1 Performance Monitoring

8.4.2.1.1 Performance Monitoring Goals and Objectives

The *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) (Figure 8.1) includes the following actions:

- 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.
  - Implement institutional controls to prevent residential use.
  - Monitor.
- K-901-A Holding Pond
  - Implement institutional controls to prevent residential use.
  - Monitor.
- K-720 Slough
  - Implement institutional controls to prevent residential use.
  - Monitor.
- 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).

This AM superseded the previous *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).

The goal of the removal action 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. Implementation details were provided in 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). Completion of the removal action is documented in the *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).

Monitoring of the K-1007-P1 Holding Pond will be performed in two phases (DOE/OR/01-2456&D1/R1). The first phase is operational monitoring that began after the pond was restocked and will continue until the pond has achieved a state where aquatic vegetation and a desirable mix of fish species have been established.

The second phase is 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 *Action Memorandum for the Ponds at the East Tennessee Technology Park* (DOE/OR/01-2314&D2), "*….A PCB concentration level of 1 µg/g in fish fillets (2.3 µg/g whole body) was set based upon levels shown to be protective of piscivorous wildlife, consistent with surrounding water bodies, and below FDA recommendations…*".

8.4.2.1.1.1 Evaluation of Operational Monitoring Data

Operational monitoring is conducted at the K-1007-P1 Holding Pond (Figure 8.16) to ensure that the ecological enhancement measures have been implemented as intended. Monitoring of plants, wildlife, water quality, and fish (which is also a performance metric) was conducted in 2014 in accordance with the *Removal Action Report for the Ponds at the East Tennessee Technology Park* (DOE/OR/01-2456&D1/R1). 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.

Figure 8.16. Heavy vegetation (top) and fish sampling (bottom) at the K-1007-P1 Pond.

Fish communities in the K-1007-P1 Holding Pond were sampled in:

- May 2007 (baseline conditions; two years prior to piscicide application).
- November 2009 (five mo. after piscicide application).
- June 2010 (one mo. after fish entered the pond from Poplar Creek via damaged weir grate).
- May 2011 (seven mo. after stocking the pond with hatchery-reared sunfish).
- July 2012 (two years after fish entered the pond from Poplar Creek).
- January 2013.
- February 2014.

The numbers of species collected and the catch rate (for all species combined) for each of these seven fish community surveys are shown in Figure 8.17.

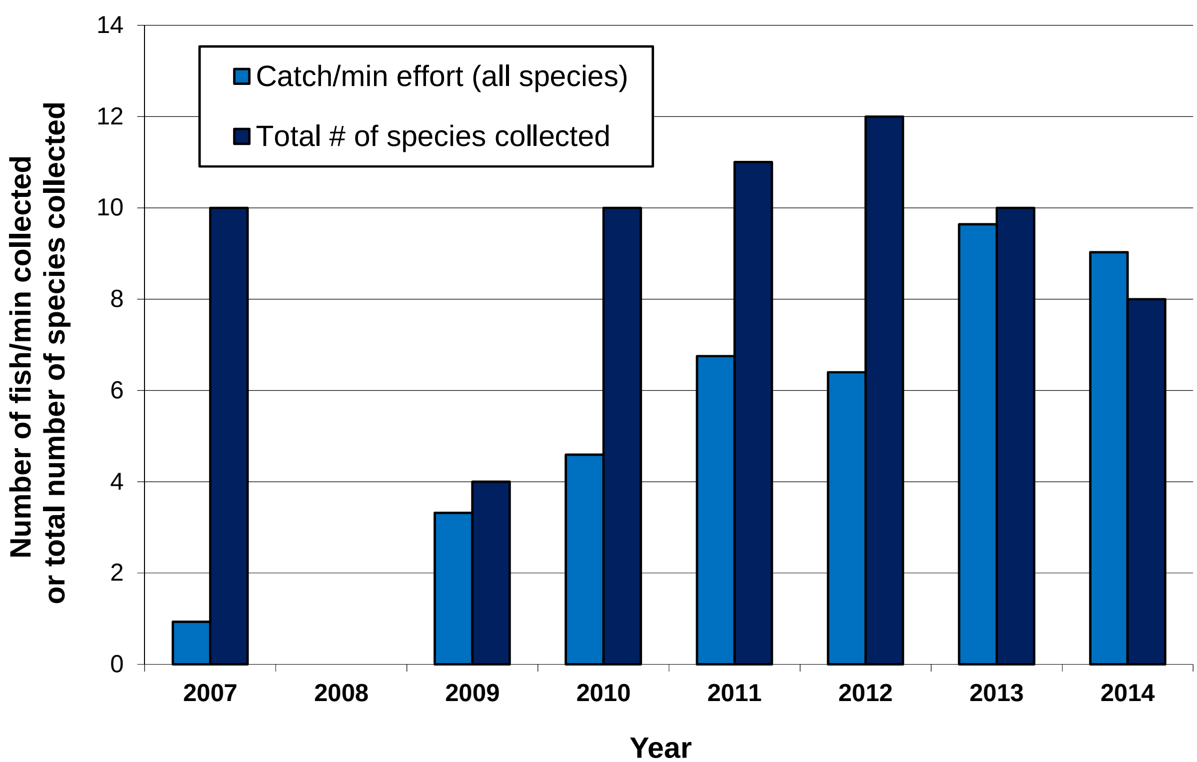


Figure 8.17. Actual catch per minute of effort (all species combined) and total numbers of species collected during fish population surveys, by boat electrofishing, K-1007-P1 Holding Pond, 2007 – 2014.

Figure 8.17 only represents fish collected by boat electrofishing, and in 2013 and 2014 an additional species, western mosquitofish (*Gambusia affinis*), was collected by backpack electrofishing K-1007-P1 Holding Pond shoreline areas.

The fish diversity in K-1007-P1 Holding Pond has reached or exceeded levels observed in 2007, prior to the initiation of remediation efforts and pond manipulations. Only one of the 10 species recorded in the pond during the baseline sampling in 2007 has not been recorded since, and that is white crappie (*Pomoxis annularis*), a species that at the time comprised ~12% of all fish in the pond. Bluntnose minnows (*Pimephales notatus*), spotted suckers (*Minytrema melanops*), western mosquitofish (*Gambusia affinis*), and redear sunfish (*Lepomis microlophus*) were known to occur in the pond prior to remediation efforts, but were not collected during the 2007 survey. Those species are again present in the pond, with bluntnose minnows, western mosquitofish, and redear sunfish having been stocked. Post-remediation evidence of spotted sucker comes from a single specimen collected in July 2012 and it is presumed to have found its way into the pond from Poplar Creek.

Four of the species found during fish population surveys, gizzard shad (*Dorosoma cepedianum*), largemouth bass (*Micropterus salmoides*), smallmouth buffalo (*Ictiobus bubalus*), and common carp (*Cyprinus carpio*), were eliminated from the pond by the Rotenone application in June 2009. These four species, as well as threadfin shad (*Dorosoma petenense*) and several other species, are believed to have entered the K-1007-P1 Holding Pond from Poplar Creek during a storm event in May 2010. Although no threadfin shad have been collected since 2012 sampling events, all five of these species continue to be removed as they are encountered, and such efforts have apparently put considerable pressure on four of the five species – gizzard shad being the notable exception. The numbers of these five species removed from P1 Pond since May 2010 are illustrated in Figure 8.18.

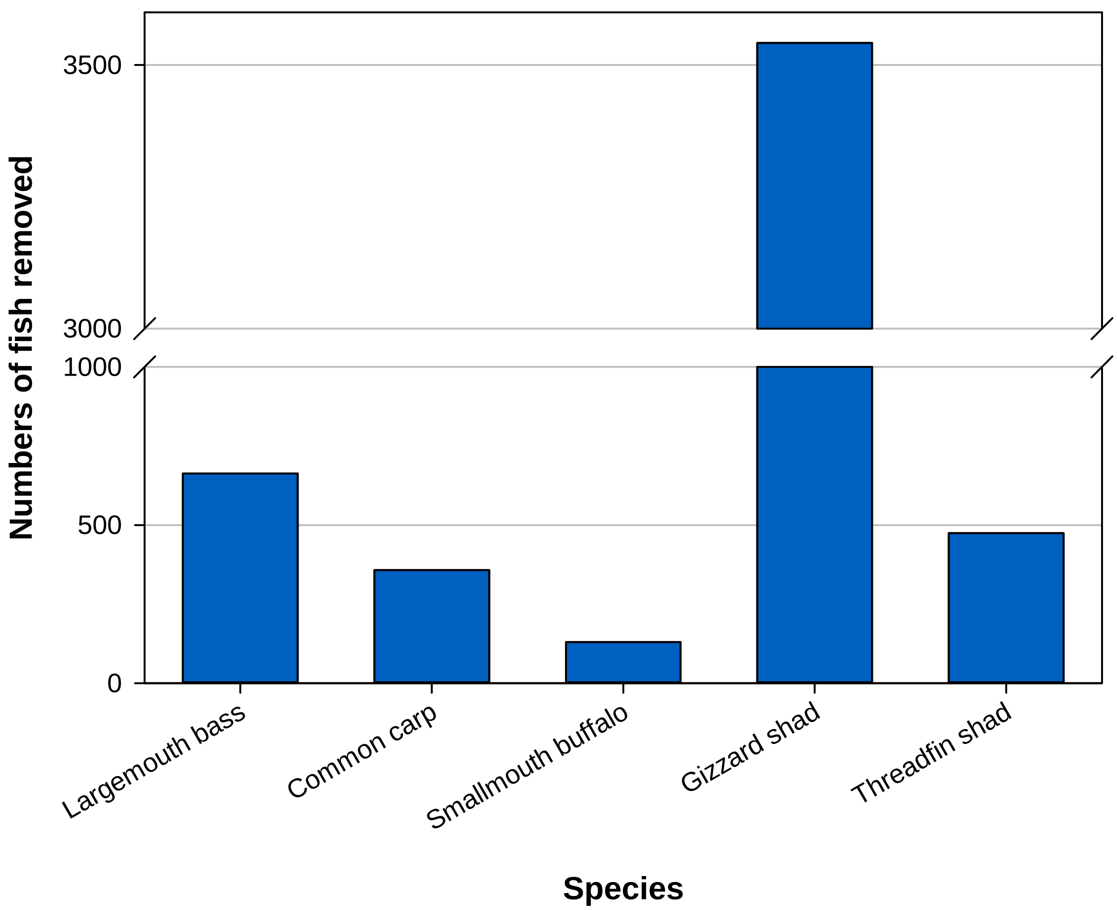


Figure 8.18. Numbers of five species of fish removed from K-1007-P1 Holding Pond in 2010 – 2014, following the weir breach in May 2010.

Changes in the fish community of the K-1007-P1 Holding pond have been considerable since the 2007 survey (Figure 8.19). Bluegill and gizzard shad have consistently been among the most dominant species each year and this trend continued in 2014. Bluegill reproduction appears to be good, and year classes 0 – 4 were present when the pond was sampled in January 2014. Bluegill lifespan averages 5 – 6 years (Etnier and Starnes, 1993). Gizzard shad tend to be a very pelagic fish preferring open water without obstructions. This is a habitat type that is decreasing in the P1 pond during the summer plant growth, which expands each year. It is hopeful that this, in conjunction with fish removal efforts, will promote the sunfish dominated fish community, which is the goal of this work. However, this did not appear to be the case in 2014 samples. Gizzard shad continue to show steady increases in biomass over the last several years with a sizable jump in 2014 (Figure 8.20). Their current biomass is about 73%, which is on the high end of reports for reservoirs which range from 40 – 80% (Etnier and Starnes, 1993). It should be noted that fish removal efforts did not occur in 2013 outside of the annual population survey, which may have had a bearing on the number of fish collected in February 2014.

Positive changes in the fish community post-action are the total removal of grass carp, which were known to negatively impact aquatic vegetation, the low numbers of common carp (no common carp were found in the 2014 sampling), and the absence of threadfin shad in the 2013 – 2014 surveys. Largemouth bass, which are also deemed an undesirable species for the pond, become reproductively mature at age two or three, depending on when they were spawned, so any removal efforts that target these individuals should be effective at reducing the presence of this species from the ponds. Since the weir breach in 2010, 663 bass have been removed from the pond. The majority of these fish were from age class two and three and these removal efforts should reduce the next generation of bass spawned in the pond.

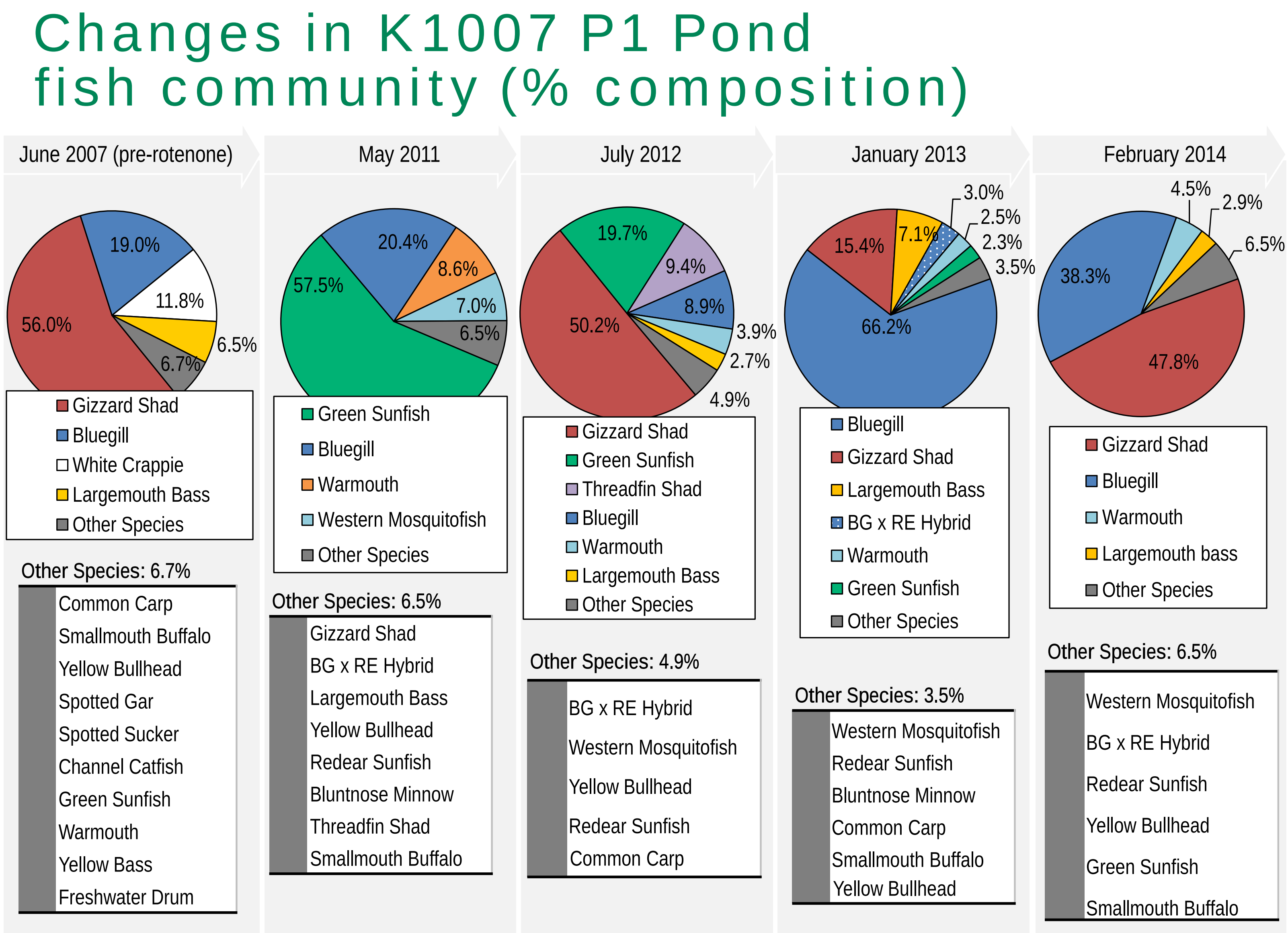


Figure 8.19. Changes in K-1007-P1 Holding Pond fish community composition.

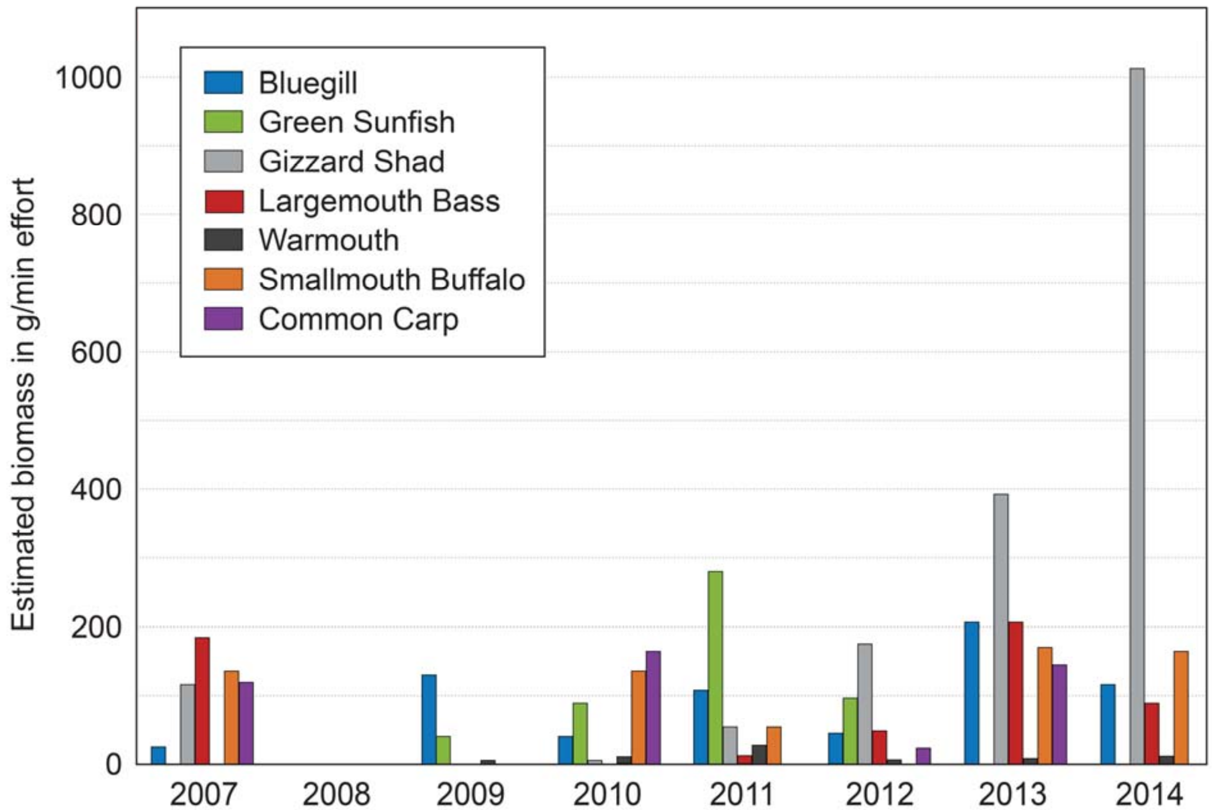


Figure 8.20. Estimated biomass in g/min of effort for seven species collected during fish population surveys, by boat electrofishing, K-1007-P1 Holding Pond, 2007 – 2014 (2009 estimates and 2010 shad, buffalo, and carp estimates are based on extrapolation of weight data from other years).

The plant community within the pond has developed substantially since the pond was re-contoured and vegetation planted as part of the removal action. In 2007, the pond was largely devoid of plants except for algae. In 2010 – 2014, surveys found coverage had increased as much as seven-fold along some transects, reaching nearly 100% coverage, except at one transect where soils were not added (Figure 8.21). The increased coverage was also matched by an increase in plant richness (Figure 8.22) in 2014 that included both species planted during the removal action and volunteer species that may have been present along the periphery of the pond. An additional survey of the root penetration of aquatic plants in 2014 revealed that despite the predominance of clay soils in the east portion of the pond, roots of aquatic plants penetrate on average to a depth of 17.5 cm and seem to be stabilizing all sediments in which they occur. The establishment of the plant community in the K-1007-P1 Holding Pond is highlighted by aerial photo comparisons between 2009, 2011, and 2014 (Figure 8.23). By the end of the growing season in 2014, floating leaf plants had extended across the pond to cover about 90% of the pond's surface.

The success of vegetation growth may be due, in part, to control of Canada geese (*Branta canadensis*) and herbivorous fish species such as grass carp (*Ctenopharyngodon idella*). Canada geese are aggressive herbivores known to damage freshly planted aquatic vegetation, and grass carp, well known for controlling overgrowth of aquatic vegetation, are almost entirely herbivorous. Improvements in habitat, coupled with a decrease in the goose population (Figure 8.24), have no doubt contributed to increased use of the pond by ducks (Figure 8.25) and other water birds, such as grebes, herons, and sandpipers. Virginia rails (*Rallus limicola*), which had not been observed on the ORR in 60 years, and least bitterns (*Ixobrychus exilis*), which are not known to have ever been observed on the ORR, were discovered using the P1 Pond in 2012 and 2013 (Roy et al. 2014). The discovery of these rare bird species on the ORR coincides well with the expansion of diverse aquatic and riparian plant communities at the P1 Pond, which resulted in relatively rapid habitat changes in the 2009 – 2013 period. The numbers of wintering bird species using P1 Pond riparian zones, such as swamp sparrows (*Melospiza georgiana*), also increased substantially during this period (from 7 species in the winter of 2009 – 2010 to 28 species in the winter of 2012 – 2013).

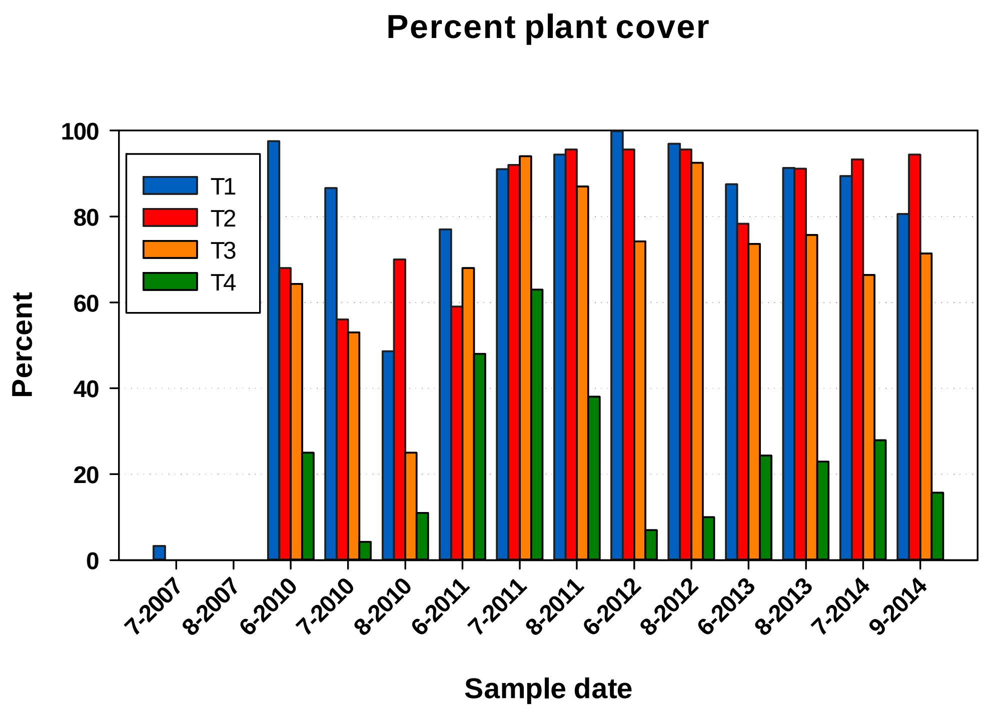


Figure 8.21. Percent vascular plant cover for four transect survey lines in K-1007-P1 Holding Pond prior to and after the remediation in 2009.

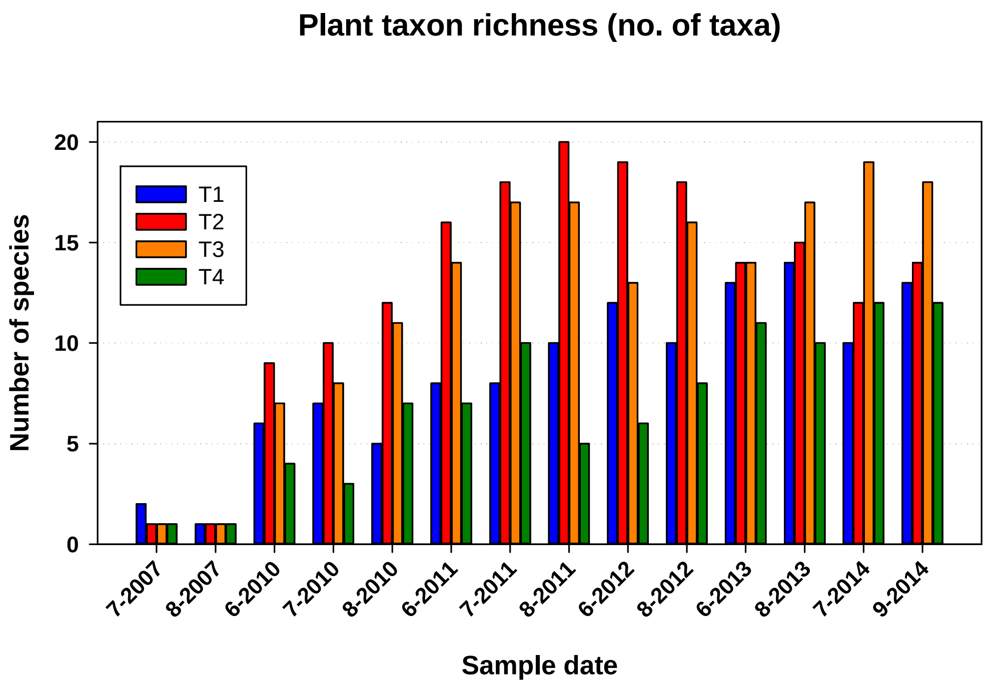


Figure 8.22. Plant taxon richness for four transect survey lines in K-1007-P1 Holding Pond prior to and after the remediation in 2009.

Figure 8.23. Aerial photos of the K-1007-P1 Holding Pond showing changes in plant coverage between the end of the first year of planting, 2009 (top), after two growing seasons, 2011 (middle), and two more growing seasons in 2014 (bottom).

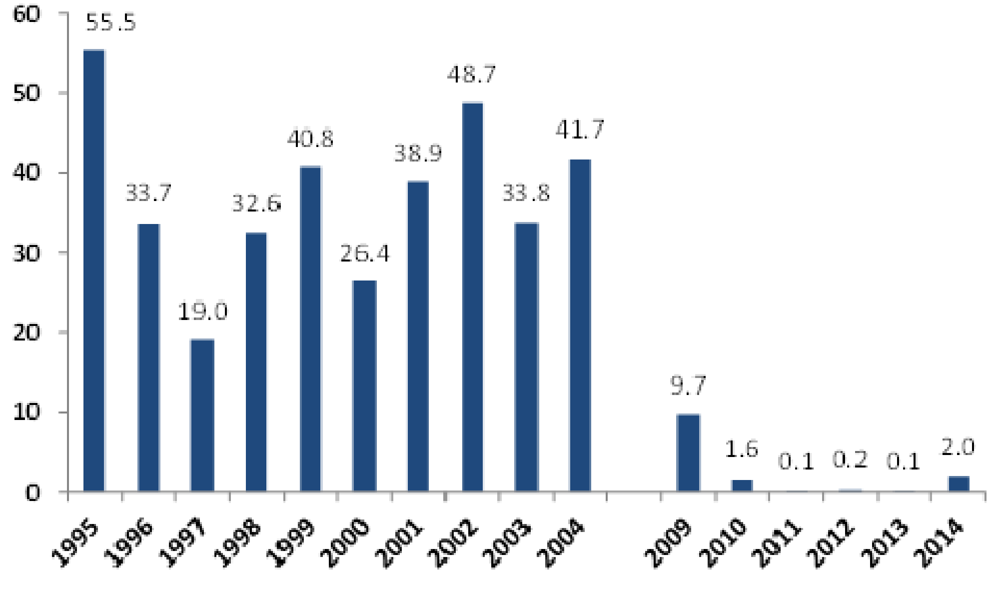


Figure 8.24. Mean numbers of geese observed per survey at the P1 Pond, prior to (1995 – 2004) and after (2009 – 2014) RAs.

All observations are based on calendar year, except that 2009 contains no data from January through April and 2014 contains no data after mid-September. Number of surveys conducted each year as follows: 1995 – 1997 & 1999 (*n*=24), 1998 (*n*=22), 2000 (*n*=17), 2001 (*n*=18), 2002 & 2004 (*n*=11), 2003 (*n*=12), 2005 – 2008 (no formal surveys were conducted), 2009 (*n*=30), 2010 (*n*=49), 2011 (*n*=44), 2012 (*n*=50), 2013 (*n*=24), 2014 (*n*=9).

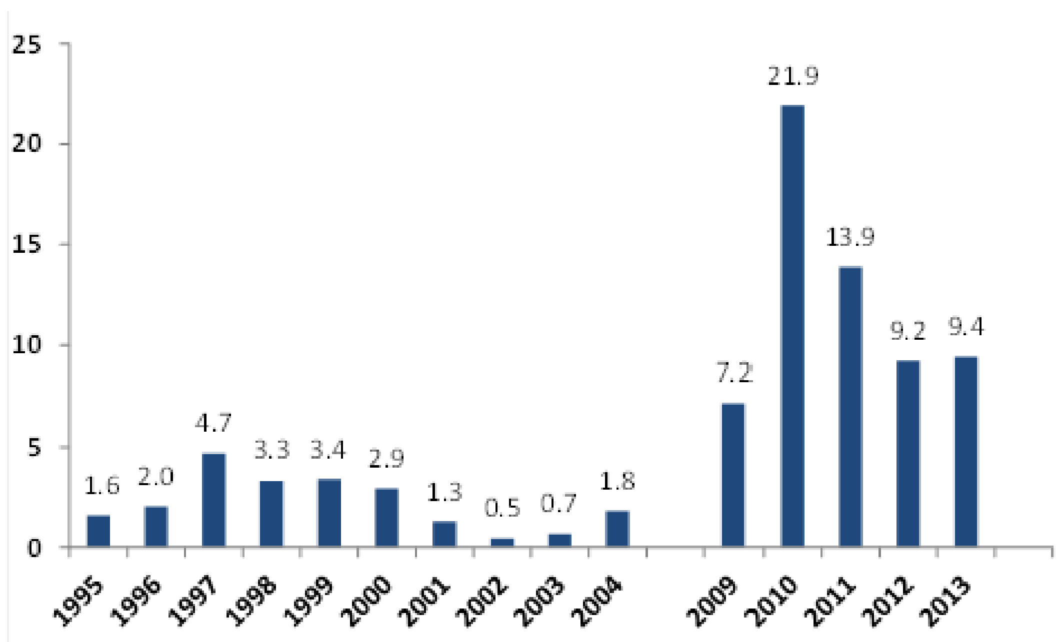


Figure 8.25. Mean numbers of ducks (all species) observed per survey at the P1 Pond, prior to (1995 – 2004) and after (2009 – 2013) RAs.

All observations are based on calendar year except that 2009 contains no data from January through April. Number of surveys conducted each year as follows: 1995 – 1997 & 1999 (*n*=24), 1998 (*n*=22), 2000 (*n*=17), 2001 (*n*=18), 2002 & 2004 (*n*=11), 2003 (*n*=12), 2005 – 2008 (no formal surveys were conducted), 2009 (*n*=30), 2010 (*n*=49), 2011 (*n*=44), 2012 (*n*=50), 2013 (*n*=24).

TSS continued to follow a decreasing trend since completion of remediation in 2009 (Figure 8.26). Concentrations of TSS in 2014 were slightly lower (mean for all samples = 2.52 mg/L) than in 2013 when the mean TSS concentration was 3.65 mg/L. In general, TSS concentrations are similar among transects in early summer, but then tend to increase through the summer at Transects B (at the middle of the pond) and C (near the dam).

As in recent years, trends in water clarity (i.e., Secchi depth) in 2014 (Figure 8.26) were consistent with trends in TSS. In 2014 Secchi depths were greater than in 2010 – 2013, and approximately three times greater than in 2004 and 2007. Mean Secchi depth in 2014 was near the pond goal of 150 cm, averaging 146.1 cm (median = 146.0 cm, and range = 116 to 175 cm). As in 2013, Secchi depths equaled the water depth at all cells on Transect A on all sampling dates. Thus, differences in Secchi depths at this transect between sampling periods and years since 2012 are due to variation in the specific locations where measurements are made and not in actual water clarity. Seasonally, the trend for water clarity is similar to that of TSS at Transects B and C; as summer progresses, water clarity generally declines at these transects.

In summary, the operational performance data suggests that the water quality, plant community, and wildlife manipulations are progressing well toward the desired end state, although in each case changes are continuing and a stable end-state has not been reached. The fish community has had some positive developments in removing or controlling carp species and maintaining a healthy and dominant sunfish community. However, some undesirable species that entered the pond after the weir breach, especially largemouth bass and shad, are increasing in numbers and/or biomass. Given the rapidly changing conditions in the pond, and the important roles of water chemistry, biology (food chain effects, bioturbation), and plant-sediment interactions on PCB bioaccumulation, operational monitoring will continue in 2015. It may take a number of years for the pond conditions to stabilize such that the success or failure of the remedy is fully determined. Operational data will provide useful process-level information as to the major factors affecting bioaccumulation and the desire or need for further modifications of the action in the future.

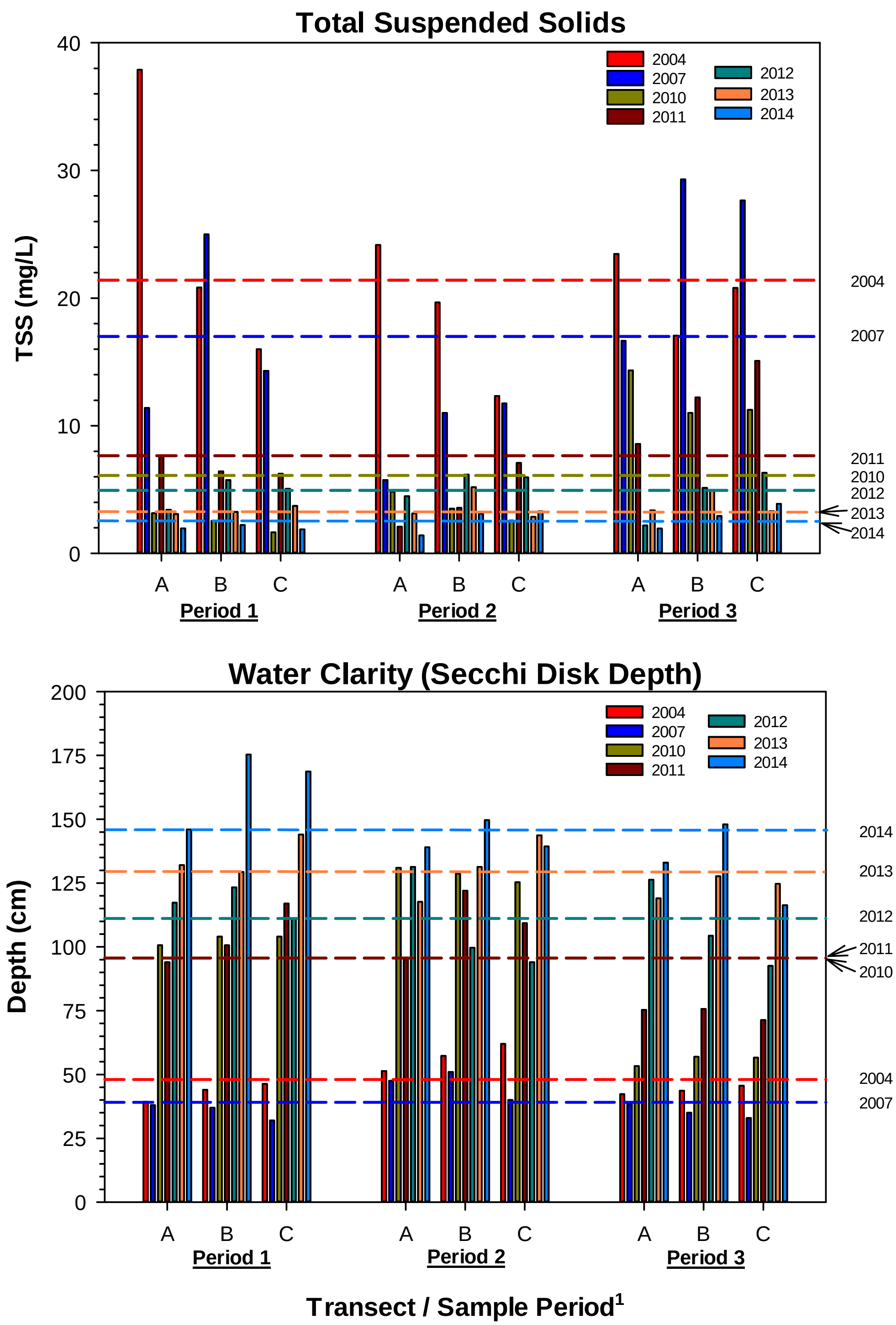


Figure 8.26. Total suspended solids and water clarity results by transect and sample period, prior to and after the removal action.

[1]Transects run from north to south and are located approximately 506 m (Transect A), 305 m (Transect B), and 152 m (Transect C) from the pond's dam. Sampling periods 1-3 generally refer to spring, early summer, and late summer, during periods of the year with the greatest suspended solids and plankton growth.

Dashed lines reflect annual means.

8.4.2.1.1.2 Evaluation of Performance Monitoring Data

Assessment of PCB exposure and bioaccumulation in the K-1007-P1 Holding Pond continued in 2014, with the primary emphasis on monitoring PCBs in fish and caged clams. Fish samples were also collected from the K-901-A Holding Pond and K-720 Slough for analysis of PCBs. Since the 2009 RA to remove fish from the K-1007-P1 Pond, the target species for fish bioaccumulation monitoring in the K-1007-P1 Holding Pond has been bluegill sunfish (*Lepomis macrochirus*). In 2014, fillets from 20 individual bluegill and six whole body composites (10 bluegill per composite) were analyzed for PCBs to assess the ecological and human health risks associated with PCB contamination in the K-1007-P1 Pond.

Average PCB concentrations in biota collected from the K1007-P1 Pond have fluctuated significantly in the 5 years post-remediation, but appear to be decreasing overall. Mean concentrations in fillets of bluegill collected from the K1007-P1 Pond in 2014 was 0.62 µg/g (compared to 0.70 in 2013) and the mean concentration in whole body composites of bluegill collected from this site was 3.21 µg/g (compared to 4.45 µg/g in 2013) (Table 8.4, Figures 8.27 and 8.28). This represents a significant decrease in fish PCB concentrations at this site, with fillet concentrations remaining below the remediation goal of 1 µg/g for two consecutive years. While whole body concentrations still remained above the remediation goal of 2.3 µg/g total PCBs, the concentrations seen in 2014 are 3 – 4 times lower than concentrations seen in whole body bluegill prior to 2009 remediation. The observed fluctuations in PCB concentrations in biota suggest that this system is still in transition and that as the fish and plant communities stabilize, further decreases in PCB bioaccumulation may become apparent.

Caged Asiatic clams (*Corbicula fluminea*) collected from the Little Sewee Creek reference site were placed near and within various storm drains entering the K-1007-P1 Holding Pond for a four-week exposure period (May – June 2014) (Figures 8.29 and 8.30). PCB concentrations in clams placed at the K1007-P1 outfall had similar concentrations to those seen in 2013 (Figure 8.29). PCB concentrations in clams placed in storm drain (SD)-100 (both upper and lower) continued to decrease significantly in 2014, from 0.095 µg/g in 2013 to ~0.05 µg/g in 2014 in upper SD-100 and from 0.9 µg/g in 2013 to < 0.2 µg/g in 2014 at lower SD-100 (Figure 8.30).

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. A total of six largemouth bass and 14 carp were collected from the K-901-A Holding Pond, and seven bass, 12 carp, and one smallmouth buffalo were collected from the K-720 Slough in 2014.

At the K-901-A Holding Pond, PCBs concentrations in largemouth bass have fluctuated annually, but these fluctuations are likely linked to fluctuations in their prey. Mean concentrations in both largemouth bass and carp from this pond in 2014 (0.45 µg/g in largemouth bass and 1.41 µg/g in carp) were less than half the mean concentrations seen in 2013 for these species (1.4 µg/g in largemouth bass and 2.94 µg/g in carp in 2013). While this decrease is statistically significant, concentrations remain within the range of those seen in recent years (Figure 8.31). Whole body gizzard shad from the K-901-A Pond, collected as a measure of potential ecological risk to terrestrial wildlife, were substantially higher in concentration (6.52 µg/g) than the fillets of bass and carp, but were lower than the concentrations seen in this species in 2013. Routine bioaccumulation monitoring in the K-720 Slough began in 2009. In all cases PCB concentrations in fish collected from the K-720 Slough were significantly lower than in the K-901-A

Holding Pond for the same species. PCB concentrations in largemouth bass collected from the K-720 Slough were significantly lower than in the other monitored ponds, averaging 0.15 µg/g in 2014 (Figure 8.31). Concentrations in carp and smallmouth buffalo collected from the Slough were higher than in bass, averaging 0.27 and 0.14 µg/g, respectively.

Table 8.4. PCB concentrations (expressed as the sum of Aroclors 1248, 1254, and 1260, in µg/g) in fish from the K-1007-P1 Holding Pond, K-720 Slough, and K-901-A Holding Pond, 2014

Site	Species	Sample type	Sample size (*n*)	Total PCBs (mean ± SE)	Range of PCB values	No. > 1 µg/g (PCBs)/*n*
K-1007-P1 Pond	Bluegill	Fillets	20	0.62 ± 0.18	0.15 - 3.96	2/20
		Whole body composites	6	3.21 ± 0.35	2.55 - 4.90	6/6
K-901-A Pond	Largemouth bass	Fillet	6	0.45 ± 0.07	0.21 - .677	0/6
	Common carp	Fillet	14	1.41 ± 0.21	0.33 - 2.50	10/14
	Gizzard shad	Whole body composites	6	6.52 ± 0.25	5.45 - 7.09	6/6
K-720 Slough	Largemouth bass	Fillet	7	0.15 ± 0.05	0.05 - 0.42	0/7
	Common carp	Fillet	12	0.27 ± 0.07	0.05 - 0.997	0/12
	Smallmouth buffalo	Fillet	1	0.14	NA	0/1
	Gizzard shad	Whole body composites	6	0.29 ± 0.02	0.24 - 0.34	0/6

NA = not applicable
PCB = polychlorinated biphenyl
SE = standard error

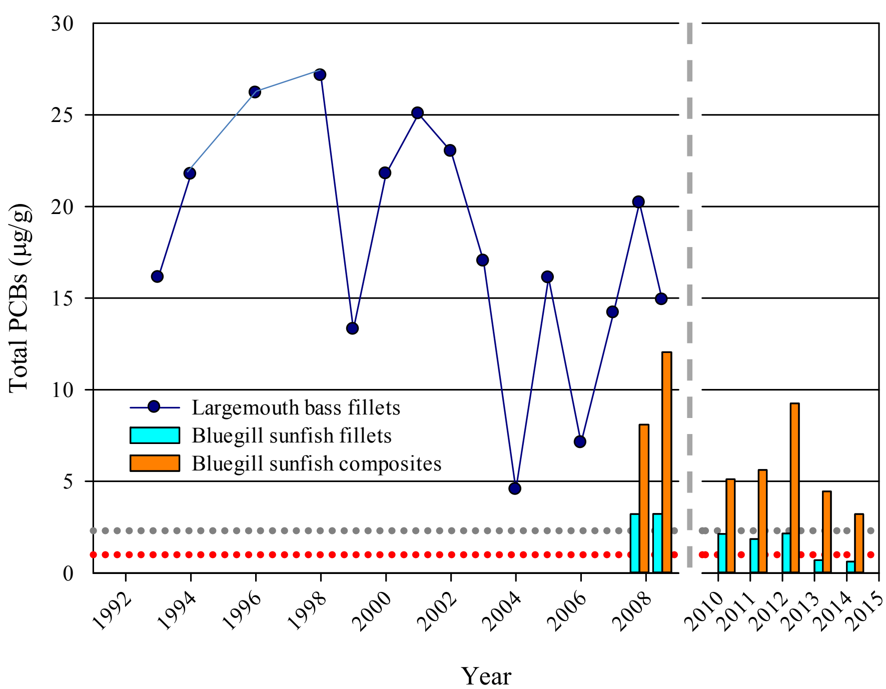


Figure 8.27. Mean concentrations of PCBs in fish from K-1007-P1 Holding Pond, 1993 – 2014.

Dotted red line signifies PCB goal of 1 µg/g in fillets, and dotted gray line signifies PCB goal of 2.3 µg/g whole body.

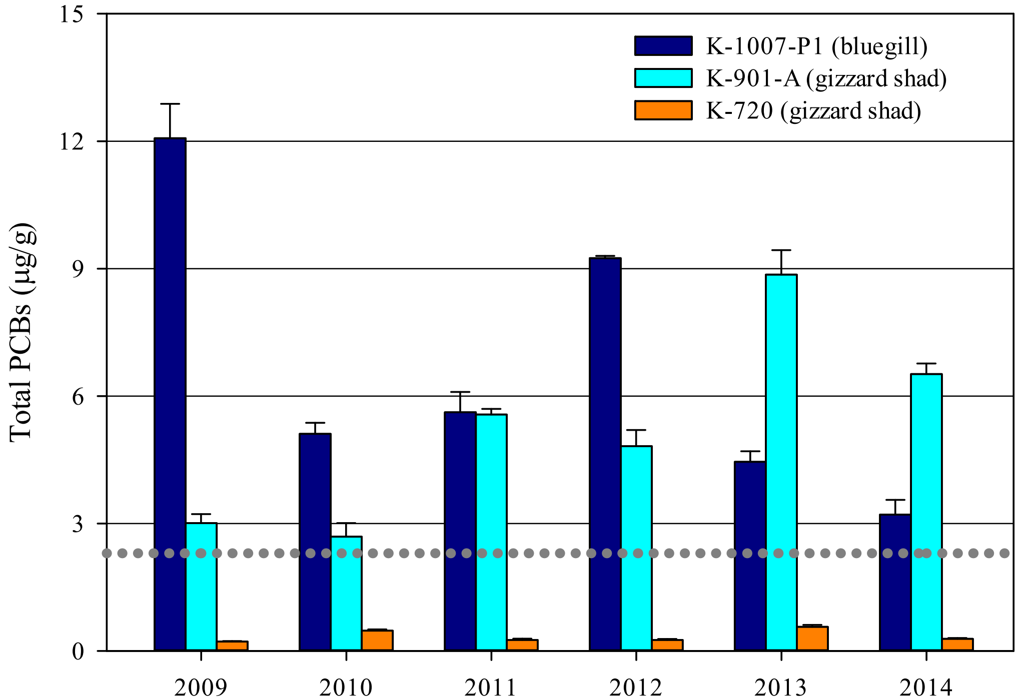


Figure 8.28. Mean concentrations of PCBs in whole body fish from K-1007-P1 Holding Pond, K-901-A Holding Pond, and K-720 Slough, 2009 – 2014.

Dotted gray line signifies goal of 2.3 µg/g total PCB concentrations in whole body fish collected from ETTP ponds.

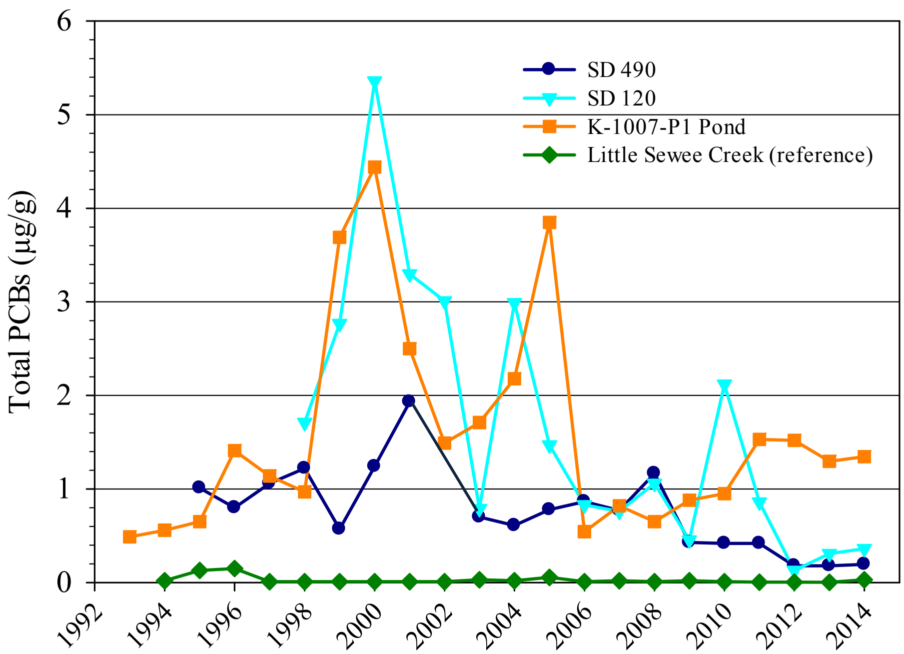


Figure 8.29. Mean total PCB concentrations (µg/g, wet wt; 1993 – 2014) in the soft tissues of caged Asiatic clams deployed in the P1 Pond near the weir and SDs 490 and 120.

N=2 composites of 10 clams each per year. Shown in green are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee). Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.

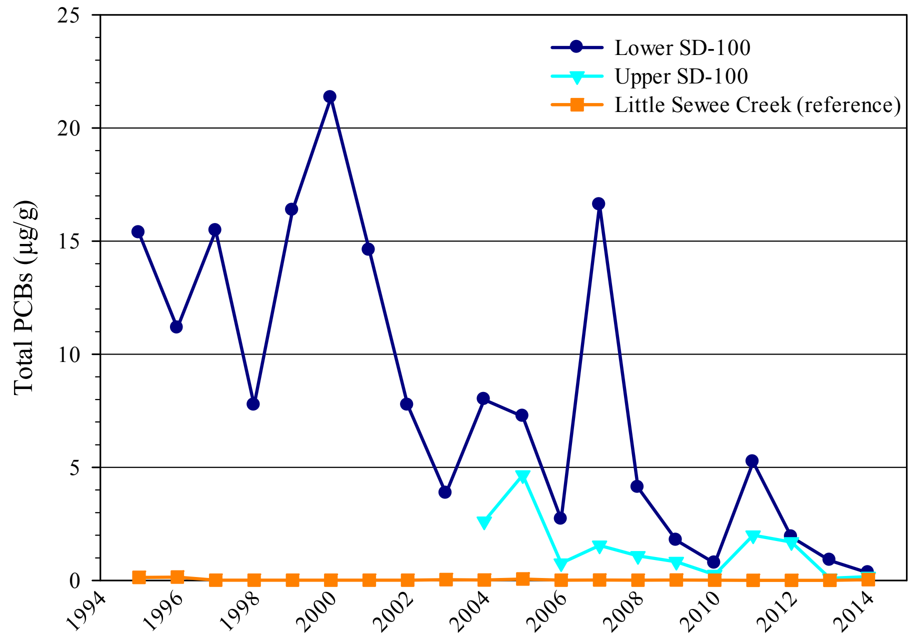


Figure 8.30. Mean total PCB concentrations (µg/g, wet wt; 1995 – 2014) in the soft tissues of caged Asiatic clams deployed at two locations in SD-100: "upper SD-100", upstream of any possible pond related sources, and "lower SD-100" at the culvert entering the pond and potentially influenced by pond sediment sources.

N=2 composites of 10 clams each per year. Shown in orange are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee). Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.

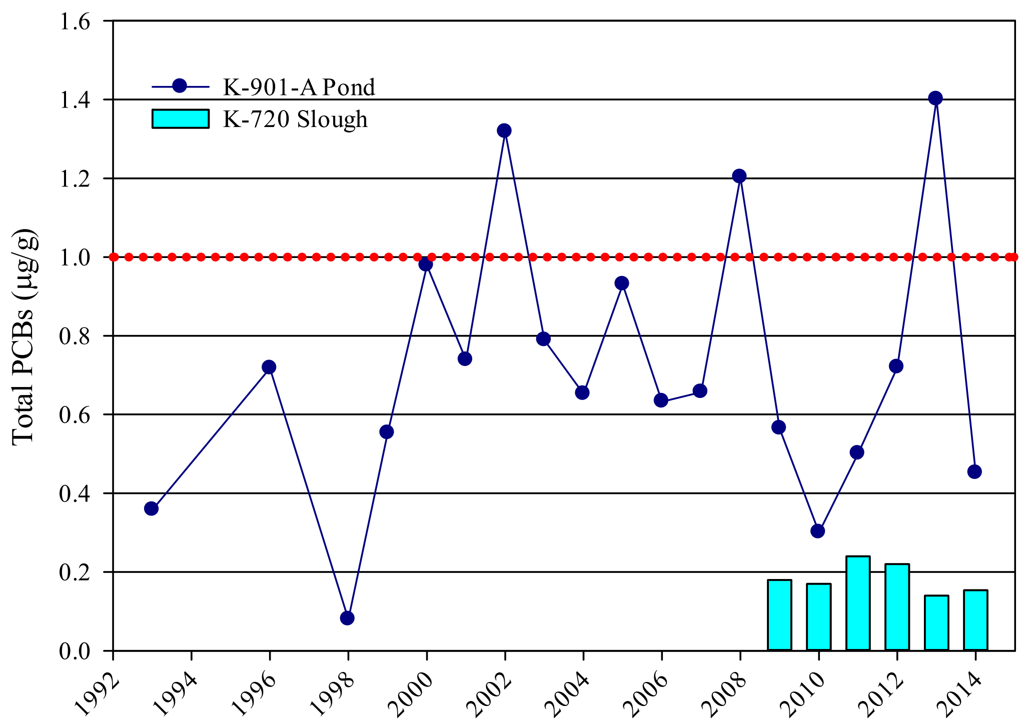


Figure 8.31. Mean concentrations of PCBs in largemouth bass fillets from K-901-A Holding Pond and K-720 Slough, 1993 – 2014.

Dotted red line signifies goal of 1 µg/g total PCB concentrations in fillets of fish collected from ETTP ponds.

8.4.2.1.2 Performance Summary

Performance monitoring at the K-1007-P1 Holding Pond began in 2010. The baseline trends show PCBs in largemouth bass around 15 µg/g as a long-term average. Bluegill concentrations have decreased from around 3 µg/g prior to the actions to 0.6 µg/g currently. This mean fillet concentration is below the target of 1 µg/g total PCBs in fish fillets in this pond. Whole body fish concentrations, however, remain above the 2.3 µg/g target. Clam studies continue to indicate that storm drains are a source of PCBs to the K-1007-P1 Holding Pond, but the magnitude of this PCB source appears to be diminishing over time. Resuspension of contaminated sediments in the pond are a more likely important source of PCBs to fish. The removal action at the K-1007-P1 Holding Pond was 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.

8.4.2.2 Other LTS Requirements

8.4.2.2.1 Requirements

The *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, Oak Ridge, Tennessee* (DOE/OR/01-2456&D1/R1) requires signs at K-1007-P1 Holding Pond, K-901-A Holding Pond, and K-720 Slough to provide notice or warning to prevent unauthorized access by fishermen and specific signs at the K-1007-P1 Holding Pond to provide notice or warning that prohibits mowing in the buffer zone. The RmAR also requires surveillance patrols be established and maintained to control and monitor access by fishermen (Table 8.2).

8.4.2.2.2 Status of Requirements

Activities conducted at the ponds in FY 2014 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. Maintenance of the K-1007-P1 weir included removing debris from the weir grate. On September 5, 2014, surveillance patrols informed an individual not to fish in the K1007 P1 Pond and the individual promptly left the area. The signs were not visible (to the fisherman) at the time of the incident. Shortly after the incident the signs were made visible. No other occurrences of fishing were reported for the ponds.

8.4.3 K-1070-C/D G-Pit and Concrete Pad

The K-1070-C/D G-Pit is the primary source of organic contaminant releases to soil and groundwater in the area. The K-1071 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 (DOE/OR/02-1486&D4). The location of the area at ETTP is shown in Figures 8.1 and 8.32. Components of the remedy included:

- Excavation of the G-Pit contents, interim storage of the material, treatment, and disposal, and

- Placement of an interim 2-ft soil cover over the Concrete Pad until remediated.

8.4.3.1 Other LTS Requirements

8.4.3.1.1 Requirements

The *Record of Decision for the K-1070-C/D Operable Unit, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/02-1486&D4) and *Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad, East Tennessee Technology Park*, *Oak Ridge, Tennessee* (DOE/OR/01-1964&D2) require interim LTS activities including maintaining institutional controls (see Table 8.2). Based on a recommendation made in the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) site visit, the frequency of inspections and mowing were reevaluated and the ETTP RA Core Team accepted the recommendation to change the frequencies. An erratum to the K-1070-C/D G-Pit and K-1071 Concrete Pad RAR (DOE/OR/01-1964&D2) submitted in February 2015 contains the revised frequencies. Specifically, annual inspections of the soil cover over the pad are to be conducted to look for erosion (previously conducted weekly); the grass on the cover is to be mowed as needed, but not less than annually (previously mowed at an estimated frequency of five times a year); radiological walkover surveys are to be conducted only if there is activity in the area to confirm the effectiveness of the K-1071 Concrete Pad soil cover in preventing exposure to ionizing radiation (previously conducted annually); and inspections of the fence are to be performed as needed, but no less than annually (previously performed semiannually). Existing institutional controls will continue to include ensuring the existing EPP program remains in place. This resolves the issue in Table 8.9.

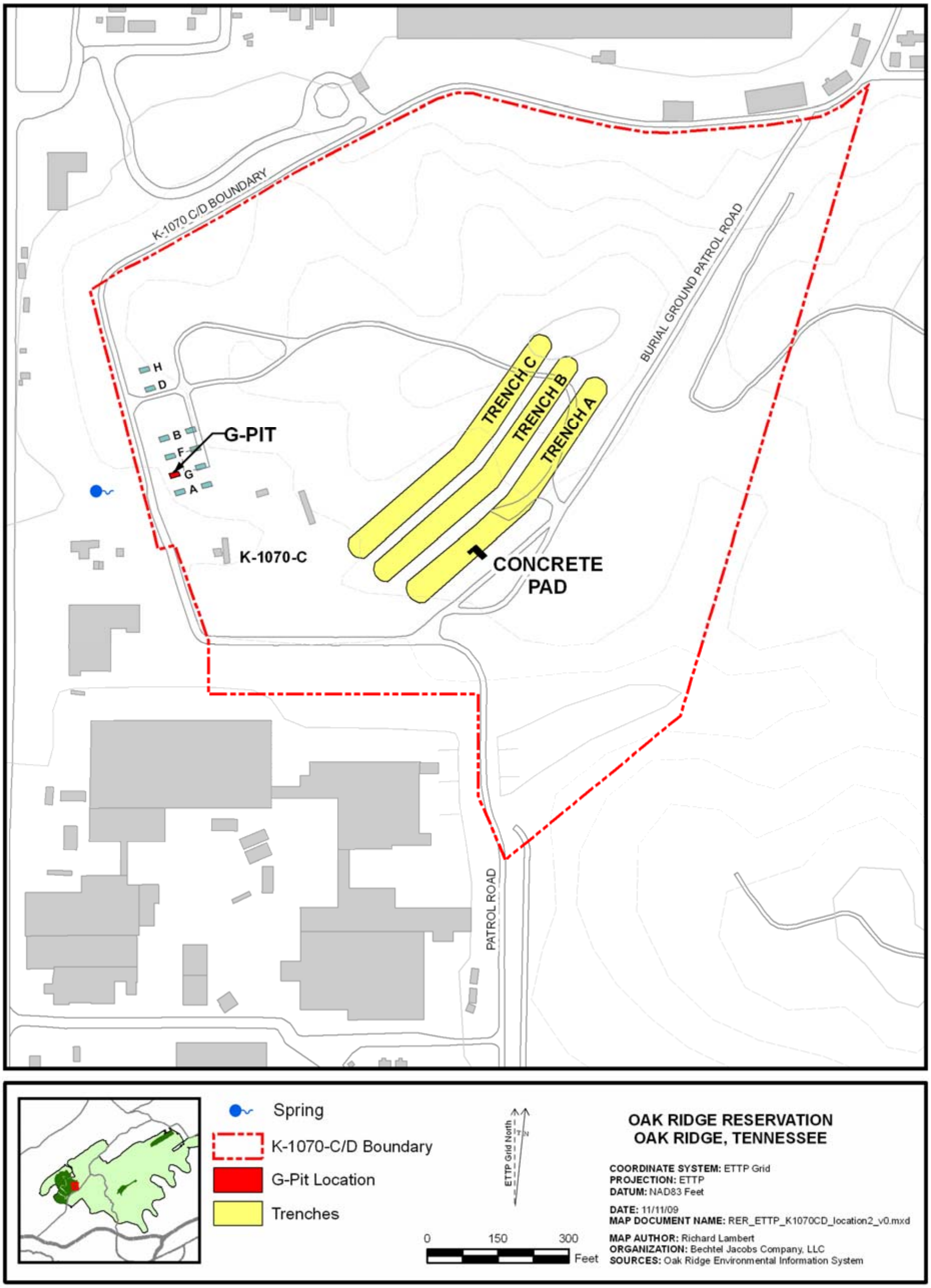


Figure 8.32. Location of K-1070-C/D G-Pit and Concrete Pad.

8.4.3.1.2 Status of Requirements

The site was inspected by the ETTP S&M Program in FY 2014 for items including condition of the warning signs, condition of fencing and locked gate, condition of the K-1071 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.

8.4.4 K-1070-A Burial Ground

The remedy in the *Record of Decision for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1734&D3) (Figures 8.1 and 8.33) 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 chlorinated VOCs and radionuclides. No known unacceptable residual risk from soils for industrial or recreational end use remain within the K-1070-A Burial Ground fenced area subsequent to completion of the RA defined in the *Record of Decision for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1734&D3).

Post-RA monitoring requirements are not specified for this action, and cleanup standards for environmental media were not identified (DOE/OR/01-2090&D1). Until a groundwater decision is finalized, downgradient Spring 21-002 is monitored as an exit pathway point (Section 8.6).

8.4.4.1 Other LTS Requirements

8.4.4.1.1 Requirements

Monthly inspections of the site for subsidence and erosion per the *Remedial Action Report for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2090&D1) are no longer applicable as described below.

Figure 8.33. Location of former K-1070-A Burial Ground.

8.4.4.1.2 Status of Requirements

The K-1070-A Burial Ground is included in EU Z1-59 in the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2). 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) documents evaluation of EU Z1-59 and concludes that "…the approximately 50 acres of the K-1070-A EU Group composed of EU 57, EU 58, EU 59, and EU 60 meet the RAO established in the Zone 1 ROD and NFA is appropriate." Therefore, the issue in Table 8.9 regarding LTS requirements at K-1070-A Burial Ground is resolved because the Zone 1 ROD and NFA determination documented in 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) supersede the requirements of the *Remedial Action Report for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2090&D1).

8.4.5 Mitchell Branch Chromium Reduction

8.4.5.1 Performance Monitoring

8.4.5.1.1 Performance Monitoring Goals and Objectives

During FY 2007, hexavalent chromium was detected in surface water in Mitchell Branch at levels exceeding the applicable AWQC of 0.011 mg/L. The source of the discharge was determined to be from groundwater infiltration into the Outfall 170 (SD-170 on Figure 8.34) piping as well as seep flows through the outfall headwall. In response to this condition, a time-critical removal action was performed to install and operate groundwater collection pumps to capture chromium-contaminated groundwater associated with the Outfall 170 discharge. The time-critical removal action to address releases of hexavalent chromium into Mitchell Branch was documented in the *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). The location of the removal action is noted on Figures 8.1 and 8.34.

Figure 8.34 shows the locations of Mitchell Branch, relevant monitoring locations, the affected storm drain piping section, and the hexavalent chromium plume. The plume discharge resulted in levels of hexavalent chromium that exceeded state hexavalent chromium water quality chronic criterion of 0.011 mg/L for the protection of fish and aquatic life. At Mitchell Branch kilometers (MIKs) 0.71 and 0.79, which are locations in Mitchell Branch immediately downstream from the Outfall 170 discharge point, hexavalent chromium levels were measured at levels as high as 0.78 mg/L. 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 30 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 time-critical removal action. On November 5, 2007, DOE notified the EPA and TDEC of their intent to conduct a CERCLA time-critical removal action.

Activities associated with the removal action included:

- Located the hexavalent chromium release path to the SD system and into Mitchell Branch.
- Installed a grout wall to impede the release of hexavalent chromium through Outfall 170 headwall seeps into Mitchell Branch.

- Installed two interception wells into the gravel bed that surrounds the Outfall 170 discharge pipes to collect the hexavalent chromium groundwater plume before it infiltrates the Outfall 170 collection system network piping. These wells are labeled as interception well (IW) 416 and IW 417 on Figure 8.34.

- Began operating the two IWs in December 2007. The collected groundwater was initially treated at the CNF. The treatment of the collected groundwater transitioned to the Chromium Water Treatment System (CWTS) in FY 2012.

A *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) for the time-critical removal action was issued in July 2008.

For a long-term solution to the release of hexavalent chromium to Mitchell Branch, an *Engineering Evaluation/Cost Analysis for the Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2422&D1) recommending *ex situ* treatment by chromium reduction was approved in December 2009. The non-time critical *Action Memorandum for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2448&D1) for a long-term solution to the release of hexavalent chromium to Mitchell Branch was approved on March 26, 2010, superseding the time-critical removal action (DOE/OR/01-2369&D1). The *Removal Action Work Plan for the Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2484&D1) was approved in November 2010.

Construction of the CWTS was initiated in the spring of 2011 with final process installation completed in FY 2012. The treatment unit initiated sustained continuous operations in May 2012. The *Removal Action Report for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2598&D2) was approved in April 2013.

Monitoring of the removal action was first documented in the *Removal Action Report for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2598&D2). Monitoring is now included in the ETTP Comprehensive Monitoring Plan (DOE/OR/01-2477&D1), which documents any monitoring changes. 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 annual RER. The Outfall 170 quarterly sampling outfall results are also reported in the NPDES Permit Discharge Monitoring Report. 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 total chromium and hexavalent chromium performance sampling points identified in the *Removal Action Report for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2598&D2) are:

- Outfall 170 discharge point.

- Mitchell Branch in-stream location (MIK 0.79) that is downstream from Outfall 170. The in-stream location below Outfall 170 provides an opportunity for the discharges to mix with the Mitchell Branch receiving stream, which is considered 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 IWs 416 and 417.

- Monitoring well TP-289, which is located in the groundwater plume.

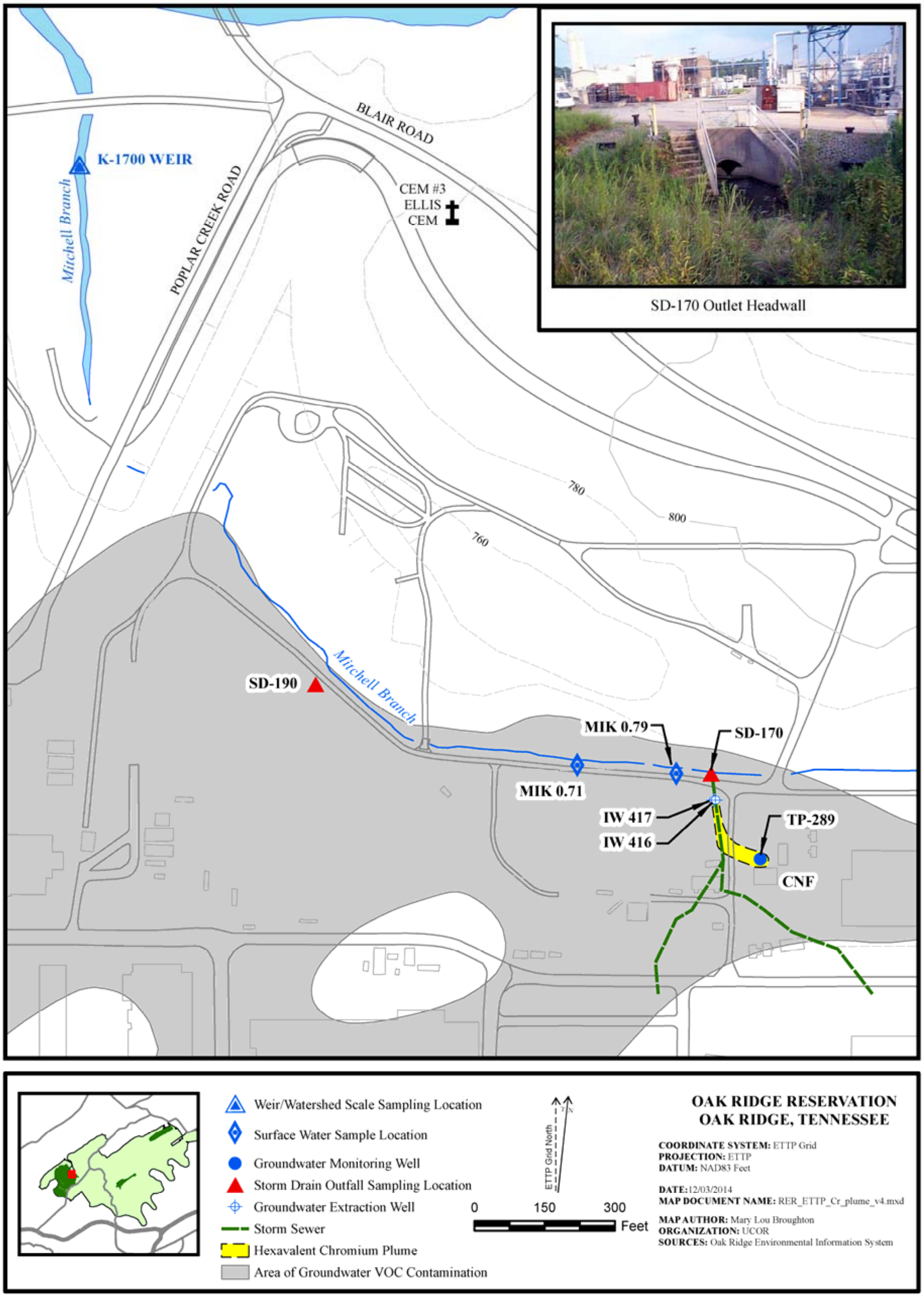


Figure 8.34. Location of hexavalent chromium releases to Mitchell Branch.

8.4.5.1.2 Evaluation of Performance Monitoring Data

The long-term water quality monitoring results for total chromium in Mitchell Branch downstream from Outfall 170 at MIK 0.79 are shown in Figure 8.35. Total chromium results were used for trending purposes instead of hexavalent chromium because there is a lack of historical hexavalent chromium data for all the sampling events, the majority of the total chromium discharged is in the hexavalent chromium form, and the total chromium analysis provides lower detection limits in comparison to hexavalent chromium analysis. During FY 2014, hexavalent chromium comprised almost 100% of the total chromium values as measured at the groundwater plume monitoring well location. The hexavalent chromium AWQC of 0.011 mg/L is provided in Figure 8.35 for reference and comparison purposes.

The surface water results in Mitchell Branch at MIK 0.79 show that the chromium collection system has been very effective in reducing the levels of chromium from a maximum measured value of 0.78 mg/L during the summer of 2007 as reflected in the maximum levels on Figure 8.35 to levels that are now consistently well below the hexavalent chromium AWQC value of 0.011 mg/L during dry and wet weather periods. During FY 2014, the MIK 0.79 in-stream hexavalent chromium results as shown in Table 8.5 were non-detect values at laboratory detection levels of 0.006 mg/L.

The hexavalent chromium quarterly performance monitoring results for FY 2014 are included in Table 8.5 and are a component of the 2010 – 2014 trend graph for all four monitoring locations as shown in Figure 8.36. Historical sampling and analysis of the chromium in the groundwater plume and in Outfall 170 have established that essentially all of the detected chromium is hexavalent chromium.

The results for hexavalent chromium at Outfall 170 varied from non-detect levels for three of the four quarters to a maximum value of 0.007 mg/L in February 2014. As previously noted, the hexavalent chromium in-stream sampling results at the MIK 0.79 point of compliance were non-detect values at a detection level of 0.006 mg/L for all four quarters of 2014. The hexavalent chromium results for the CWTS influent (combined water flows that are collected in IWs 416 and 417) varied from a low of 0.180 mg/L to a maximum value of 0.233 mg/L. The hexavalent chromium results at well TP-289 varied from a low of 0.860 mg/L to a maximum value of 1.236 mg/L.

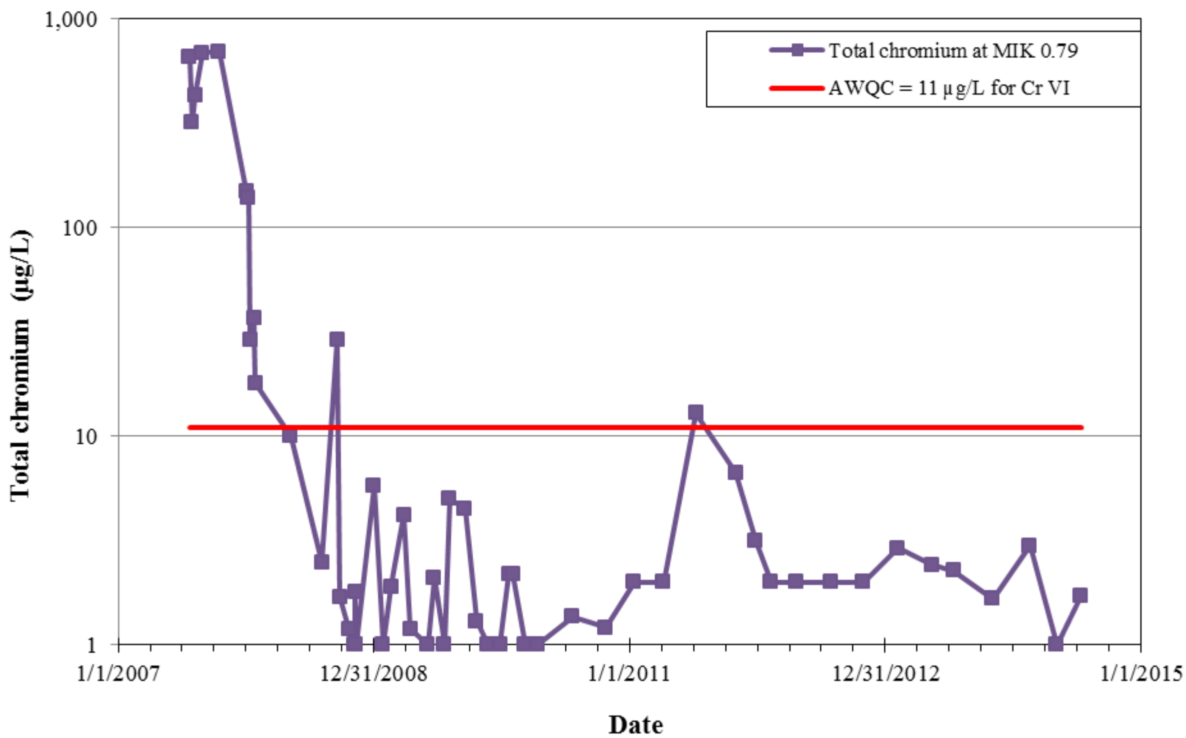


Figure 8.35. Mitchell Branch (MIK 0.79) total chromium concentrations, FY 2007 – 2014.

Table 8.5. FY 2014 performance monitoring results for reduction of hexavalent chromium releases into Mitchell Branch

Sample Date	**November 2013**	**February 2014**	**May 2014**	**July 2014**
Location Description	**Hexavalent Chromium (mg/L)**	**Hexavalent Chromium (mg/L)**	**Hexavalent Chromium (mg/L)**	**Hexavalent Chromium (mg/L)**
MIK 0.79 downstream from Outfall 170	0.006 U	0.006 U	0.006 U	0.006 U
Outfall 170	0.006 U	0.007	0.006 U	0.006 U
CWTS influent (CWTS-INF)	0.180	0.214	0.233	0.192
Well TP-289	1.236	0.878	0.973	0.860

CWTS = Chromium Water Treatment System
FY = fiscal year
INF = influent
MIK = Mitchell Branch kilometer
U = indicates nondetection at the analytical detection limit.

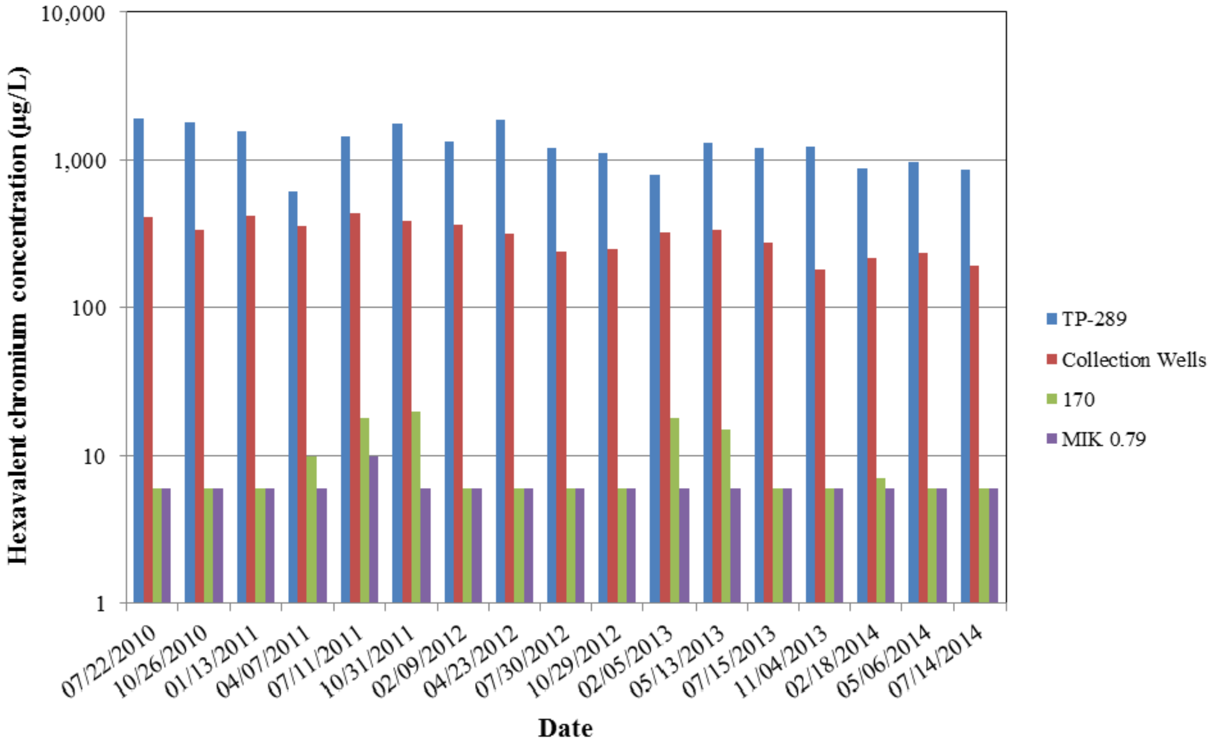


Figure 8.36. Hexavalent chromium performance trends from 2010 – 2014.

8.4.5.1.3 Performance Summary

Water sampling in FY 2014 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 Outfall 170 discharge at the MIK 0.79 point of compliance.

8.4.5.2 Other LTS Requirements

8.4.5.2.1 Requirements

The *Removal Action Report for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park* (DOE/OR/01-2598&D2) states that the CWTS will be operated and maintained in accordance with contractor procedures. The procedures will describe all components of the system, the operating instructions, alarm response, waste acceptance criteria, and surveillance monitoring. No interim LUCs beyond those already established for ETTP are required.

The primary components of the completed removal action consist of:

- Groundwater extraction wells;
- Grout barrier wall installed in the Outfall 170 gravel bed;
- Reduction of hexavalent chromium to trivalent chromium using steel wool;
- One-Flow Anti-Scaling System;

- Removal of VOCs with an air stripper;
- Discharge to the Clinch River;
- Operations and maintenance;
- Monitoring.

8.4.5.2.2 Status of Requirements

Construction of CWTS was completed in FY 2012 as the facility transitioned to continuous operations in May 2012, as described in the *Removal Action Report for the Long-term Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2598&D2).

During FY 2014, the chromium collection system wells operated during 100% of the days with only short duration periods where collection system pumping volumes were limited due to treatment facility operational constraints. The total volume of wastewater that was treated in FY 2014 was approximately 6 million gal.

An operational challenge that continued in FY 2014 was associated with high levels of calcium and magnesium in the plume groundwater that creates scale buildup on the facility pumps, valves, and piping. This has been an operational issue from the start of the pump and treat operations. The high levels of calcium and magnesium required changes to earlier CNF water chemistry treatment recipes and in 2009 the initially installed pneumatic pumps were replaced with electric pumps. The electric pumps have provided the capacity for higher pumping rates while also providing more consistent performance by reducing maintenance requirements.

During FY 2013, CWTS operational changes were implemented to help address the scale buildup issues by installing the One-Flow Anti-Scaling System upstream of the air stripper in February 2013. The additional equipment in the treatment train seemed to reduce the rate of the scale buildup in FY 2014, but there was still a need for numerous pump replacements and repairs for both the air stripper and day tank pumps during the past year.

Pump scale buildup was the cause of a treatment system bypass that occurred in early October 2014 for a period of approximately 48 hr. The volume of plume water that bypassed treatment for a direct discharge into the Clinch River was approximately 22,000 gal. As described in the *Removal Action Report for the Long-term Reduction of Hexavalent Chromium Releases into Mitchell Branch* (DOE/OR/01-2598&D2), notifications were provided to the CERCLA regulatory project teams for a bypass that exceeds four hours in duration. The notification provided information on the cause of the event, volume of water bypassed, the most recent quarterly sampling results, and the point when the treatment unit pumps were repaired. Facility modifications are being evaluated to determine if cost effective changes could be implemented to decrease the water scaling pump and valve maintenance issues.

To continue to address the system scaling issues, a process improvement initiative was approved and initiated at the CWTS facility in late September 2014. Process testing and implementation actions continue into October and November 2014. The process improvement actions include the following:

Electrocoagulation Unit Removal:

- Because of problems with mineral scaling, the Electrocoagulation Unit (ECU) Removal was no longer used as a functional piece of equipment in CWTS. The removal of the excess ECU equipment provides more operational room at the facility for routine maintenance and will provide additional flexibility for future treatment system adjustments as needed.

Phosphate Injection System:

- To further reduce scaling buildup, a phosphate injection system was installed through a calibrated feed pump. This pump will inject 1 – 5 ppm of phosphates, which will interfere with the crystallization of the minerals in the groundwater as it flows through the system.

Dual Bag Steel Wool Reaction Module:

- The steel wool used in the reduction of hexavalent chromium was previously loaded in trays within the air stripper, a piece of equipment that also helps to eliminate VOCs from the water. The steel wool change outs in this air stripper unit required numerous maintenance steps including electrical lockout/tagout actions. To reduce the maintenance steps and to also increase the contact time between the steel wool and contaminated groundwater, a second set of dual bag filters filled with steel wool was added to the treatment process in a location before the water reaches the air stripper.

The effectiveness of these process system changes will be evaluated during FY 2015.

8.5 DEMOLITION PROJECTS

8.5.1 LTS Requirements

The scope of demolition projects is the demolition of above-grade structures to slab or to grade. The scope of remediation of the slabs, subsurface structures, and underlying soils is addressed under the *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1997&D2) and the *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). Until the slab is evaluated for remediation under one of these RODs, the slab is included in the Radiation Protection Program, Storm Water Pollution Prevention (SWPP) Program, and S&M Program that operate in accordance with:

- 10 CFR 835, Occupational Radiation Protection
- 40 CFR 761.61(a), Disposal of PCB Remediation Waste
- 40 CFR 761.30(p), Continued use of porous surfaces contaminated with PCBs regulated for disposal by spills of liquid PCBs
- Clean Water Act, Section 304(e)
- TCA 69-3-101 through 69-3-120
- DOE Order 458.1, Radiation Protection of the Public and the Environment
- DOE Order 430.1B, Real Property and Asset Management

- DOE Order 5400.5, Radiation Protection of the Public and the Environment.[1]

When a slab, field, or building is above the free release criteria in DOE Order 458.1, it is posted for radiological controls, and the area becomes part of the Radiation Protection Program surveillance and monitoring program. If radiological contamination is found to be migrating out of the contamination area, then additional controls are implemented to control the contamination. The demolition completion documents describe the end state of slabs and indicate if they are monitored by the above programs. The building slab will remain in these programs until the slab either is removed or it meets the Radiation Protection Program release criteria.

Interim LTS requirements for slabs following building demolition are the subject of an open issue identified in Table 8.9. The ETTP D&D and RA Project Teams have reached agreement on the management of slabs and are in the process of documenting and implementing the agreement. The results of implementing this agreement will be reflected in the next RER.

8.6 OTHER WATERSHED MONITORING

This section provides a summary of ETTP sitewide groundwater, surface water, and aquatic biology monitoring.

8.6.1 Groundwater Plumes

Extensive groundwater monitoring at the ETTP site, using SDWA MCLs as groundwater screening values, has identified VOCs as the most significant groundwater contaminant on site. The principal chlorinated hydrocarbon chemicals that were used at ETTP were PCE, TCE, and 1,1,1-TCA.

Figure 8.37 shows the distribution and generalized concentrations of the sum of the primary chlorinated hydrocarbon chemicals and their transformation products, respectively, at ETTP. Specific compounds included in the summation of chlorinated VOCs include chloroethenes (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCA, and VC), chloroethanes (1,1,1-TCA, 1,1,2-TCA, 1,2-DCA, 1,1-DCA, and chloroethane), and chloromethanes (carbon tetrachloride, chloroform, and methylene chloride). 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 site. In the vicinity of the K-1070-C/D source (Section 8.4.3), a high degree of degradation has occurred, although a strong source of contamination still remains in the vicinity of the “G-Pit,” where approximately 9,000 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 (Section 8.4.1). Transformation processes are weak or inconsistent at the K-1004 and K-1200 area, K-1035, K-1413, and K-1070-A Burial Ground (Section 8.4.4), and little transformation of TCE is observed in the K-27/K-29 source and plume area.

[1]U.S. Department of Energy (DOE) Order 458.1, which became effective in February 2011, replaced DOE Order 5400.5; however, many decision documents for Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) actions on the Oak Ridge Reservation (ORR) that were signed before that date include applicable or relevant and appropriate requirement (ARAR) sets that identify DOE Order 5400.5 as a requirement. If at some point any of these decision documents are reopened or modified, the ARAR list may be revised to replace the DOE Order 5400.5 citation with a citation to DOE Order 458.1.

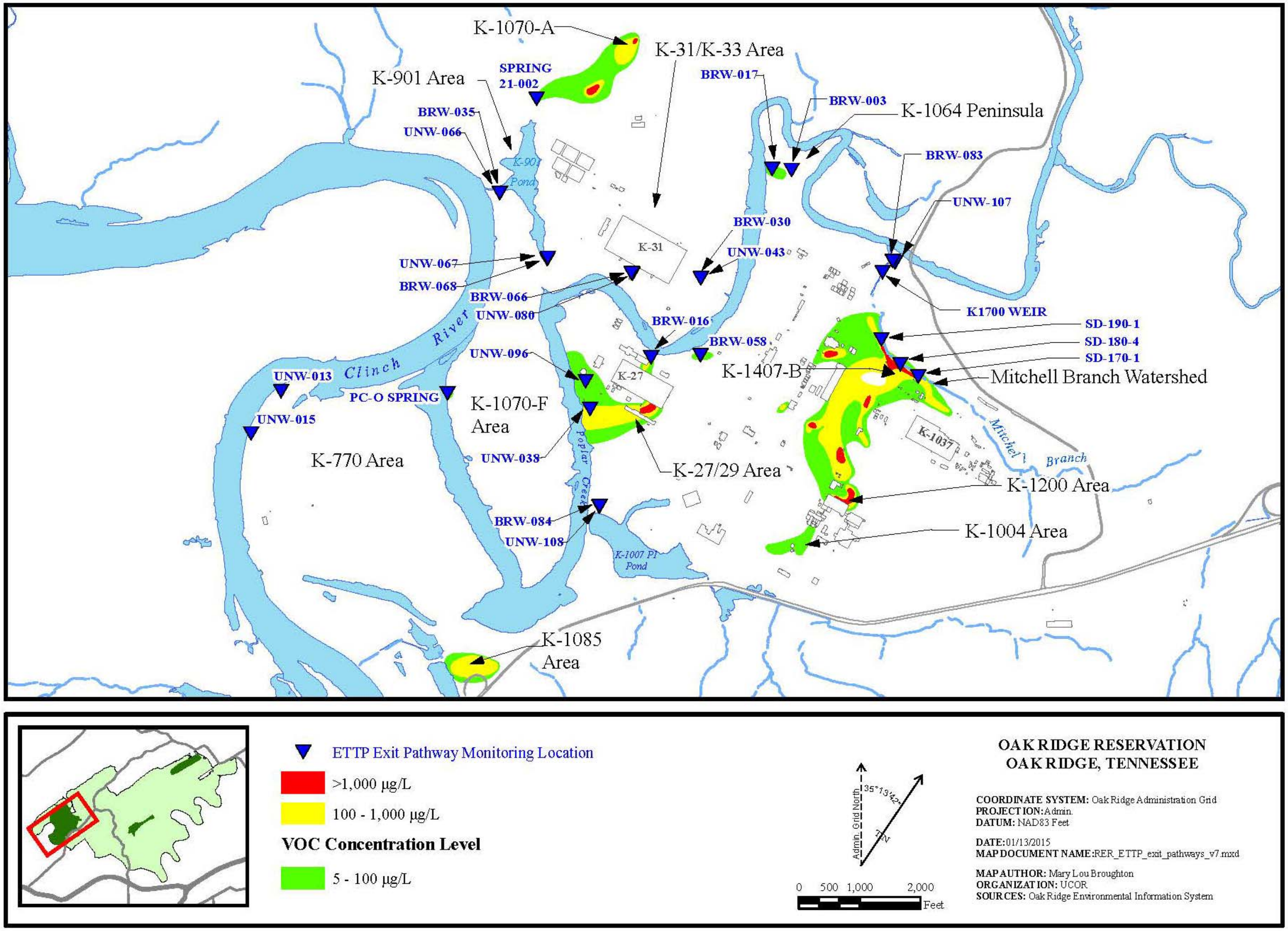


Figure 8.37. ETTP exit pathways monitoring locations.

8.6.2 Groundwater Exit Pathways

Groundwater exit pathway monitoring sites are shown in Figure 8.37. Groundwater monitoring results for the exit pathways are discussed below:

Mitchell Branch – The Mitchell Branch groundwater exit pathway is monitored using surface water data from the K-1700 Weir on Mitchell Branch and wells BRW-083 and UNW-107. Section 8.6.4 includes discussion of the detected concentrations of VOCs in Mitchell Branch.

Wells BRW-083 and UNW-107, located near the mouth of Mitchell Branch, have been monitored since 1994. Table 8.6 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. No chlorinated VOCs were detected in BRW-083 or UNW-107 during FY 2014.

K-1064 Peninsula area – Wells BRW-003 and BRW-017 monitor groundwater at the K-1064 Peninsula burn area. Figure 8.38 shows the history of VOC concentrations in groundwater from FY 1994 through FY 2014. TCE concentrations have declined in both wells over that period of time. TCE was present at concentrations less than the MCL during FY 2014 at well BRW-017 and was not detected in either sample from well BRW-003. 1,1,1-TCA has declined to undetectable concentrations in well BRW-003. Cis-1,2-DCE was detected at concentrations much less than its MCL in both semiannual samples in well BRW-017.

K-31/K-33 area – Groundwater is monitored in four wells (BRW-066, BRW-030, UNW-080, and UNW-043) that lie between the K-31/K-33 area and Poplar Creek. VOCs are not COCs in this area; however, leaks of recirculated cooling water in the past have left residual subsurface chromium contamination. Figure 8.39 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 addition of acid preservative releases 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 2014, field-filtered (i.e., dissolved) and unfiltered samples were collected from UNW-043. Chromium concentrations in the field-filtered samples are consistently much less than the MCL. During FY 2014, both field-filtered and unfiltered samples were collected from wells BRW-066, UNW-043 and UNW-080. Chromium was non-detect in all samples from well BRW-066 during FY 2014.

K-27/K-29 area – Several exit pathway wells are monitored in the K-27/K-29 area, as shown on Figure 8.37. Figure 8.40 provides concentrations of detected VOCs in wells both north and south of K-27 and K-29 through FY 2014. The source of VOC contamination in well BRW-058 is not suspected to be from K-27/K-29 area operations. With the exception of cis-1,2-DCE in well BRW-058, which appears stable to slightly increasing but remains less than its MCL, the VOC concentrations in this area show very slowly declining concentrations. TCE levels in well UNW-038 fluctuate between 10 to 20 times the MCL and appear to be in a nearly stable fluctuation range since about 2011. At BRW-016, cis-1,2-DCE levels show a decreasing trend and vinyl chloride has decreased to < 1 µg/L which is less than its MCL.

Table 8.6. VOCs detected in groundwater in the Mitchell Branch Exit Pathway

Well	Date	cis-1,2-DCE	PCE	TCE	VC
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
	3/15/2011	2.8	**6.7**	**22**	ND
	8/10/2011	ND	ND	ND	ND
	3/1/2012	ND	ND	ND	ND
	8/16/2012	ND	ND	ND	ND
	8/6/2013	ND	ND	ND	ND
	3/13/2013	ND	ND	ND	ND
	3/13/2014	ND	ND	ND	ND
	8/7/2014	ND	ND	ND	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
	3/16/2011	ND	ND	ND	ND
	8/11/2011	ND	ND	ND	ND
	3/20/2012	ND	ND	ND	ND
	9/12/2012	ND	ND	ND	ND
	8/8/2013	ND	ND	ND	ND
	3/20/2013	ND	ND	ND	ND
	3/18/2014	ND	ND	ND	ND
	8/20/2014	ND	ND	ND	ND

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

Bold table entries exceed SDWA MCL screening values (PCE, TCE = 5 µg/L, cis-1,2-DCE = 70 µg/L, VC = 2 µg/L)
All concentrations µg/L.

BRW = bedrock well
DCE = dichloroethene
J = estimated value
MCL = maximum contaminant level
ND = Not Detected
PCE = tetrachloroethene
SDWA = Safe Drinking Water Act
TCE = trichloroethene
UNW = unconsolidated well
VC = vinyl chloride
VOC = volatile organic compound

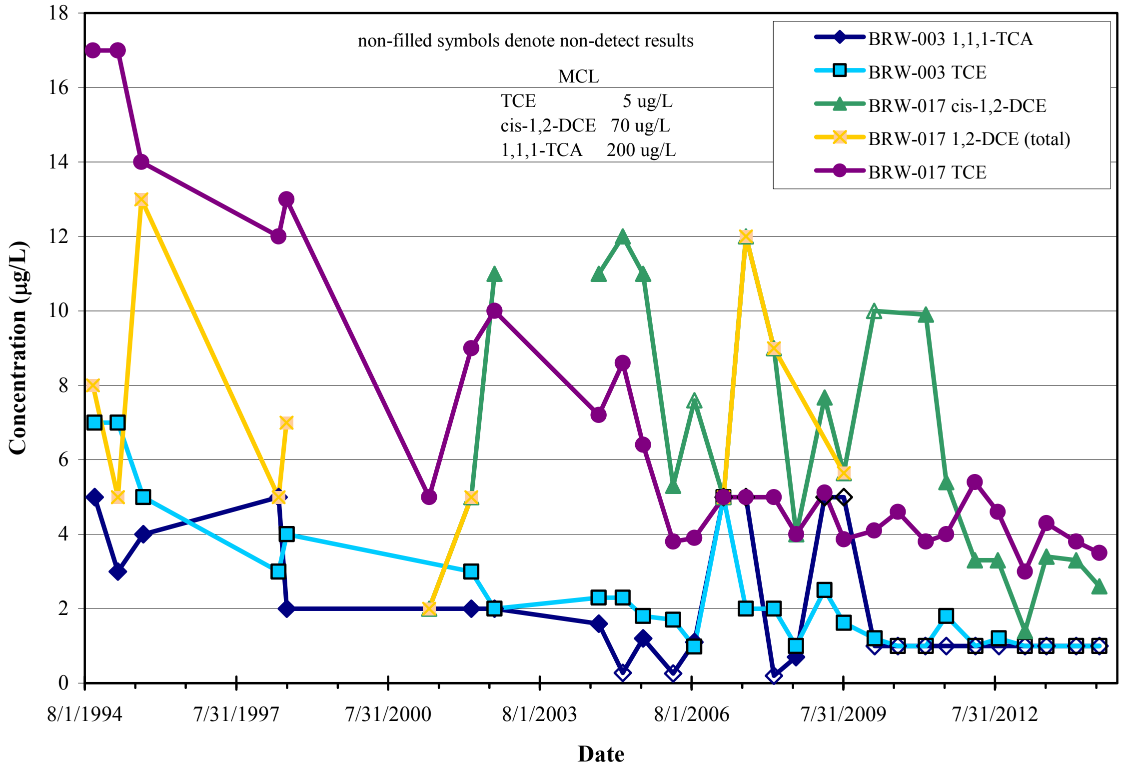


Figure 8.38. VOC concentrations in groundwater at K-1064 Peninsula area.

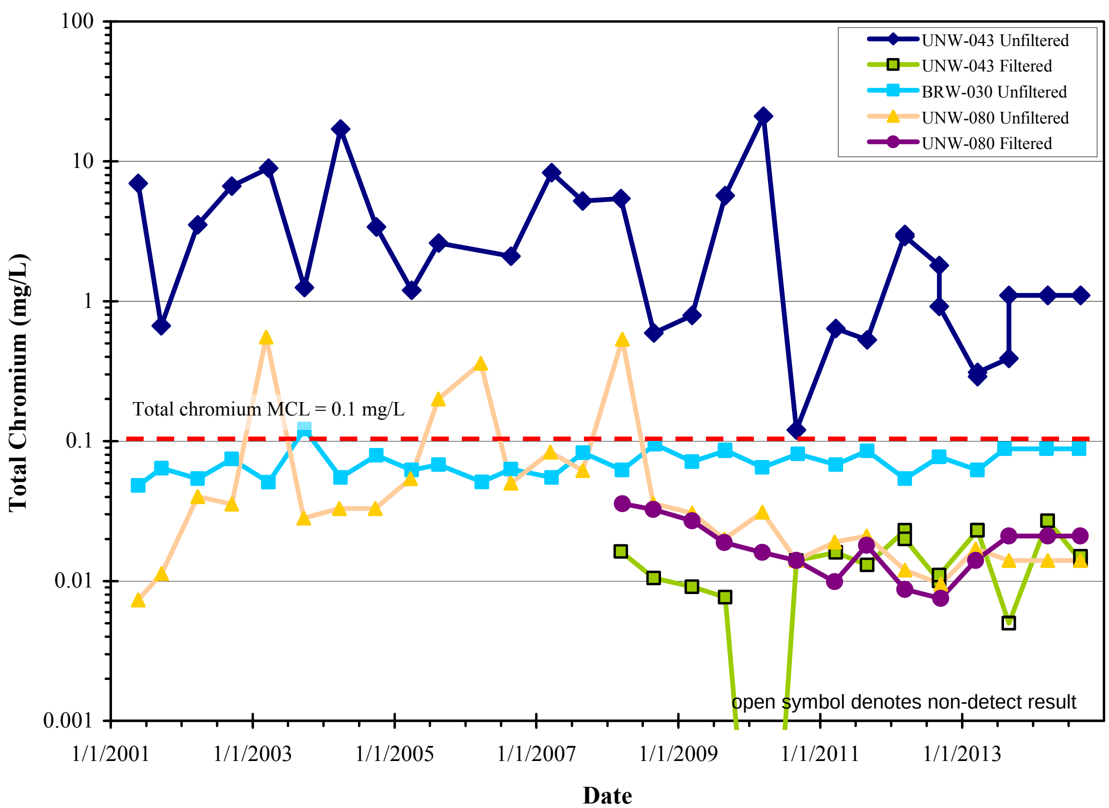


Figure 8.39. Chromium concentrations in groundwater in the K-31/K-33 area.

K-1007-P1 Holding Pond area – Wells BRW-084 and UNW-108 are exit pathway monitoring locations at the northern edge of the K-1007-P1 Holding Pond (Figure 8.37). These wells were monitored intermittently from 1994 through 1998 and semiannually from FY 2001 through FY 2014. 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. VOCs were not detected in either of these wells during FY 2014. Metals have been detected in the past associated with the presence of high turbidity in the samples. Arsenic was not detected in either well during FY 2014. A single detection of cadmium at a concentration below the MCL and the AWQC levels occurred at well UNW-108 in the unfiltered aliquot collected in August. Chromium was detected at concentrations below its MCL or AWQC levels in the filtered sample from BRW-084 in March and from the unfiltered samples from both wells collected in August. Aluminum exceeded its secondary MCL in the unfiltered sample from well BRW-084 in August and from the unfiltered aliquots from both sample dates at well UNW-108. Aluminum was detectable in the filtered aliquot from the March sample from UNW-108 at 0.15 mg/L which is within the range of the secondary MCL (0.2 mg/L). Iron exceeded its secondary drinking water standard in both of the unfiltered aliquots from well UNW-108 but was not detected in the filtered aliquots. Manganese exceeded its secondary drinking water standard in both the filtered and unfiltered samples from UNW-108 in the August 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 2014. Zinc was detected (21 µg/L) in the unfiltered aliquot from well UNW-108 at a concentration far below its secondary drinking water standard (5 mg/L).

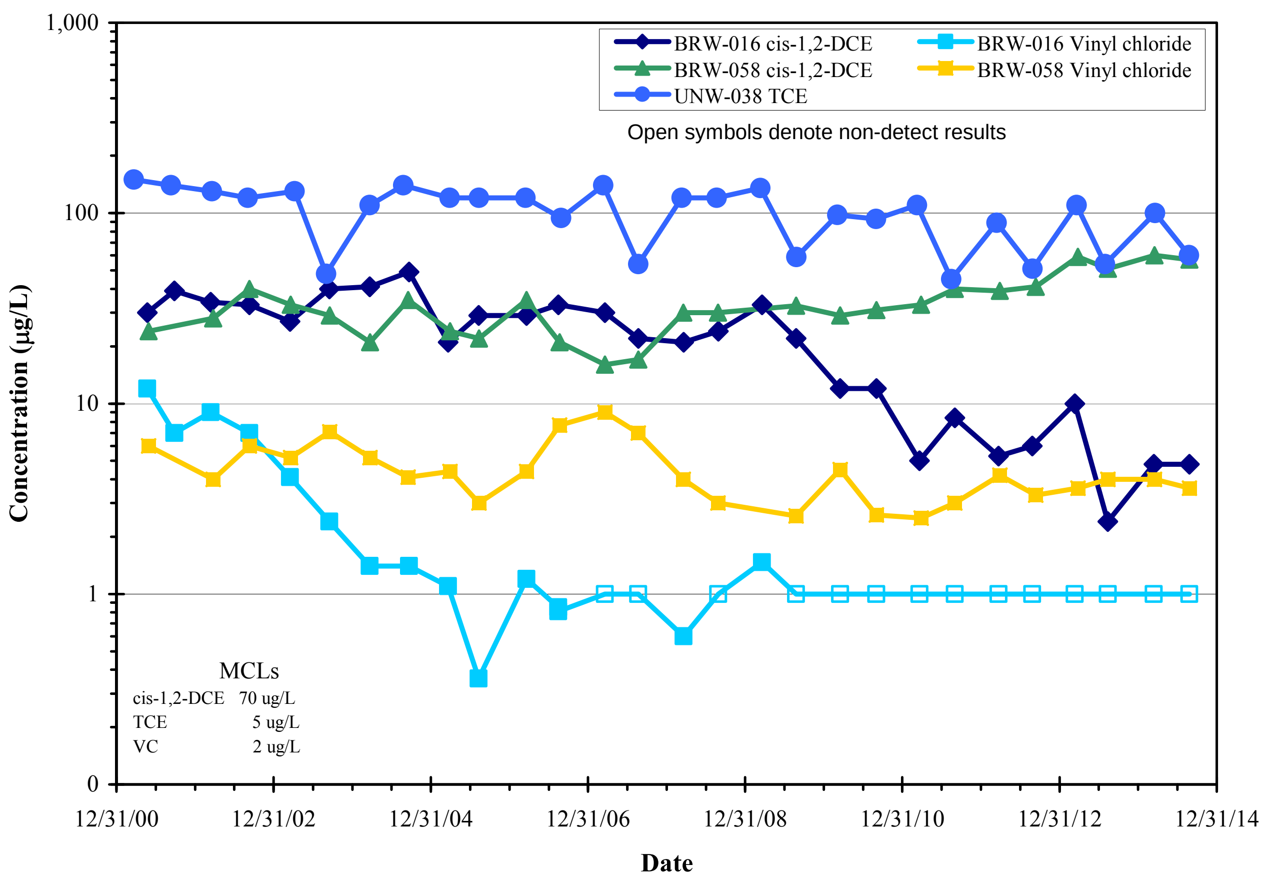


Figure 8.40. Detected VOC concentrations in groundwater exit pathway wells near K-27 and K-29.

K-901-A Holding Pond area – Exit pathway groundwater in the K-901-A Holding Pond area (Figure 8.37) 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 Holding Pond exit pathway wells during FY 2014. Alpha activity was detected at approximately 3 pCi/L in both semiannual samples from well UNW-066. Alpha activity was not detected in samples from the other three wells. Beta activity levels were less than the 50 pCi/L screening level, with the highest measured activity (15.8 pCi/L) occurring in well BRW-035.

TCE is the most significant groundwater contaminant detected in the springs, and the historic TCE concentrations are shown in Figure 8.41. 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. In late winter 2012 DOE installed a sampling pump in the spring mouth to allow year-round sampling. The contaminant source for the PC-0 spring is presumed to be disposed waste at the former Construction Spoil Area (K-1070-F) located on Duct Island. The TCE concentrations in PC-0 spring have varied between non-detectable levels and 26 µg/L and have decreased from their highest measured value in 2006 to concentrations less than or just slightly greater than the drinking water standard.

Although TCE is the principal contaminant detected at spring 21-002, 1,1-DCE, and carbon tetrachloride, were present at concentrations less than 3 and 4 µg/L, respectively. The TCE concentration at spring 21-002 tends to vary between less than 5 and 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. During FY 2014, TCE was detected below its MCL in the March sample and at approximately four times the MCL in the June and August samples. Arsenic was detected at 7.3 µg/L in the November 2013 sample but was not detected in any of the other three samples collected during FY 2014. Alpha activity was detected at 2.26 pCi/L in the June sample and the highest detected beta activity was 11.3 pCi/L measured in the June sample. Technetium-99 was detected in all the samples collected during FY 2014, with the maximum detected activity of 21.4 pCi/L, which is much lower than the 900 pCi/L drinking water standard for this radionuclide. Uranium-234 and ^{238}U were detected at less than 1 pCi/L.

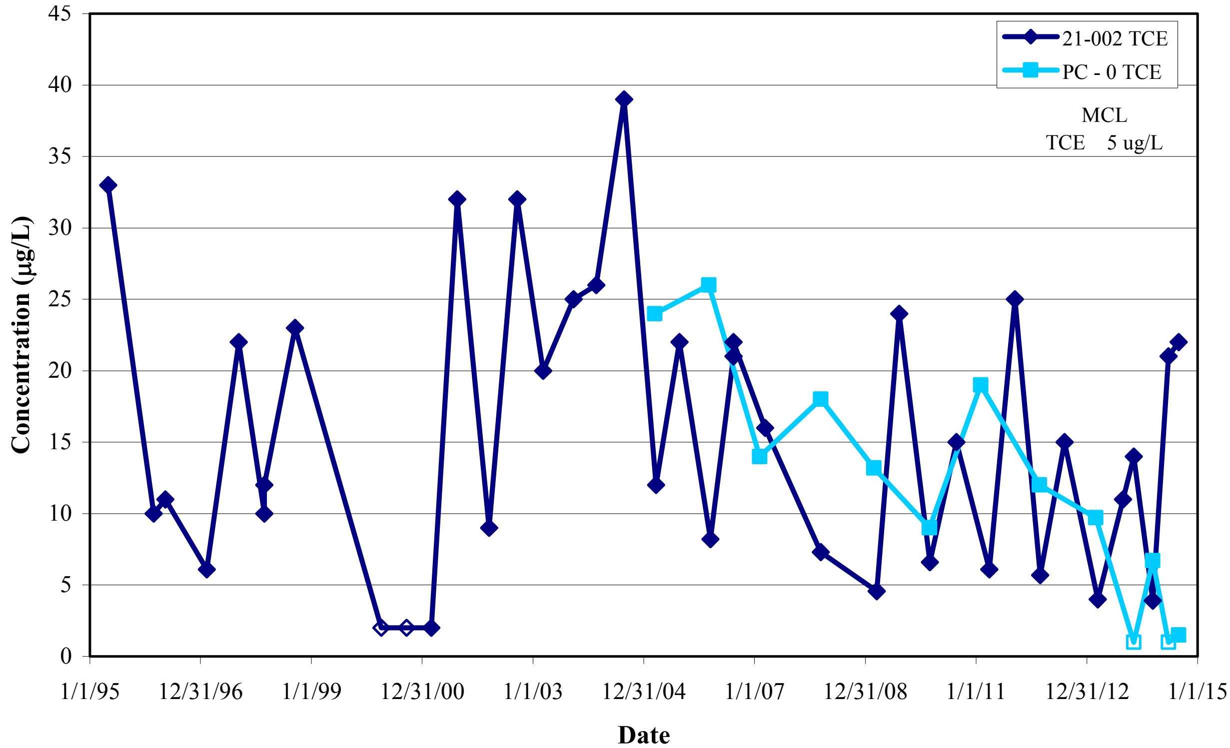


Figure 8.41. TCE concentrations in K-901 area springs.

K-770 area – 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 (Figure 8.37). Measured alpha and beta activity levels were below screening levels during FY 2014 except for the August beta activity in well UNW-013, which was 57 pCi/L. Figure 8.42 shows the history of measured alpha and beta activity in this area. Historic 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. Much lower alpha and beta activity levels have been measured in well UNW-015 since sampling was resumed in FY 2013 following an interruption in sampling during site remediation activities.

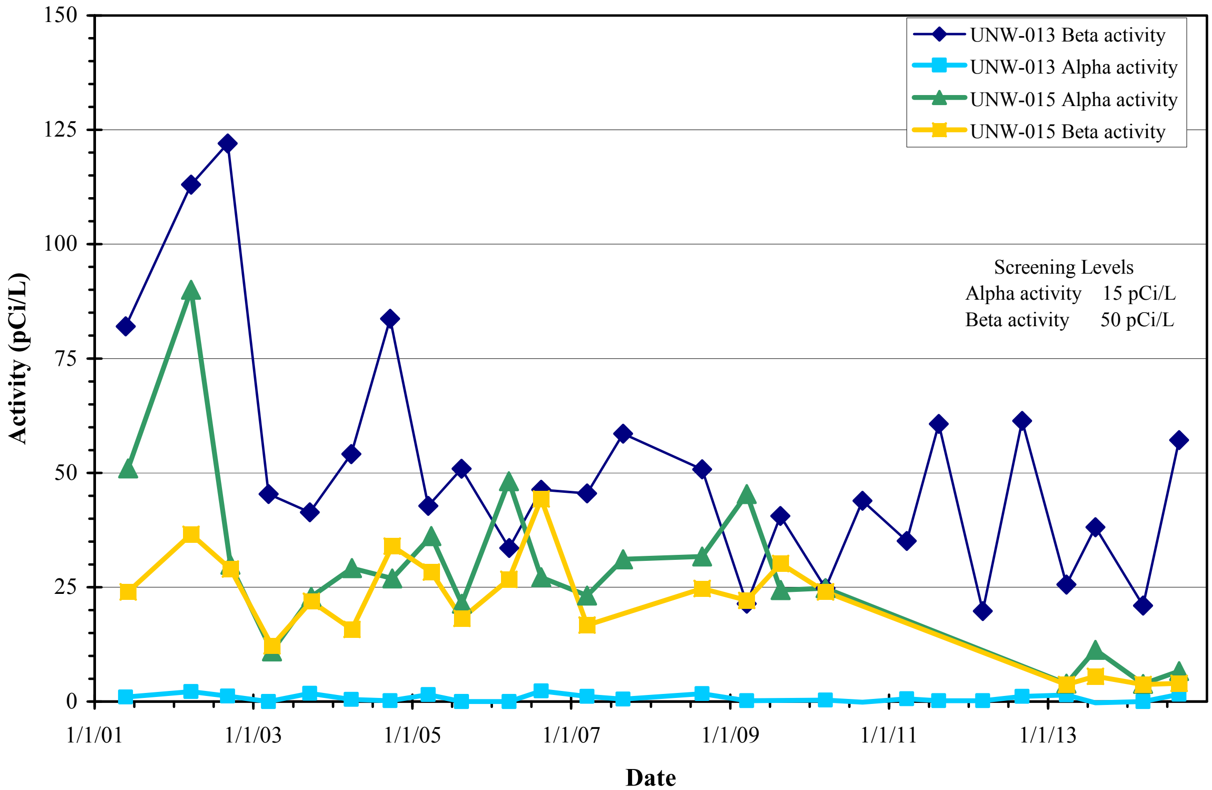


Figure 8.42. History of measured alpha and beta activity in the K-770 area.

8.6.3 Technetium-99 in ETTP Site Groundwater

During FY 2014, a Removal Site Evaluation (RmSE) was performed to assess the potential threat to human health and the environment from the elevated ^{99}Tc levels observed in groundwater, storm water, and sanitary sewage during demolition of the K-25 Building. Background information about the behavior of ^{99}Tc in the environment and a summary of groundwater sampling to evaluate levels at ETTP are provided below. Other media sampling results are discussed in Section 8.6.4.5.

8.6.3.1 Background

Environmental fate of some metal contaminants in groundwater is strongly dependent on the pH and redox state of the water. A summary review of the environmental behavior of ^{99}Tc in the environment was published by Pacific Northwest National Laboratory (PNNL; PNNL-15372) related to tank wastes at Hanford. Background information from that report is used in preparation of the following interpretation of potential ^{99}Tc mobility in groundwater at the ETTP site.

Under electrochemically oxidizing conditions technetium forms the negatively charged pertechnetate ion (TcO_4^-) with technetium assuming a valence of 7^+. The pertechnetate ion is quite mobile in aqueous settings since negatively charged ions do not tend to adsorb to mineral surfaces in soil or rock which inherently tend to have negatively charged to neutrally charged surfaces. Under electrochemically reducing conditions the pertechnetate ion is not stable and technetium may assume a 4^+ valence. In the 4^+ valence state technetium may form ionic combinations with oxygen and hydroxyl groups, which may be amorphous solids with lower solubility's than the pertechnetate ion. In the 4^+ valence, in the absence of complexing ligands, technetium may adsorb to mineral and organic matter surfaces, and may become bound in low solubility technetium oxyhydroxides. In the 4^+ valence, technetium may also form soluble complexes with carbonate/bicarbonate ions as well as sulfate. Thermodynamic and directly measured speciation and solubility relationships for technetium carbonate and sulfate complexes have not been established, although these complexes may be important to technetium mobility in reducing electrochemical environments.

In addition to standard physical chemical conditions, microbial processes are important as potential mediators that can lead to reduction of technetium from the highly soluble and mobile 7^{+} valence in the pertechnetate ion to the 4^{+} valence in the lower solubility forms. Microbial processes often occur in very localized regions in the subsurface where chemical conditions are favorable. This fact is evident in groundwater at the ETTP site where intrinsic microbial communities are known to slowly degrade chlorinated organic compounds in some areas but not in other areas. Factors that may favor microbial reduction of dissolved compounds include relatively slow groundwater movement, which limits influx of dissolved oxygen via groundwater recharge; presence of organic carbon that can serve as electron donor material; and presence of microbes capable of affecting the required molecular transformations.

8.6.3.2 ETTP Site Groundwater Electrochemistry and General Chemistry

Data from groundwater, spring, and surface water sampling and analyses conducted at the ETTP site as part of the ETTP Water Quality Program (EWQP) during FY 2014 have been reviewed for parameters pertinent to understanding the potential for ^{99}Tc mobility in site groundwater. During collection of all groundwater samples at ETTP, field measurement of pH and redox potential are made and recorded. The field measurements of pH and redox potential from all groundwater, spring, and surface water samples collected in FY 2014 have been plotted and superimposed over the technetium Eh-pH diagram excerpted from the PNNL report (Figure 8.43). Individual data points are posted for samples analyzed for ^{99}Tc and the detection/non-detection status is indicated by symbol color. As shown, some of the locations where ^{99}Tc was detected had Eh – pH conditions that plot below the pertechnetate ion stability field. Review of turbidity data from those sampling events at those locations indicates the presence of turbidity ranging from 1 ntu (Spring 21-002) to 307 ntu (UNP-008). Although filtered samples were not collected and analyzed to verify particle association of ^{99}Tc, the presence of some level of turbidity suggests the possibility that at least a portion of the ^{99}Tc was adsorbed to solids in the samples. The data shown on Figure 8.43 suggest that ^{99}Tc is quite mobile in site groundwater.

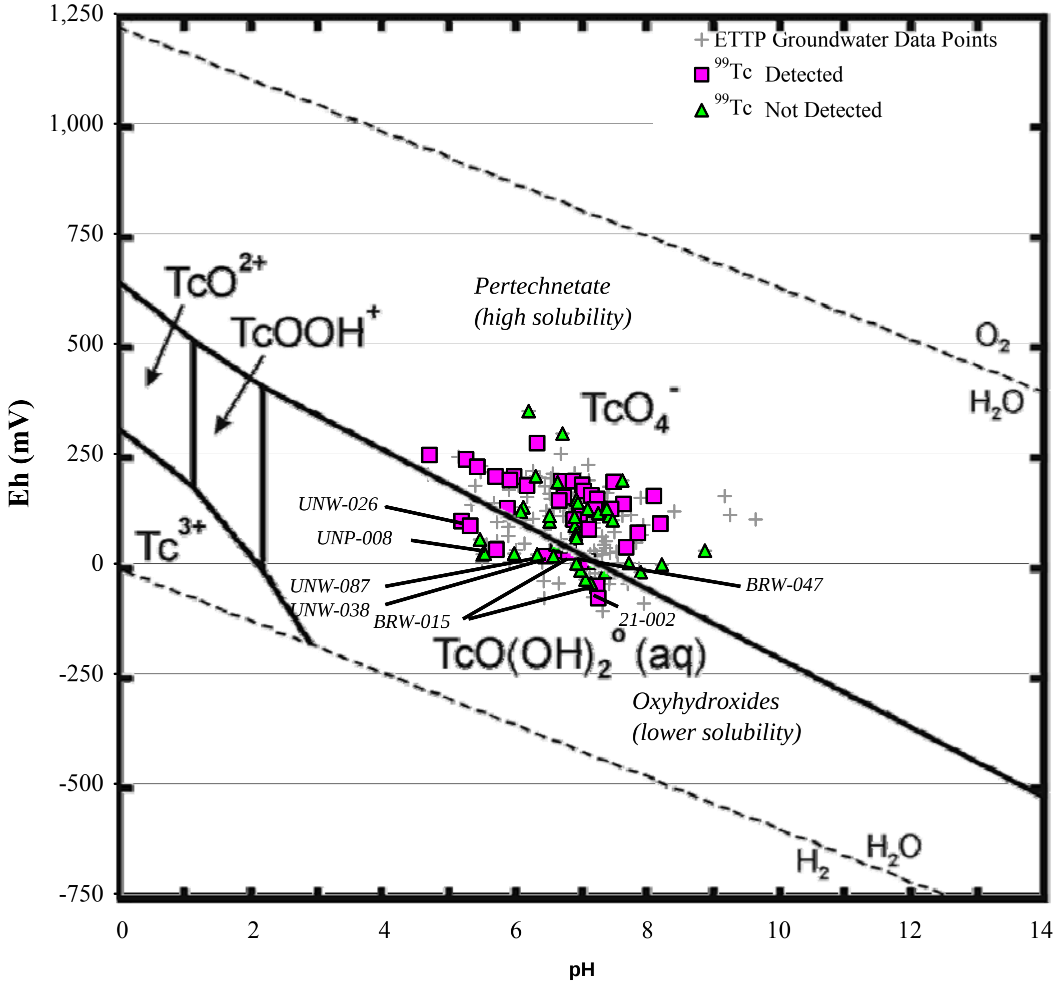


Figure 8.43. Eh – pH region in which ETTP groundwater, spring water, and surface waters lie in relation to the technetium Eh – pH speciation regions at 25º C and 900 pCi/L ^{99}Tc.

In addition to physicochemical data, major dissolved anions including bicarbonate, carbonate, and sulfate are measured on a subset of groundwater samples. Bicarbonate concentrations ranged from a low of 5 mg/L in well BRW-118 which monitors groundwater in the siliceous bedrock of the lower Rome Formation near Highway 58, to a high of 290 mg/L in well BRW-003 which monitors groundwater in the limestone-rich Chickamauga Group within Zone 2. The bicarbonate concentration in site groundwater samples averaged about 110 mg/L. Sulfate concentrations ranged from a low of not detectable at well UNW-121 that monitors groundwater in the soils at the K-1070-A site to a high of 98 mg/L at well BRW-017 that monitors groundwater in bedrock in a portion of the Chickamauga Group. Sulfate concentrations averaged about 16 mg/L in site groundwater. These data indicate that ^{99}Tc could form soluble complexes with bicarbonate and sulfate ions under some conditions that would allow contaminant mobility via groundwater transport.

Much of the ETTP physicochemical data suggests that ^{99}Tc mobility would generally be fairly high. Under this condition, dilution and dispersion processes during groundwater transport would be the only concentration reduction processes that would reduce ^{99}Tc activities since adsorption of pertechnetate ion is negligible. Site groundwater chemical and microbial conditions in some areas may provide attenuation processes that will reduce ^{99}Tc geochemical mobility in the groundwater system. If ^{99}Tc is present where these conditions occur, these processes would be additive to dilution and dispersion processes expected to reduce contaminant levels with increasing transport distances.

8.6.3.3 Distribution of ^{99}Tc in ETTP Site Groundwater

Technetium-99 has been known to occur in groundwater at the ETTP site for many years. The MCL-DC for ^{99}Tc is 900 pCi/L. Various phases of RIs have sampled and analyzed for ^{99}Tc in groundwater. In the past, the highest ^{99}Tc activity levels (as high as 6,000+ pCi/L) of have been observed beneath the K-1070-A burial ground. The area along Mitchell Branch near the former K-1407 Ponds has residual ^{99}Tc contaminated groundwater from the operational era of the ponds, and possibly from K-1420, with much lower activity levels (< 100 pCi/L).

During demolition of the K-25 East Wing in the winter of 2014, fugitive dust suppression misting and rainfall carried ^{99}Tc off the work area. Contaminated runoff apparently percolated through soil and into subsurface utility lines and probably into backfill surrounding the buried utilities. Groundwater sampling for ^{99}Tc was increased in wells in the general vicinity of the East Wing and where wells were available along potential groundwater transport pathways. Figure 8.44 shows groundwater sampling locations where ^{99}Tc was analyzed along with maximum detected levels, where detected. The area where detected ^{99}Tc is highest is in the vicinity of wells UNP-008, BRW-015, UNW-026. These wells are located near the K-1413 Neutralization Pit Facility. Prior to the K-25 East Wing demolition ^{99}Tc was not detected in these wells. The conceptual model that explains the elevated ^{99}Tc in that area is that percolation water from the contaminated slab area probably entered the backfill around the electrical duct bank and other utilities that run north-south along the east side of the building. Rapid transport along these utilities must have carried the high concentrations of ^{99}Tc into the vicinity of these wells. Multiple samples from the wells near K-1413 have been collected for ^{99}Tc analysis. At well UNW-026 ^{99}Tc was measured at 8,760, 16,200, and 7,860 pCi/L in February, April, and September, respectively. At UNW-027 the ^{99}Tc activities were 17.3, 81, and 10.3 pCi/L in February, April, and September. Well UNP-008 was sampled in April and September with results of 13,900 and 24,000 pCi/L, respectively. Well BRW-015 was also sampled in April and September with activities of 105 and 1,580 pCi/L, respectively. These data indicate much lower levels in groundwater in bedrock than in the groundwater at the base of the unconsolidated zone just above the bedrock surface.

The plume trajectory for ^{99}Tc from this area has been evaluated based on hydraulic gradient direction as well as from temporal changes in ^{99}Tc activities. The result of this evaluation indicates that the plume trajectory is to the northeast through well UNW-089 and on toward well UNP-005 that is located very near to Mitchell Branch. At well UNW-089 the ^{99}Tc activities were non-detect at 9.86 pCi/L in February with a result of 408 pCi/L in September. As indicated by the piezometric surface shown on Figure 8.44, there is a trough in the water table surface that is formed in a now filled valley that leads from the K-1413 area northward toward Mitchell Branch. The inset box in Figure 8.44 shows an inferred plume trajectory arrow from the contaminated area near K-1413 toward UNP-005. At well UNP-005 low levels of ^{99}Tc have been detected biannually with previous results of 12.8 pCi/L in August 2010 and 7.6 pCi/L in September 2013. Technetium-99 has also been detected intermittently in groundwater in wells UNW-003 and BRW-047 further east along Mitchell Branch. The levels in well UNW-003 have fluctuated in the range of about 10 – 50 pCi/L since reliable ^{99}Tc analytical data became available in 1998. A single sample result is available from well BRW-047 which contained about 45 pCi/L of ^{99}Tc. It is also noted that during construction activities in the 1940's and 1950's the culverts for the SD-190 network were laid in the pre-existing valley beneath the contour fill. Infiltration of ^{99}Tc plume water into the SD-190 culvert is expected. Groundwater sampling and analysis for ^{99}Tc in all the wells where it has been detected as shown on Figure 8.44 will continue.

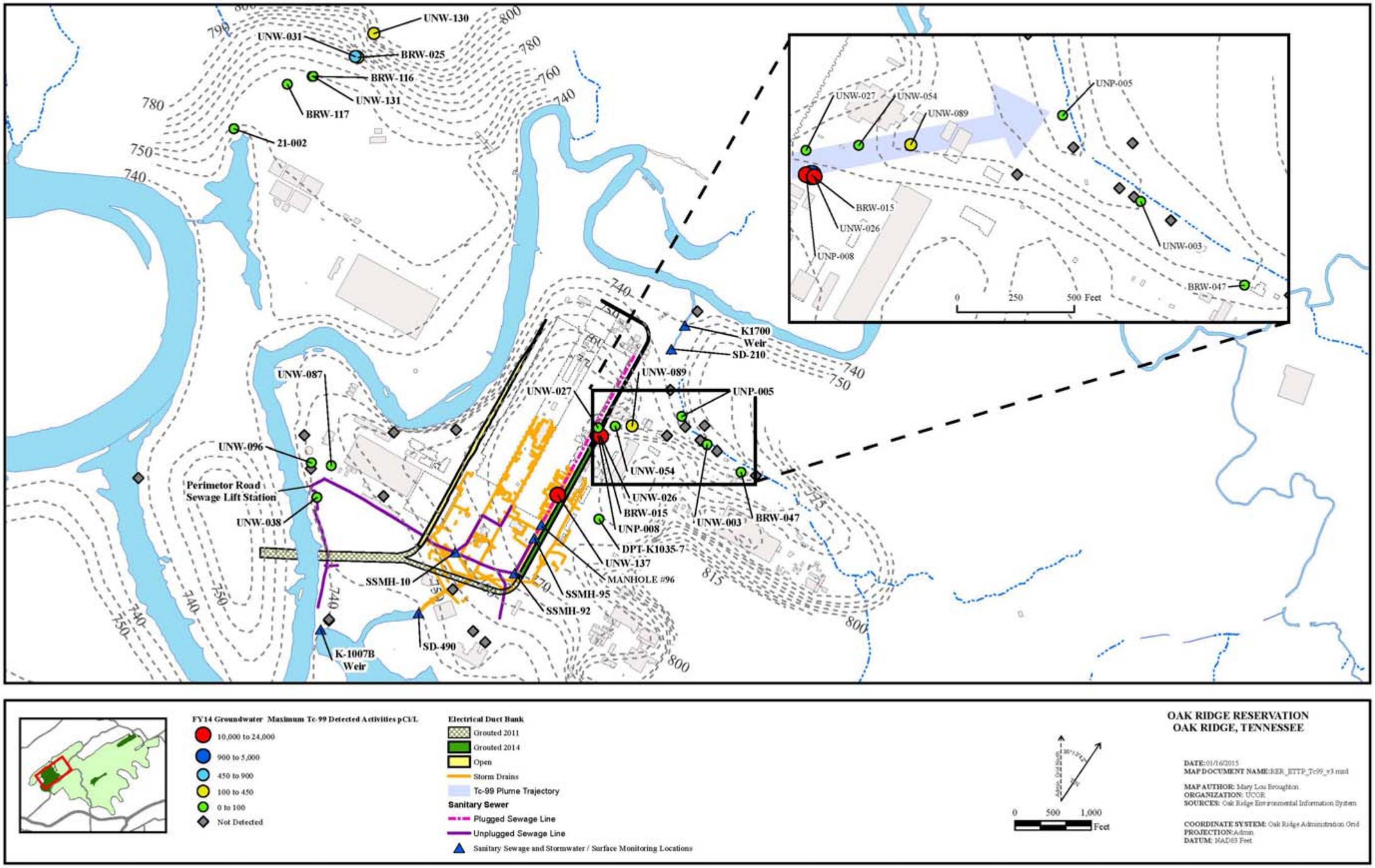


Figure 8.44. Sample locations and maximum detected ^{99}Tc in ETTP groundwater.

8.6.4 Surface Water

Surface water monitoring is conducted at 12 locations (Figure 8.45) to monitor exit pathway watershed integration points (K-1700 weir, K-1007-B weir, and K-901-A Holding Pond weir); adjacent off-site ambient in-stream conditions (Clinch River kilometer [CRK] 16; CRK 23; K-1710; K-716; K-702-A); and on-site Mitchell Branch in-stream locations MIK 0.4, 0.59, 0.71, and 1.4). Surface water sample collection activities on the Clinch River and at Mitchell Branch are shown in Figure 8.46.

A summary of the results for radionuclides, VOCs, chromium, mercury, and ^{99}Tc follows.

8.6.4.1 Radionuclides

Samples were collected and analyzed for radionuclides either quarterly (K-1700 and MIK 1.4) or semiannually (K-716, K-901-A, K-1007-B, K-1710, CRK 16, and CRK 23), and the results are compared with the DCSs from DOE Standard DOE-STD-1196-2011. Radiological data are reported as fractions of the DCSs. If the sum of DCS fractions for a location exceeds a screening level of 4% of the DCS for the year, a source field investigation is conducted to determine if there are changing conditions within the watershed that are leading to increased radiological discharge levels. The FY 2014 monitoring results are summarized in Figure 8.47. All results were below the 4% of the DCS screening threshold in FY 2014.

8.6.4.2 VOCs

The primary VOC detected in samples from Mitchell Branch is TCE. Figure 8.48 illustrates the concentrations of TCE at the Mitchell Branch K-1700 weir, which is the only surface water monitoring location where VOCs are regularly detected. Concentrations of TCE ranged from 17 µg/L to 27 µg/L in samples collected in FY 2014. These levels are well below the AWQC for TCE (300 µg/L). Other VOCs such as 1,2-DCE are measured well below the applicable standards. VOCs have been detected in groundwater in the vicinity of Mitchell Branch and in building sumps discharging into storm water outfalls that discharge into the stream. However, SD network monitoring generally has not detected these compounds in the storm water discharges at levels higher than those in the stream. Therefore, it appears that the primary source of these compounds is contaminated groundwater. The concentrations of VOCs detected in surface water at the K-1700 weir were also screened for aquatic toxicity against equilibrium partitioning benchmarks using the sum toxic unit approach. Concentrations of individual compounds and a mixture of the detected VOCs were well below these benchmark values for potential surface water toxicity.

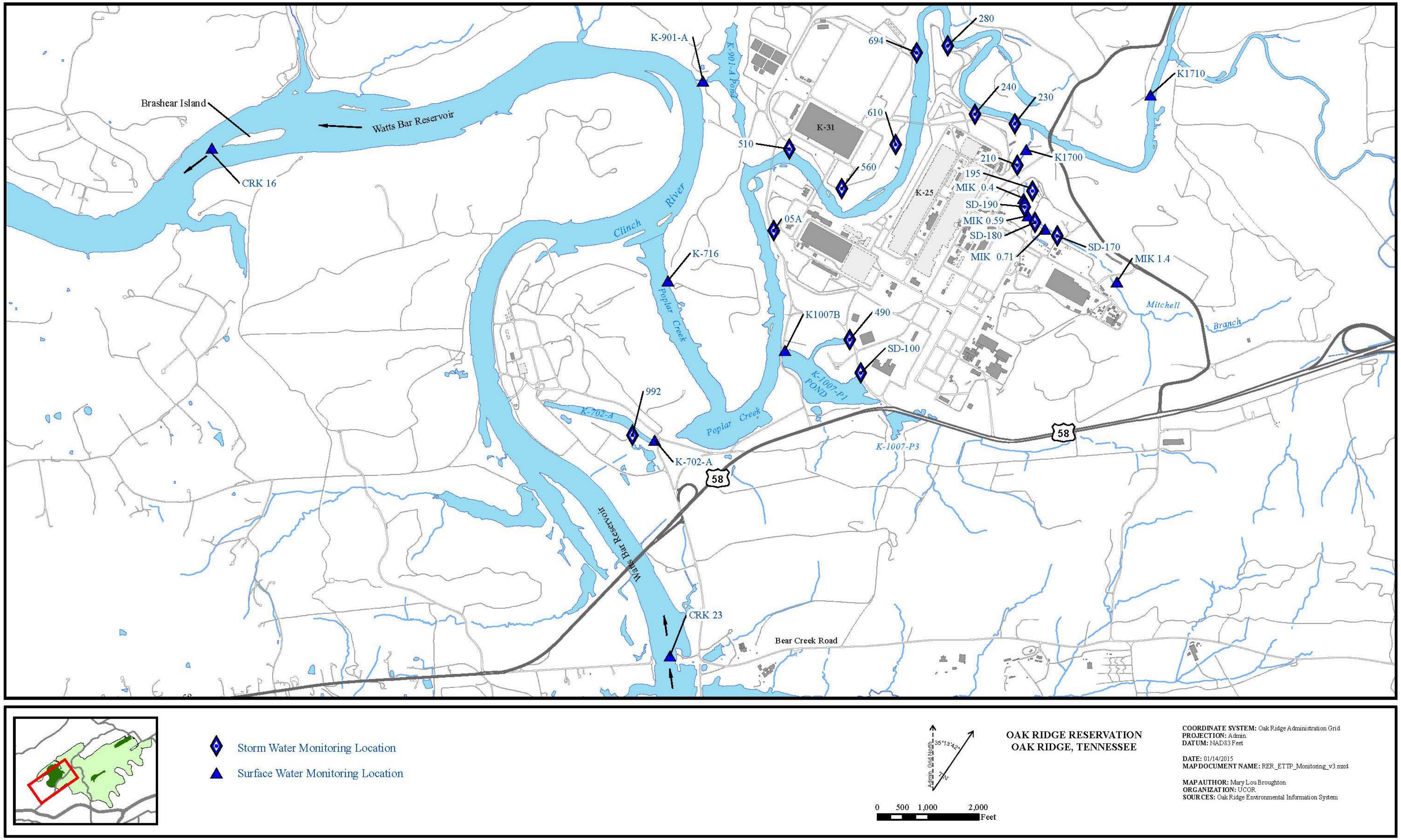


Figure 8.45. Surface water monitoring locations.

This page intentionally left blank.

Figure 8.46. Surface water sample collection on the Clinch River (top) and at Mitchell Branch (bottom).

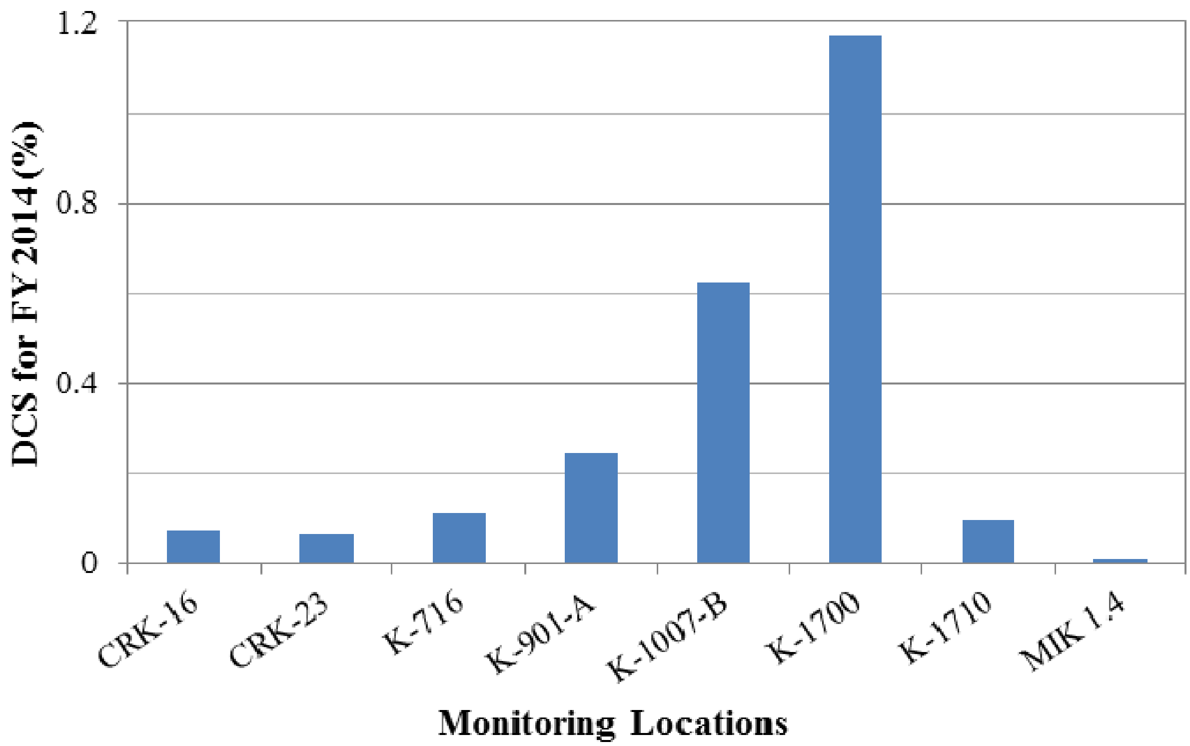


Figure 8.47. Percentage of DCSs at surface water monitoring locations.

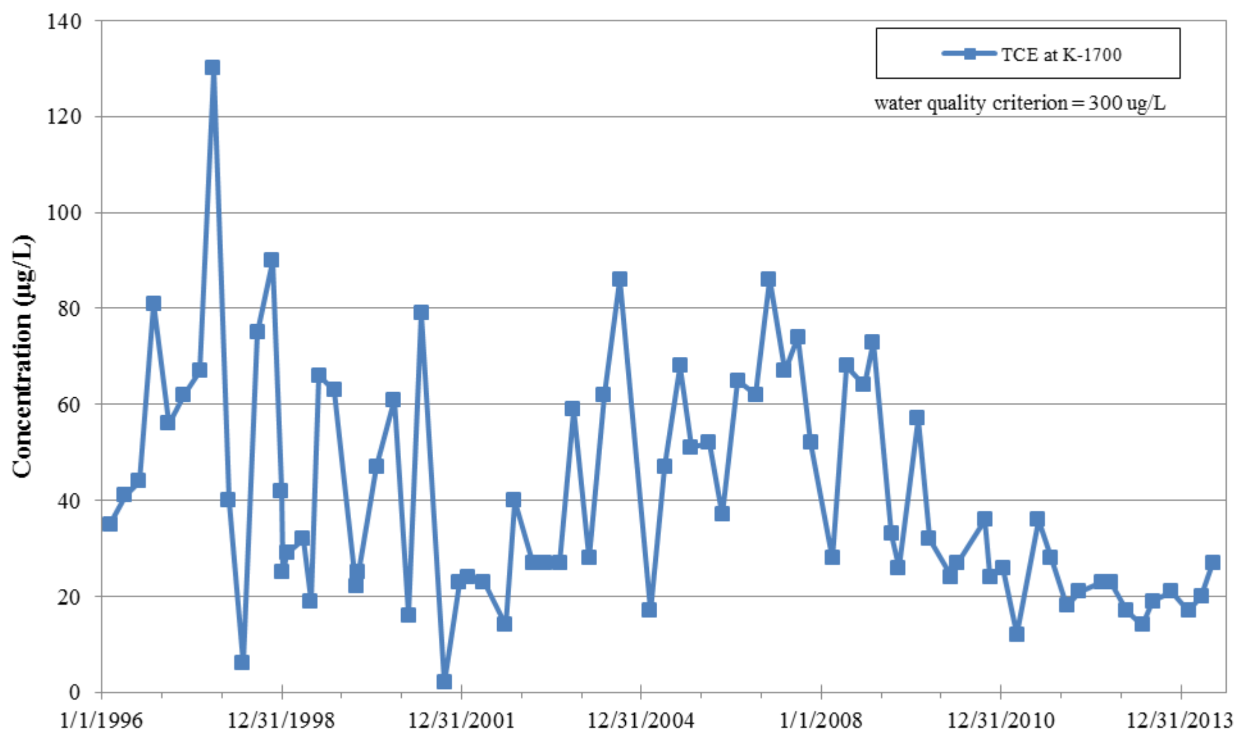


Figure 8.48. TCE concentrations at K-1700 weir.

8.6.4.3 Chromium

A detailed review of the Mitchell Branch Chromium Reduction CERCLA action is provided in Section 8.4.5 and includes the time period of FY 2007 and FY 2008 when levels of chromium were above the AWQC for hexavalent chromium (11 µg/L) prior to the groundwater collection system being installed in FY 2008. A summary of the long term trend measurements of total chromium at the Mitchell Branch K-1700 weir over the past 18 years (Figure 8.49, 1996 through 2014) for periods before and after the Chromium Reduction CERCLA action have been shown to be generally less than the AWQC for hexavalent chromium (11 µg/L) or, in some instances, at non-detectable levels. Results from routine surface water monitoring conducted in the spring of 2007 indicated that chromium levels had increased above the AWQC. After an extensive CERCLA investigation (as discussed in previous sections) a chromium groundwater collection system was installed to pump contaminated groundwater from the vicinity of Outfall 170 for treatment. Since this system was installed, chromium levels in Mitchell Branch have dropped dramatically. In FY 2014, levels of total chromium ranged from 1.9 µg/L to 2.3 µg/L at the K-1700 weir. Hexavalent chromium was not detected in any of the samples collected from the K-1700 weir in FY 2014.

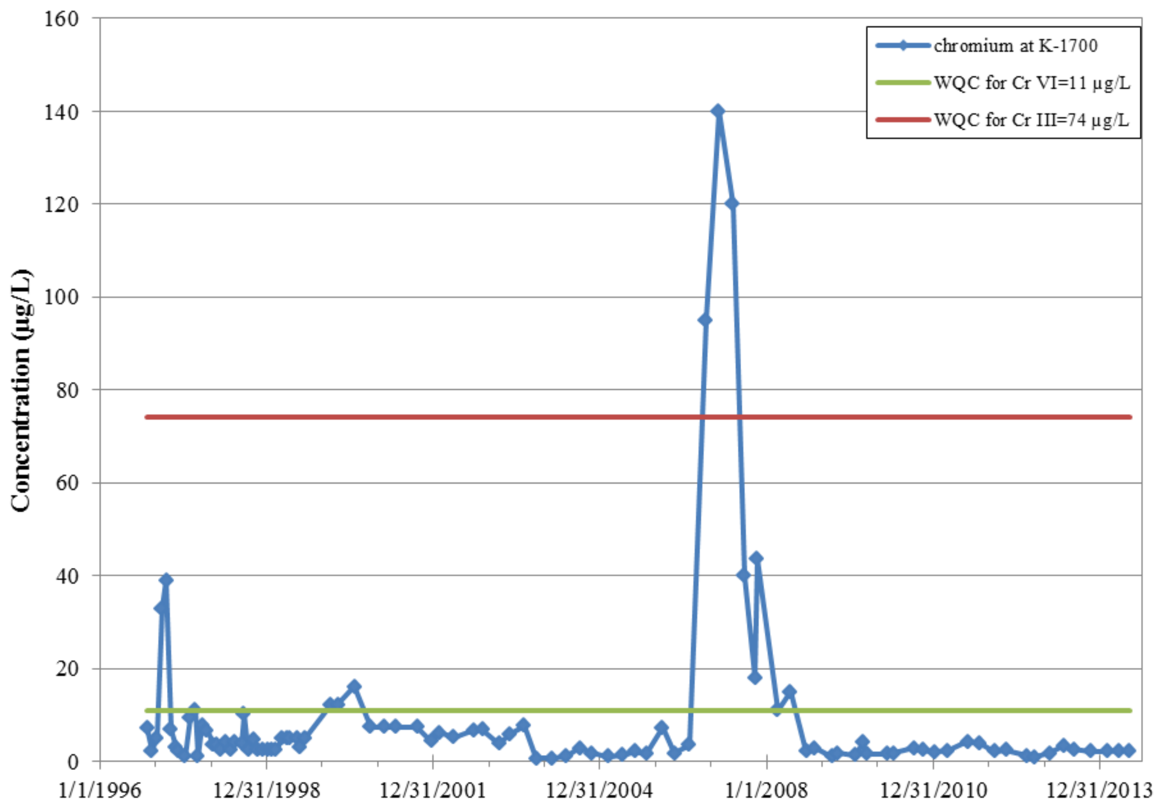


Figure 8.49. Total chromium concentrations at K-1700 weir.

8.6.4.4 Mercury

The current ETTP NPDES storm water permit was issued on February 26, 2010, with an effective date of April 1, 2010. During the storm water outfall characterization efforts to complete the storm water permit renewal application, lower mercury detection level laboratory methods became more commercially viable and were integrated into the ETTP NPDES Program. As a result, mercury was identified as a constituent of concern at outfalls in several subwatershed locations as compared to the AWQC for mercury, which is 51 ng/L.

In particular, four storm water Outfalls – 05A, 170, 180, and 190 (Figure 8.45) – were identified as outfalls that would be monitored as a requirement of the NPDES Permit on a quarterly frequency. The requirement in the current NPDES permit is to monitor and report mercury without a compliance regulatory limit because the sources of the mercury releases are historical legacy operations to be addressed under CERCLA.

Information on the sources of mercury releases that is obtained through the ongoing NPDES SWPP Program will support the CERCLA investigation and any required cleanup actions that follow. There are no current ETTP operations where mercury is routinely used, so the SWPP Program monitoring is to assess potential mercury releases from legacy sources. Historical operating areas where mercury was present include areas where instruments such as manometers and thermometers may have been utilized; laboratory, mercury recovery operations; and instrument maintenance shops. The investigation effort includes mercury sampling at catch basins within the outfall networks to determine at what point in the network mercury begins to be present in the system.

Mercury – Mitchell Branch Subwatershed Trend Results – Storm water Outfalls 170, 180, and 190 discharge to Mitchell Branch. The sampling results since April 1, 2010 (when mercury became a quarterly monitored NPDES parameter) are shown in Figure 8.50.

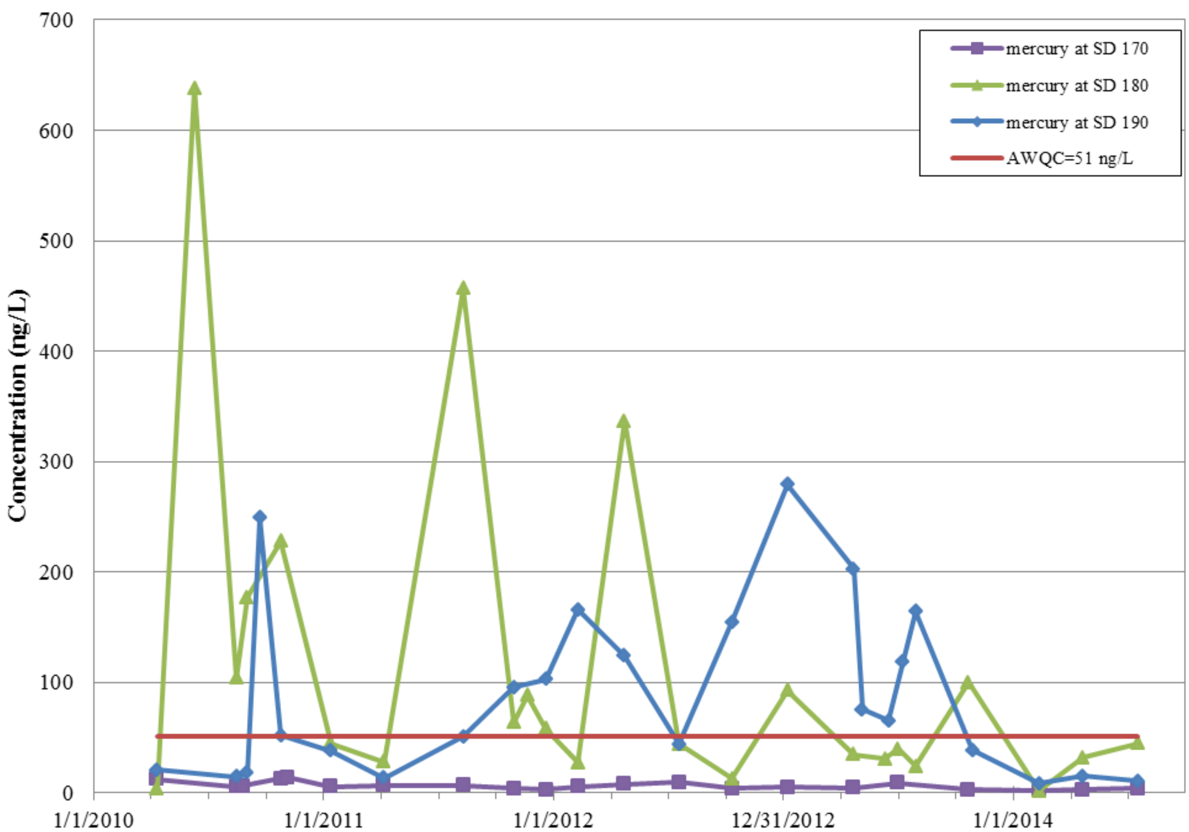


Figure 8.50. Mercury concentrations at SD-170, SD-180, and SD-190.

The trends from the three outfalls show mixed results over the last five years. The SD-170 drainage area discharges have not exceeded, or even approached, the AWQC level of 51 ng/L over the last five years. In contrast, SD Outfalls 180 and 190 continue to periodically discharge mercury at levels greater than the AWQC level. Network investigations indicate the following:

- Most of the mercury in the Outfall 180 drainage system appears to be entering the system below the last manhole in the network or may have been transported into the piping between the last manhole and the outfall as a result of past storm events and is likely to be trapped in the network sediments.

- Historical activities that were once conducted in K-1401 and K-1035 are likely to be the primary contributors of mercury into the Outfall 190 drainage system and are the source of contaminated sediments within the network.

In addition to analytical data from Outfalls 170, 180, and 190, analytical data from the in-stream Mitchell Branch K-1700 weir has also been evaluated as noted in Figure 8.51. Figure 8.51 presents analytical results from the K-1700 weir from 2010 to 2014. From March of 2010 through 2012, the mercury results in Mitchell Branch frequently exceeded the AWQC level of 51 ng/L. However, mercury levels were not measured above the AWQC level at K-1700 in FY 2014.

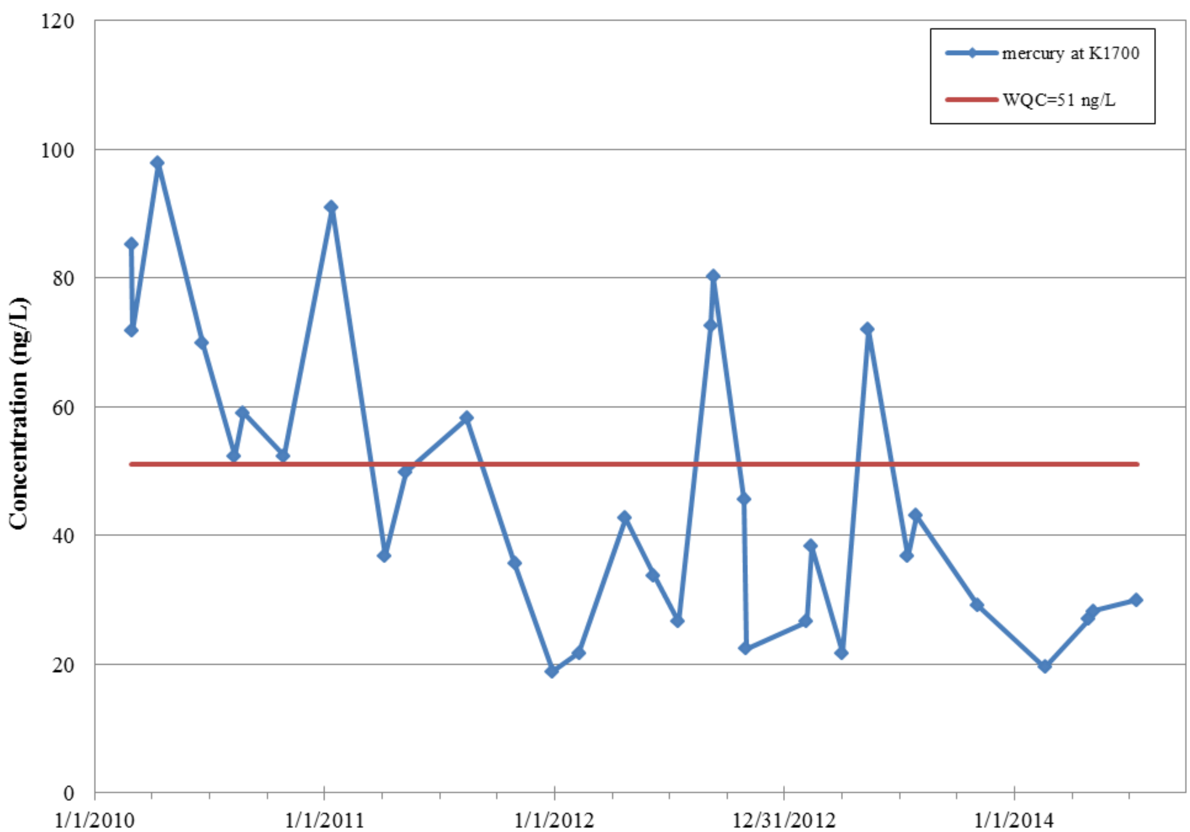


Figure 8.51. Mercury concentrations at Mitchell Branch in-stream sampling location K-1700.

An investigation of the analytical results from K-1700 has indicated that the in-stream concentrations begin to increase downstream from storm water Outfalls 180 and 190. However, additional increases of in-stream mercury water concentrations further downstream from these two outfalls have also been observed. In-stream mercury levels continue to increase to the final Mitchell Branch K-1700 exit pathway sampling point. These same downstream increasing trends have also been measured in other sampling media such as sediment and clam tissue analysis. Mercury has also been measured in fish tissue sampling in the downstream locations. The mean mercury concentration in sunfish fillets in 2014 was calculated at 0.46 mg/kg, which is above EPA's recommended criterion of 0.3 mg/kg for mercury in fish. The potential source of the legacy mercury being measured in Mitchell Branch downstream from Outfalls 180 and 190 may be attributable to seeps, legacy sediment deposits within the stream, and other downstream storm water outfall contributions.

A review of mercury results in Poplar Creek showed one result that was above the AWQC value during FY 2014 at the downstream K-716 location. Mercury levels were not measured above the AWQC level at the upstream Poplar Creek K-1710 location in FY 2014.

Mercury – Sitewide SWPP Program Investigations – In addition to the specific outfall sampling requirements from the NPDES Permit for the four quarterly locations (05A, 170, 180, 190), monitoring was performed as part of the FY 2014 SWPP Program to evaluate mercury discharges from a number of storm water outfalls in other subwatersheds across the ETTP site. The SWPP Program sampling effort included wet weather sampling in select storm water outfalls, sediment sampling in Mitchell Branch outfalls, and water and sediment sampling in the K-1203 former Sewage Treatment Plant (STP) area. These potential sources were further investigated in FY 2014 to support future CERCLA investigation and cleanup actions. The additional outfalls sampled in FY 2014 included Outfalls 100, 195, 210, 230, 240, 280, 490, 510, 560, 610, 694, and 992. Table 8.7 provides the results of all mercury sampling at the ETTP in FY 2014 that exceeded the AWQC of 51 ng/L (NPDES quarterly and SWPP Program investigations).

Table 8.7. Mercury results from storm water monitoring conducted at ETTP outfalls in FY 2014
(all results in ng/L)

Outfall	10/13	2/14	4/14	7/14	9/14
05A	223*	78*	208*	238*	
180	100*				
190	59*[a]				
694					910

*NPDES compliance sample.
[a]Sample was collected on 10/28/13. Figure 8.50 does not show a result of 59 ng/L for Outfall 190 on this date because a duplicate sample was also collected from Outfall 190 on 10/28/13. The result of the duplicate sample was 18 ng/L. Figure 8.50 shows the average of the regular sample and duplicate sample results (38.5 ng/L).

ETTP = East Tennessee Technology Park
FY = fiscal year
NPDES = National Pollution Discharge Elimination System

No results for Outfalls 100, 170, 195, 210, 230, 240, 280, 490, 510, 560, 610, or 992 are shown in Table 8.7 because no mercury results at these locations were measured above the AWQC of 51 ng/L during the SWPP Program investigations that were conducted in FY 2014. NPDES Permit quarterly sampling results greater than 51 ng/L were noted at Outfall 180 on one occasion and at Outfall 190 on one occasion in samples collected in FY 2014.

Mercury – NPDES STP Outfall 05A Trend Analysis – In accordance with the NPDES Permit, Outfall 05A is sampled for mercury on a quarterly frequency. Outfall 05A discharges directly to Poplar Creek. The trend results for mercury measurements at Outfall 05A are shown in Figure 8.52.

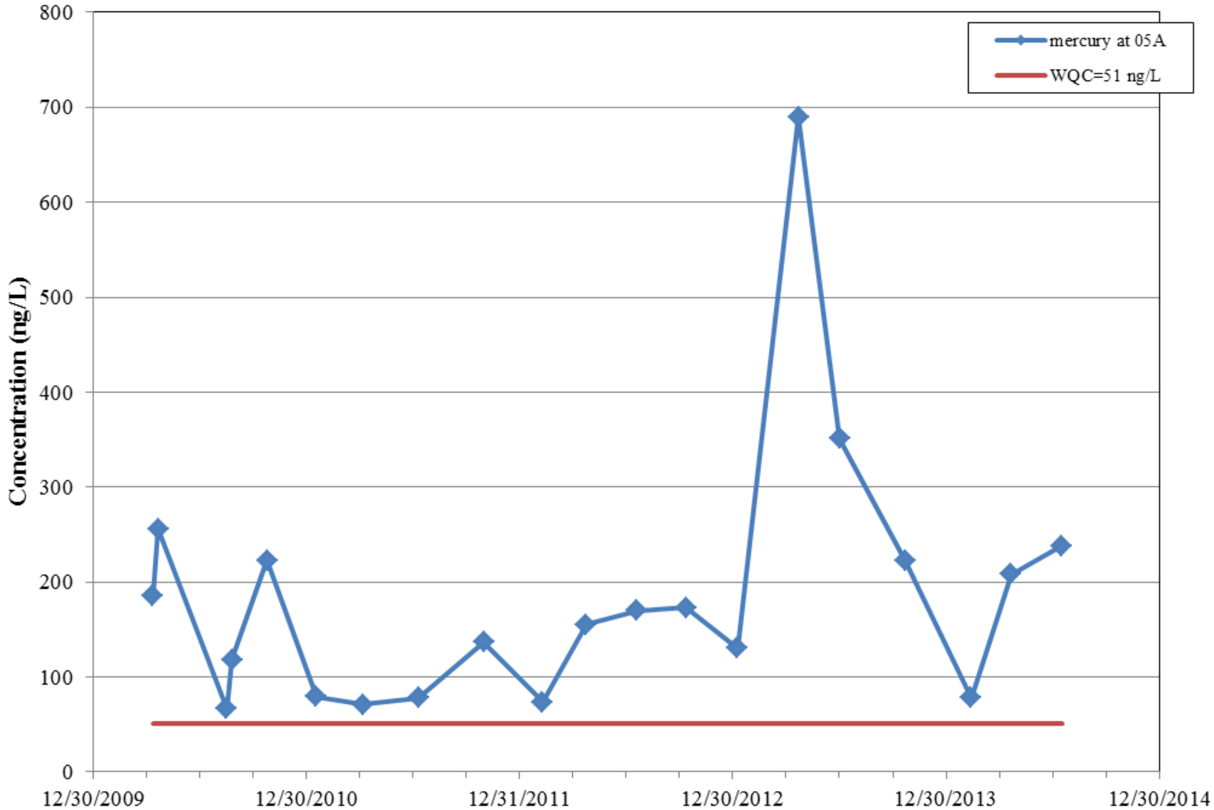


Figure 8.52. Mercury sample results for storm water Outfall 05A discharge to Poplar Creek.

The mercury results for Outfall 05A have been in a range between 65 and 256 ng/L from 2006 until the quarterly sampling events in April and July of 2013 when higher levels (690 ng/L and 351 ng/L, respectively) were measured. The K-1203-10 collection sump is the location where NPDES permit compliance samples for storm water Outfall 05A are collected. Repairs to the K-1203-10 sump pump were conducted shortly before the elevated mercury readings were noted. Sediments in the sump may have been agitated during these repairs, causing the elevated results. Following the higher results for the last two quarters of FY 2013, results from FY 2014 were similar to historical trends.

Mercury – STP Outfall 05A SWPP Program Investigations – Storm water Outfall 05A receives storm water runoff from a subwatershed that is limited to the inactive K-1203 STP footprint. The K-1203 STP was shut down as an active treatment unit in 2008. Sewage generated from current DOE operations and commercial entities located at the ETTP site is collected and pumped to the City of Oak Ridge Rarity Ridge STP.

Storm water sheet flow in the K-1203 STP footprint migrates to a low elevation point in the subwatershed at the K-1203-10 collection sump. The water from this sump is pumped to storm water Outfall 05A which discharges to Poplar Creek downstream from Mitchell Branch. The sump is equipped with an automatic pump that discharges the dry weather base flow that leaks into the inactive facility piping network, the much higher pipe flow volumes that occur during rain events, and the storm water sheet flow runoff from this subwatershed.

The results of historical investigative influent sampling into the K-1203-10 collection sump identified mercury results that are similar to the discharges from the sump to Poplar Creek. The infrastructure piping and equipment at the inactive K-1203 STP were further investigated for the presence of mercury as part of the FY 2014 SWPP Program. Table 8.8 shows the results of sediment sampling conducted in FY 2014 at the K-1203 STP. Sediment samples were analyzed for both total mercury and Toxicity Characteristic Leaching Procedure (TCLP) mercury.

Table 8.8. Mercury results from sediment sampling conducted in the K-1203 STP area in FY 2014

Location	Total Mercury (µg/g)	TCLP Mercury (mg/L)
05A	267	0.00067 U
K-1203 aeration basin	45.8	0.00072 J
K-1203 clarifier	4.67	0.00067 U
K-1203 sludge holding tank	40.1	0.00067 U
K-1203-14 comminutor	6.63	0.00067 U
K-1203-2A East Imhoff tank	6.02	0.00067 U
K-1203-2B West Imhoff tank	36.5	0.00067 U
K-1203-6 sludge drying bed	0.361	0.00067 U

FY = fiscal year
J = indicates result is an estimated quantitation
STP = Sewage Treatment Plant
TCLP = Toxicity Characteristic Leaching Procedure
U = indicates nondetect results

Analytical results from sediment sampling conducted in FY 2014 at the K-1203 STP area show that mercury contamination is present in the sediments in various process treatment units of the inactive STP and at infiltration points into the inactive STP infrastructure pipe network.

The rainwater and shallow groundwater that collects in the surface equipment and infiltrates the subsurface infrastructure network appears to be mobilizing the legacy mercury contamination that enters the K-1203-10 sump prior to the discharge to Poplar Creek through Outfall 05A.

Mercury – Ongoing Monitoring and Future CERCLA Actions

Legacy sources of mercury contamination will be addressed under planned CERCLA response actions. Demolition of the inactive STP (K-1203) and support facilities near Outfall 05A will be performed under the *Action Memorandum for the Remaining Facilities Demolition Project at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2049&D2]). Soil will be remediated in the Mitchell Branch and STP Outfall 05A areas under the *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) and the future Sitewide ROD. In addition, the new NPDES storm water permit for ETTP scheduled for issuance in FY 2015 will specifically require additional investigative monitoring for and emphasis on mercury. This additional monitoring will support these ongoing and future CERCLA actions. This closes an issue identified in Table 8.9. During the interim period prior to future CERCLA actions, S&M operations will be conducted in a manner to minimize any disturbances that could increase releases.

8.6.4.5 Technetium-99 Sampling Investigation

The conclusion of the *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1) indicates the measured levels of ^{99}Tc in site surface water releases are in compliance with applicable regulatory requirements and DOE Orders and do not pose a threat to human health and the environment. A summary of the groundwater sampling to evaluate the ^{99}Tc levels was discussed in Section 8.6.3. The discussion that follows describes the other media sampling results for FY 2014.

Storm Water

Elevated levels of ^{99}Tc were first observed at storm water Outfall 490 in November 2013. The concentration of ^{99}Tc at this location ranged from 1,300 pCi/L to a high value of 59,200 pCi/L. As the storm water controls were modified and the waste was removed from the demolition pad, the measured results declined to 543 pCi/L at Outfall 490 in April. Outfall 490 discharges into the K-1007-P1 Pond and is the main storm water discharge point from the purge cascade demolition area.

Additional storm water outfalls and surface water locations around ETTP were also sampled as identified in Figure 8.45:

- K-1007-P1 Pond K-1007-B Weir, which feeds Poplar Creek via the K-1007-P1 Pond, was in the range of 203 pCi/L to 2,780 pCi/L, with a result of 218 pCi/L in April.
- Location K-716, which is in the Poplar Creek mixing zone downstream from the K-1007-P1 Pond discharge at the K-1007-B Weir, was 2 pCi/L in February and 4 pCi/L in March 2014, with a result below detection limits in April.
- Outfall 210, which discharges storm water from the northern half of Building K-25 East Wing to Mitchell Branch, ranged from 8 pCi/L to 153 pCi/L, with a result of 87 pCi/L in April.
- Mitchell Branch K-1700 Weir, was 53 pCi/L in February, 32 pCi/L in March 2014, and 40.7 in April.

The ^{99}Tc storm water discharges in FY 2014 and surface water instream concentrations were below DOE Order annual sum-of-fraction requirements.

Electrical Duct Bank

An employee noticed discolored water seeping from the top of an electrical duct bank manhole cover in the Portal 4 parking lot and discharging to the SD-490 network. An investigation was initiated and water in three electrical duct banks located on the east side of the Building K-25 East Wing were sampled at Row 21. The ^{99}Tc concentrations ranged from 36,456 pCi/L to 293,317 pCi/L. As a result, 38 electrical duct bank manholes as noted on Figure 8.44 associated with Building K-25 were grouted to eliminate flow paths of water. The impacted portion of the Portal 4 parking lot has been decontaminated.

Sanitary Sewer

The sanitary sewer system at Manhole 96 located to the southeast of the demolition area as shown on Figure 8.44, was sampled and the ^{99}Tc concentrations ranged from 3.0 pCi/L to 269,000 pCi/L. Based on these results, all connections to the sanitary sewer system around the Building K-25 demolition area were isolated, and the sanitary sewer trunk line was plugged at Manhole 96.

Sampling of the City of Oak Ridge sanitary sewer line at Manhole 95 that was the next downgradient manhole from the plug was performed in February 2014 with a result 32,579 pCi/L. The influent line to Manhole 95 was then isolated with follow-up sampling completed in March through June 2014, with results that ranged from 3 to 480 pCi/L. Additional sampling was performed in February through September 2014 along the City of Oak Ridge sanitary sewer line and at the City's Rarity Ridge STP that is located west of the ETTP Site Powerhouse area on the opposite side of the Clinch River from the ETTP DOE acreage:

- After the influent pipe to Manhole 95 was plugged, additional downgradient Manholes 92 and 10 were added as surveillance monitoring locations. The range of results between April to September 2014 were 244 pCi/L to 1,410 pCi/L.

- Concentrations at the Rarity Ridge Lift Station #1 declined from 35,900 pCi/L in February to 303 pCi/L in September.

- Concentrations at the Rarity Ridge Effluent Weir declined from 41,383 pCi/L in February to 506 pCi/L in September.

- Concentrations at the Rarity Ridge Biological Treatment Aeration Basins declined from 82,100 pCi/L in February to 53,200 pCi/L in September.

- Concentrations at the Rarity Ridge Digester increased from 522,000 pCi/L in February to 904,000 pCi/L in April. The results then dropped back down to 438,000 pCi/L in September.

- During FY 2014, six tanker shipments of approximately 5,000 gal per tanker of digester sludge were pumped and shipped off-site for treatment as LLW.

The ^{99}Tc sewage treatment network influent concentrations and STP effluent discharges in FY 2014 were both in compliance with DOE Order annual sum-of-fraction requirements.

8.6.5 Aquatic Biology

Long-term trends in PCB accumulation in fish from the K-901-A Holding Pond, the K-1007-P1 Holding Pond, and the K-720 Slough were presented in Section 8.4.2. Other biological monitoring locations at ETTP are shown in Figure 8.53.

Biological monitoring in Mitchell Branch, conducted by the ETTP Biological Monitoring and Assessment Program (BMAP), includes: (1) contaminant accumulation in fish, (2) fish community surveys, and (3) benthic macroinvertebrate surveys (Figure 8.54). Bioaccumulation monitoring for the ETTP BMAP has historically focused on evaluating the impact of PCB discharges into the environment as a result of past operations at the ETTP complex. It was previously assumed that mercury flux into Poplar Creek and the Clinch River originated largely from the Y-12 discharges into East Fork Poplar Creek. However, recent evidence of elevated mercury concentrations in ETTP SD waters has prompted interest in evaluating the mercury inputs to Poplar Creek deriving from ETTP operations. Total mercury has been monitored sporadically over the years in redbreast sunfish fillets at MIK 0.2. Figure 8.55 shows long term trends in total mercury concentrations (µg/g) in these fish. Mercury concentrations in fish were in the 0.1 to 0.2 µg/g over the 1989 – 1991 time period, but then increased to around 0.25 – 0.4 µg/g range in 1992 – 1993 where they have remained until 2014. Mean mercury concentrations in Mitchell Branch sunfish fillets in 2014 (0.46 µg/g) were comparable to those in 2013, remaining above EPA's fish-based recommended AWQC for mercury (0.3 µg/g).

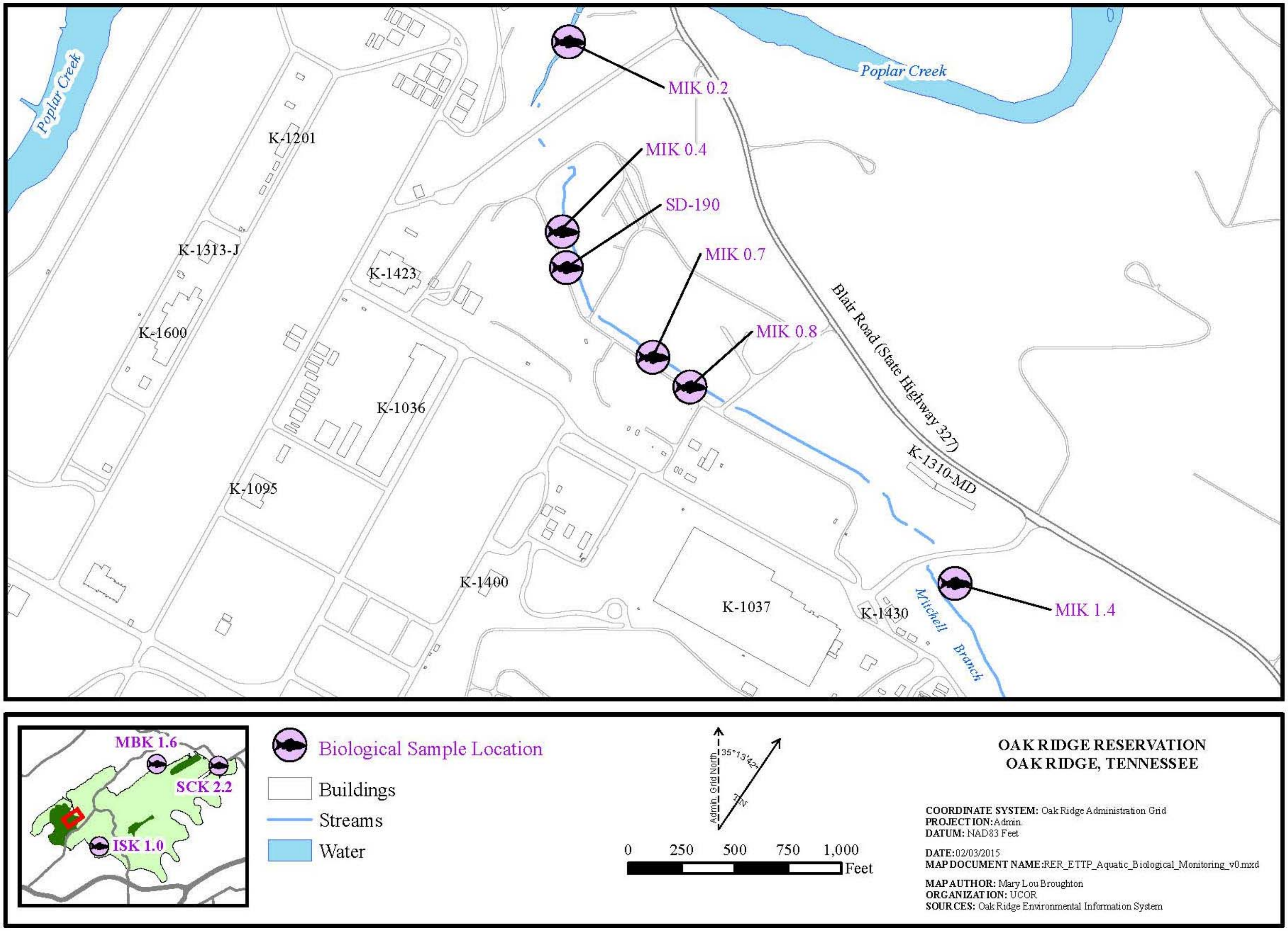
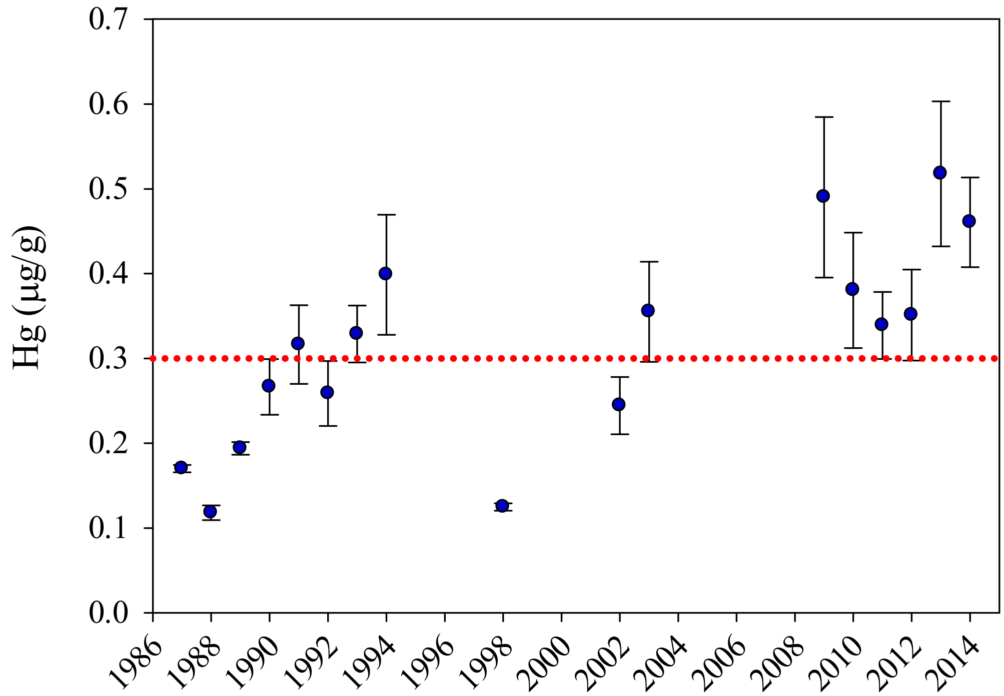


Figure 8.53. Other ETTP biological monitoring

Figure 8.54. Habitat assessment in Mitchell Branch.

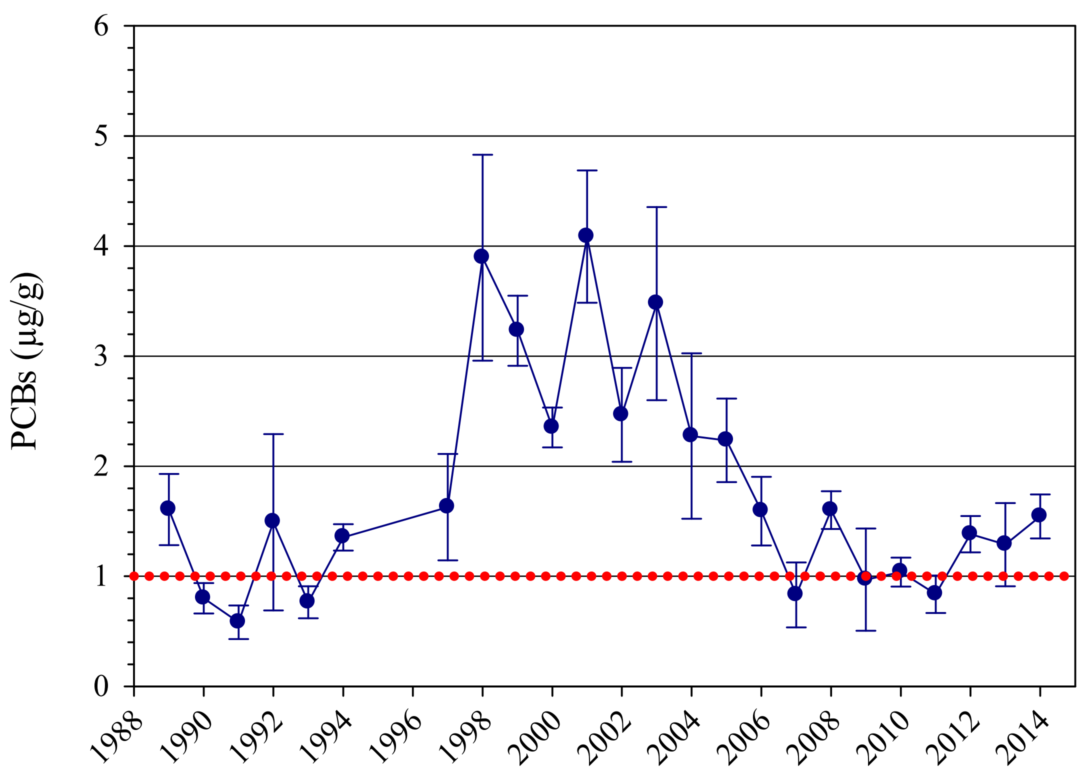
Mean PCB concentration in redbreast sunfish collected from Mitchell Branch in FY 2014 averaged 1.54 µg/g, within the range of values seen in recent years but well below historically high levels in the late 1990s and early 2000s when levels in fish were in the 3 to 4 µg/g range (Figure 8.56). The 1 to 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 (May – June 2014) to evaluate the importance of PCB sources to the creek. As has historically been the case, clams placed in Mitchell Branch upstream of SD-190 were relatively low in PCBs (< 0.1µg/g), while clams placed at SD-190 and in the creek downstream of SD-190 were relatively high (range 0.9 to 1.9 µg/g).

The species richness (number of species) of the fish communities in Mitchell Branch (MIK 0.4 and 0.7) has improved since the 1990s (Figure 8.57), and has stabilized at slightly higher levels in recent samples taken from 2008 – 2014. This diversity is now only a few values below the range of species richness values of comparable reference streams in the area. Although similar in overall species richness, the fish community at Mitchell Branch still has fewer sensitive species of fish, such as darters and suckers and at lower densities than at comparable reference streams indicating that recruitment of these species is being hindered despite the streams proximity to a larger body of water (Poplar Creek) and a potential source for recruitment. The continued presence of sensitive species may increase as water quality improves and habitat stabilizes.



Red dotted line signifies the EPA recommended AWQC for mercury in fish fillet (0.3 µg/g).

Figure 8.55. Mean mercury concentrations in redbreast sunfish from Mitchell Branch, FY 1993 – 2014.



Red dotted line signifies the remediation goal for K-1007-P1 Pond at ETTP (1 µg/g PCBs in fish fillet).

Figure 8.56. Mean PCB concentrations in redbreast sunfish from Mitchell Branch, FY 1993 – 2014.

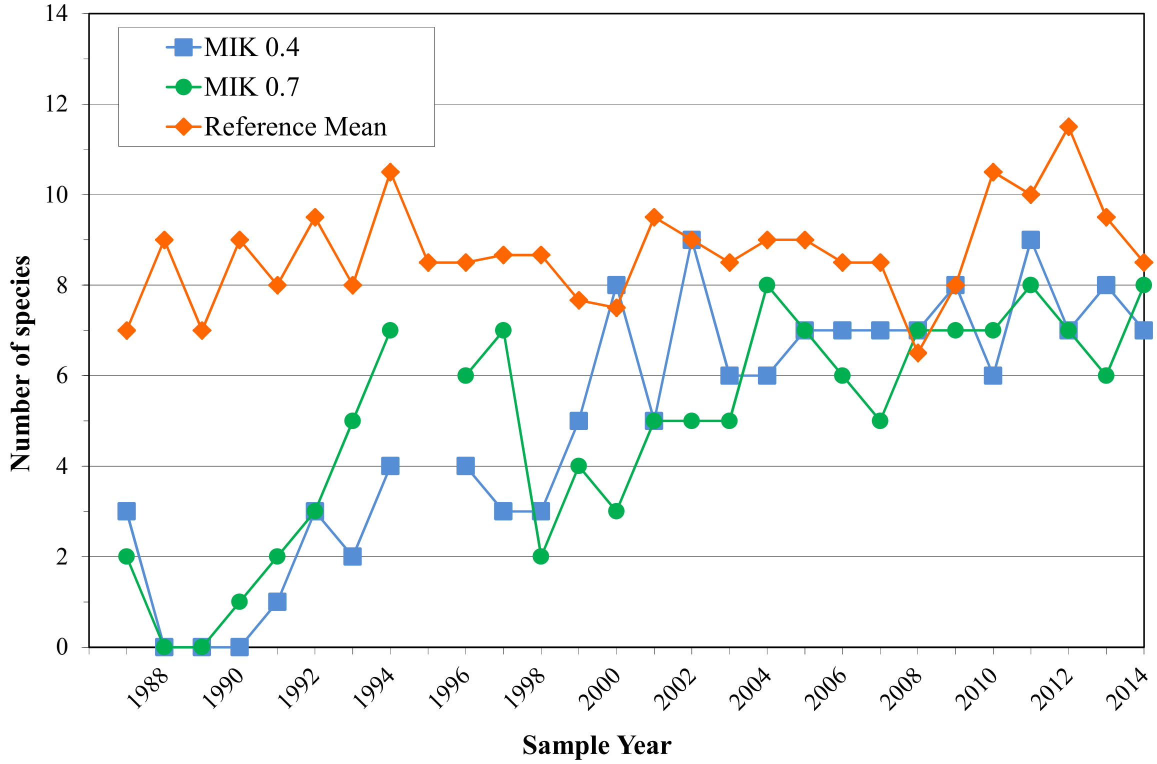


Figure 8.57. Species richness (number of species) in spring samples of the fish community in Mitchell Branch (MIK) and the mean value of two-three reference streams, Scarboro Creek, Mill Branch, and Ish Creek, 1989 – 2014[a]

[a]Interruptions in data lines indicate missing samples.

Based on the mean number of pollution intolerant taxa (i.e., EPT taxa richness, or taxa richness of the EPT) collected per sample at Mitchell Branch sites in the 2014 survey, the benthic macroinvertebrate community continues to exhibit characteristics of moderately degraded conditions at MIK 0.4; however, notable increases have occurred at this site in the past two years. The number of pollution intolerant taxa found at MIKs 0.7 and 0.8, in contrast, continues to be similar to those at the reference site MIK 1.4 (Figure 8.58, top graph). However, the EPT taxa continue to comprise a much smaller percentage of the total community density at all three sites downstream of the reference site (Figure 8.58, bottom graph). Thus, while improvements are evident at MIK 0.7 and MIK 0.8, evidence of degraded conditions persists.

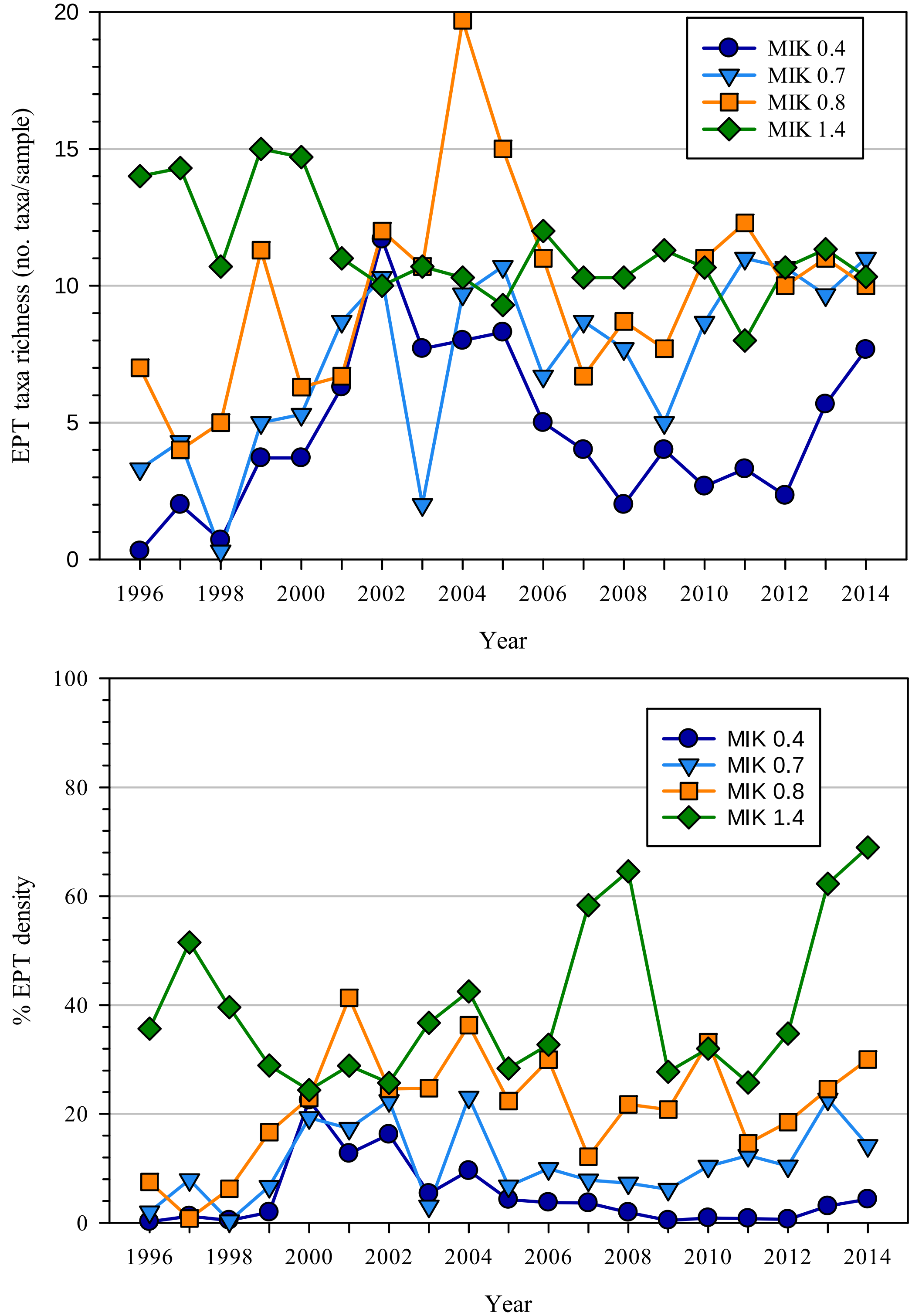


Figure 8.58. Mean (n = 3) taxonomic richness of the pollution-intolerant taxa for the benthic macroinvertebrate community at sites in Mitchell Branch, April sampling periods, 1996 – 2014.

EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies and caddisflies.

8.6.6 Monitoring Summary

During FY 2014, surface water and groundwater monitoring indicates that contaminant levels are generally stable to decreasing in most instances and are consistent with the data from previous years with the exception of the ^{99}Tc topic discussed below. All surface water radiological data were below the screening level of 4% of the DCS. VOC concentrations at the Mitchell Branch K-1700 weir are well below the applicable AWQC and the benchmark values for potential surface water toxicity. Collection and treatment of groundwater containing hexavalent chromium is ongoing and is protective of water quality in Mitchell Branch.

In FY 2014 mercury continues periodically to exceed the AWQC in storm water outfalls and in surface water, and exceeds the EPA's recommended criterion in fish tissue. The long term trend at the K-1700 Mitchell Branch exit pathway location shows a continuing decline from peak levels in FY 2010. Over the last 12 quarters only one result was above the AWQC value of 51 ng/L. However, there are storm water locations such as Outfall 05A that continue to routinely exceed the AWQC value. Legacy sources of mercury contamination will be addressed under planned CERCLA response actions for D&D and soil remediation. In addition, the new NPDES storm water permit for ETTP scheduled for issuance in FY 2015 will specifically require additional investigative monitoring for and emphasis on mercury. This additional monitoring will support these ongoing and future CERCLA actions.

VOCs are the most significant groundwater contaminant at ETTP. TCE concentrations in wells BRW-003 and -017 in the K-1064 Peninsula area and from the PC-0 spring in the K-901-A Holding Pond area are continuing to decline. At the K-770 area the alpha and beta activity levels have reached relatively low levels although seasonal fluctuations are apparent in the data. Measured alpha and beta activity levels in K-770 area groundwater were below drinking water screening levels in FY 2014 except the beta activity level in well UNW-013 was greater than the 50 pCi/L screening level in the August sample.

Following demolition of Building K-25, ^{99}Tc was found in storm water and underground utilities associated with Building K-25. Following an extensive investigation of storm water sewers, underground electrical duct banks, sanitary sewers, and groundwater, the conclusion was that the concentrations of ^{99}Tc were in compliance with applicable regulatory requirements and DOE Orders and did not pose a threat to human health and the environment. A *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1) was prepared that documented the findings. In FY 2015 the recommendations of the Removal Site Evaluation will be addressed, characterization of EUs Z2-20, -21, and -22 (Building K-25 footprint) will be completed, and increased monitoring for ^{99}Tc in groundwater and surface water will be completed.

Aquatic biological monitoring of Mitchell Branch indicates mercury and PCBs are elevated in fish to concentrations above human health thresholds, and fish and benthic communities remain impaired relative to upstream and reference sites, especially in the lower sections.

8.7 ETTP ISSUES AND RECOMMENDATIONS

The issues and recommendations for the ETTP watershed are in Table 8.9.

Table 8.9. Summary of technical issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issues Carried Forward[b]			
1. An asphalt cover has been placed over the K-29 slab since approval of the CERCLA completion document for building demolition. (2014 RER)	1. An addendum to the *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) will be prepared to reflect the new slab end state and changes in slab monitoring. A meeting is planned among the FFA parties to determine an approach for managing contaminated footprints and the outcome will be reported in the next RER as appropriate.	DOE/EPA & TDEC	FY 2015
2. There are several issues associated with the interim management of potentially contaminated slabs at ETTP. Monitoring requirements identified in demolition completion documents have been changed or eliminated following a remedial action decision for the area without appropriate interaction. The frequency of radiological monitoring by the Radiation Protection Program has changed without notification to the Regulators. Fixatives placed over radiological contamination do not have specified inspection and maintenance requirements. (2013 RER)	2. Discussions are ongoing among the FFA parties to develop an approach for managing potentially contaminated slabs at ETTP, and the outcome will be documented in the next RER.	DOE/EPA & TDEC	FY 2015
3. 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)	3. DOE acknowledges the land use differences that exist between the BORCE and that which is designated in the Zone 1 ROD. The *Final Proposed Plan for Soils in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2648&D1) addresses anticipated future industrial and recreational land use in Zone 1. The determination in the Proposed Plan that industrial use goals for Zone 1 are also protective of recreational uses is planned to be included in the Zone 1 Final Soils ROD.	DOE/EPA & TDEC	FY 2015 with Zone 1 Final Soils ROD
Completed/Resolved Issues			
1. The *Remedial Action Report for the K-1070-A Burial Ground, Oak Ridge, Tennessee* (DOE/OR/01-2090&D1) specifies the frequency of inspections for subsidence and erosion and the frequency of mowing. These specified frequencies are no longer required, and the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) recommended the	1. The K-1070-A Burial Ground is in EU Z1-59 in the Interim Zone 1 ROD. 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) documents evaluation of EU Z1-59 and concludes that "…the approximately 50 acres of the K-1070-A EU Group composed of EU 57, EU 58, EU 59, and EU 60 meet the RAO established in the Zone 1 ROD and NFA is appropriate." Therefore, the LTS requirements in the *Remedial*	DOE/EPA & TDEC	FY 2014

Table 8.9. Summary of technical issues and recommendations (cont.)

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
frequencies be changed. (2014 RER)	*Action Report for the K-1070-A Burial Ground, Oak Ridge, Tennessee* (DOE/OR/01-2090&D1) have been superseded.		
2. A recommendation was made in the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2) site visit to clarify the requirements and frequencies in the *Remedial Action Report for the K-1407-B Holding Pond and the K 1407-C Retention Basin* (DOE/OR/01-1371&D1). (2014 RER)	2. The requirements and frequencies in the *Remedial Action Report for the K-1407-B Holding Pond and the K 1407-C Retention Basin* (DOE/OR/01 1371&D1) were clarified in an erratum.	DOE/EPA & TDEC	FY 2015
3. The frequency of soil cover inspections, mowing, radiological surveys, and fence inspections for the K-1071 pad are excessive. (2013 RER)	3. These requirements in the RAR for the K-1070-C/D G-Pit and K-1071 Concrete Pad (DOE/OR/01-1964&D2) were changed in an erratum.	DOE/EPA & TDEC	FY 2014
4. Mercury monitoring results in the Mitchell Branch area and STP Outfall 05A area routinely exceed the mercury AWQC level. (2014 RER)	4. The sources of mercury contamination will be addressed under the planned CERCLA response actions. Demolition of the inactive STP (K-1203) and support facilities will be performed under the *Action Memorandum for the Remaining Facilities Demolition Project at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2049&D2). Soil will be remediated in the Mitchell Branch and STP Outfall 05A areas under the *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) and the future Sitewide ROD. In addition, the new NPDES storm water permit for ETTP scheduled for issuance in FY 2015 will specifically require additional investigative monitoring for and emphasis on mercury. This additional monitoring will support these ongoing and future CERCLA actions.	DOE/EPA & TDEC	As determined by FFA Appendix E and J

[a]An issue identified as a "Current Issue" indicates an issue identified during evaluation of current FY 2014 data for inclusion in The 2015 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 Project Team level.

[b]The year in which the issue originated is provided in parentheses, e.g., (2013 RER).

AWQC = ambient water quality criteria
BORCE = Black Oak Ridge Conservation Easement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ETTP = East Tennessee Technology Park
EU = exposure unit
FFA = Federal Facility Agreement
FY = fiscal year
NFA = no further action
NPDES = National Pollutant Discharge Elimination System
RA = remedial action
RAO = remedial action objective
RAR Remedial Action Report
RER = Remediation Effectiveness Report
ROD = Record of Decision
STP = Sewage Treatment Plant
TDEC = Tennessee Department of Environment and Conservation

8.8 REFERENCES

DOE Order 430.1B, Chg 2. *Real Property and Asset Management*, 2011, U.S. Department of Energy, Washington, D.C.

DOE Order 458.1, Admin Chg 3. *Radiation Protection of the Public and the Environment*, 2013, U.S. Department of Energy, Office of Health, Safety and Security.

DOE Order 5400.5, Chg. 2. *Radiation Protection of the Public and the Environment,* 1993, Washington, D.C. (superseded for general use by DOE Order 458.1 of the same name approved February 2011)

DOE/OR/01-1125&D3. *Record of Decision for the K-1407-B/C Ponds at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, 1993, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR/01-1371&D1. *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin, Oak Ridge, Tennessee*, 1995, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1734&D3. *Record of Decision for the K-1070-A Burial Ground, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2000, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1964&D2. *Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad, East Tennessee Technology Park, Oak Ridge, Tennessee,* 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1988&D2. *Action Memorandum for the Decontamination and Decommissioning of the K-25 and K-27 Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-1997&D2. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* 2002, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2049&D2. *Action Memorandum for the Remaining Facilities Demolition Project at East Tennessee Technology Park, Oak Ridge, Tennessee*, 2003, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2090&D1. *Remedial Action Report for the K-1070-A Burial Ground East Tennessee Technology Park, Oak Ridge, Tennessee*, 2003, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2161&D2. *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2167&D1/A5. *Addendum to Waste Handling Plan for Demolition of the K-25 and K-27 Building Structures and Remaining Components Located at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2224&D3/R1. *Remedial Design Report/Remedial Action Work Plan for Zone 2 Soils, Slabs, and Subsurface Structures East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2259&D1. *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*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2261&D2. *Phased Construction Completion Report for the Duct Island Area and K-901 Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2294&D2/A1. *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,* 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2294&D2/A2. *Addendum II 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,* 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2309&D2. *Phased Construction Completion Report for the Laboratory Area Facilities of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2314&D2. *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,* 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2348&D1. *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,* 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2359&D2. *Removal Action Work Plan for the Removal Action at the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee,* 2008, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2369&D1. *Action Memorandum for Reduction of Hexavalent Chromium Releases Into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,* 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2384&D1. *Removal Action Report for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2008, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2422&D1. *Engineering Evaluation/Cost Analysis for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2009, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2443&D2. *Fiscal Year 2010 Phased Construction Completion Report for EU Z2-31 in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2448&D1. *Action Memorandum for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge,* Tennessee, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2456&D1/R1. *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, Oak Ridge, Tennessee,* 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2477&D1. *East Tennessee Technology Park Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2484&D1. *Removal Action Work Plan for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2010, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee,* 2012, U.S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE/OR/01-2541&D1. *Phased Construction Completion Report for Building K-33 of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* 2011, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2541&D2. *Phased Construction Completion Report for Building K-33 of the Remaining Facilities Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee,* 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2561&D3. *Final Zone 1 Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee,* 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2582&D1. *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: Demolition of North Wing and Retaining Walls*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2598&D2. *Removal Action Report for the Long-term Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,* 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2618&D2. *Phased Construction Completion Report for Exposure Unit Z2-35 Sumps in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2619&D2. *Phased Construction Completion Report for Decommissioning the Central Neutralization Facility at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2620&D1. *Phased Construction Completion Report for the K-33/K-31 Process Tie Line Demolition Project at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2644&D2. *Waste Handling Plan – Part 2 for Building K-31 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2648&D1. *Final Proposed Plan for Soils in Zone 1 at East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2651&D1. *Completion Report for Building K-25 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2652&D1. *Waste Handling Plan for Building K-27 Process Equipment and Piping at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2663&D1. *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2723&D2. *Fiscal Year 2007 Phased Construction Completion Report for the Zone 2 Soils, Slabs, and Subsurface Structures at East Tennessee Technology Park, Oak Ridge, Tennessee*, 2008, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2723&D2/A1. *Addendum to the Fiscal Year 2007 Phased Construction Completion Report for the Zone 2 Soils, Slabs, and Subsurface Structures at East Tennessee Technology Park, Oak Ridge, Tennessee*, 2013, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1486&D4. *Record of Decision for the K-1070-C/D Operable Unit, East Tennessee Technology Park, Oak Ridge, Tennessee*, 1998, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1550&D2. *Action Memorandum for the K-901-A Holding Pond and the K-1007-P1 Pond Removal Action, East Tennessee Technology Park, Oak Ridge, Tennessee*, 1997, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE-STD-1196-2011. *Derived Concentration Technical Standard*, 2011, U.S. Department of Energy, Washington, D.C.

Etnier, D. A. and W. C. Starnes. 1993. The Fishes of Tennessee. The University of Tennessee Press, Knoxville, TN.

PNNL-15372. *Advances in Geochemical Testing of Key Contaminants in Residual Hanford Tank Waste*, 2005, Pacific Northwest National Laboratory, Richland, WA.

Roy, W. K., N. R. Giffen, M. C. Wade, A. M. Haines, J. W. Evans, and R. T. Jett. 2014. Oak Ridge Reservation Bird Records and Population Trends. ORNL/TM-2014/109, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

This page intentionally left blank.

9. CERCLA ACTIONS AT OTHER SITES

9.1 INTRODUCTION AND STATUS

9.1.1 Introduction

This chapter presents the remedial effectiveness evaluation for CERCLA actions that are not physically situated within one of the five established watersheds or Chestnut Ridge but are located on the ORR. Table 9.1 lists these CERCLA actions and identifies those with monitoring and other LTS requirements. Figure 9.1 locates the key CERCLA sites and actions. In subsequent sections the effectiveness of each completed action is assessed by discussing performance monitoring objectives and results and other LTS requirements and status. Table 9.2 lists the other LTS requirements for these CERCLA actions. Figure 9.2 shows interim controls requiring LTS.

For a complete discussion of background information and performance metrics for each remedy, a compendium of all CERCLA decisions not located in the five established watersheds or Chestnut Ridge is provided in Chapter 11 of Volume 1 of the *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2516&D2). This information is updated in the RER and published every fifth year in the CERCLA FYR.

9.1.2 Status Update

During FY 2014, no additional CERCLA actions were implemented or completed at the White Wing Scrap Yard, the Oak Ridge Associated Universities South Campus Facility, or elsewhere on the ORR in the area that falls outside the five established watersheds and Chestnut Ridge. Monitoring in support of performance assessments and evaluations continued.

9.2 WHITE WING SCRAP YARD

The White Wing Scrap Yard is located north of the western end of BCV (Figure 9.3). This RA removed contaminated surface debris retrievable without excavation. Buried material remains at the site.

9.2.1 Other LTS Requirements

White Wing Scrap Yard has LTS requirements (Table 9.2). There are no LTS requirements in the *Interim Record of Decision for the Oak Ridge National Laboratory Waste Area Grouping 11 Surface Debris* (DOE/OR-1055&D4). However, the *Interim Remedial Action Postconstruction Report for Waste Area Grouping 11 at Oak Ridge National Laboratory* (DOE/OR/01-1263&D2) 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 S&M will continue until decisions are made for future and/or final CERCLA remedial actions at the site."

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/ Other LTS required
White Wing Scrap Yard (WAG 11) Surface Debris	IROD (DOE/OR-1055&D4): 10/06/92	PCR[b] (DOE/OR/01-1263&D2) approved 09/14/94	No/Yes
Oak Ridge Associated Universities South Campus Facility	ROD (DOE/OR/02-1383&D3): 12/28/95	RAR (DOE/OR/02-1474&D2) approved 08/20/96	Yes/Yes

[a]Detailed information of the status of ongoing actions is from Appendix E of the *Federal Facility Agreement* (DOE/OR-1014) and is available at <http://www.ucor.com/ettp_ffa_appendices.html>.
[b]This action was completed prior to uniform adherence to the RAR process; hence, no RAR exists for this decision.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
IROD = Interim Record of Decision
LTS = long-term stewardship
ORR = Oak Ridge Reservation
PCR = post construction report
RAR = remedial action report
ROD = Record of Decision
WAG = Waste Area Grouping

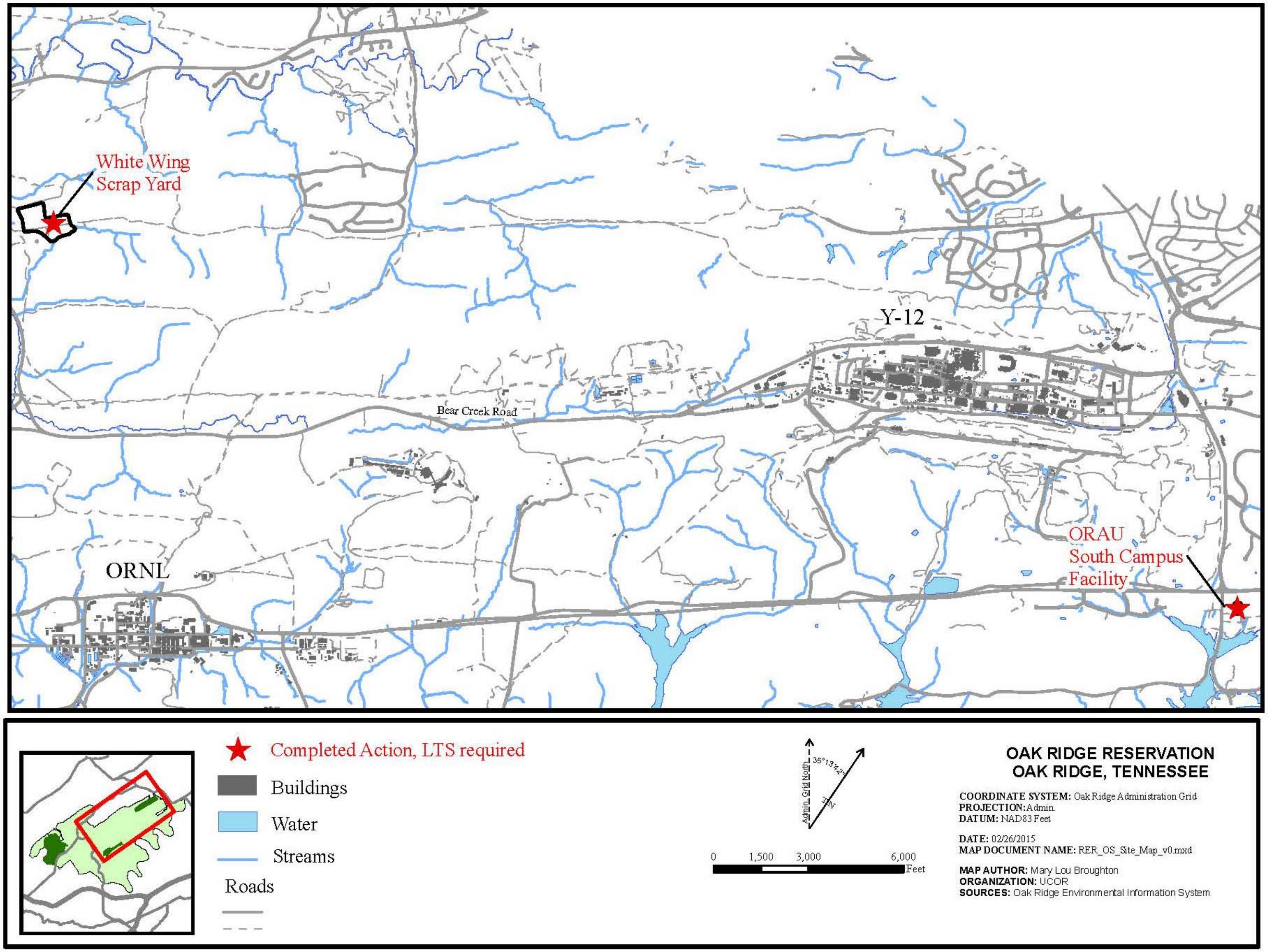


Figure 9.1. Other Sites on the ORR.

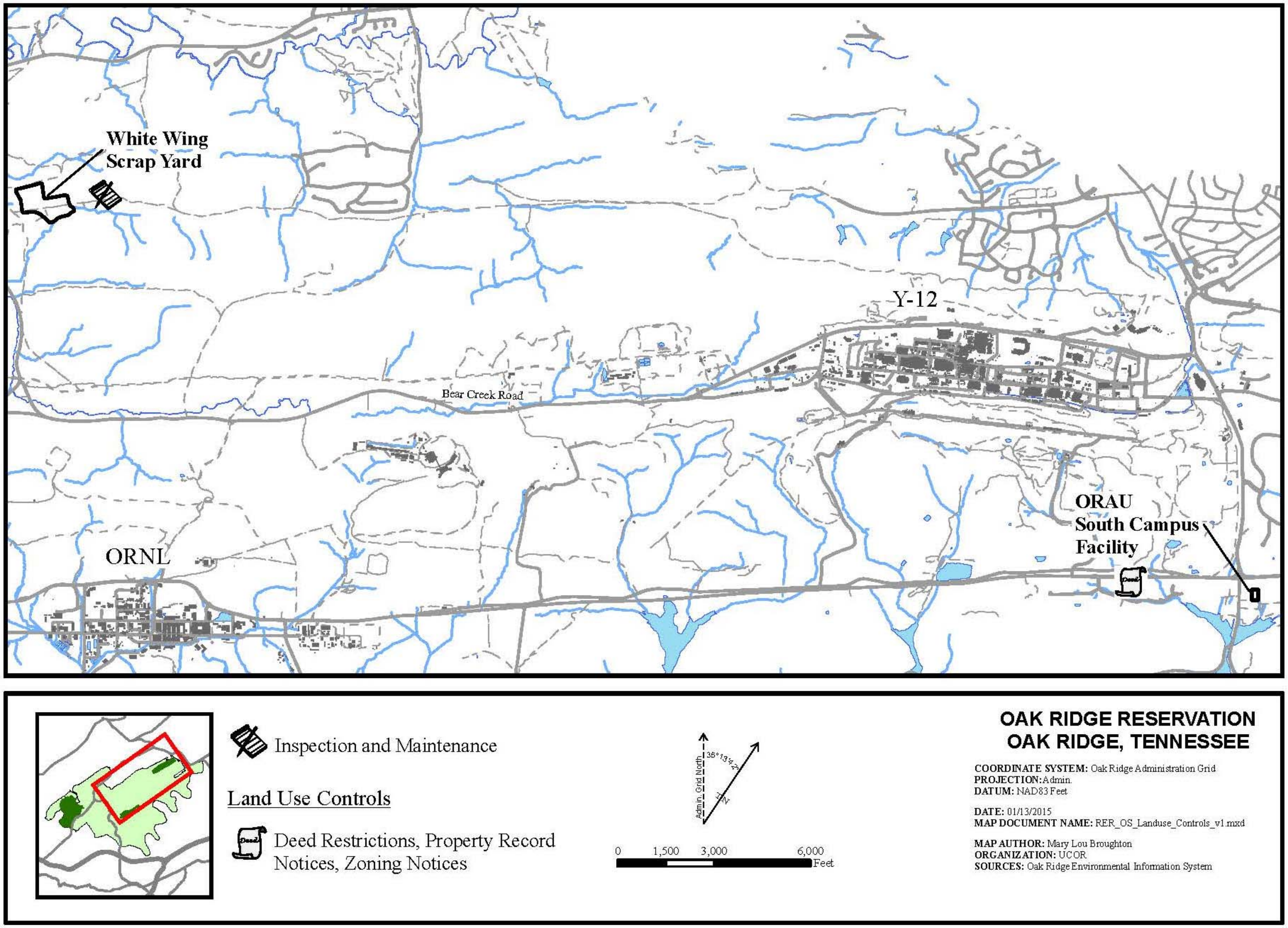


Figure 9.2. Interim controls requiring LTS at Other Sites on the ORR.

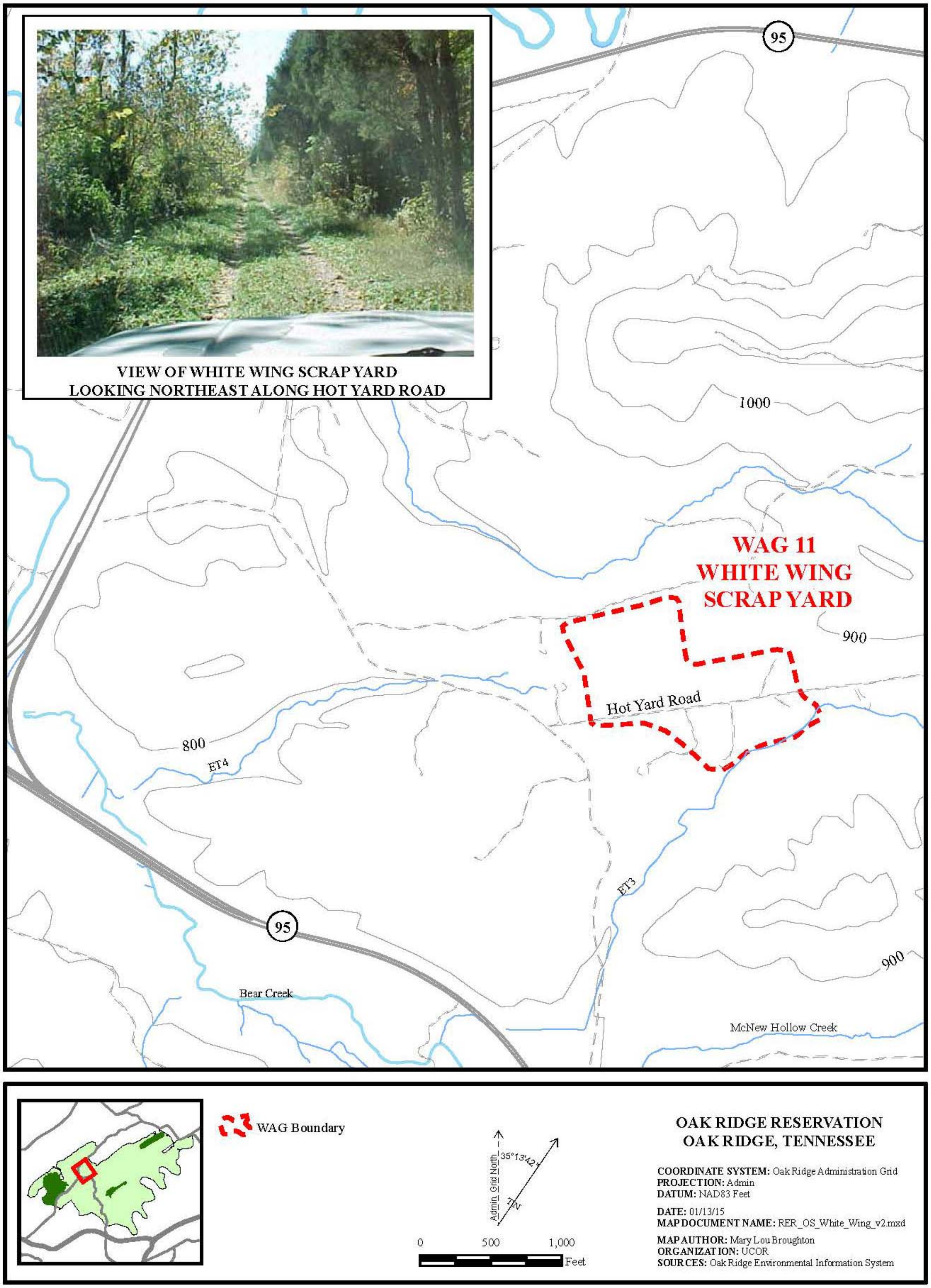


Figure 9.3. Location of White Wing Scrap Yard.

Table 9.2. Other LTS requirements for Other Sites

Other LTS requirements for Completed Actions Other Sites[a]			
Specific Areas	**Project Documents**	**Other LTS Requirements**	**Frequency/Implementation**
White Wing Scrap Yard (WAG 11) Surface Debris	PCR (DOE/OR/01-1263&D2)	• Because the interim RA was to remove the debris, no operation and maintenance are necessary as a result of the interim action. However, long-term S&M will continue until decisions are made for future and/or final CERCLA RAs at the site.	• Long-term S&M will continue until decisions are made for future and/or final CERCLA RAs at the site
Oak Ridge Associated Universities South Campus Facility	ROD (DOE/OR/02-1383&D3) RAR (DOE/OR/02-1474&D2)	• A notification will be added to the Deeds of Records at the Anderson County Courthouse alerting potential owners to the TCE contamination	• FYRs are required until natural attenuation in the zone of contamination decreases TCE concentrations below regulatory levels of concern

[a]LTS for specific areas is determined by each remediation project and listed in the project specific completion report.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
FYR = Five-Year Review
LTS = long-term stewardship
PCR = Post-construction Report
RA = remedial action
RAR = Remedial Action Report
ROD = Record of Decision
S&M = surveillance and maintenance
TCE = trichloroethene
WAG = Waste Area Grouping

9.2.2 Status of Requirements

The Y-12 S&M Program performed monthly inspections in FY 2014 to inspect components including deteriorating access road conditions; damaged or missing gate locks or unlocked gate; debris buildup or blockage at the fence/creek boundaries; unauthorized materials placed within the area; and damage to site perimeter fencing. 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. Site maintenance in FY 2014 included removing trees that had fallen on the fencing and across the road.

9.3 OAK RIDGE ASSOCIATED UNIVERSITIES SOUTH CAMPUS FACILITY

9.3.1 Performance Monitoring

9.3.1.1 Performance Monitoring Goals and Objectives

The South Campus Facility is a former experiment station where the radionuclide effects on animals were studied (Figure 9.4). The *Record of Decision for Oak Ridge Associated Universities South Campus Facility* (DOE/OR/02-1383&D3) specified groundwater monitoring in the vicinity of a VOC contaminated area and LUCs that include a groundwater use restriction.

The *Record of Decision for Oak Ridge Associated Universities South Campus Facility* (DOE/OR/02-1383&D3) 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. The *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review* (DOE/OR/01-2289&D3) recommended continued annual sampling of two wells (GW-841 and GW-842) and two surface water locations (SCF-WS1 and SCF-WS2). The *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation* (DOE/OR/01-2516&D2) recommended that the remedy be continued as monitored natural attenuation for groundwater with the ultimate goal of reaching MCLs for VOCs, that annual sampling be continued, and that the remaining wells (except GW-841 and GW-842) be plugged and abandoned.

9.3.1.2 Evaluation of Performance Monitoring Data

During FY 2014, samples were collected from wells GW-841, GW-842 and surface water locations SCF-WS1 and SCF-WS2 and were analyzed for VOCs. Figure 9.5 shows that the concentrations of detected VOCs in wells GW-841 and GW-842 from FY 1994 through FY 2014 have exhibited a long-term decreasing concentration history with a slight increase during FY 2013 and FY 2014. The FY 2014 results show that TCE in well GW-841 increased slightly to 10 µg/L which is twice the 5 µg/L drinking water standard. TCE in well GW-842 increased slightly from a concentration of 2.9 µg/L in FY 2013 to 3.2 µg/L in FY 2014, which remains below the drinking water standard. Cis-1,2-DCE was detected in the sample from GW-841 at 18 µg/L and was detected in well GW-842 at 1.2 µg/L, both of which are much less than the 70 µg/L drinking water standard. VC was not detected in samples from either groundwater monitoring well in FY 2014. No VOCs were detected in surface water at the site during FY 2014.

9.3.2 Other LTS Requirements

Other LTS requirements for the South Campus Facility are listed in Table 9.2.

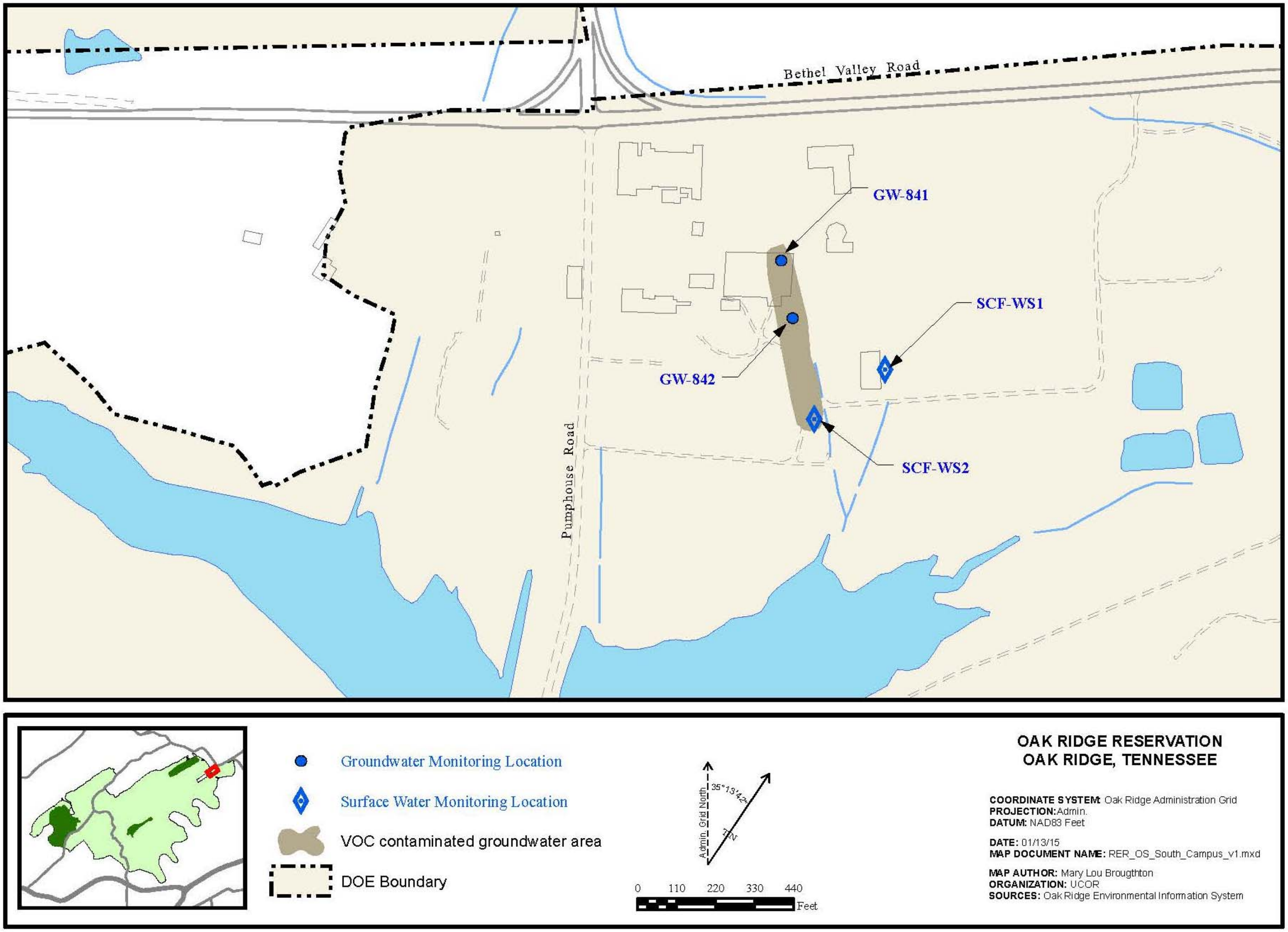


Figure 9.4. South Campus Facility monitoring locations and contaminated groundwater.

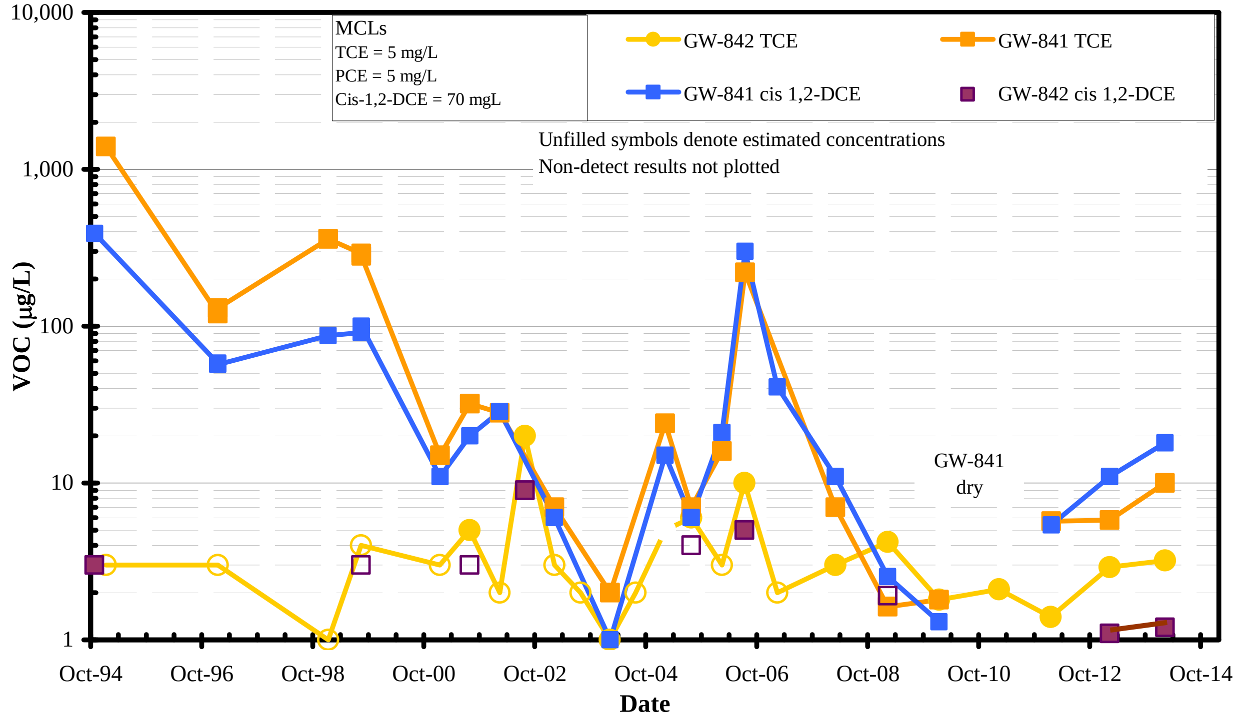


Figure 9.5. Organic compound concentrations in wells GW-841 and GW-842 at South Campus Facility.

9.3.2.1 Requirements

The *Record of Decision for Oak Ridge Associated Universities South Campus Facility* (DOE/OR/02-1383&D3) 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.

9.3.2.2 Status of Requirements

The land use restrictions have been maintained and groundwater monitoring has been conducted at the site. An online search of the Anderson County Register of Deeds web site conducted in FY 2014 verified the notice remains filed.

9.4 OTHER SITES ISSUES AND RECOMMENDATIONS

The issues and recommendations for the Other Sites are in Table 9.3.

Table 9.3. Other Sites issues and recommendations

Issue[a]	Action/Recommendation	Responsible parties Primary/Support	Target response date
Current Issue			
None			
Issue Carried Forward			
None			
Completed/Resolved Issues[b]			
None			

[a]A "Current Issue" is an issue identified during evaluation of FY 2014 data for inclusion in the 2015 RER. An "Issue Carried Forward" is an issue identified in a previous year's RER or FYR so the issue can be tracked through resolution. Any additional discussion will occur at the appropriate regulatory level.

[b]The year in which the issue originated is in parentheses, e.g., (2013 RER).

FY = fiscal year
FYR = Five-Year Review
RER = Remediation Effectiveness Report

9.5 REFERENCES

DOE/OR/01-1263&D2. *Interim Remedial Action Postconstruction Report for Waste Area Grouping 11 at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, 1994, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE/OR/01-2289&D3. *2006 Remediation Effectiveness Report/Second Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2007, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1383&D3. *Record of Decision for Oak Ridge Associated Universities South Campus Facility, Oak Ridge, Tennessee*, 1995, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1014. *Federal Facility Agreement for the Oak Ridge Reservation*, 1992, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR-1055&D4. *Interim Record of Decision for Oak Ridge National Laboratory Waste Area Grouping 11 Surface Debris, Oak Ridge, Tennessee*, 1992, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

This page intentionally left blank.

APPENDIX A
CERTIFICATION OF LAND USE CONTROL IMPLEMENTATION
FISCAL YEAR 2014

This page intentionally left blank.

CERTIFICATION OF LAND USE CONTROL IMPLEMENTATION FISCAL YEAR 2014

The Land Use Control Assurance Plan (LUCAP) requires that the Manager, U.S. Department of Energy (DOE) Oak Ridge Office 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 (ORR). As with the FY 2013 certification, the Manager of the Oak Ridge Office of Environmental Management (OREM) is the designated official. This certification will identify any noncompliance with these LUCIPs and describe steps taken to address any such noncompliance(s). Certification is provided for fiscal year (FY) 2014, comprising the period October 1, 2013, through September 30, 2014. The LUCAP also requires that the annual report serve to notify the U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Environment and Conservation (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 (MV) watershed was approved by EPA and TDEC in May 2006, and revised through errata to the MV Remedial Action Report (RAR) in 2009. Land use controls (LUCs) that were implemented in MV during FY 2014 are identified in Table A.1.

In accordance with Section 2.9 of the LUCAP (DOE/OR/01-1824&D1/A2), I certify based on the information and belief formed after reasonable inquiry, that all required LUCs in MV have been implemented in accordance with the approved LUCIP for the watershed (DOE/OR/01-1977&D6). The LUCs in Table A.1 have been implemented, as required.

Susan M. Cange, Manager
Oak Ridge Office of Environmental Management

March 20, 2015
Date

This page intentionally left blank.

Table A.1. Verification of LUCs for the MV Watershed LUCIP requirements being certified as of September 30, 2014[a]

MV LUCIP Requirements					
Type of control	**Affected areas**	**Implementation**	**Frequency**	**Verification Requirements**	**Certification Documentation[b]**
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 ICMA/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 DOE 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.
3. EPP 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 2014 against existing procedures.

Table A.1. Verification of LUCs for the MV Watershed
LUCIP requirements being certified as of September 30, 2014 (cont.)[a]

MV LUCIP Requirements					
Type of control	**Affected areas**	**Implementation**	**Frequency**	**Verification Requirements**	**Certification Documentation[b]**
4. State advisories/ postings (e.g., no fishing or contact advisory)	WOL and WOCE	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 WOL dam and at access to the WOCE 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.
5. Access controls (e.g., fences, gates, portals)	At 20 locations throughout MV 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. It was noted that conditions at two locations had changed, but adequate controls are in place.
6. Signs	At 20 locations throughout MV Watershed near major access points At six of the 20 locations around the WOL and WOCE at major access points	In place within six 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 six of the 20 sign locations around the WOL and WOCE also provide notice to resource users of contamination and prohibit fishing/contact.
7. Surveillance patrols	Patrol of selected areas throughout MV, 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.

Table A.1. Verification of LUCs for the MV Watershed
LUCIP requirements being certified as of September 30, 2014 (cont.)[a]

MV LUCIP Requirements					
Type of control	**Affected areas**	**Implementation**	**Frequency**	**Verification Requirements**	**Certification Documentation[b]**
Additional Project-Specific PCCR Requirements					
None specified[c]	MV ISG Trenches 5 & 7 SWSA 6 SWSA 4 Pit and Trenches SWSA 5 TRU Trenches Soils and Sediments				

[a]Zoning notice to City Planning Commission will be completed if/when MV contaminated areas are transferred out of DOE federal control.
[b]Documentation of verification completed by WRRP annually.
[c]No attachments to Appendix A of the MV LUCIP as of September 30, 2014.

DOE = U.S. Department of Energy
EM = Environmental Management
EPA = U.S. Environmental Protection Agency
EPP = excavation/penetration permit
FY = fiscal year
HTF = Hillcut Test Facility
ICMA = Interim Corrective Measures Area
ISG = in-situ grouting
LUC = land use control
LUCIP = Land Use Control Implementation Plan
MV = Melton Valley
PCCR = Phased Construction Completion Report
RAR = Remedial Action Report
S&M = surveillance and maintenance
SWSA = Solid Waste Storage Area
TDEC = Tennessee Department of Environment and Conservation
TRU = transuranic
WOCE = White Oak Creek Embayment
WOL = White Oak Lake
WRRP = Water Resources Restoration Program

REFERENCES

DOE/OR/01-1824&D1/A2. *Land Use Control Assurance Plan for the Oak Ridge Reservation*, 2010, U.S. Department of Energy, Oak Ridge, TN.

DOE/OR/01-1977&D6. *Land Use Control Implementation Plan for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge*, *Tennessee*, 2006, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

APPENDIX B
SELECTED OAK RIDGE NATIONAL LABORATORY GROUNDWATER DATA

This page intentionally left blank

CONTENTS

This page intentionally left blank.

B.1 BETHEL VALLEY SOLID WASTE STORAGE AREA 3 GROUNDWATER HYDROGRAPHS

This page intentionally left blank.

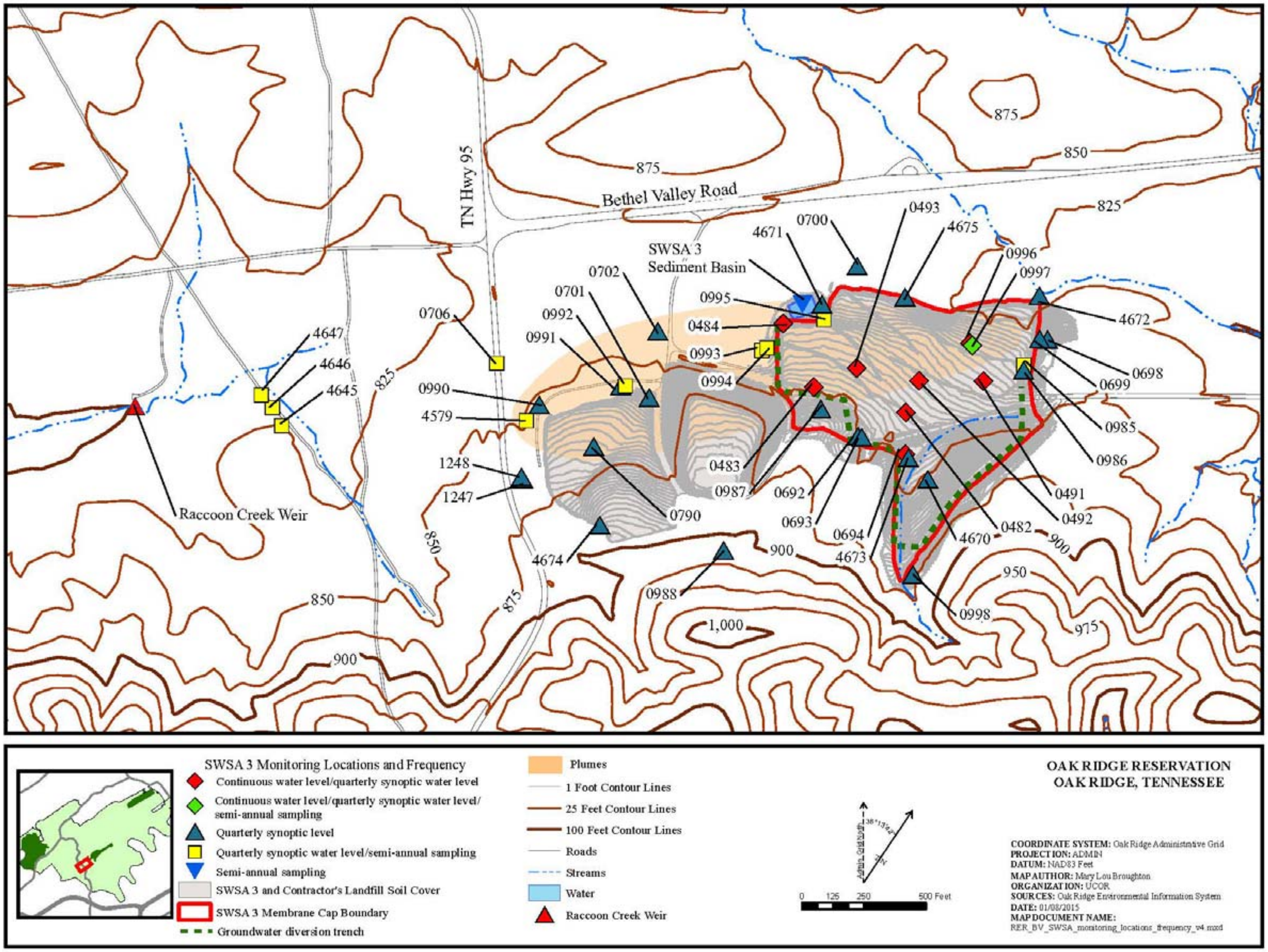


Figure B.1.1. Groundwater monitoring locations at SWSA 3.

Table B.1.1. SWSA 3 Target Groundwater Elevations and FY 2014 Average Levels

Well	Elevation Goal (ft aMSL)	FY 2014 Average Groundwater Elevation (ft aMSL)
0482	823	**826.97**
0483	835	827.68
0484	824	816.29
0491	816	**824.94**
0492	818.5	**824.70**
0493	829	820.98
0694	838.33	831.81
0996	814.31	807.98
0997	818.64	811.85

BOLD values indicate the elevation goal is exceeded.

aMSL = above Mean Sea Level
FY = fiscal year
SWSA = Solid Waste Storage Area

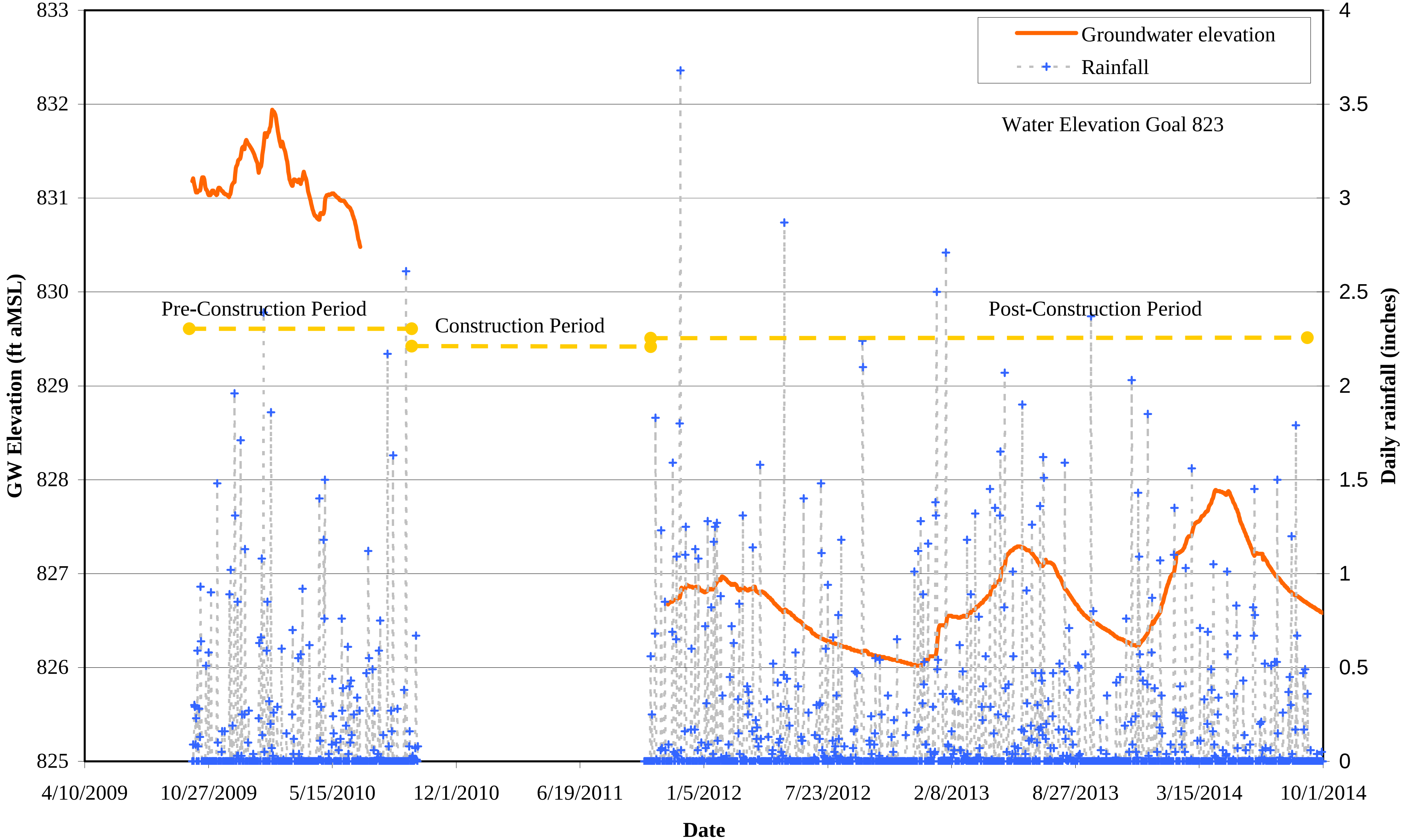


Figure B.1.2. Well 0482 Hydrograph.

B-10

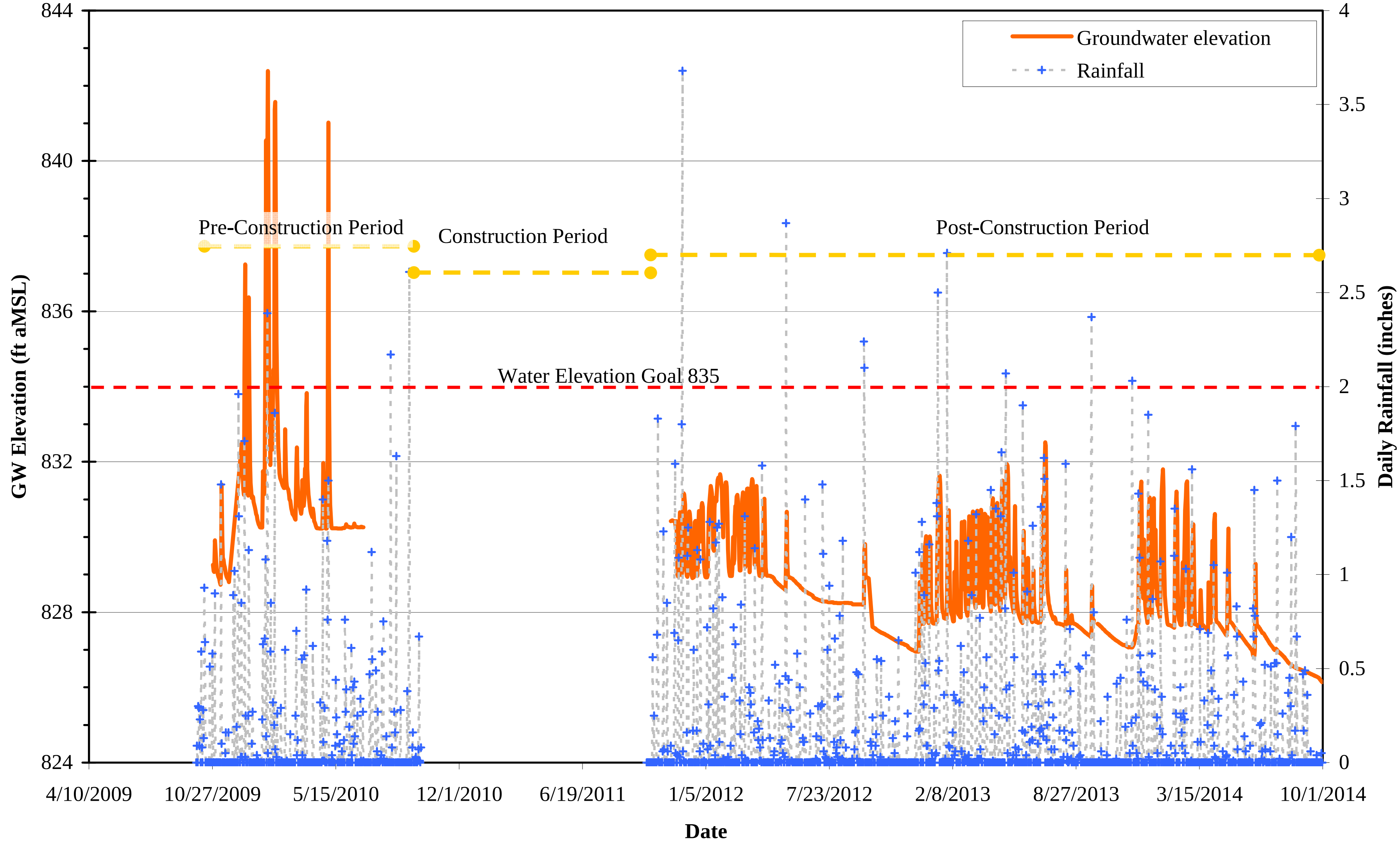


Figure B.1.3. Well 0483 Hydrograph.

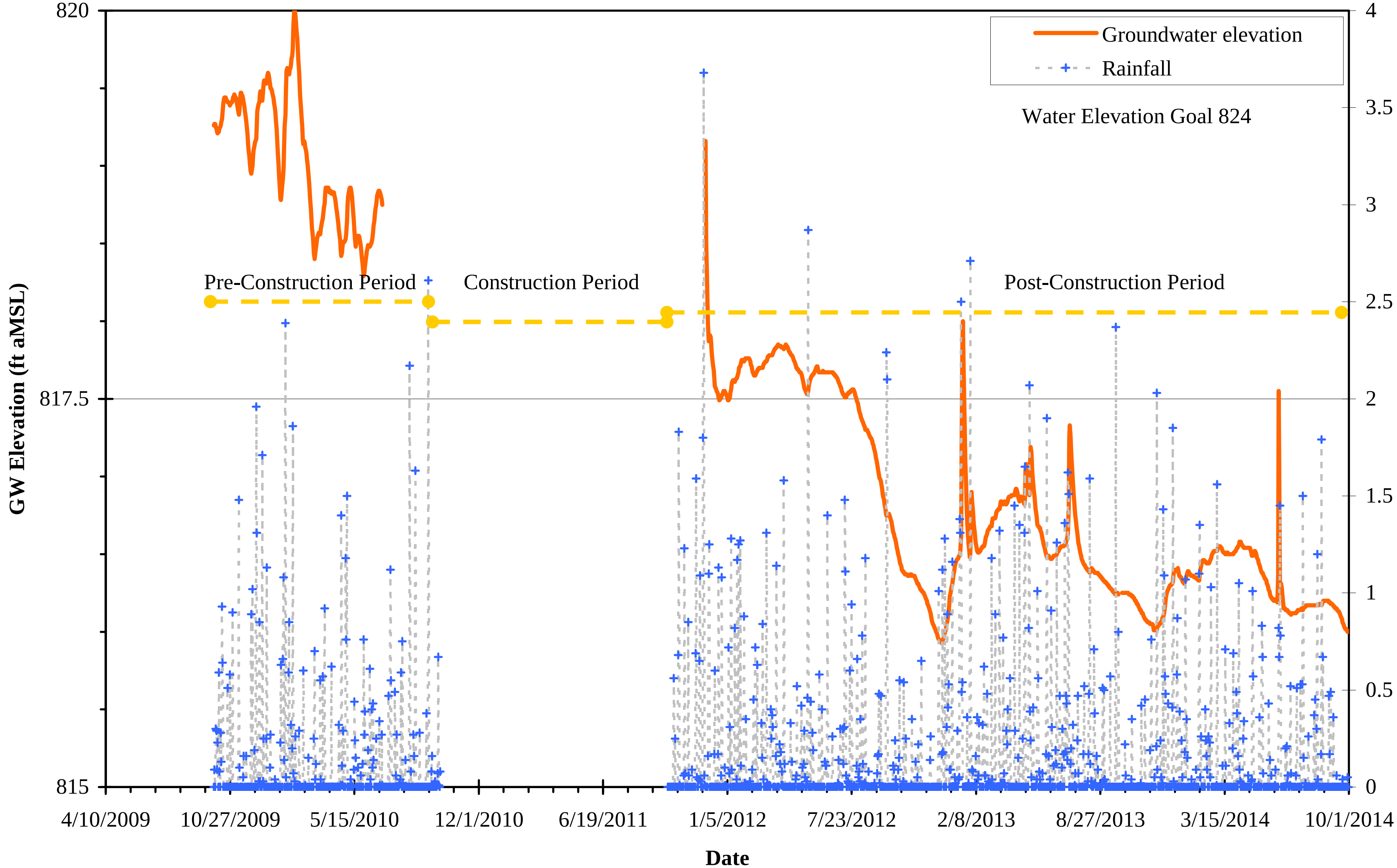


Figure B.1.4. Well 0484 Hydrograph.

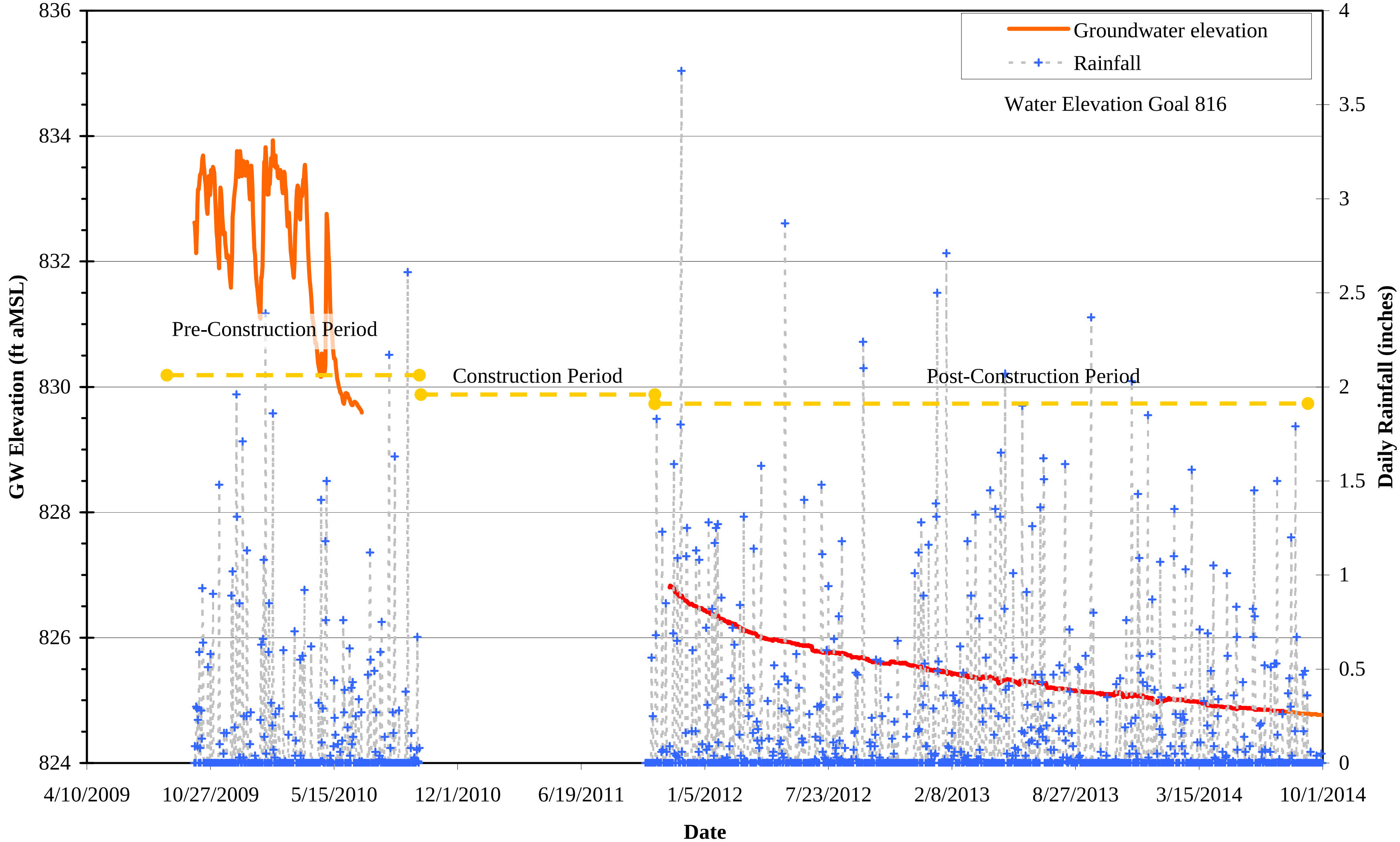


Figure B.1.5. Well 0491 Hydrograph.

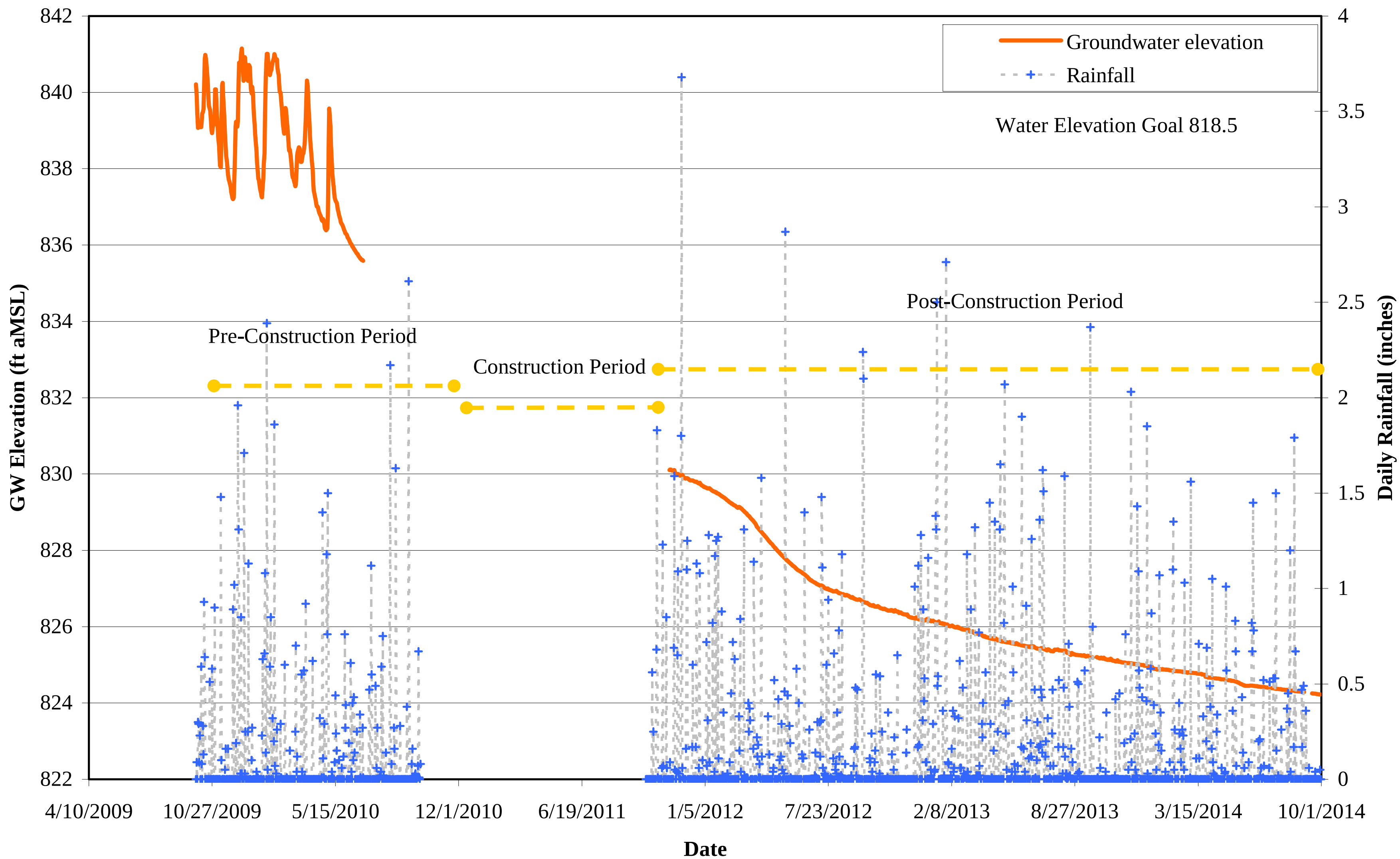


Figure B.1.6. Well 0492 Hydrograph.

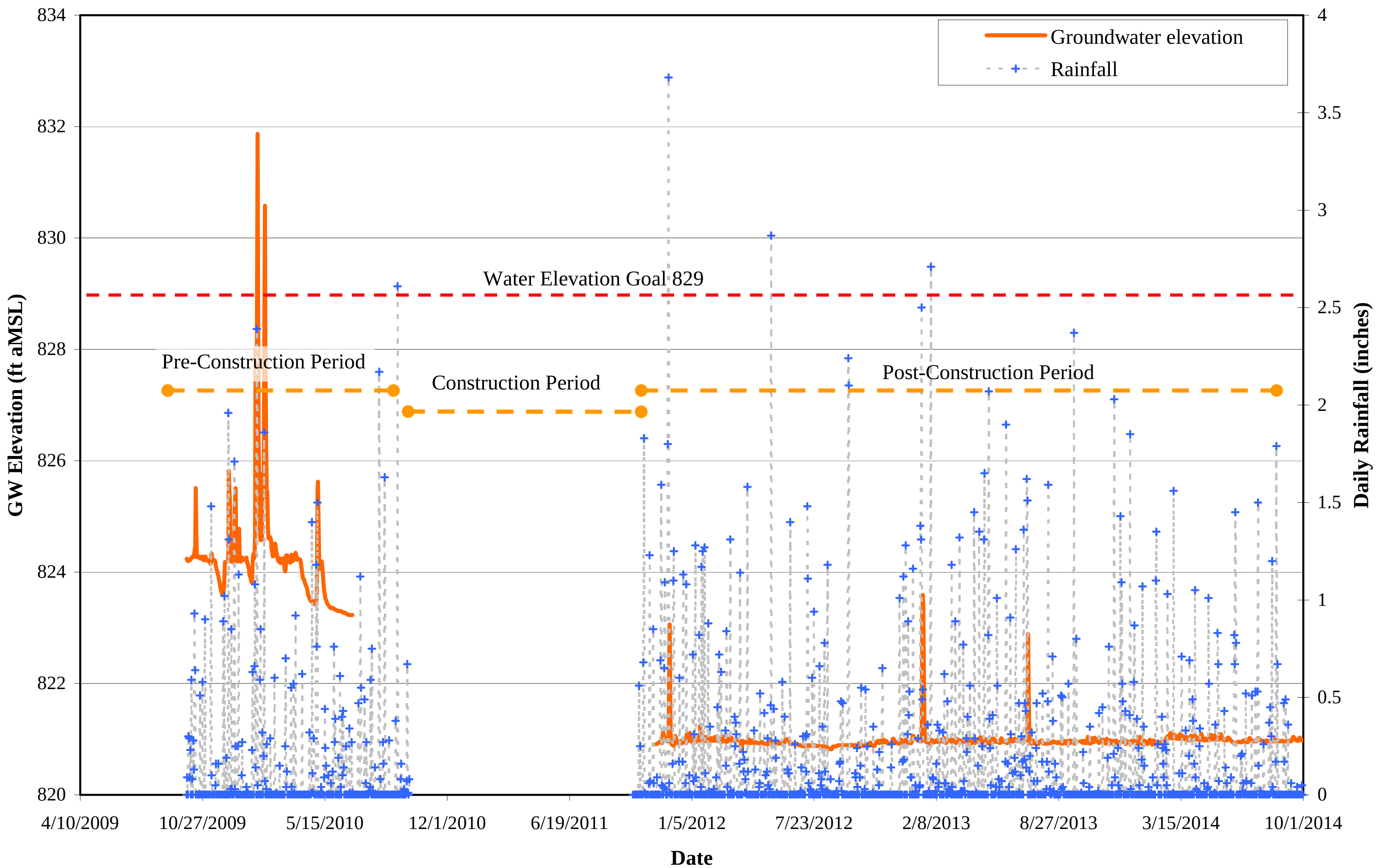


Figure B.1.7. Well 0493 Hydrograph.

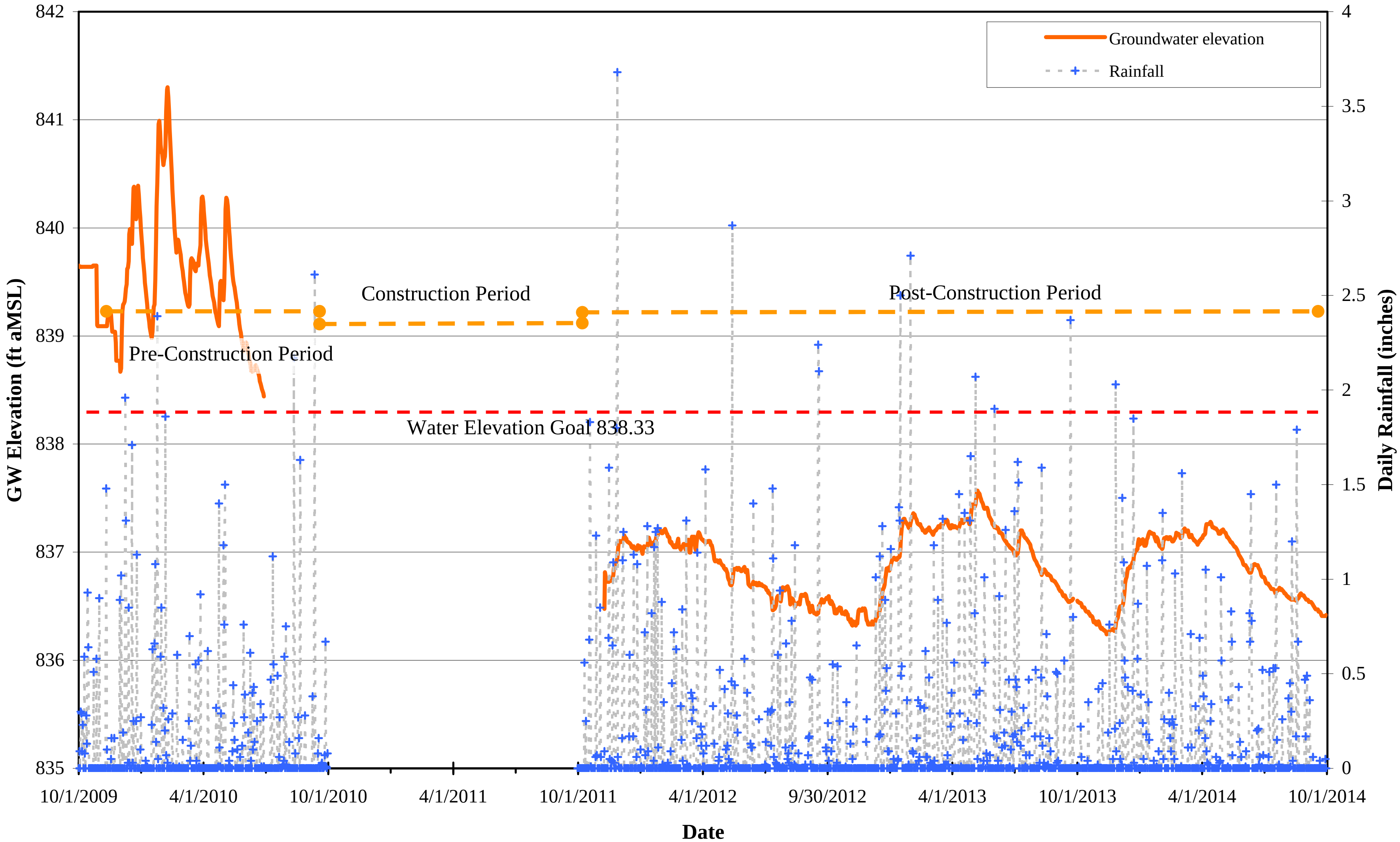


Figure B.1.8. Well 0694 Hydrograph.

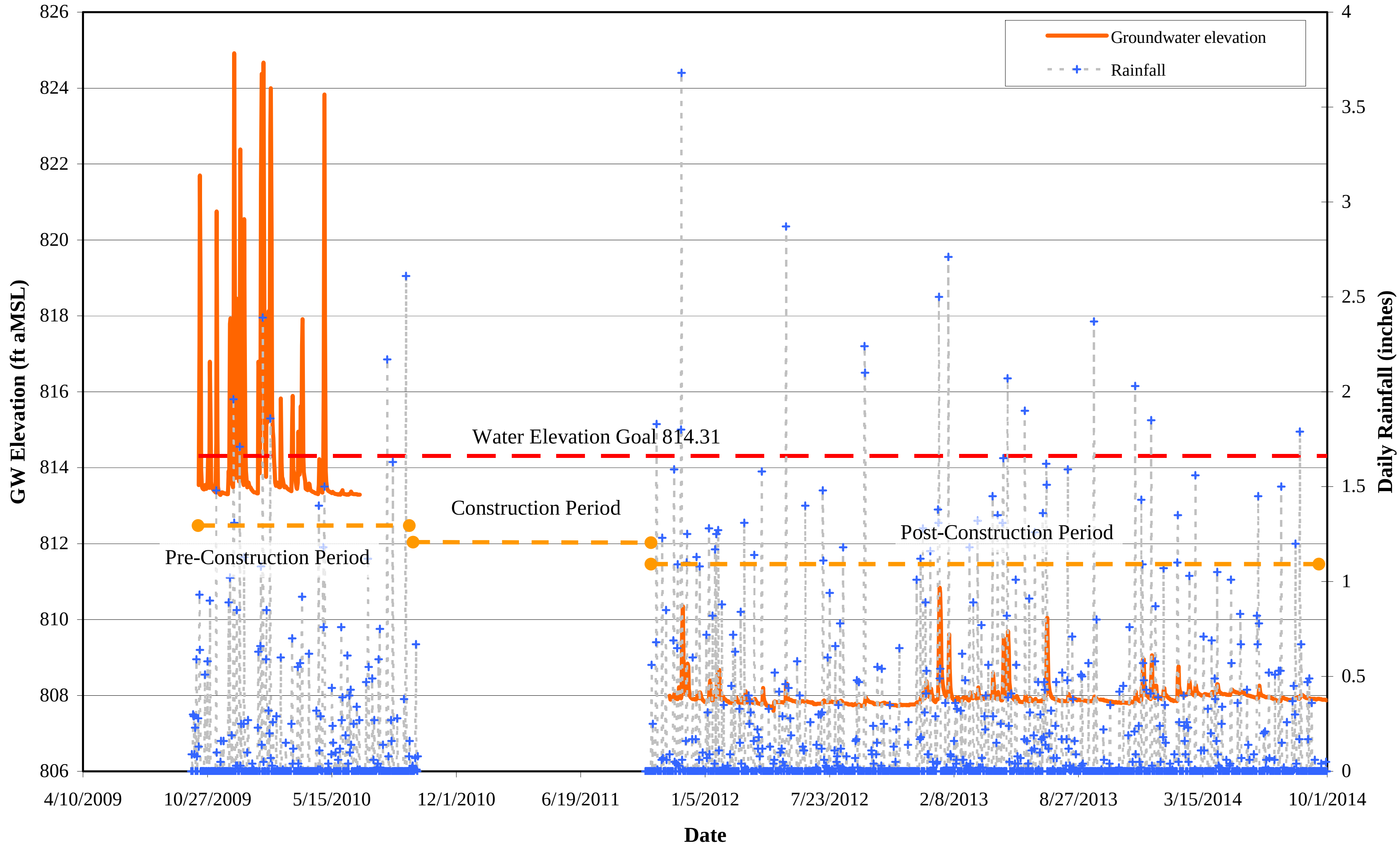


Figure B.1.9. Well 0996 Hydrograph.

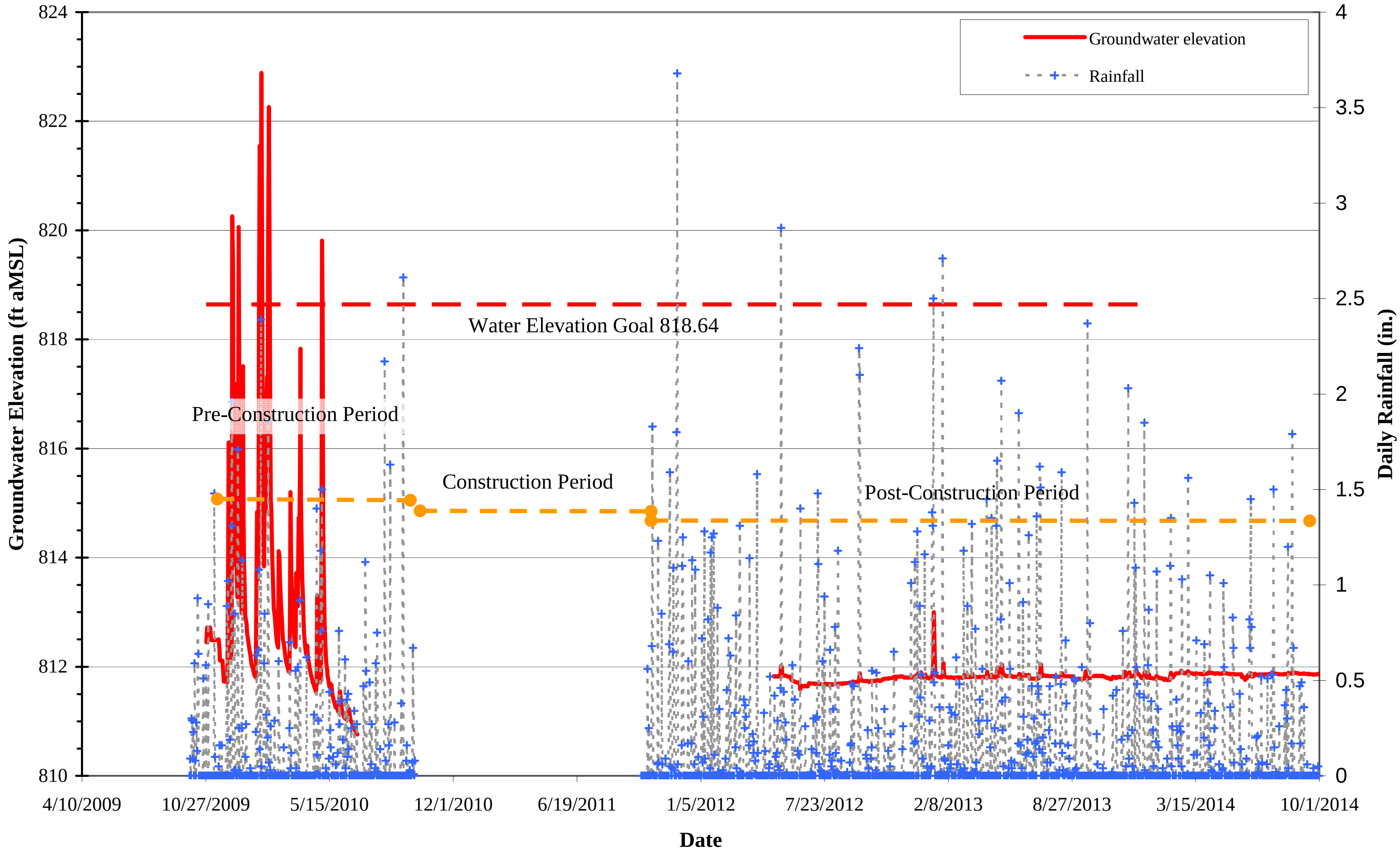
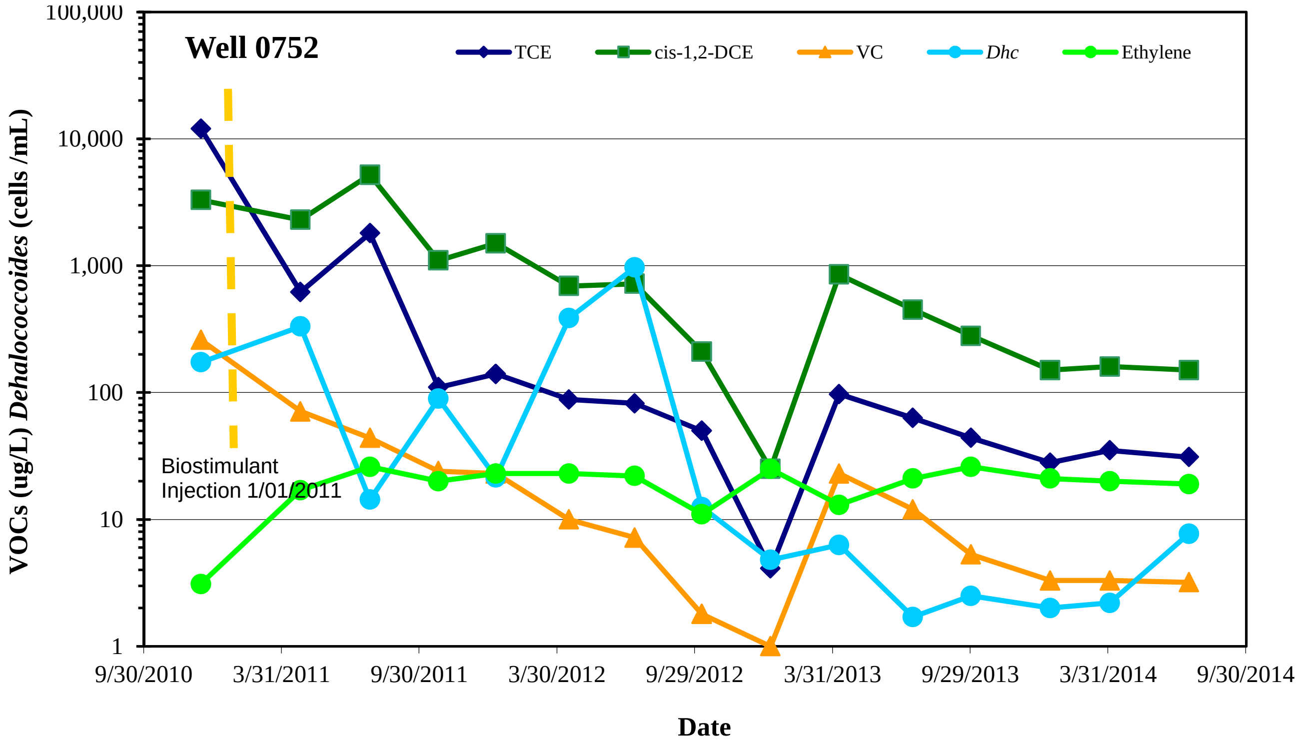


Figure B.1.10. Well 0997 Hydrograph.

This page intentionally blank.

B.2 BETHEL VALLEY 7000 AREA BIOSTIMULATION PILOT TEST GRAPHS

This page intentionally left blank.



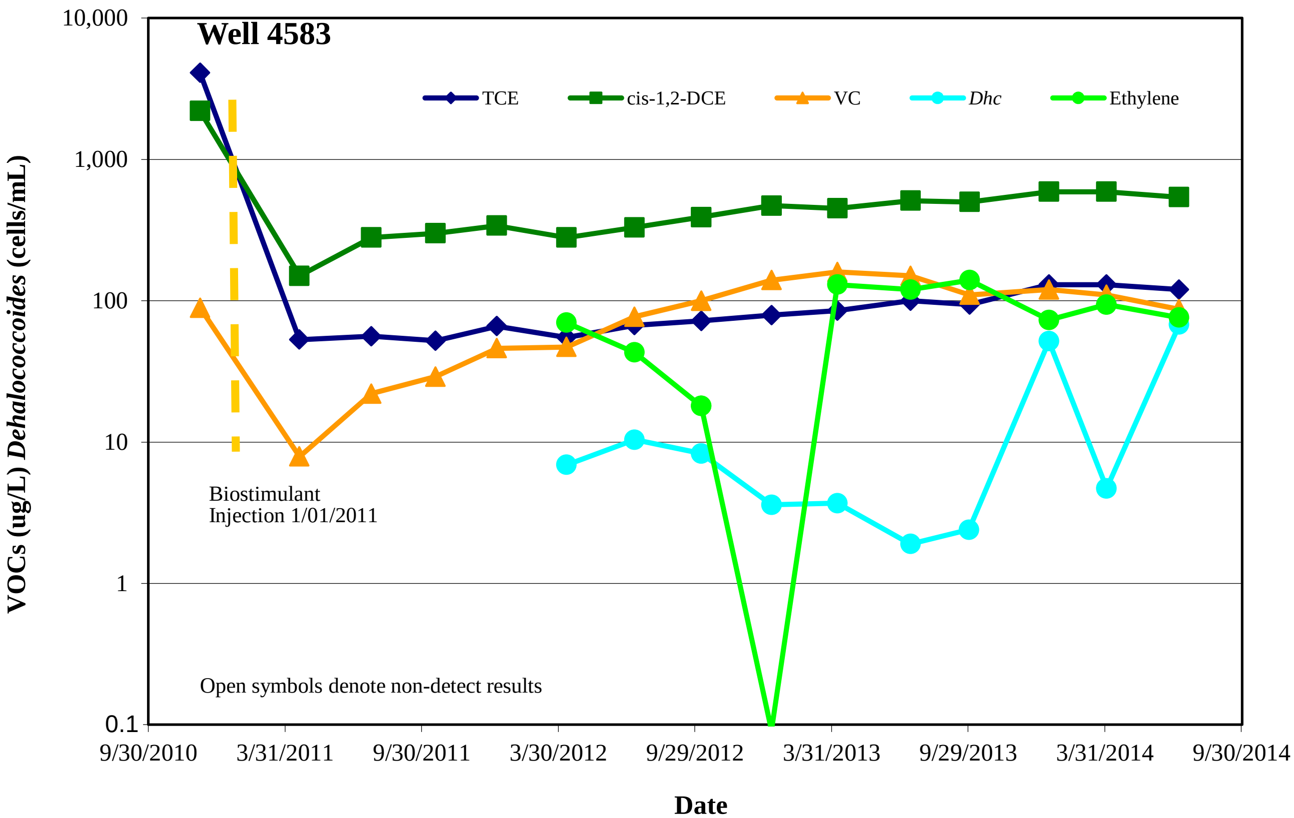
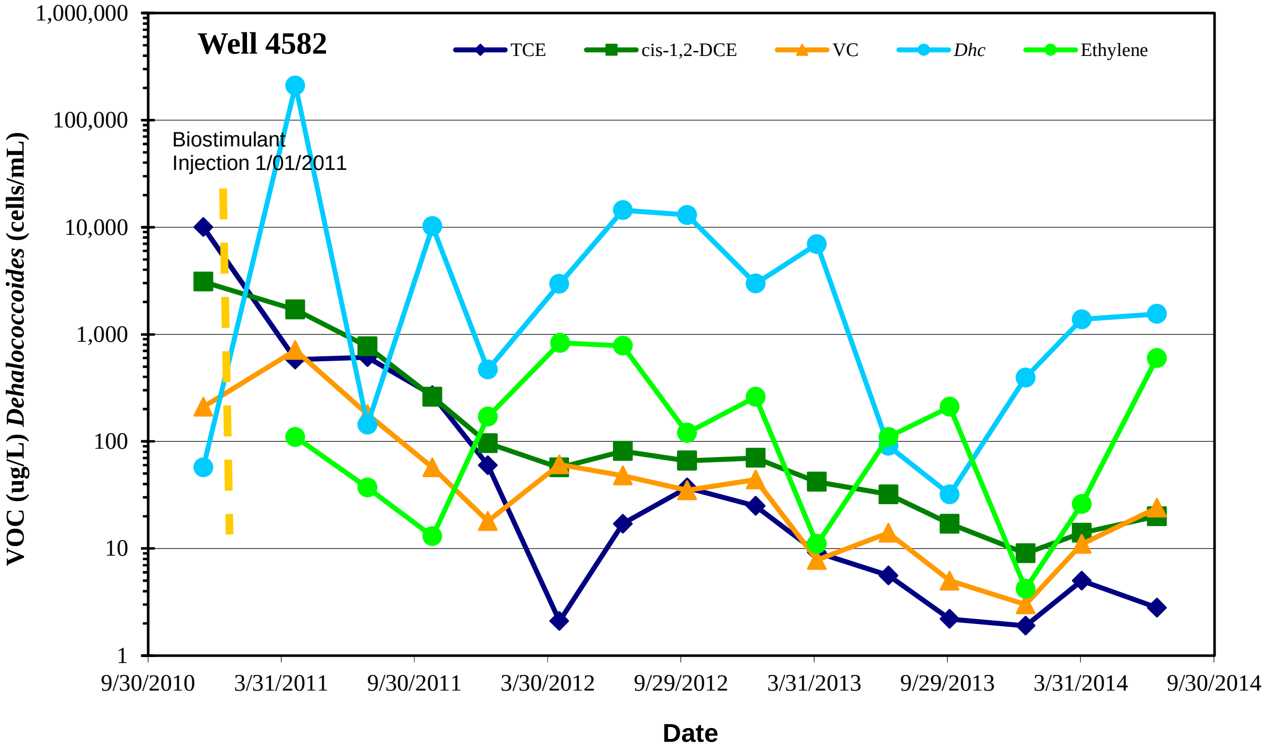


Figure B.2.1. Volatile organic compound and *Dehalococcoides* trends in wells 0752 and 4583.



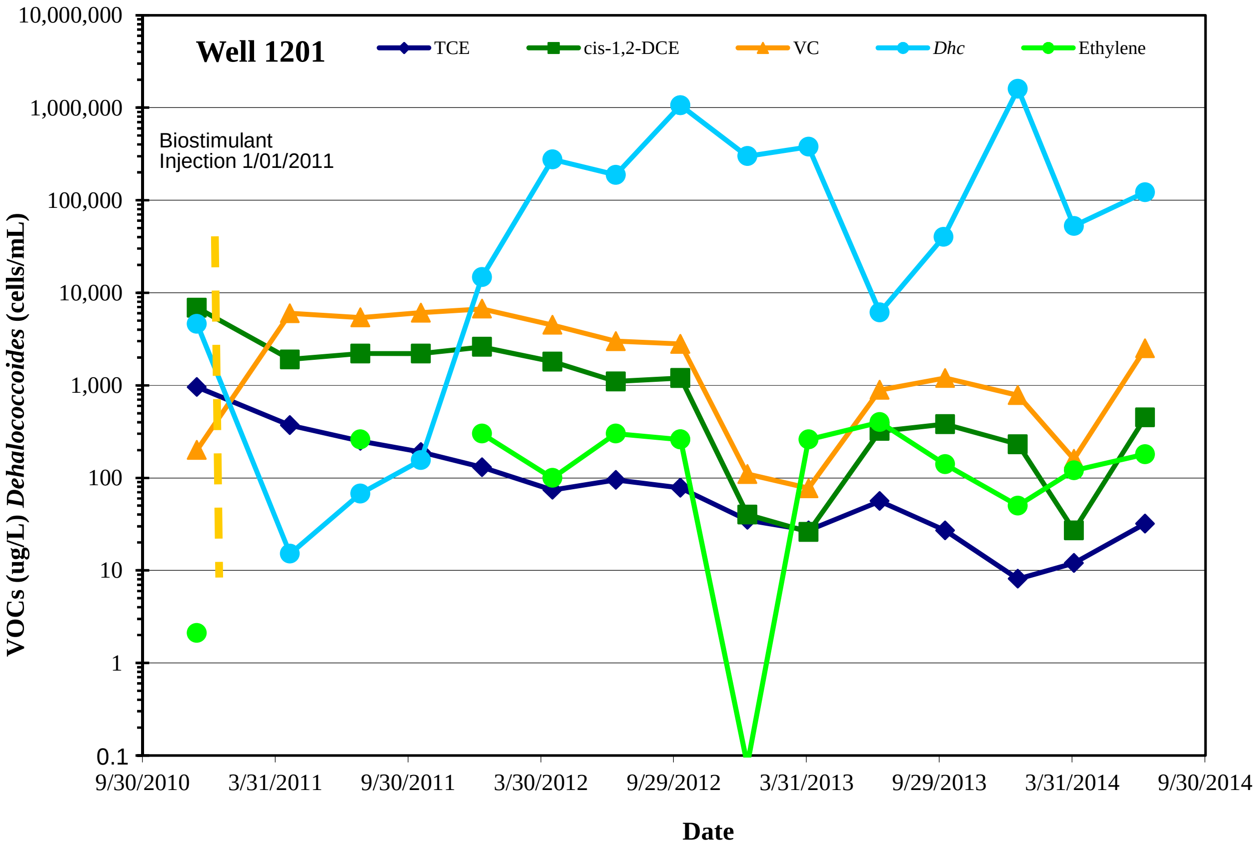


Figure B.2.2. Volatile organic compound and *Dehalococcoides* trends in wells 4582 and 1201.

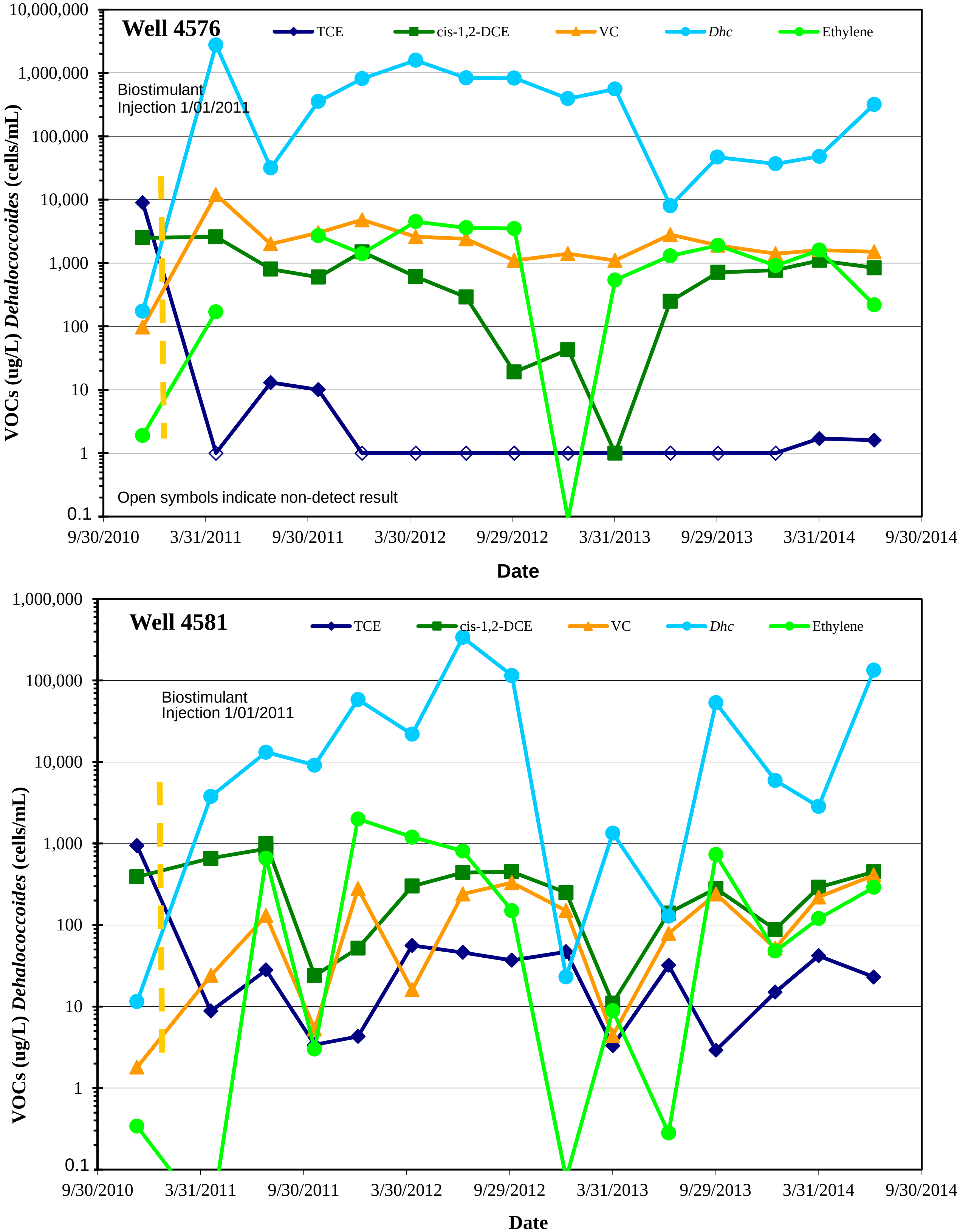


Figure B.2.3. Volatile organic compound and *Dehalococcoides* trends in wells 4576 and 4581.

This page intentionally left blank.

B.3 MELTON VALLEY GROUNDWATER LEVEL PERFORMANCE AND HYDROGRAPHS

This page intentionally blank.

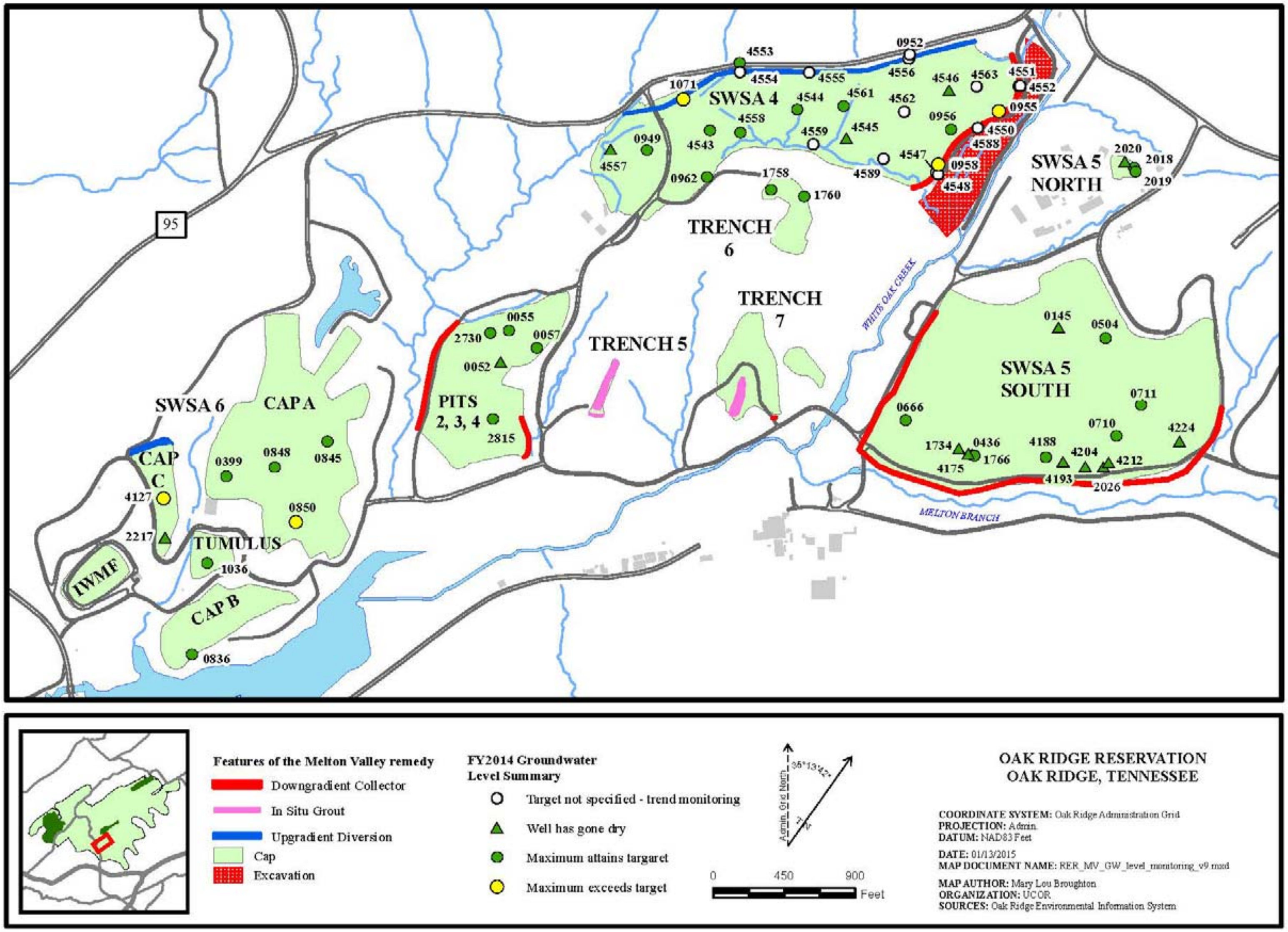


Figure B.3.1. Locations of groundwater elevation monitoring in Melton Valley.

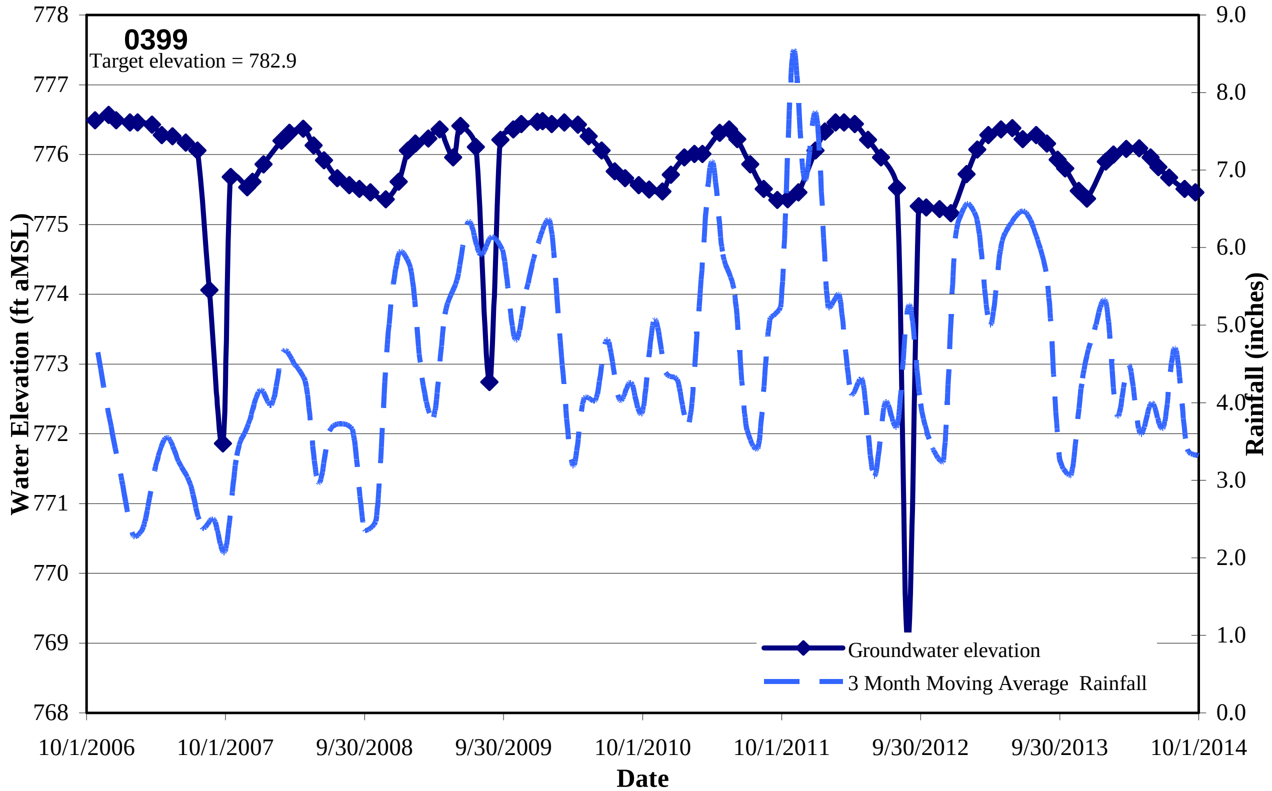
Table B.3.1. FY 2014 Melton Valley Groundwater Level Summary

Well	Area	Meas Freq	Maximum Elevation (ft aMSL)	Observed Range (ft)	TE (ft aMSL)	Target Range (ft)	Meets TE	Meets Fluct
0052	PT-2,3,4	M	dry	--	791.0	NS	Y	NA
0055	PT-2,3,4	C	785.52	0.57	795.00	NS	Y	NA
0057	PT-2,3,4	M	783.16	1.83	795.00	NS	Y	NA
2730	PT-2,3,4	M	778.78	0.75	791.00	NS	Y	NA
2815	PT-2,3,4	M	770.08	0.99	789.00	NS	Y	NA
1758	PT-Trench 6	M	829.83	3.21	836	4.42	Y	Y
1760	PT-Trench 6	M	820.95	2.01	836	1.00	Y	N
0949	SWSA 4	C	803.04	1.52	813.78	1.48	Y	N
0955	SWSA 4	M	761.73	2.99	759.42	1.03	N	N
0956	SWSA 4	C	767.38	0.21	770.49	0.40	Y	Y
0958	SWSA 4	Q	762.07	1.88	761.25	0.72	N	N
0962	SWSA 4	Q	818.4	1.23	822.85	0.57	Y	N
1071	SWSA 4	C	803.16	0.76	802.44	0.79	N	Y
4543	SWSA 4	C	798	0.86	803.31	NS	Y	NA
4544	SWSA 4	C	789.56	0.28	791.89	N	Y	NA
4545	SWSA 4	M	dry		777.25	NS	Y	NA
4546	SWSA 4	M	dry		NS	1.1	Y	
4554	SWSA 4	M	810.64	1.75	NS	NS	NA	NA
4555	SWSA 4	C	810.8	3.9	NS	1.25	Y	NA
4556	SWSA 4	C	807.61	2.3	NS	NS	NA	NA
4557	SWSA 4	M	dry	--	NS	NS	Y	NA
4558	SWSA 4	M	789.91	0.100	NS	0.18	NA	N
4559	SWSA 4	M	777.32	0.16	NS	0.38	NA	Y
4561	SWSA 4	M	792.16	0.5	NS	NS	NA	NA
4562	SWSA 4	M	782.31	0.16	NS	NS	NA	NA
4563	SWSA 4	C	777.34	0.83	NS	NS	NA	NA
2018	SWSA 5-N	M	821.86	NA	822.2	2.5	Y	Y
2019	SWSA 5-N	M	809.66	3.68	824.30	1.67	Y	N
2020	SWSA 5-N	M	dry	--	828.20	0.78	Y	NA
0145	SWSA 5-S	M	dry	--	829.10	1.9	Y	NA
0436	SWSA 5-S	M	766.07	0.47	773.90	2.35	Y	Y
0504	SWSA 5-S	M	810.8	0.1	813.10	1.83	Y	Y
0666	SWSA 5-S	M	768.11	1.06	776.10	1.35	Y	Y
0710	SWSA 5-S	M	778.16	0.34	791.50	1.10	Y	Y

Table B.3.1. FY 2014 Melton Valley Groundwater Level Summary (cont.)

Well	Area	Meas Freq	Maximum Elevation (ft aMSL)	Observed Range (ft)	TE (ft aMSL)	Target Range (ft)	Meets TE	Meets Fluct
0711	SWSA 5-S	M	796.77	0.08	806.1	2.9	Y	Y
1734	SWSA 5-S	M	dry	--	776.70	2.2	Y	NA
1766	SWSA 5-S	M	772.8	NA	773.9	2.1	Y	NA
2026	SWSA 5-S	M	771.63	0.49	773.3	1.2	Y	Y
4175	SWSA 5-S	M	dry	--	775.80	4.10	Y	NA
4188	SWSA 5-S	M	770.26	--	772.90	1.63	Y	NA
4193	SWSA 5-S	M	dry	--	775.40	1.32	Y	NA
4204	SWSA 5-S	M	dry	--	773.00	1.40	Y	NA
4212	SWSA 5-S	M	dry	--	773.7	1.68	Y	NA
4224	SWSA 5-S	M	dry	--	781.6	1.88	Y	NA
0399	SWSA 6	M	776.09	0.72	782.90	1.36	Y	Y
0836	SWSA 6	M	746.98	1.7	753.00	NS	Y	NA
0845	SWSA 6	M	781.47	0.63	784.10	0.82	Y	Y
0848	SWSA 6	M	778	0.82	779.20	0.27	Y	N
0850	SWSA 6	C	767.13	1.9	765.90	2.1	N	Y
1036	SWSA 6	C	764.44	4.48	768.00	NS	Y	NA
2217	SWSA 6	M	dry	--	767.6	2.5	Y	NA
4127	SWSA 6	M	774.45	1.89	772.30	2.25	N	Y

aMSL = above Mean Sea Level
C = continuous groundwater level monitoring using pressure transducer and data logger
FY = fiscal year
M = monthly manual groundwater level measurements
N = no
NA = not applicable
NS = not specified in the Melton Valley Remedial Action Report
Q = quarterly manual groundwater level measurements
SWSA = Solid Waste Storage Area
TE = target elevation
Y = yes



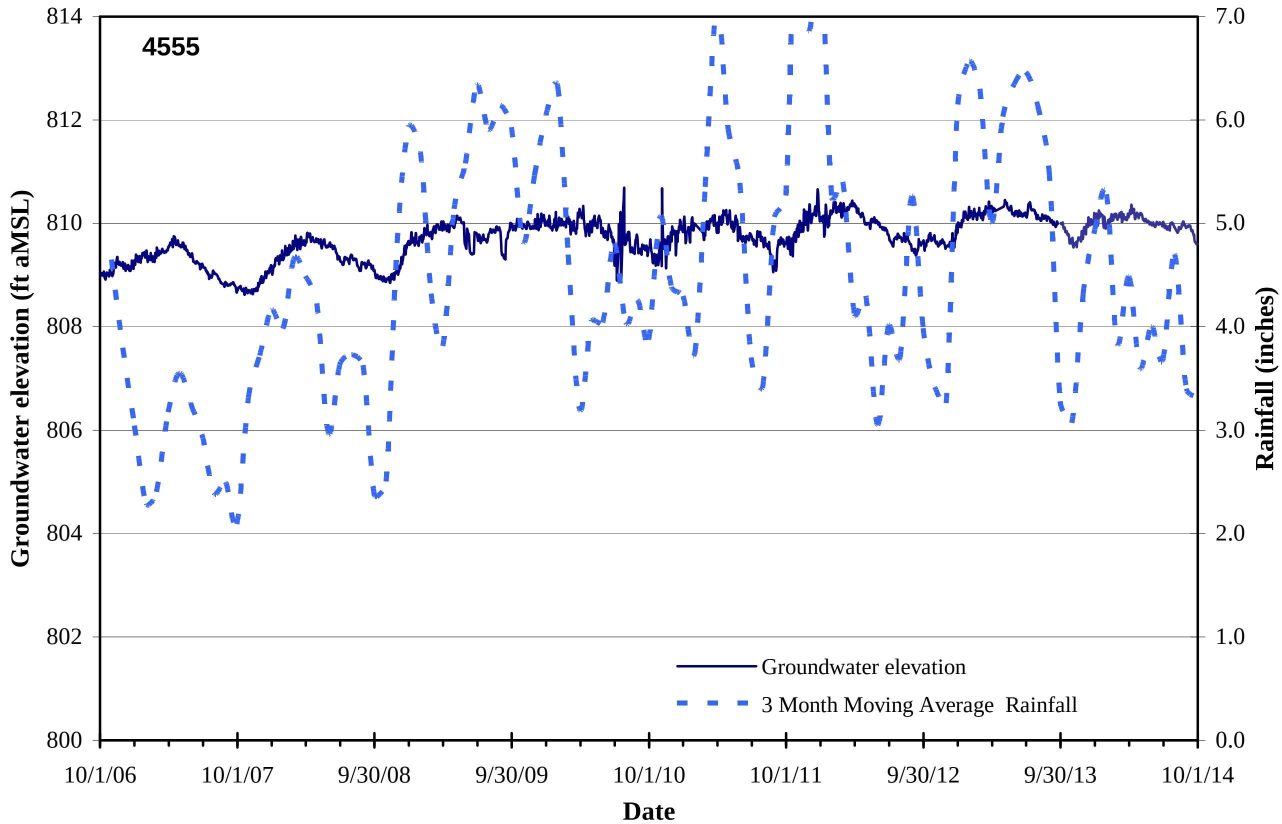
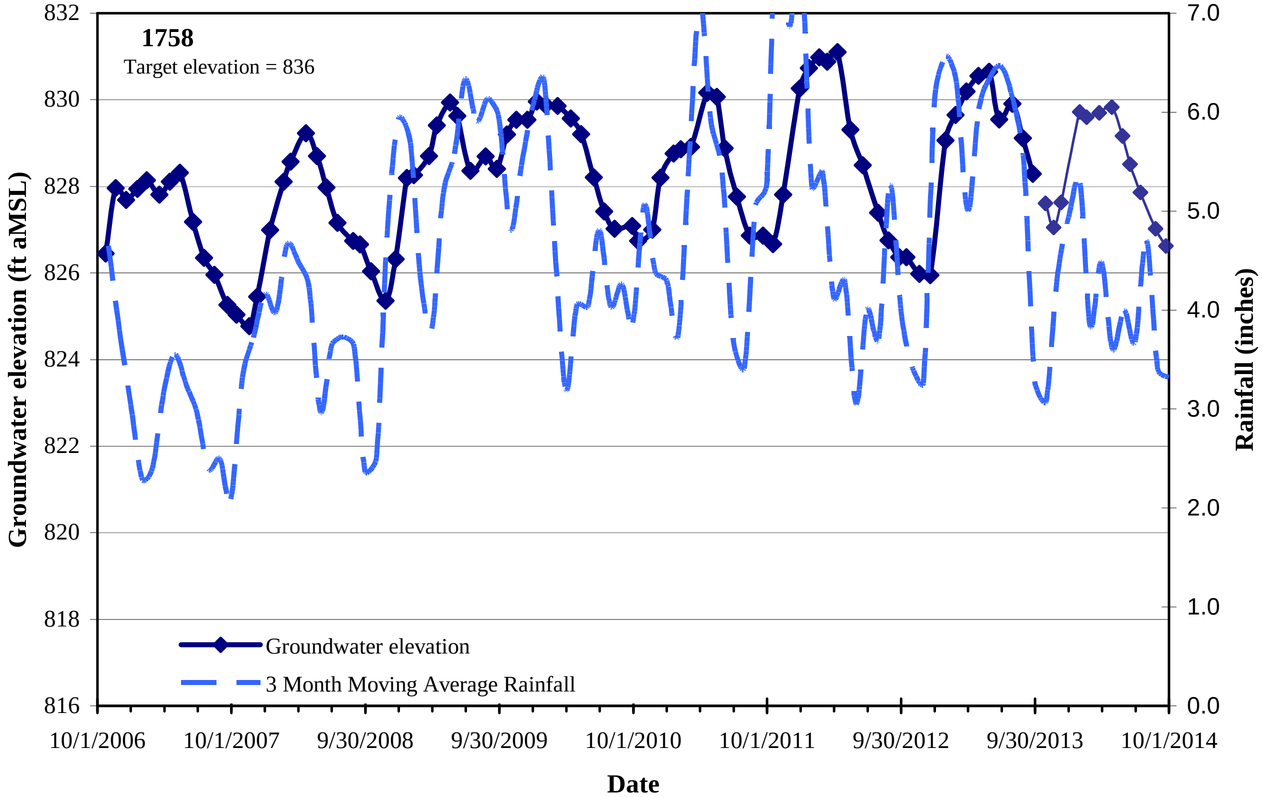


Figure B.3.2. Well hydrographs for wells 0399 and 4555.



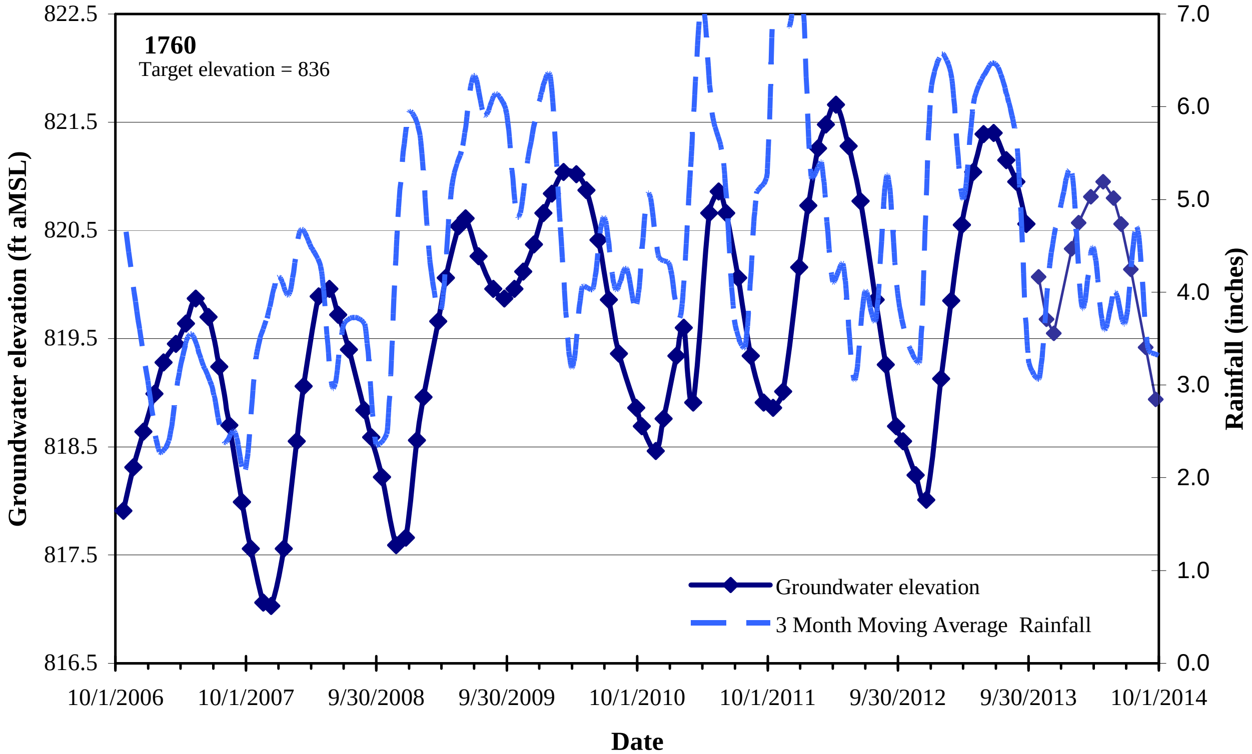
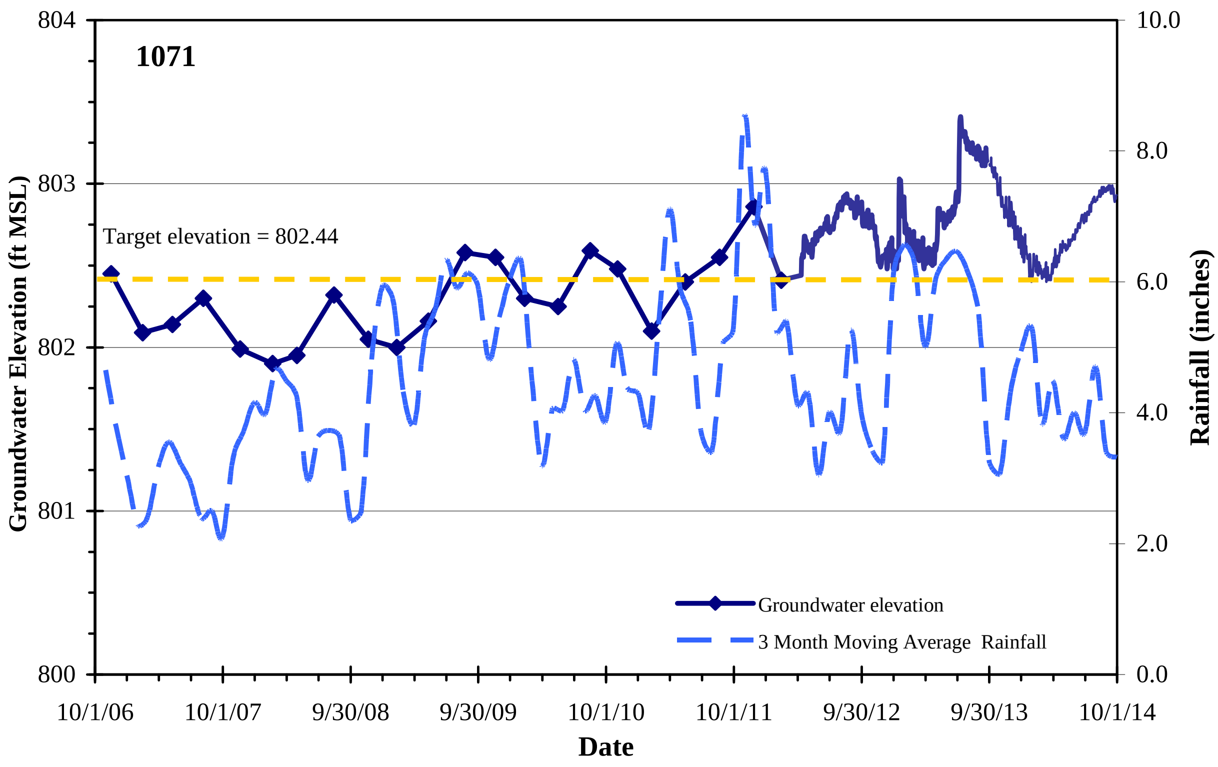


Figure B.3.3. Well hydrographs for wells 1758 and 1760.



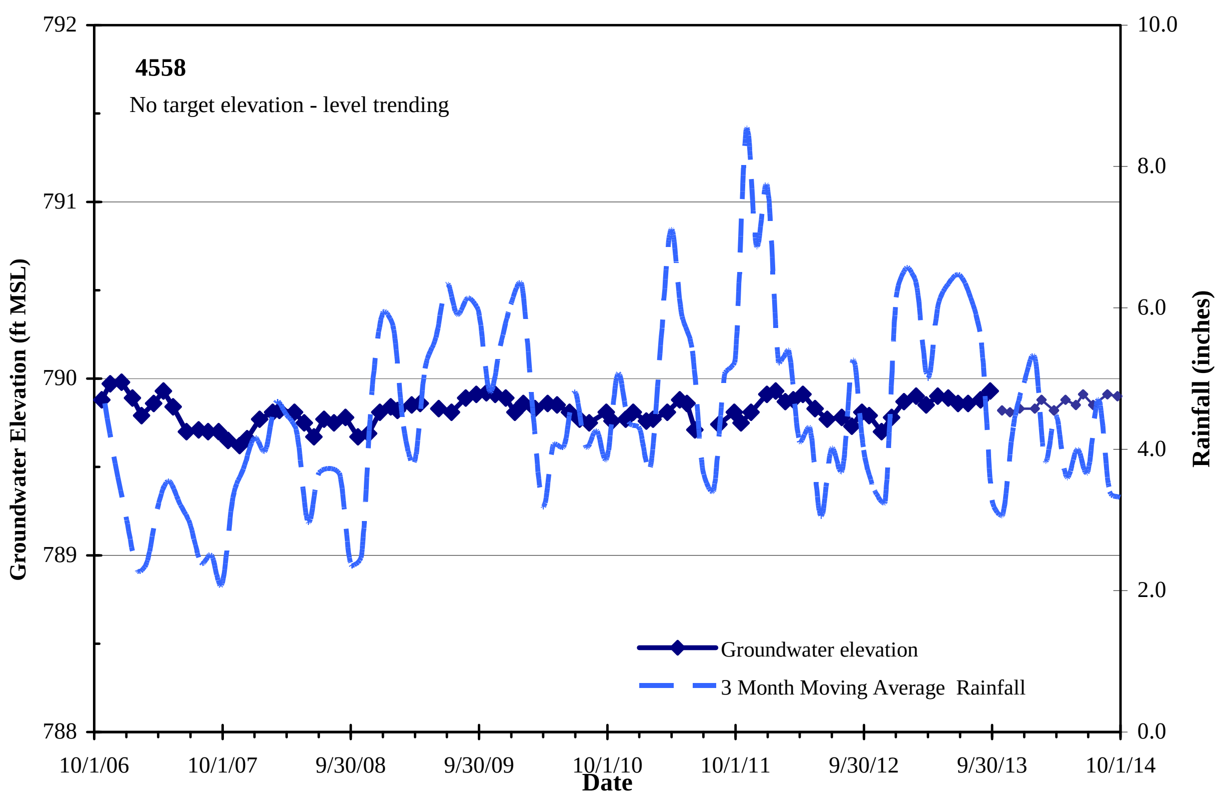
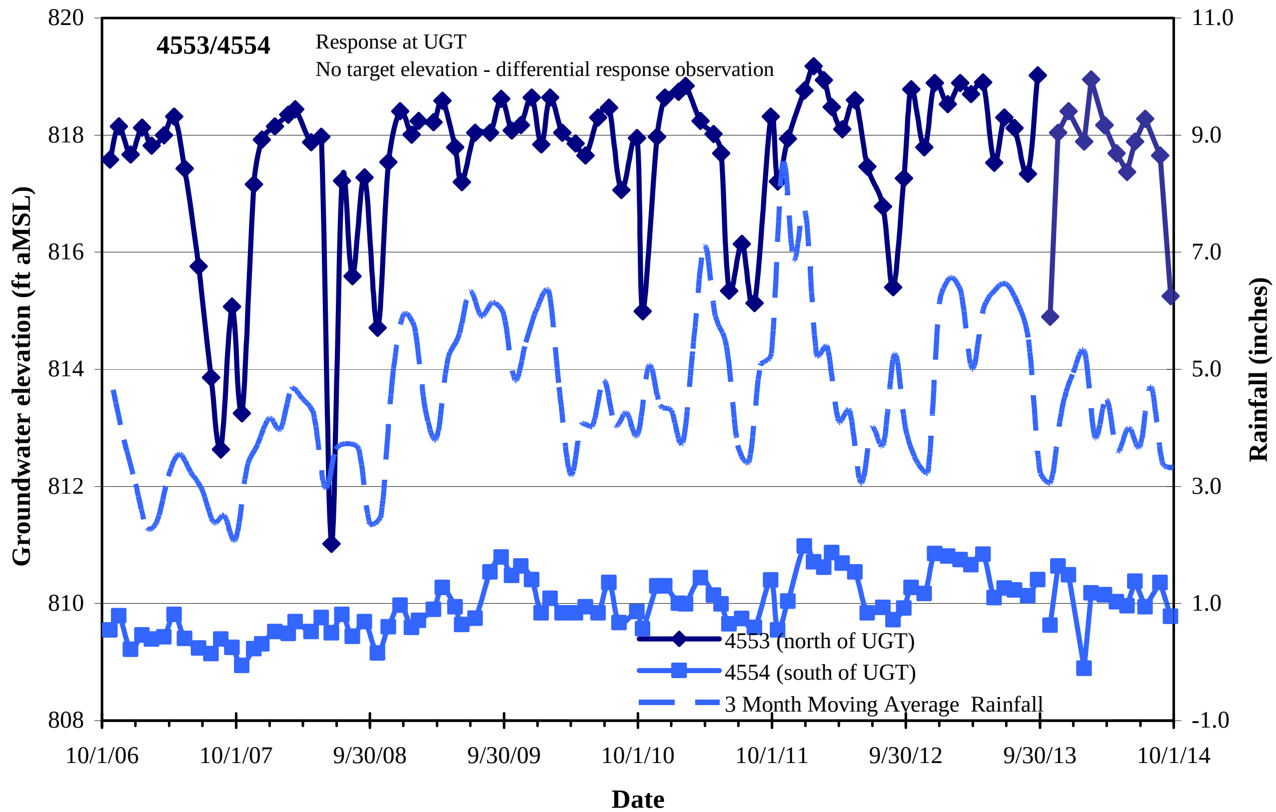


Figure B.3.4. Well hydrographs for wells 1071 and 4558.



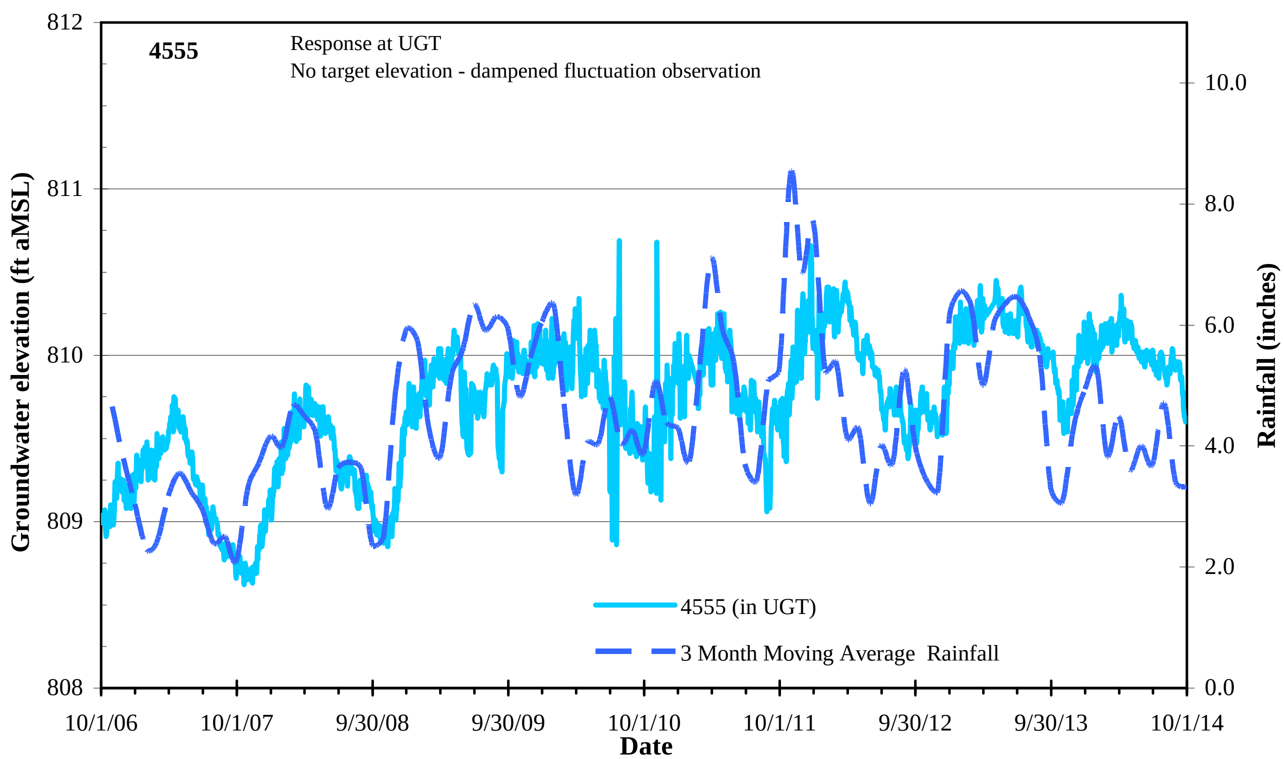
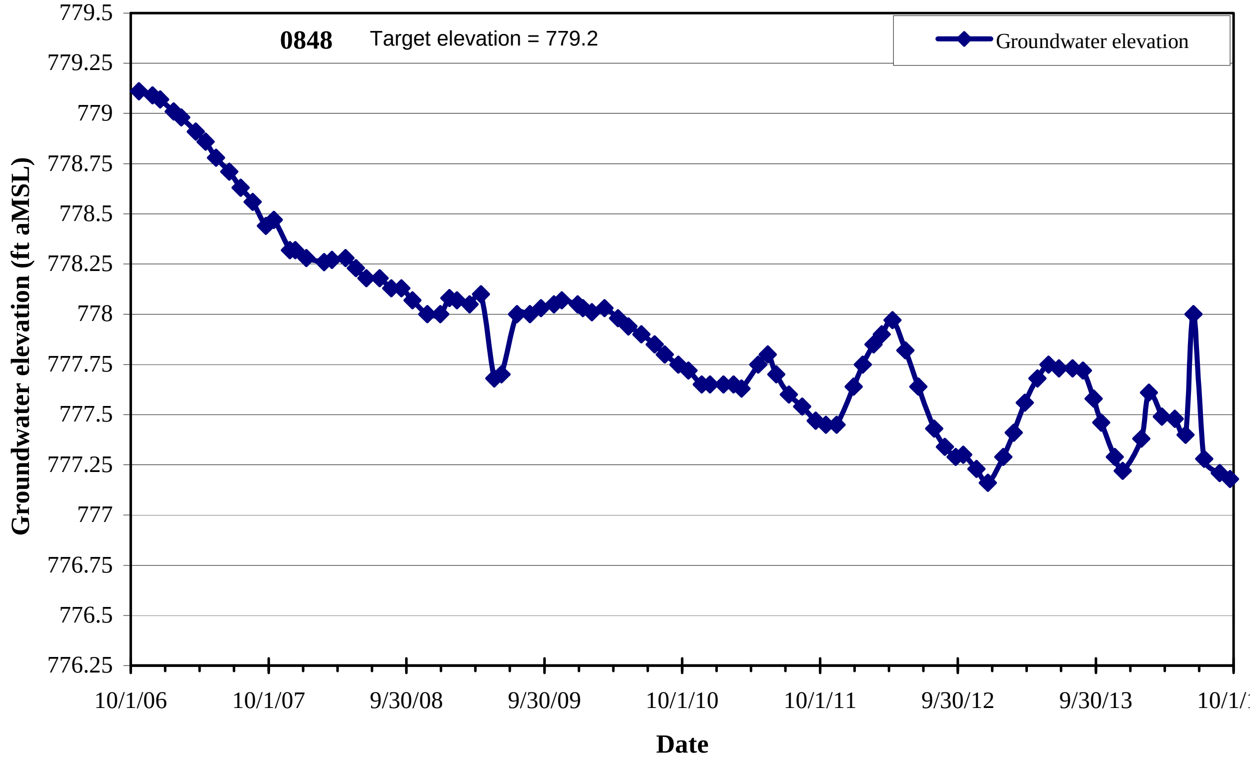


Figure B.3.5. Well hydrographs for wells 4553/4554 and 4555.



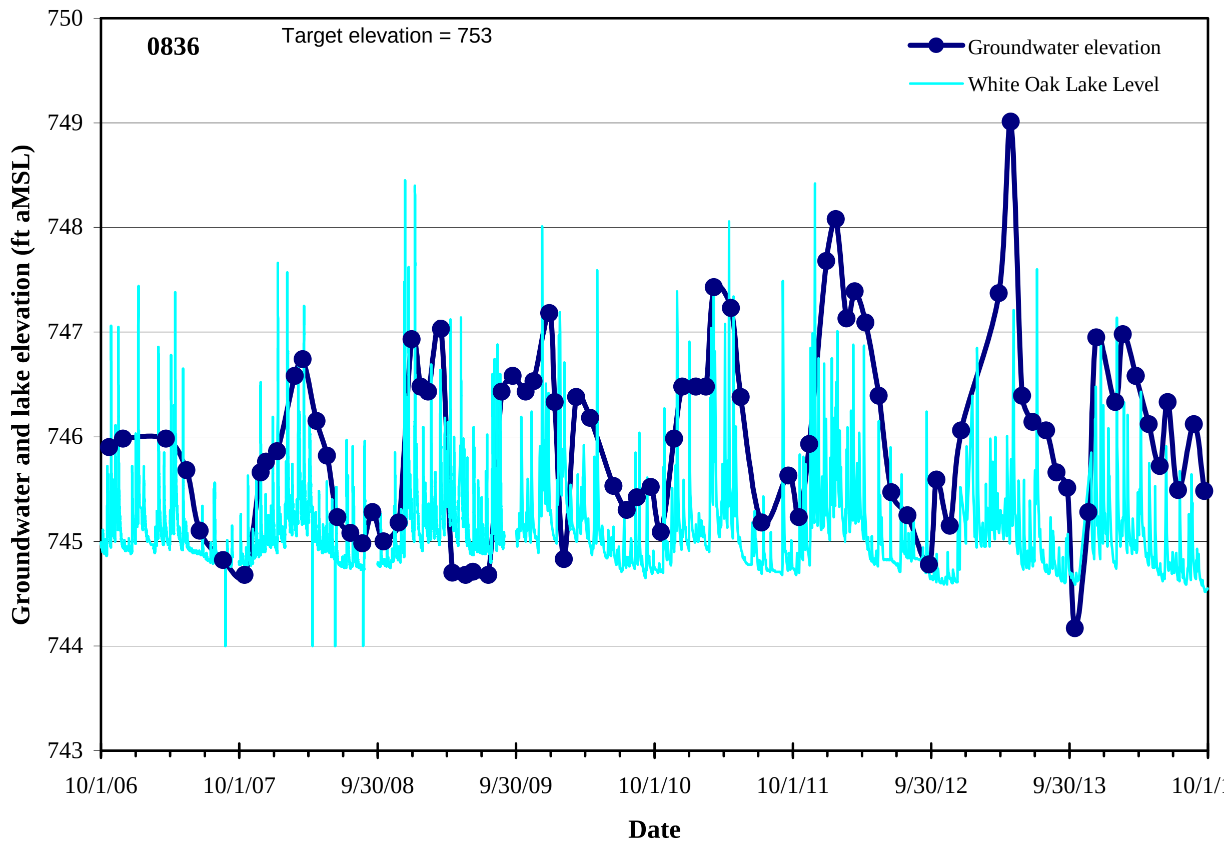
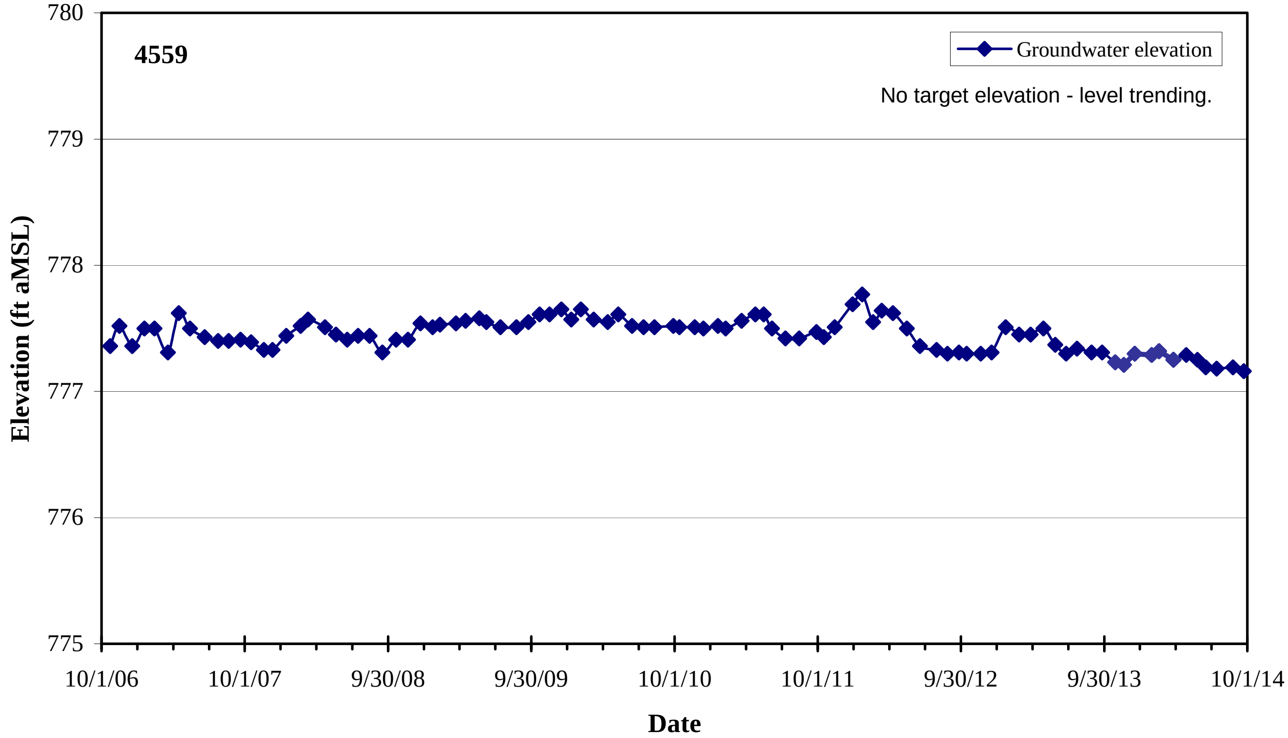


Figure B.3.6. Well hydrographs for wells 0848 and 0836.



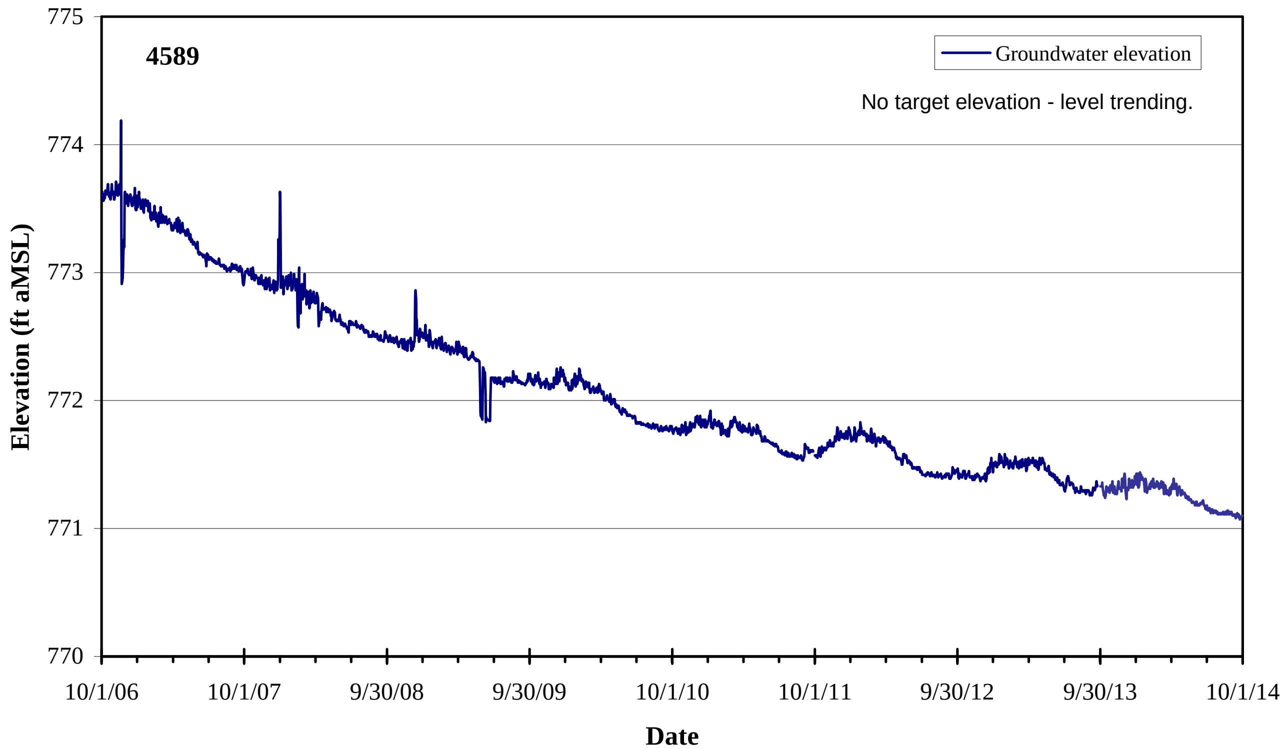
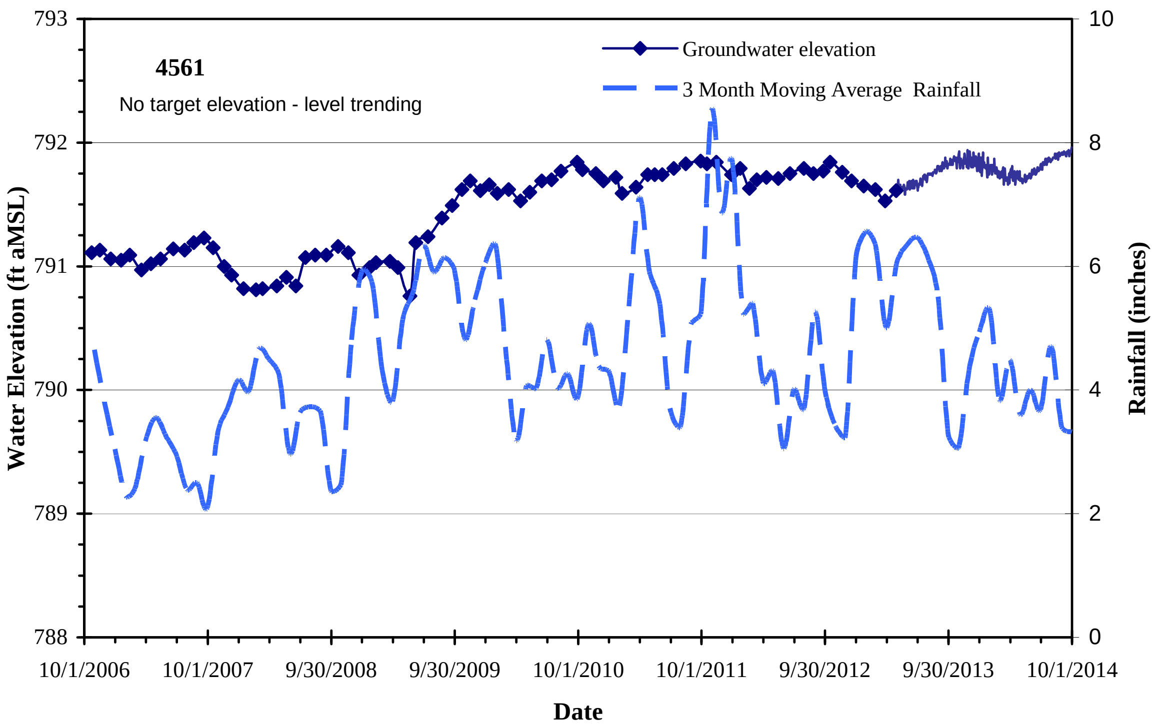


Figure B.3.7. Well hydrographs for wells 4559 and 4589.



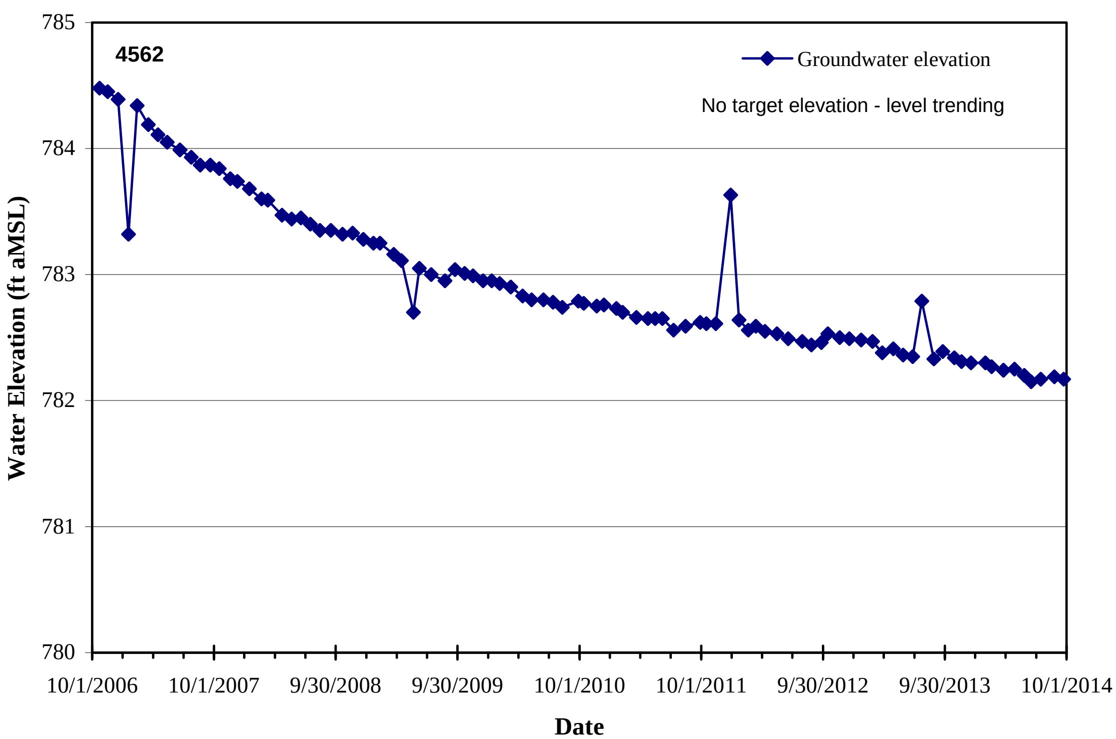
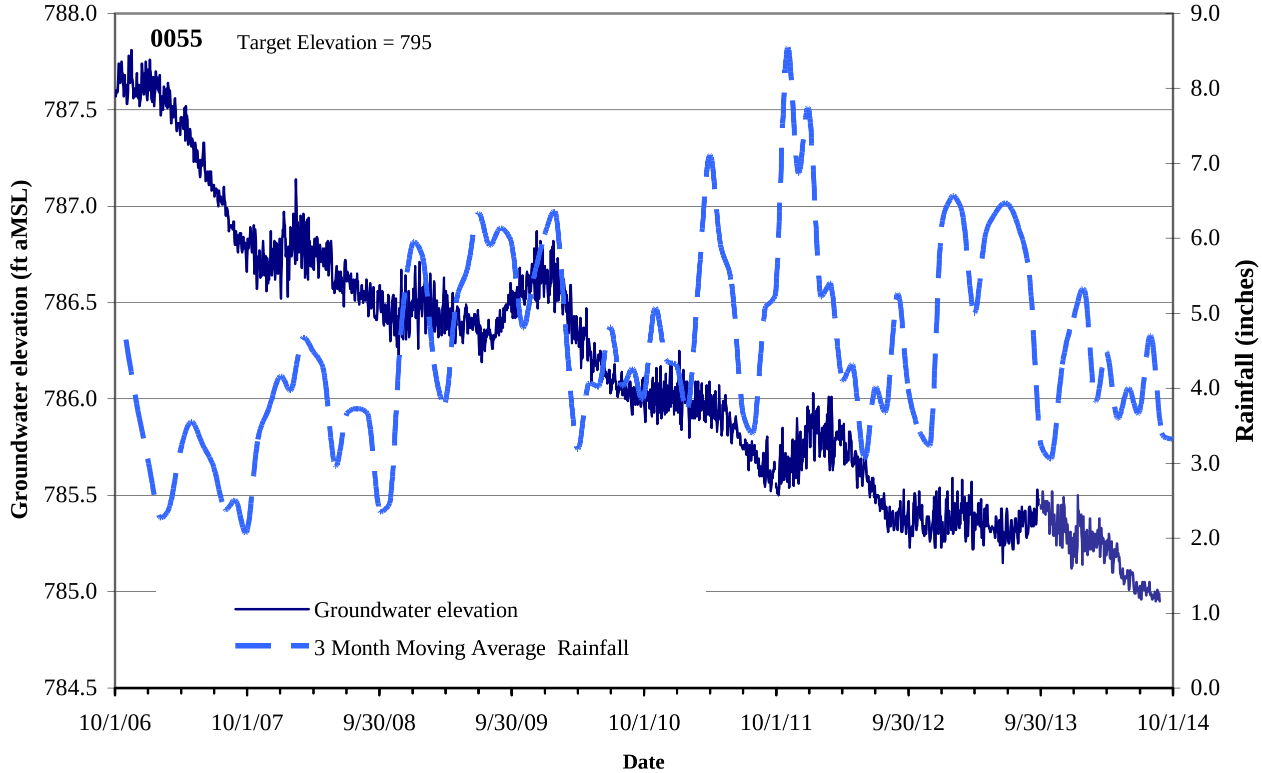


Figure B.3.8. Well hydrographs for wells 4561 and 4562.



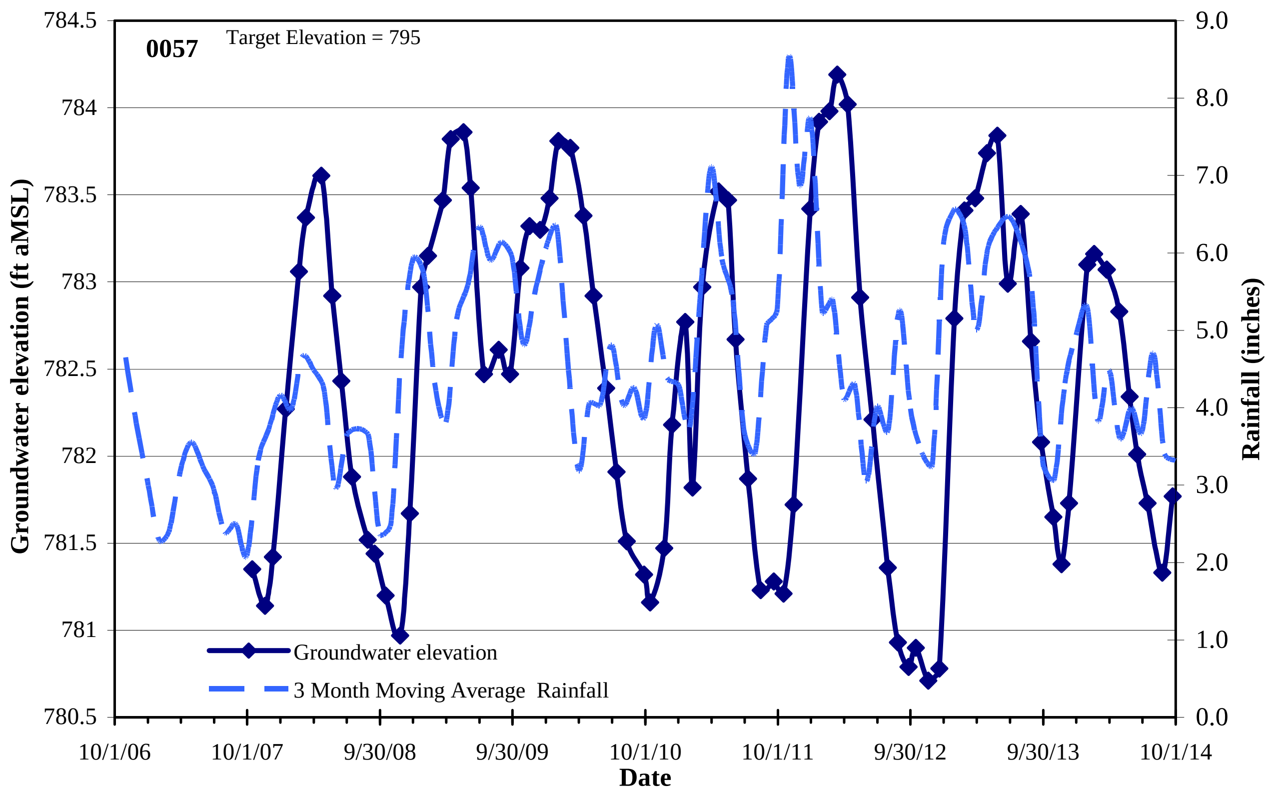
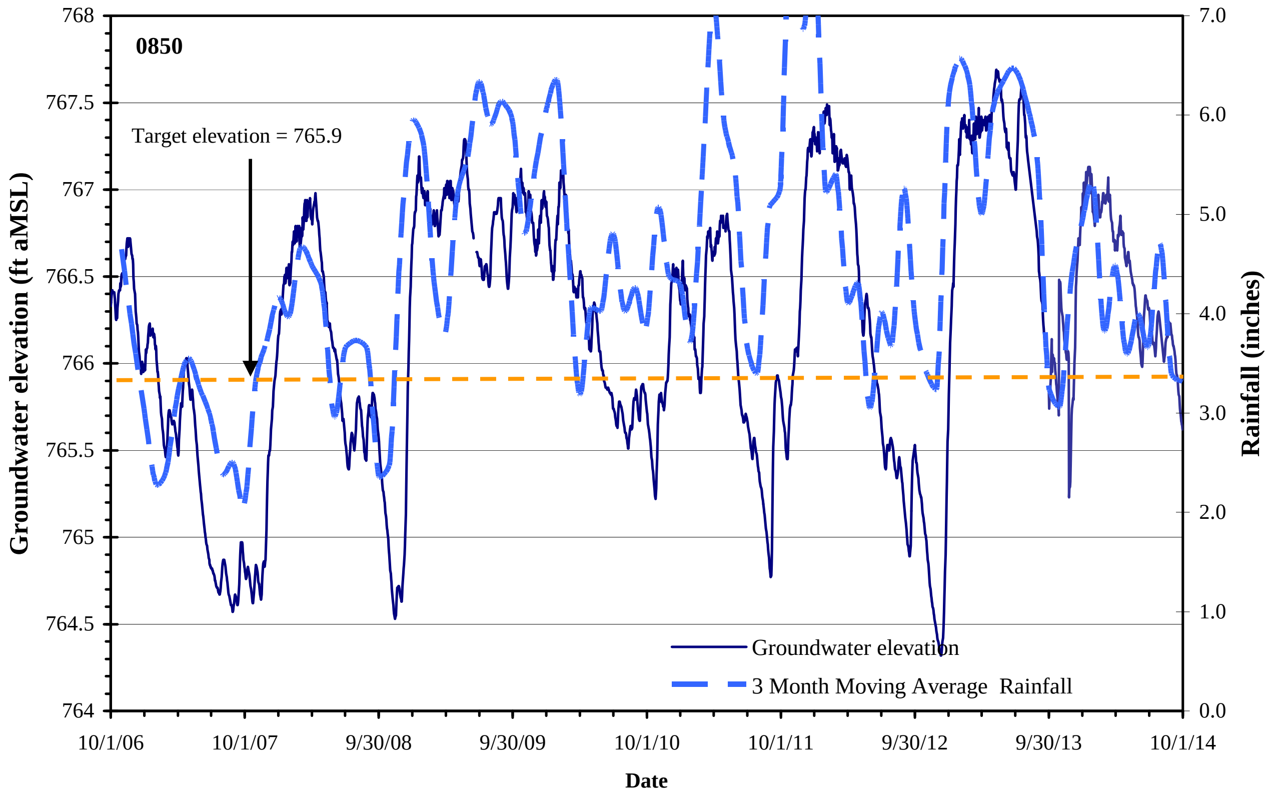


Figure B.3.9. Well hydrographs for wells 0055 and 0057.



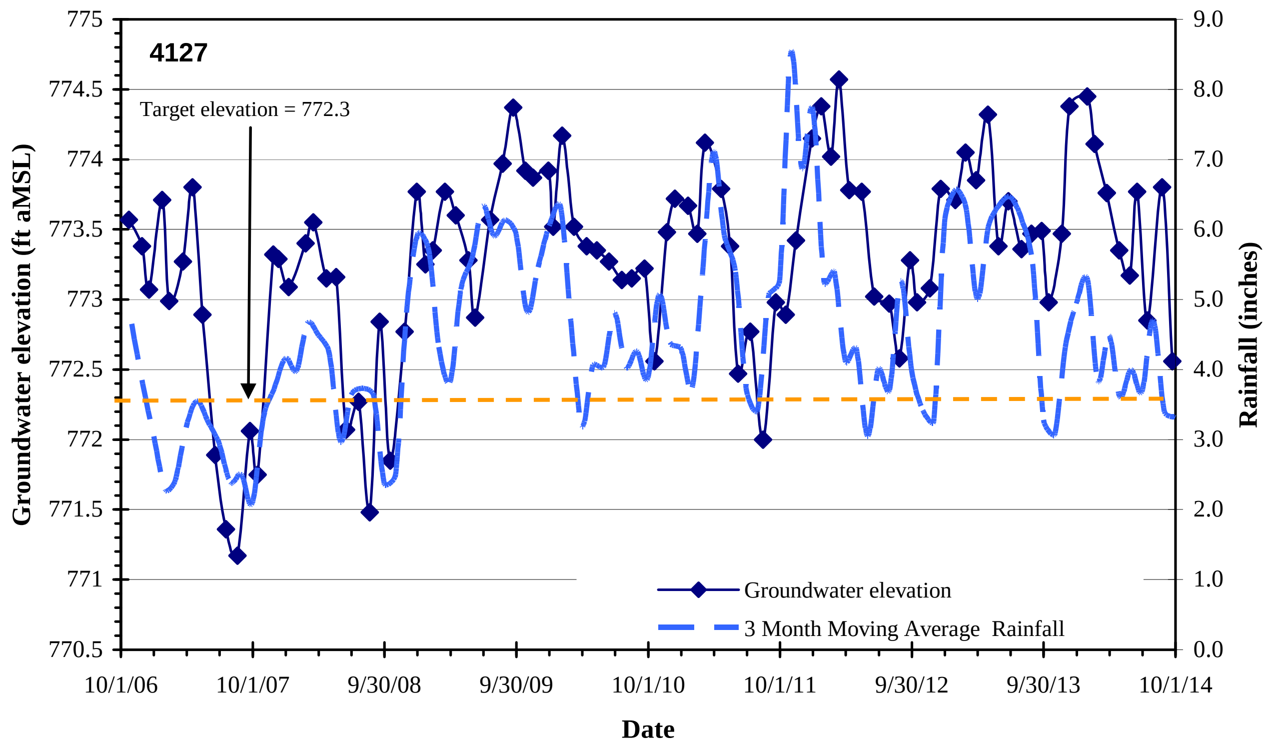
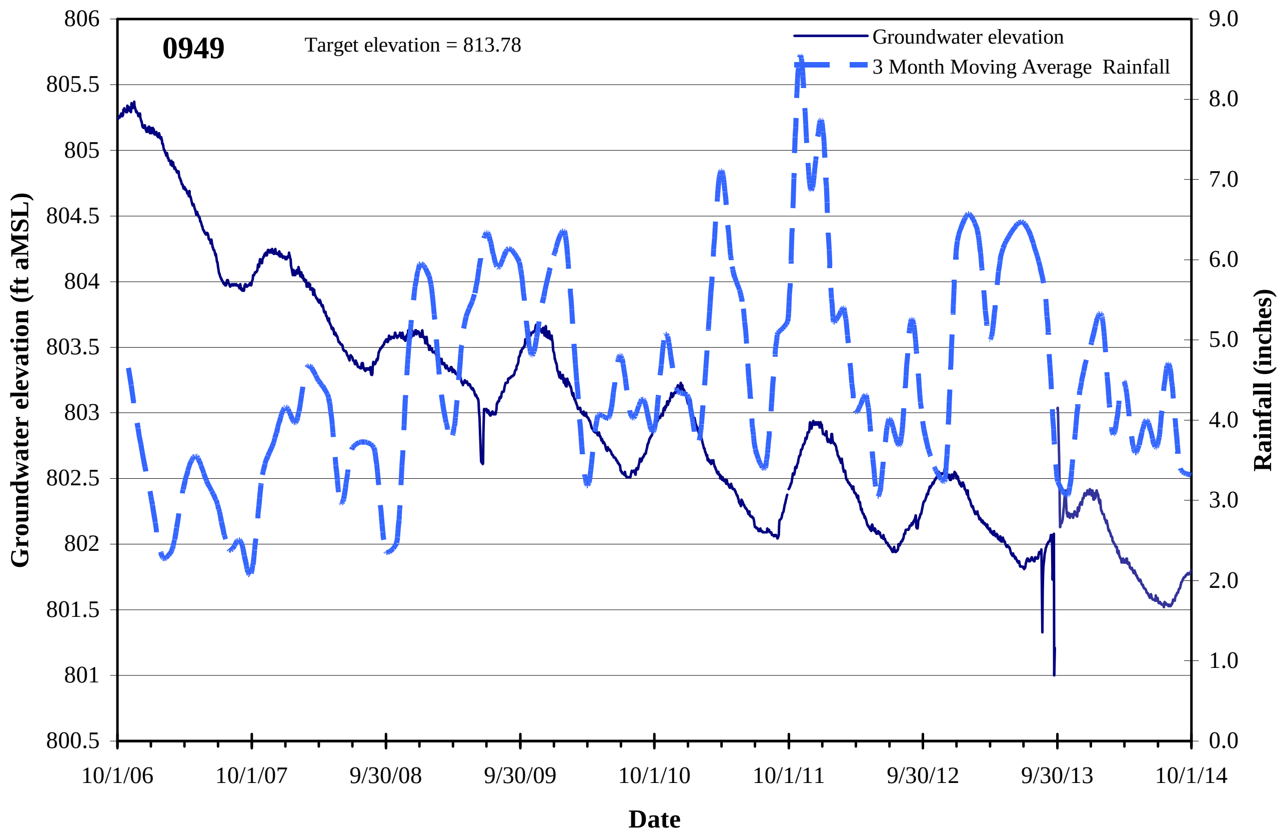


Figure B.3.10. Well hydrographs for wells 0850 and 4127.



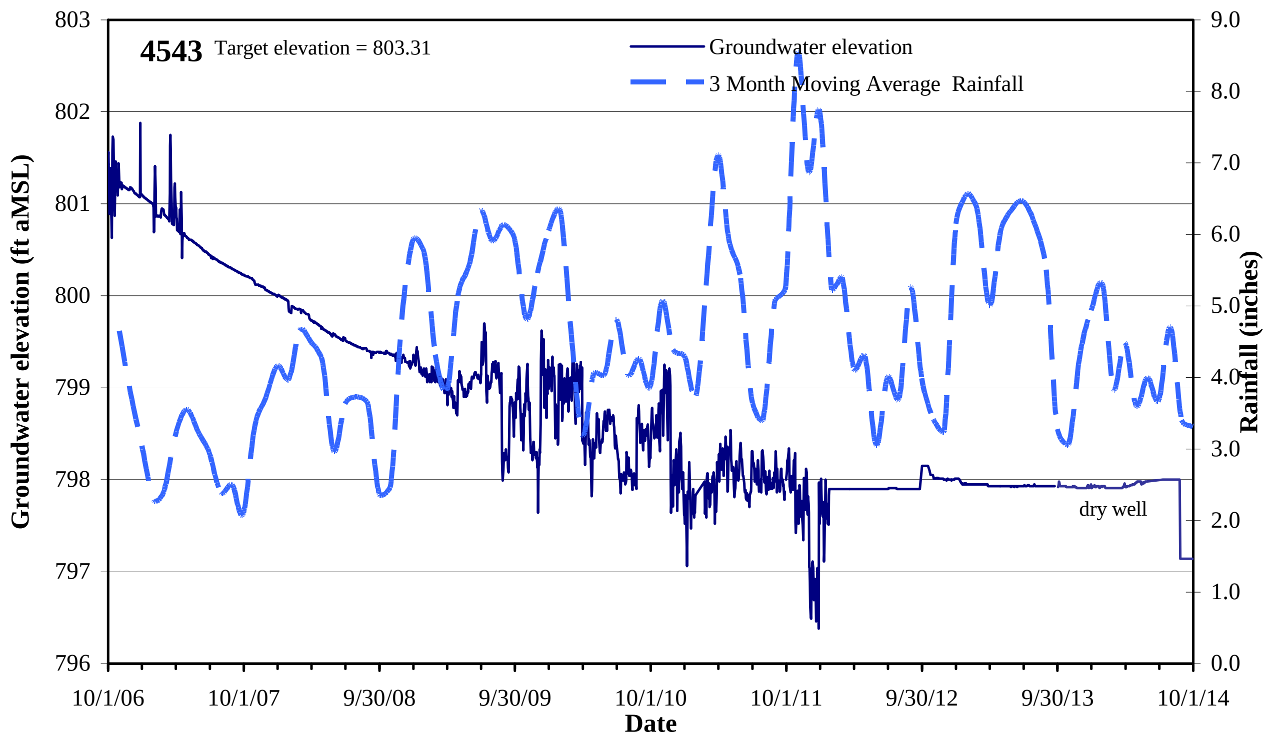
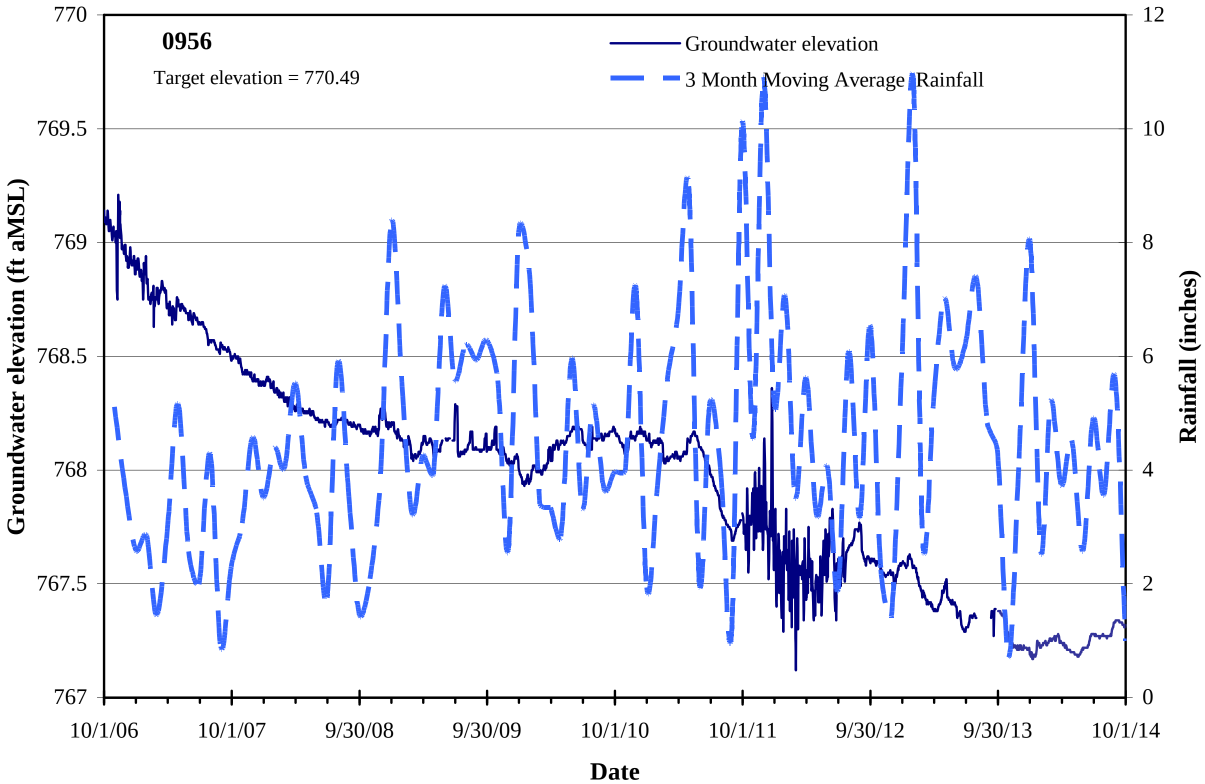


Figure B.3.11. Well hydrographs for wells 0949 and 4553.



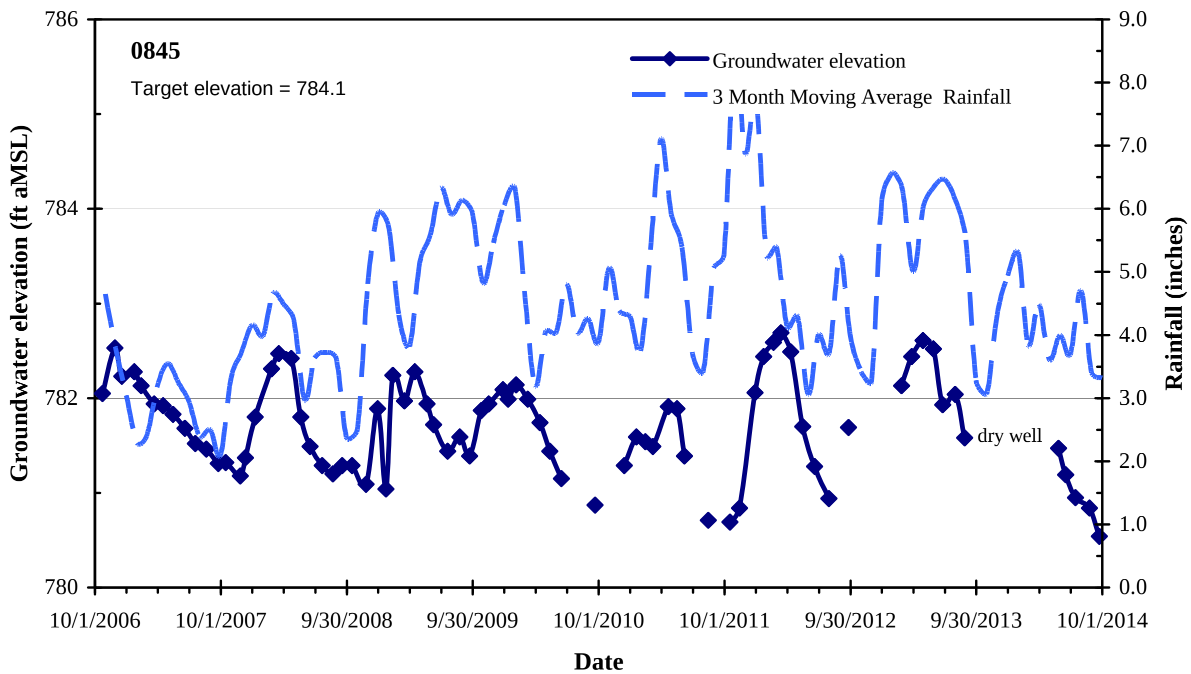
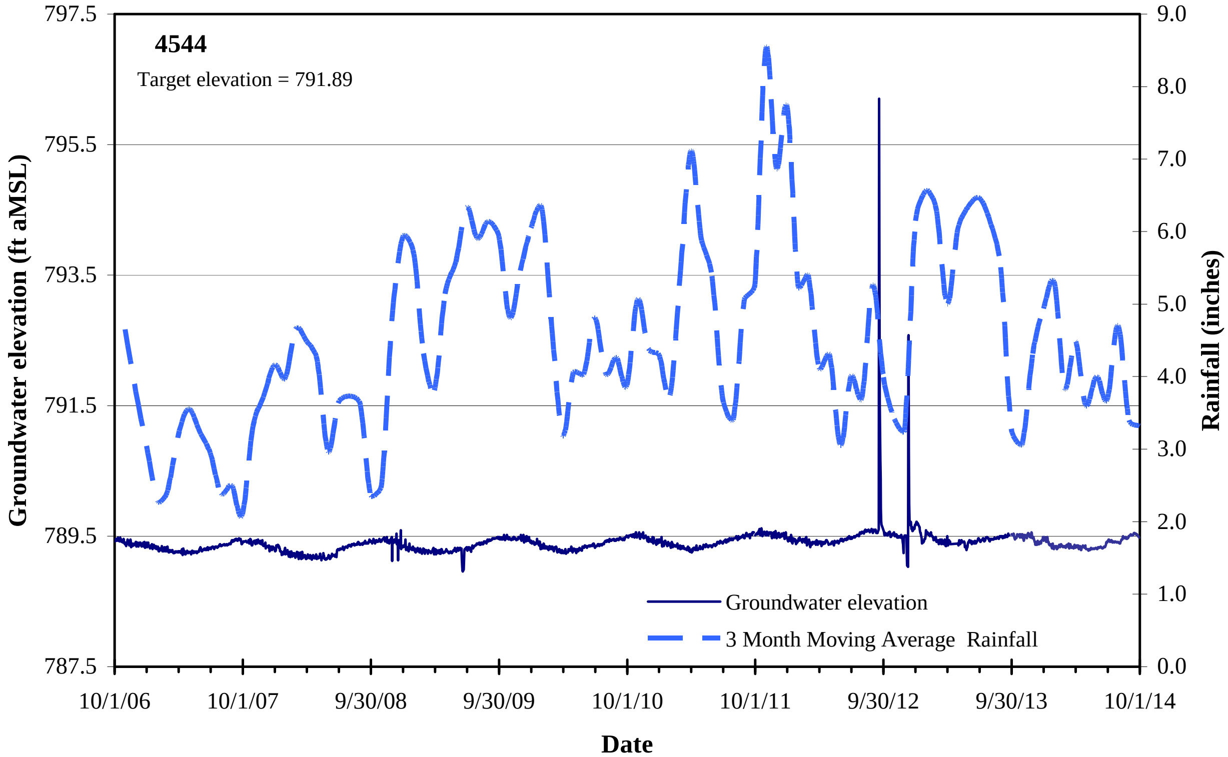


Figure B.3.12. Well hydrographs for well pair 0956 and well 0845.



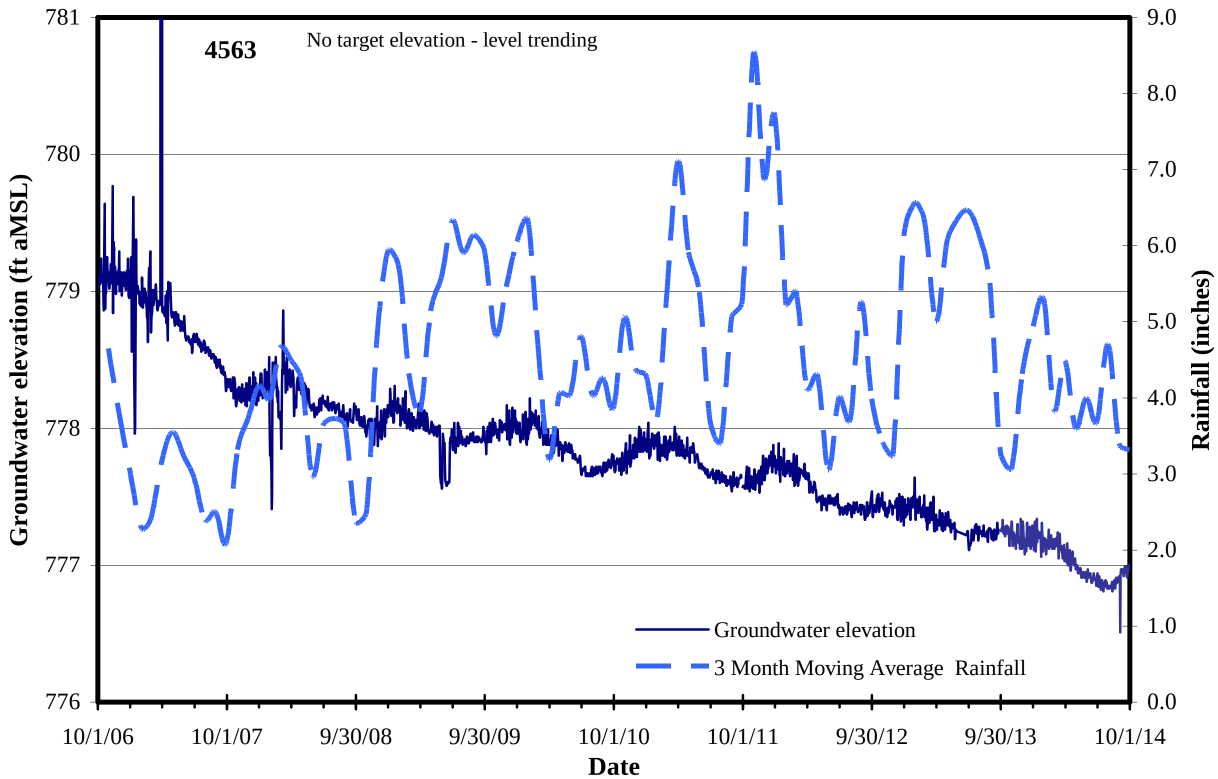
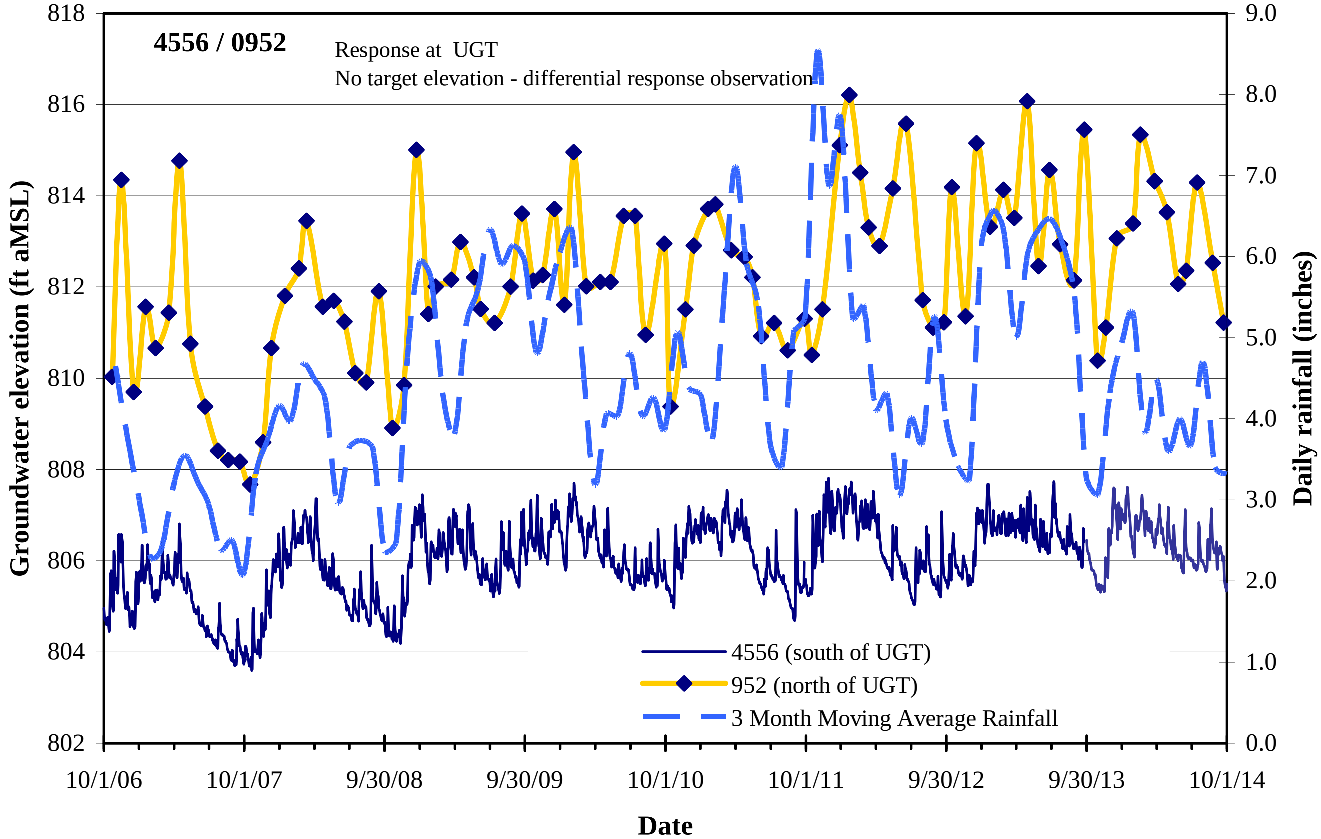


Figure B.3.13. Well hydrographs for wells 4544 and 4563.



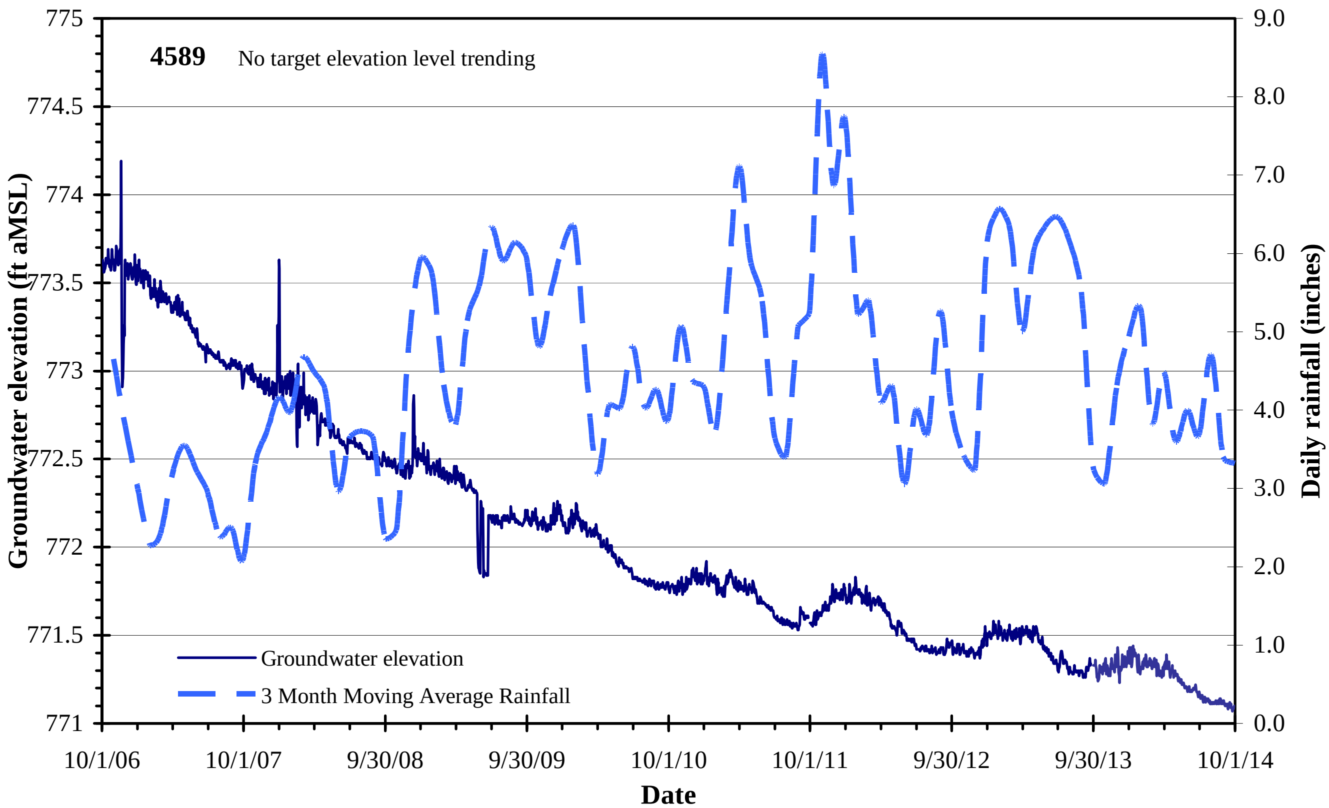


Figure B.3.14. Well hydrographs for wells 4556/0952 and 4589.

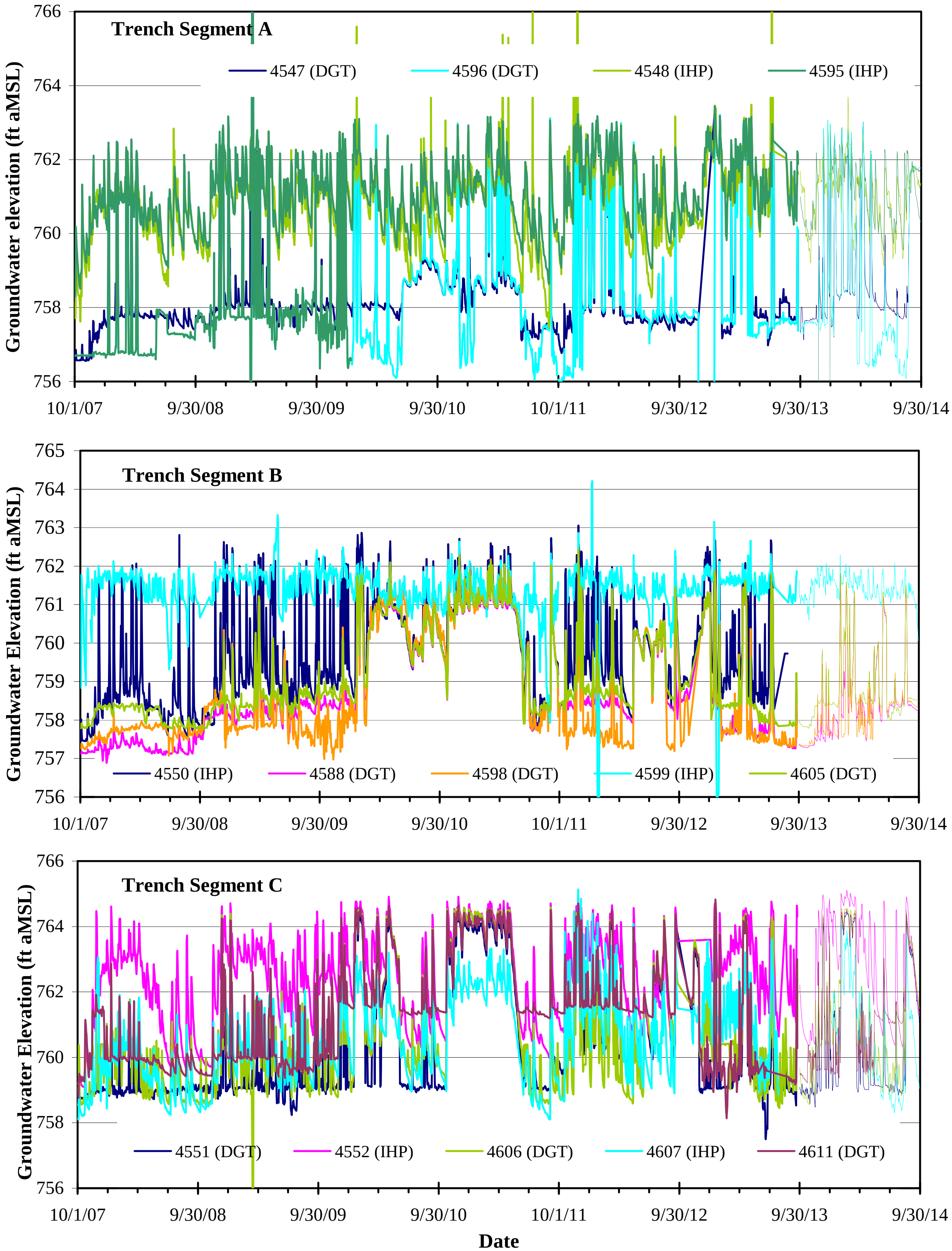
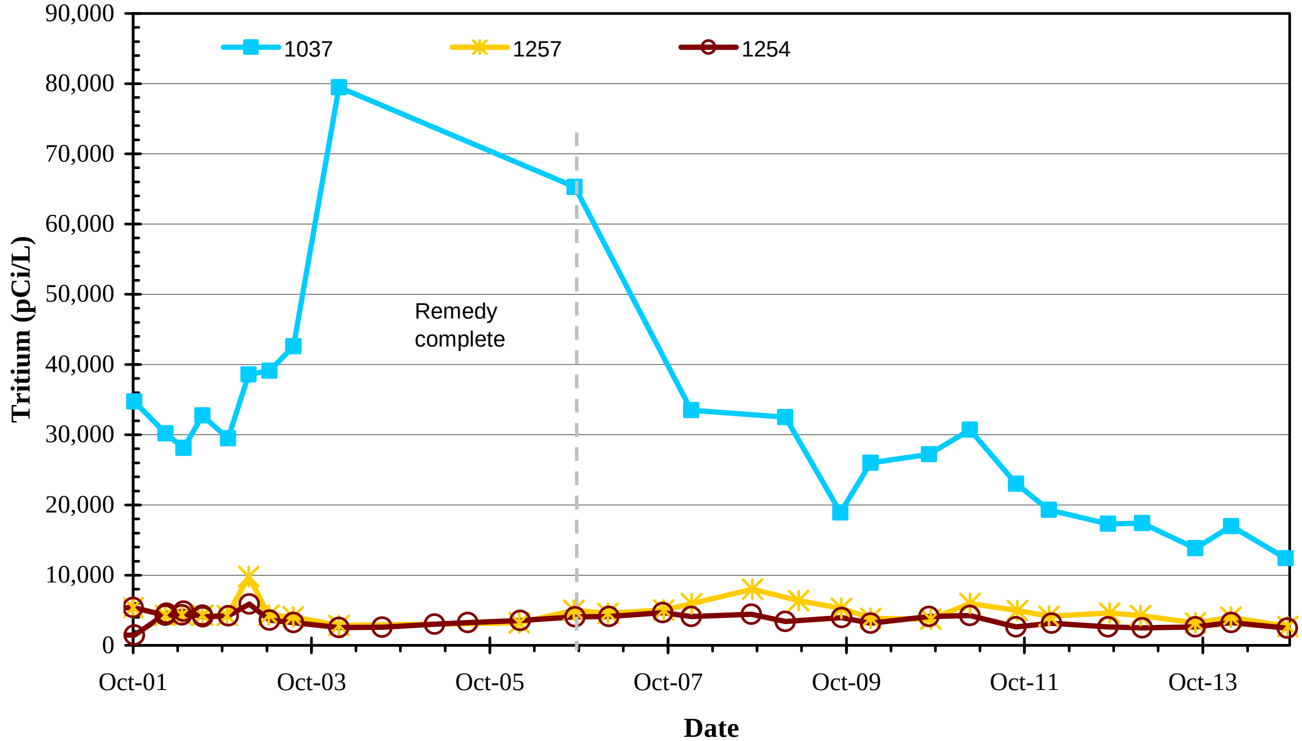


Figure B.3.15. Well hydrographs for wells at the SWSA 4 downgradient trench (FY 2008-FY 2014)

This page intentionally left blank.

B.4 SOLID WASTE STORAGE AREA 6 TUMULUS GROUNDWATER TRITIUM CONCENTRATION TIME HISTORY GRAPHS

This page intentionally left blank.



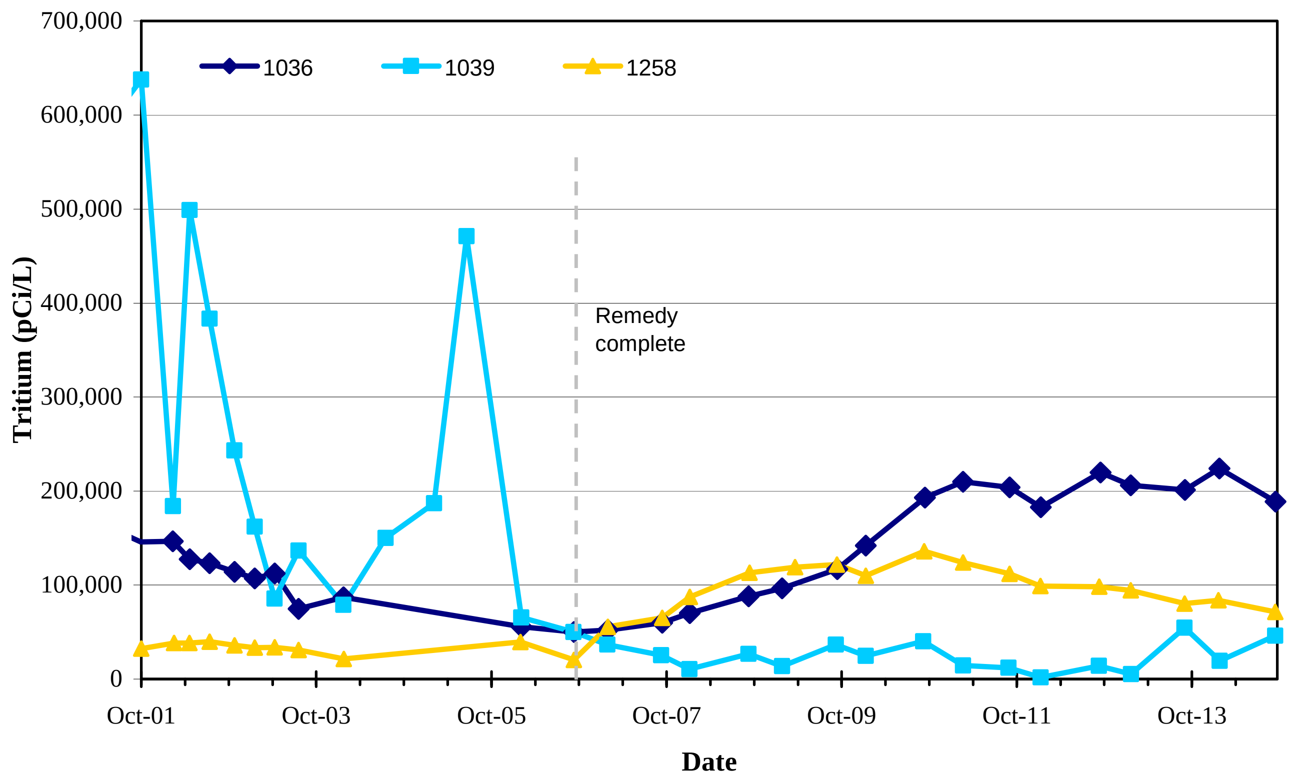


Figure B.4.1. SWSA 6 Tumulus groundwater tritium time histories.

This page intentionally left blank.

B.5 MELTON VALLEY OFF-SITE MONITORING WELL HYDROGRAPHS

This page intentionally left blank.

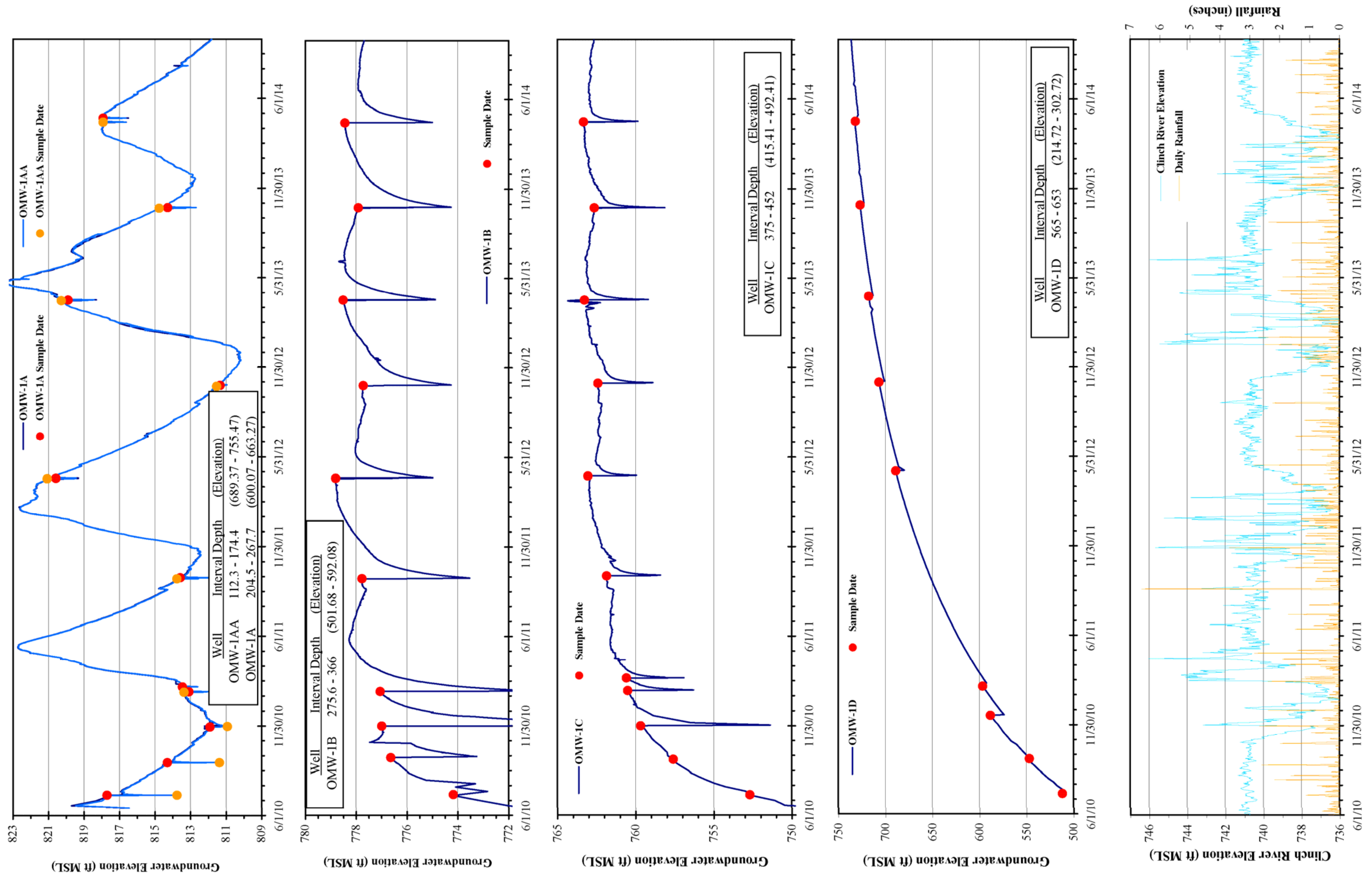


Figure B.5.1. Hydrographs for wells in cluster OMW-1.

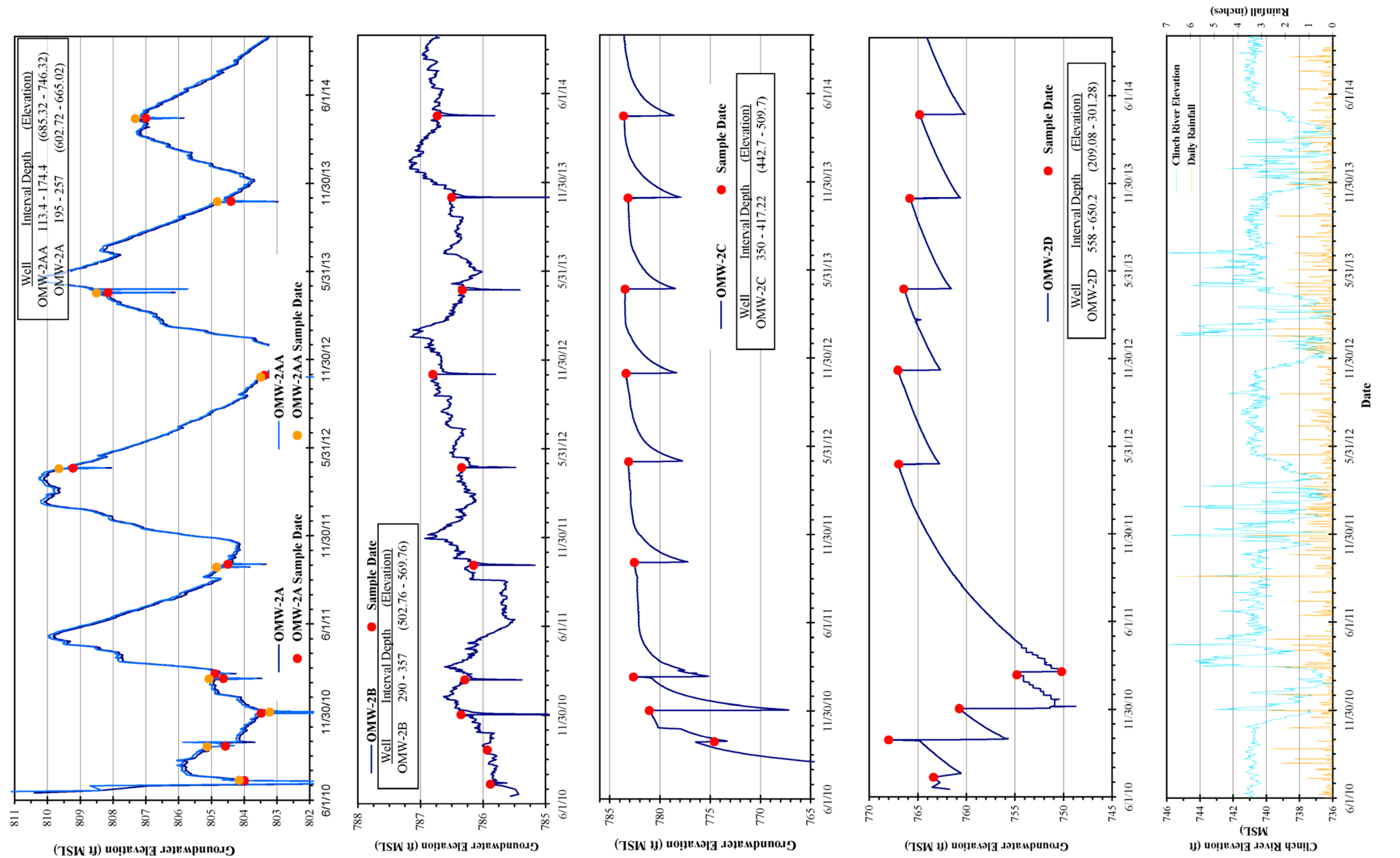


Figure B.5.2. Hydrographs for wells in cluster OMW-2.

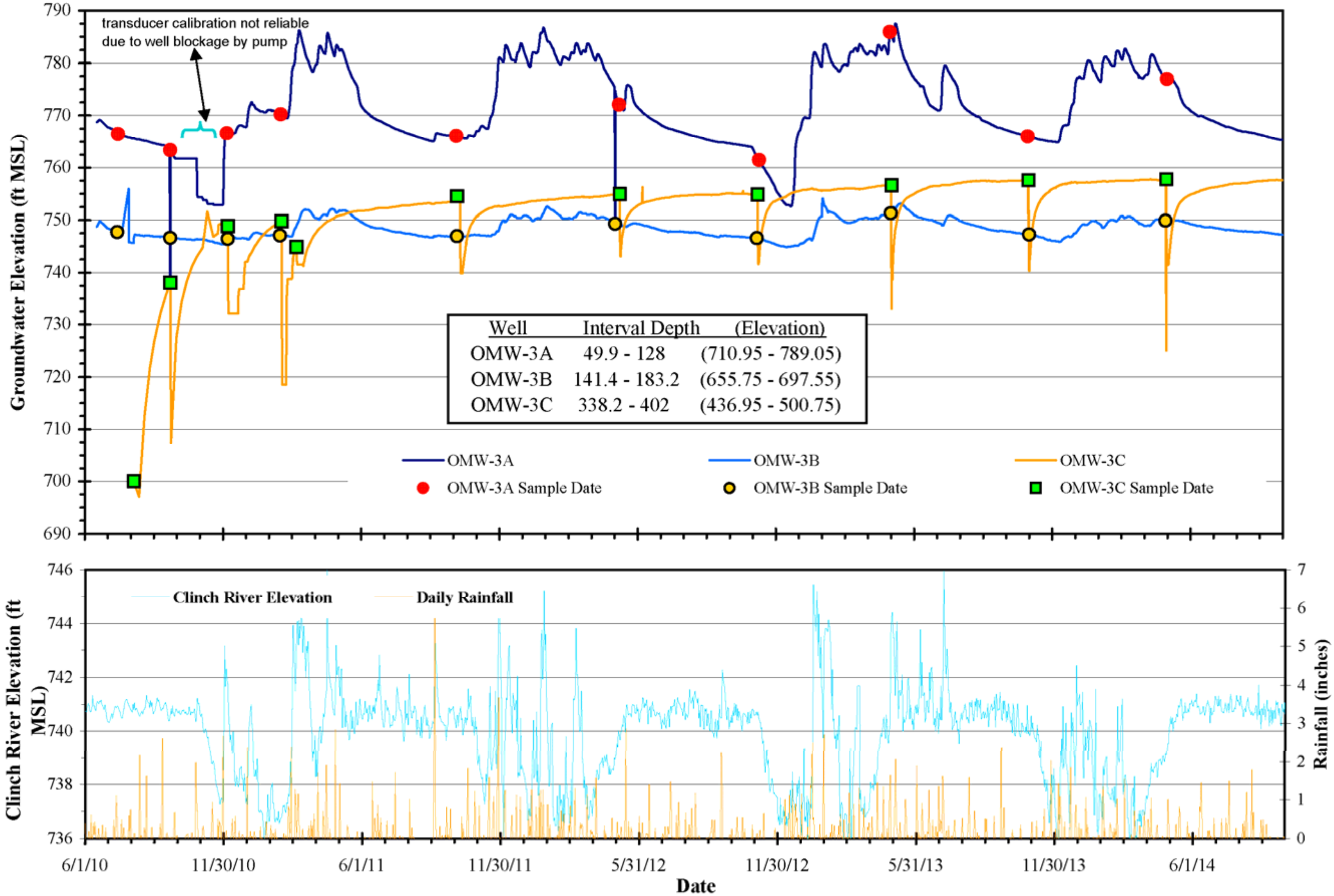


Figure B.5.3. Hydrographs for monitoring zones in OMW-3.

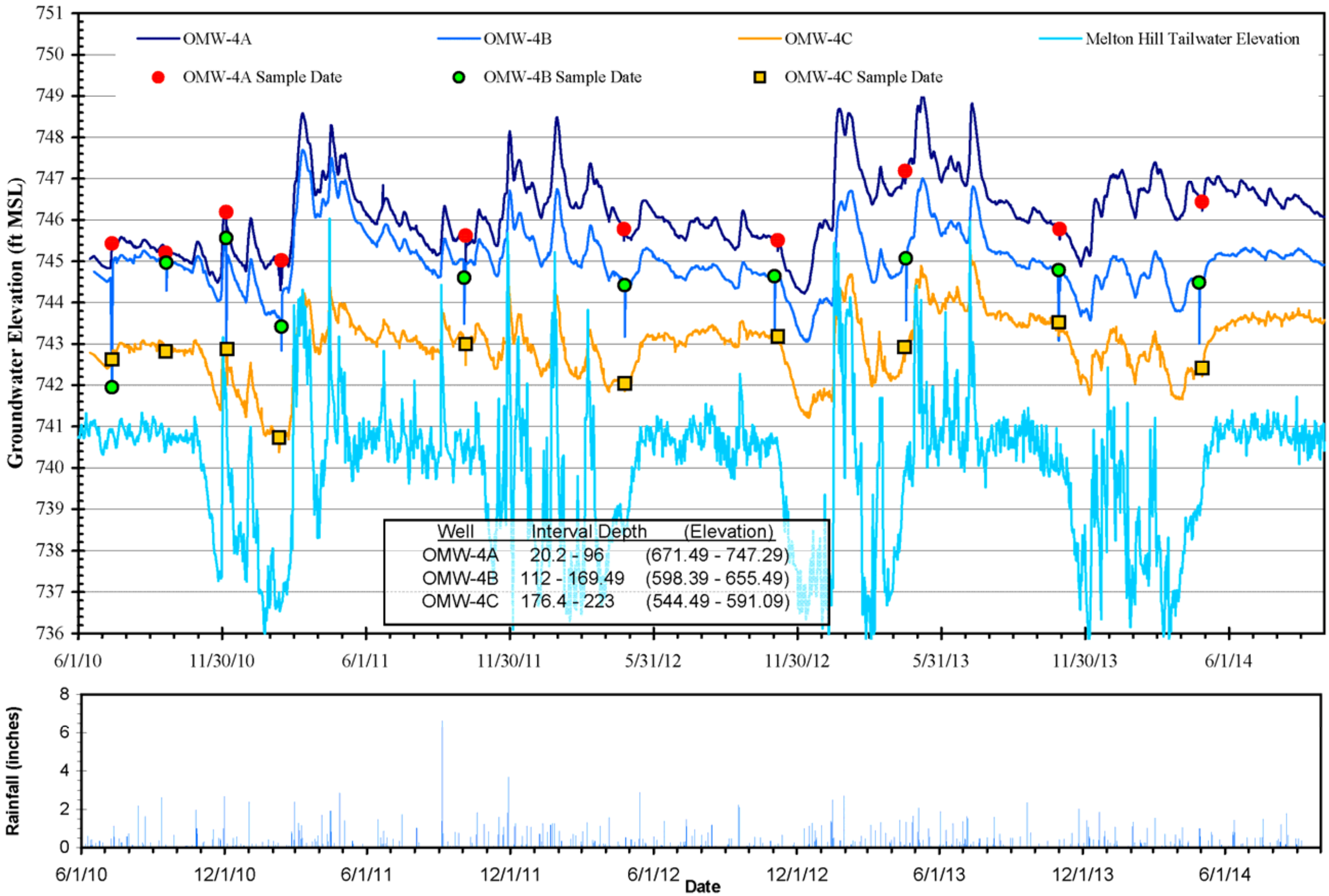


Figure B.5.4. Hydrographs for monitoring zones in well OMW-4.

APPENDIX C
ACTION PLANS IDENTIFIED FROM
2011 THIRD RESERVATION-WIDE CERCLA FIVE-YEAR REVIEW
(DOE/OR/01-2516&D2)

This page intentionally left blank.

ACTION PLANS IDENTIFIED FROM 2011 THIRD RESERVATION-WIDE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) FIVE-YEAR REVIEW (FYR) (DOE/OR/01-2516&D2)

Action Plan Number	Status	Title
1	Open	East Fork Poplar Creek (EFPC) Streambed and Bank Sediments
2	Open	Mercury Bioaccumulation in LEFPC
3	Closed	Review of Cs 137 Action Level
4	Closed	Solid Waste Storage Area (SWSA) 4 Downgradient Trench Performance
5	Closed	Bethel Valley (BV) ROD Goal
6	Closed	Corehole 8 Plume Collection System Upgrade
7	Closed	East End Volatile Organic Compound (EEVOC) Plume Point of Compliance
8	Closed	Bear Creek Valley (BCV) Chemicals of Concern
9	Closed	S3 Pond Pathways 1-3

REFERENCES

DOE/OR/01-2516&D2. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

ACTION PLAN 1
East Fork Poplar Creek (EFPC) Streambed and Bank Sediments

STATUS: Open
FIVE-YEAR REVIEW (FYR) ISSUE: OF-2
Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Operable Unit (OU): #28

ISSUE: New information suggests mobilization of mercury from East Fork Poplar Creek (EFPC) streambed and stream banks is a major source of mercury exposure during high-flow conditions. The current Record of Decision (ROD) did not fully consider the entire hydrologic system and did not explicitly address creek bank or creek bed sediments and the role that these sources of mercury could have in contributing to the overall mercury flux and to mercury bioaccumulation in biota in the stream.

BACKGROUND: The role of in-stream and floodplain mercury sources on mercury flux, speciation, and bioavailability in the EFPC system is a complex and not well understood issue. Various studies in Oak Ridge have provided useful information but there remain numerous data gaps and high uncertainty associated with the various mercury source terms. The focus of the U.S. Department of Energy's (DOE's) current and near-future remediation activities to address mercury contamination is in the "upstream areas" near the Y-12 National Security Complex (Y-12), as any potential action downstream will need to be addressed as part of a sequencing approach to the system. Current efforts to address this issue will focus on closing data gaps on the roles of streambed and stream bank soil and sediment and shallow groundwater (GW) beneath the floodplain as sources of mercury and methylmercury to the Lower East Fork Poplar Creek (LEFPC) aquatic ecosystem, and providing information for future remedial decision-making.

PLAN/SCHEDULE: The action plan will involve conducting select field and laboratory investigations to close data gaps and to better define mercury contributions from stream bank and channel sources. Newly collected data will be used to develop conceptual and systems-based models that can be used as tools to refine source estimates. The evaluations will be conducted over a three year period leading to the 2016 Five-Year Review (FYR), and progress reported annually in the Remediation Effectiveness Report (RER).

The focus of proposed investigations and schedule is as follows:

Fiscal Year (FY) 2013: Investigations focused on three tasks: 1) quantification of stream bank erosion and evaluation of shallow groundwater beneath mercury contaminated soil areas, 2) laboratory evaluation of floodplain soil, sediment, and bank soil as sources of mercury and methylmercury to LEFPC, and 3) development of a quantitative model to describe the sources and the processes controlling mercury bioaccumulation in LEFPC.

FY 2014: The focus of year two investigations is to scale-up field and laboratory data to the EFPC hydrologic watershed as a whole, using a systems-based quantitative model framework. Physical and chemical information key to modeling efforts will be obtained from previous reports or publications, unpublished data from other monitoring programs, available remote sensing/Geographic Information System (GIS) data/land cover data, and direct measurement.

FY 2015: The final product of the three year effort is to provide a systems-based quantitative model of use in 1) defining the relative LEFPC source contributions, 2) simulating various changes in source assumptions or remediation scenarios, and 3) visualizing complex mercury processes and model runs for regulator and decision-maker purposes.

Update on FY 2014 studies

The primary Action Plan 1 effort in FY 2014 included field studies of bank soil erosion and bank mercury concentrations, shallow groundwater studies, and geospatial and modeling analyses. The studies have focused on obtaining a better understanding of the role of major source compartments of the watershed (see Figure C-1). Field studies of bank soils and groundwater were initiated in FY 2013 and will be conducted through the first half of FY 2015. Laboratory studies, focused on source media mercury leachability, methylation, and bioaccumulation, were performed in FY 2013 and were completed in FY 2014. Geospatial analysis and modeling efforts were initiated in FY 2013 but will be a major emphasis in FY 2015, the last year of the 3 year study.

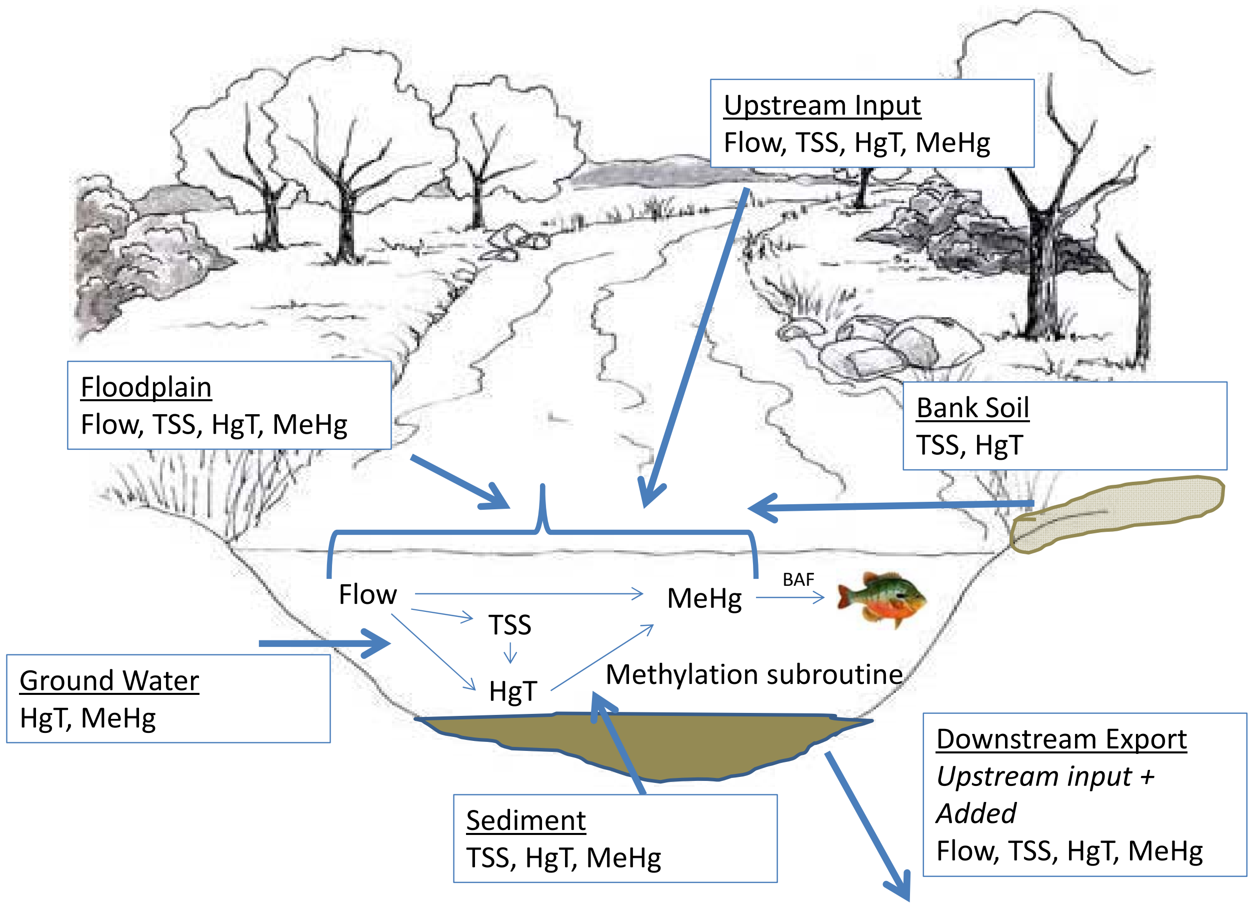


Figure C-1. Conceptual model for understanding mercury source contributions and bioaccumulation in Lower East Fork Poplar Creek, where HgT = total mercury, MeHg= methylmercury, and TSS= total suspended solids.

Quantification of Stream Bank Erosion

Two interrelated approaches have been adopted to obtain quantitative estimates of streambank erosion along lower EFPC. The first of these approaches involves the use of Global Positioning System (GPS)-referenced video mapping of the entire length of lower East Fork Poplar Creek (EFPC) to its confluence with Poplar Creek. The second approach involves the installation of erosion pins at a few sites identified from the video survey to ground-truth the estimates originating from the video survey. Sampling locations for the video mapping were throughout the entire stream, while pin surveys were located near BMAP sampling locations (Figure 7.3). Sampling site naming is in reference to kilometer distance upstream of the mouth of East Fork Poplar Creek; thus for example EFK 1 is East Fork Kilometer 1, which is1 km upstream of the confluence of East Fork Poplar Creek and Poplar Creek, and EFK 25 is 25 kilometers upstream and very close to the headwaters within Y-12) (Figure 7.3).

A GPS-based, kayak-mounted above-water and underwater video mapping and electronic sensor system was used to survey streambank and erosion conditions on EFPC. The cameras recorded georeferenced digital video of the streambanks, and side pointing lasers measured stream width. Stream and bank attributes were acquired from interpretation of the recorded video and kayak sensor measurements. Erosion rates fluctuate along the creek from EFK 23 to the confluence with Poplar Creek (Figure C-2). Rates start with an average of 0.044 ft/year around EFK 23 and increase 70% to 0.151 ft/year in EFK 22. Rates decrease to the second lowest level on the creek with 0.0126 ft/year along EFK 19. Rates increase again and then fluctuate through EFK 13, where average erosion rates decrease to 0.042 ft/year. Erosion rates are 0.013–0.052 ft/year at EFK 13.2 and then reach their lowest value at the confluence with Poplar Creek.

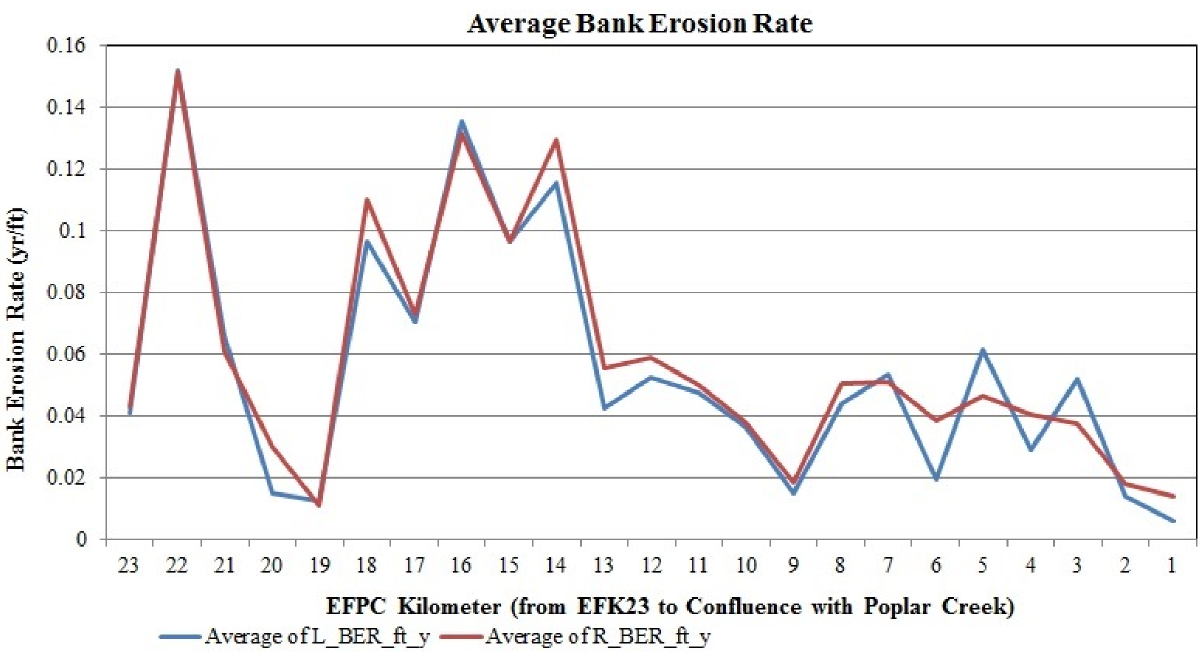


Figure C-2. Average bank erosion rate at 1 km intervals from EFK 23 to the confluence with Poplar Creek.

Eight erosion pin sets were installed at seven sites along the creek in November 2013. Two to three erosion pins were installed at each site along a vertical streambank transect extending from near the water's edge to near the top of the streambank. Net erosion was recorded for most pins across all sites during the first 252 days of deployment (Figure C-3). To date, virtually all erosion occurred between deployment in November 2013 and April 2014, with the majority occurring in the first 96 days. Two mechanisms contributed to bank erosion. First was frost heave during the winter. From deployment to April 2014, the area received 10.6 in. of snow. During the January sampling campaign, extensive ice lenses were observed beneath a very friable surface of ~5 mm of bank soil. Field observations suggested the second major mechanism was material that slumped down the streambank from higher locations. Material slump was likely brought on by frost heave and undercut by the flowing creek.

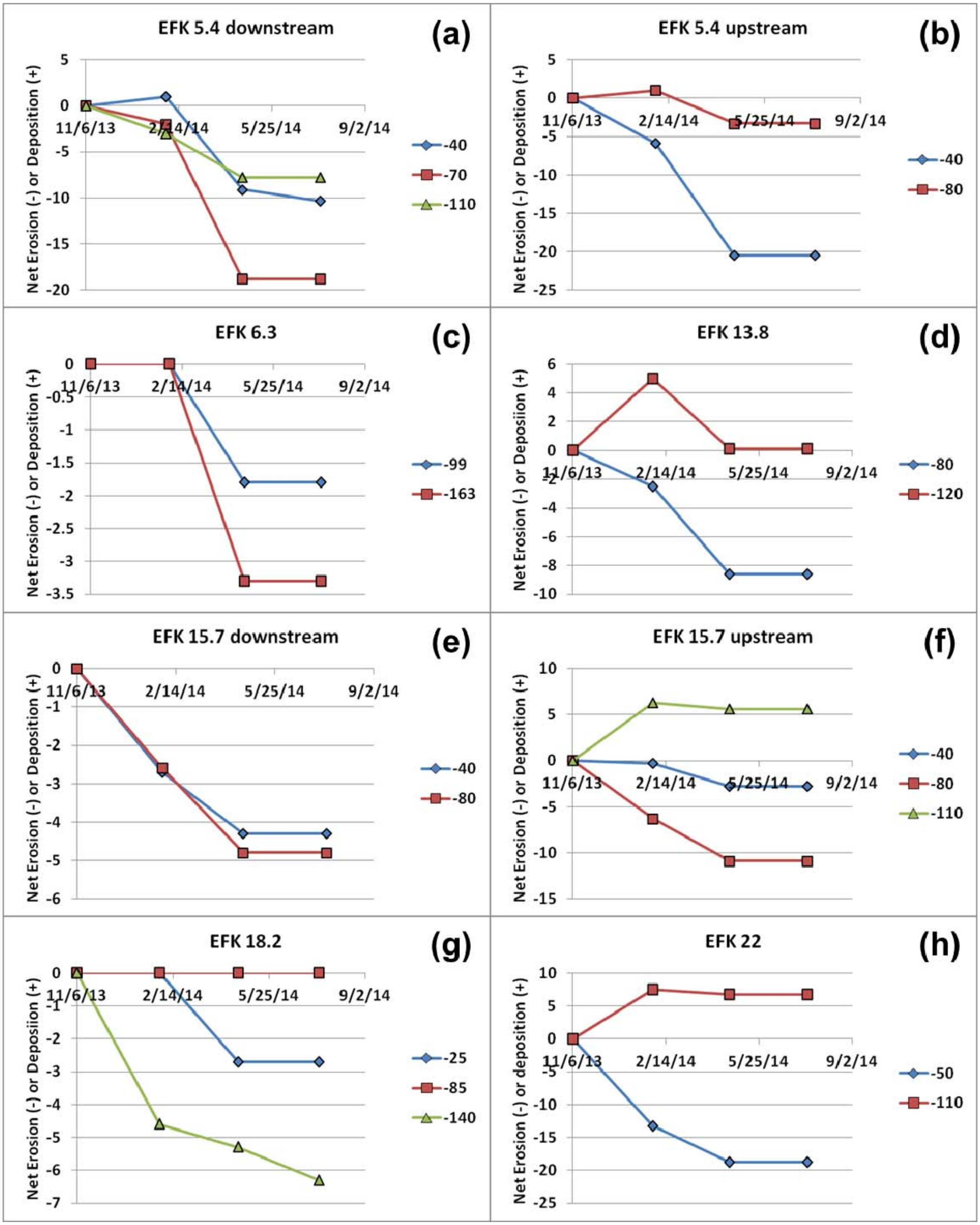


Figure C-3. Estimates of net erosion or deposition over time from erosion pin measurements at eight sites.

Numbers in the legend of each plot indicate the distance in centimeters to the erosion pin from the top of the creek bank.

Bank soil erosion from pin surveys will be coupled with the GPS assessment to provide estimates of bank soil loading from the headwaters to the mouth of EFPC. Mercury sampling of soil is ongoing and will be used along with erosion data to estimate total mercury flux from banks. Information from these studies will feed into the LEFPC mercury transport model.

Evaluation of Shallow Groundwater Connections to EFPC

New shallow groundwater wells were established near EFK 15.7, adjacent to where the Mill Branch tributary enters EFPC (Figure C-4). Four wells were installed at this location on July 2, 2013. Wells were installed by hand-driving 1 in. PVC casing to the point of refusal. After installation, each well was purged using a peristaltic pump until purge water was clear. Subsequent to well installation and development, groundwater and surface water were sampled for analysis in August 2013 and then monthly beginning in November 2013.

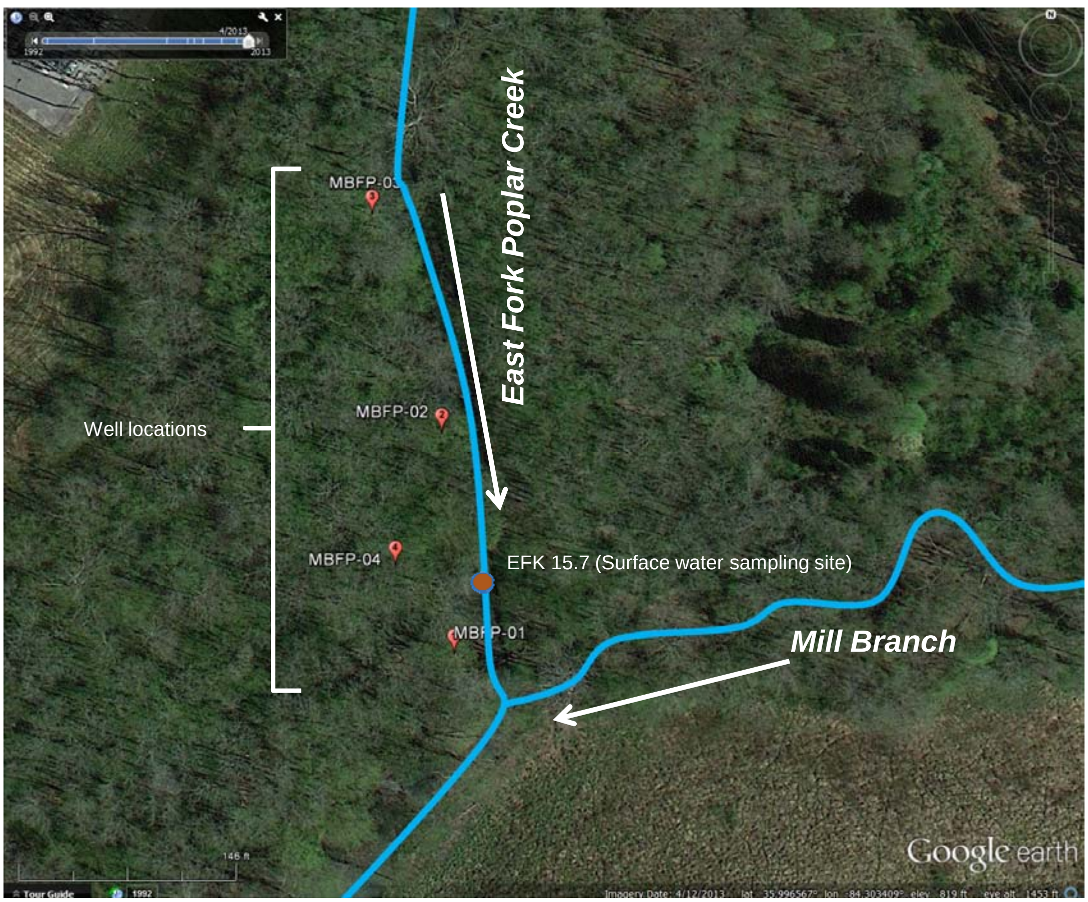


Figure C-4. Well and surface water sampling sites near the confluence of East Fork Poplar Creek and Mill Branch.

Results to date demonstrate that the groundwater has a chemical composition that is both distinct from the surface water and consistent with active anaerobic microbial metabolism necessary for methylmercury production. Sampling results strongly suggest that the shallow groundwater at the Mill Branch site supports methylmercury production (Figure C-5). Although dissolved mercury (HgD) concentration is lower in groundwater than in surface water, dissolved methylmercury (MeHgD) concentrations are comparable to or much greater than in surface water, and the percent MeHg in groundwater is significantly greater than in surface water. Additionally, two of the wells, MBFP-03 and MBFP-04, showed a strong seasonal pattern in MeHgD concentration, with lower concentrations in winter and higher concentrations in summer. The temporal variability in groundwater chemistry, coupled with groundwater gradients, suggests water exchange with surface water is possible through a combination of lateral flow with the creek water and vertical recharge from precipitation. It is possible that the groundwater is a source of methylmercury to the surface water, but additional studies are required to establish the likelihood and magnitude of occurrence.

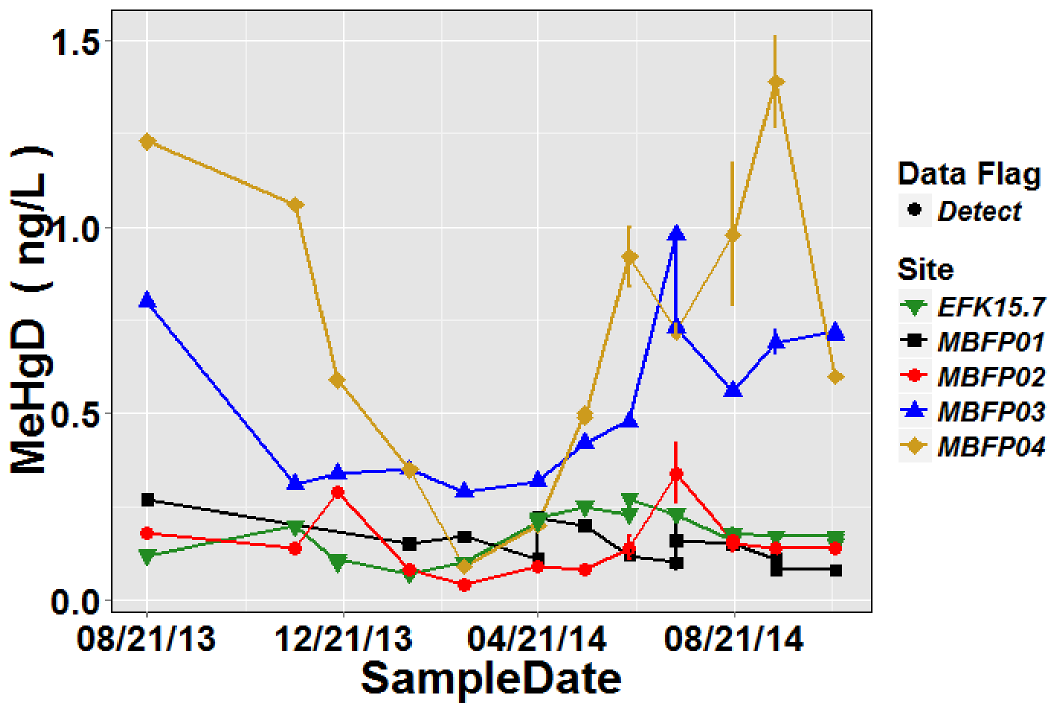


Figure C-5. Concentrations of dissolved (< 0.2 µm) methylmercury (MeHg) in surface water (EFK 15.7) and groundwater (MBFP01 to MBFP04).

Error bars indicate ± 1 standard error of the analytical measurement. Error bars not visible are smaller than the symbol size.

Watershed Modeling

In FY 2014 watershed modeling efforts focused on (1) building a geospatial data base of mercury data collected over the past 30 years and (2) continuing development and conversion of an existing LEFPC mercury model.

The geospatial analysis involved development of a geospatial database that includes acquiring and assembling both spatial and tabular data for the study area of the EFPC watershed that will be needed to support watershed modeling. Some of the data needed to support modeling were collected during last year's effort. These included data layers showing county and watershed boundaries, rivers, streams, soils, geology, and land cover datasets. The next steps in the geospatial analysis were to delineate the contributing areas to each of the EFPC units identified in the modeling effort as well as to identify the sources and collect long-term monitoring data for the following parameters:

- Water volume
- Flow

- Water temperature
- Precipitation
- Inorganic mercury loading
- TSS loading
- Mercury methylation
- Bioaccumulation factors for different fish species
- Bank erosion

Data sources for these parameters are available from various studies conducted in LEFPC. Some of these data are available in tabular form to download from the Oak Ridge Environmental and Information System website as well as the GPS-based video mapping study described above. The goal of the geospatial analysis process is to identify the most accurate information to be transferred onto a GIS platform and loaded into a geodatabase. The geospatial database will provide empirically-derived calculations that are inputs to the quantitative model. Modeling run simulations will also be translated to various geospatial mapping products.

The LEFPC Mercury Model uses the STELLA platform. STELLA uses an iconographic interface to facilitate construction of dynamic systems structures. The four major components or building blocks of a STELLA model are stocks, flows, converters, and connectors. The stocks are used to represent system components that can accumulate over time, which in this case represented water flow, TSS, HgT, and MeHg. The flows represent components whose values are measured as rates, which may be a constant, a function of time, or a function of some other component in the system. The job of flows is to fill and drain accumulations. The converters are used to hold values for constants, define external inputs to the model, calculate algebraic relationships, and provide graphical functions, which enable the modeler to sketch relationships between model variables without resorting to complex analytical expressions. The mercury sorption coefficient (Kd), bioaccumulation factor (BAF), and methylation factors were represented as converters in the STELLA model. The connectors are used to connect model elements and represent the cause/effect relationship between diagram components. The functional relationships between the essential features of stocks, flows, and auxiliary parameters in the model can be defined using the mathematical, logical, or graphical functions. To reduce complexity of the model, to allow in-depth understanding of the system processes and their interactions, and to make calibration of the model less difficult, the model was divided into five interactive sectors: water flow (H2O), total suspended solids (TSS), total mercury (HgT), methylmercury (MeHg), and fish bioaccumulation (Figure C-6).

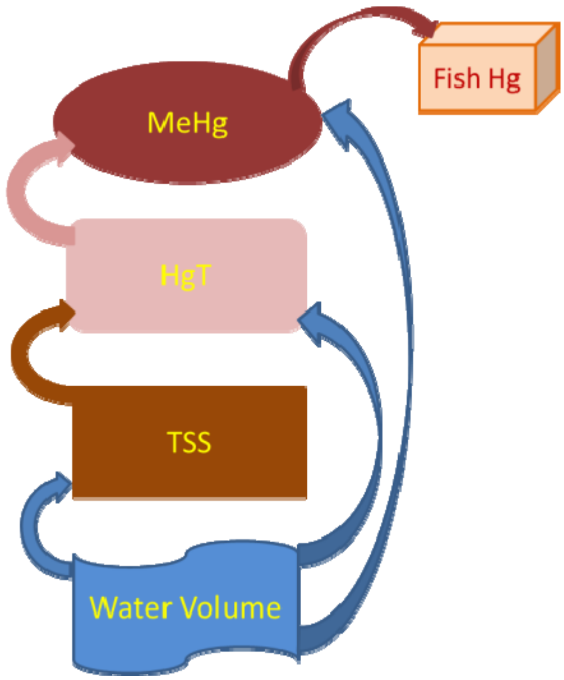


Figure C-6. Conceptual diagram of mercury flow between different sectors in East Fork Poplar Creek (EFPC).

The model's sectors are water volume, total suspended solids (TSS), HgT, MeHg, and fish bioaccumulation (Fish Hg).

In FY 2014 much of the model development effort was dedicated to analyzing and summarizing various data sets that provide input data for the STELLA model, but significant progress was also made in the following areas of model development:

1. Better definition and representation of spatial scale
2. Better definition and representation of temporal scale
3. Incorporation of historical flows
4. Streambank erosion effects
5. Water temperature effects on methylation

More specific model development in FY 2014 included (1) modifying the operation of the different sectors to operate in the revised temporal (daily 365 d/year) and spatial (five variable sized reaches) scales and (2) adding additional inputs of the different model constituents being tracked (e.g., adding TSS from bank erosion). In all cases an effort was made to make use whenever possible of existing historical data and the results of studies (e.g., the kayak survey data and bank erosion study) being conducted as part of Action Plan 1.

In FY 2015, the addition of streambank erosion potential, flood plain erosion data, continuous base flow data, actual LEFPC stream physical characteristics, and periphyton data will add more insights into the watershed scale evaluation and analysis of mercury dynamics within the LEFPC watershed. Further the geospatial and analytical temporal data will be coupled with the STELLA simulation model to allow for a more in-depth evaluation of the landscape and physical watershed factors that affect the transport and fate of mercury in LEFPC.

ACTION PLAN 2
MERCURY BIOACCUMULATION IN LEFPC

STATUS: Open
FYR ISSUE: OF-3
CERCLIS OU: #10

ISSUE: New mercury bioaccumulation studies show mercury uptake in spiders along LEFPC.

BACKGROUND: Questions regarding mercury bioaccumulation in plant and animal species along LEFPC have been documented as a decision uncertainty and information gap in the conceptual site model for the creek in the Remedial Investigation (RI) (DOE/OR/02-1119&D2)/Feasibility Study (FS) (DOE/OR/02-1185&D2&V2), Proposed Plan (PP)/ROD, and 2006 FYR. The 2011 FYR included additional information from studies along LEFPC indicating mercury uptake by spiders. Based upon the new spider information, uncertainty, and data gaps, the 2011 FYR deferred the protectiveness determination for LEFPC.

PLAN/SCHEDULE: The plan in FY 2014 was to conduct a literature evaluation that would provide data for a revised ecological risk evaluation for the LEFPC floodplain, which would inform the protectiveness determination. A comprehensive analysis of these new (spider) data along with an analysis of new toxicity information in the literature (e.g., Bergeron et al., [2011] and Albers et al., [2007]) and new information on methylmercury uptake in spiders near the South River in Virginia was completed in early FY 2013. The scope of the literature review included the following components:

1. Review the original ecological risk inputs in the LEFPC RI/ROD.
2. Review recent literature for new information that could be used to update risk inputs, including:
    a. Mercury toxicity to endpoint receptors (wildlife);
    b. Wildlife feeding ecology in floodplain habitats (geographic differences, diet composition, prey preferences, foraging behaviors);
    c. Mercury composition of prey items in contaminated floodplain (spatial variation);
    d. Distribution of prey items in floodplain systems (abundance, biomass); and
    e. Prey ecology effecting exposure to mercury.
3. Revise LEFPC ecological site conceptual model and risk calculations using estimates of key parameters from literature.

The schedule for this effort was to complete this Action Plan report in the 2014 RER. Additionally, it was believed that the findings would result in a protectiveness statement for LEFPC. However, after results were attained, it was determined that more conclusive site-specific floodplain information was needed that would decrease the uncertainty.

Therefore, DOE agreed to complete a Data Quality Objectives (DQOs) workshop and LEFPC Sampling and Analysis Plan in FY 2014. In FY 2015 sampling would take place and an evaluation will be completed in time for the FYR in 2016 at which time a LEFPC protectiveness statement will be made.

Update on FY 2014 studies

In FY 2014, soil surveys and an invertebrate reconnaissance study was conducted prior to invertebrate sampling scheduled in FY 2015. The overall objectives of the FY 2014 studies were to identify plots of land that would have appropriate habitat for the target invertebrate taxa and that would be representative of high, medium, and low mercury (defined for this project as >100 ppm, 20–100 ppm, and <20 ppm, dry weight, respectively) exposure to invertebrates. The study was designed such that there would be a range of exposure conditions to calculate bioconcentration factors for invertebrates that could then be used in risk calculations.

Soil surveys

Soil sampling took place within each of three floodplain areas along the length of LEFPC, as follows:

- Upstream location (US) from EFK 22.4 to EFK 22.2, just downstream of the National Oceanic and Atmospheric Administration (NOAA) remediation area

- Mid-stream (MS) location between EFK 18 and the most upstream portion of the Bruner remediation area

- Downstream (DS) location between the confluence of Bear Creek and LEFPC, and the confluence of LEFPC and Poplar Creek within the Horizon Center site

Samples also were collected from plots at a nearby reference stream (Brushy Fork). Plots of approximately 10 × 10 m were selected randomly from each floodplain area, as previously described (Figure C-7). Within each sample plot, five sampling points were selected (one from the center of the plot and one each from the four corners of a square superimposed over the center of the plot with each corner nominally 4 m [13 ft] from the center of the plot). Samples were collected by WRRP staff at each of these points, for a total of 75 to 90 samples per floodplain area (5 to 6 sample areas × 3 sample plots × 5 samples/plot), as well as 15 samples from the reference location.

The collected floodplain soil samples were sent to ORNL's Environmental Sciences Division (ESD) for mercury and moisture content analysis. Upon arrival at ESD, the samples were immediately stored in freezers (-20°C). Before analysis, soil samples were well homogenized using a clean, dry mortar and pestle. Samples were analyzed at ESD for total mercury in accordance with EPA solid waste (SW)-846 method 7473 using a direct mercury analyzer (Milestone's DMA-80). Split samples were analyzed at a DOE Consolidated Audit Program-audited lab using SW-846 method 7471. The moisture content of soil samples was determined so that mercury concentrations could be reported on a dry-weight basis. ESD laboratory quality control samples included method blanks, LCSs, and MS/MSD samples. Samples were analyzed as received (on a wet basis), but moisture content analysis data were used to report concentrations on a dry basis.

The mean total mercury concentrations collected from each sampling plot are presented in Figure C-8. Mean concentrations for sample plots ranged from 0.042 ppm at the Brushy Fork reference site to 259 ppm at the upstream NOAA site. The highest individual sample measured was 348 ppm at the NOAA site. Not surprisingly, mercury concentrations were highest at upstream locations and lowest at downstream locations (Figure C-9). The study team had originally hypothesized that within a given area, mercury concentrations would decrease with increasing distance from the creek, but there was no correlation between mercury concentration and distance from the creek within a given area (US, MS, DS). Among all areas, the majority of plots had mercury concentrations in the "medium" range. Based on findings, nine plots were selected from each of the three floodplain areas. Invertebrate samples will be collected from these selected sample plots in FY 2015, and the soil data presented here will be used to calculate BAFs once biota mercury data are available. The low variability between samples in a plot will help manage uncertainty when calculating BAFs.

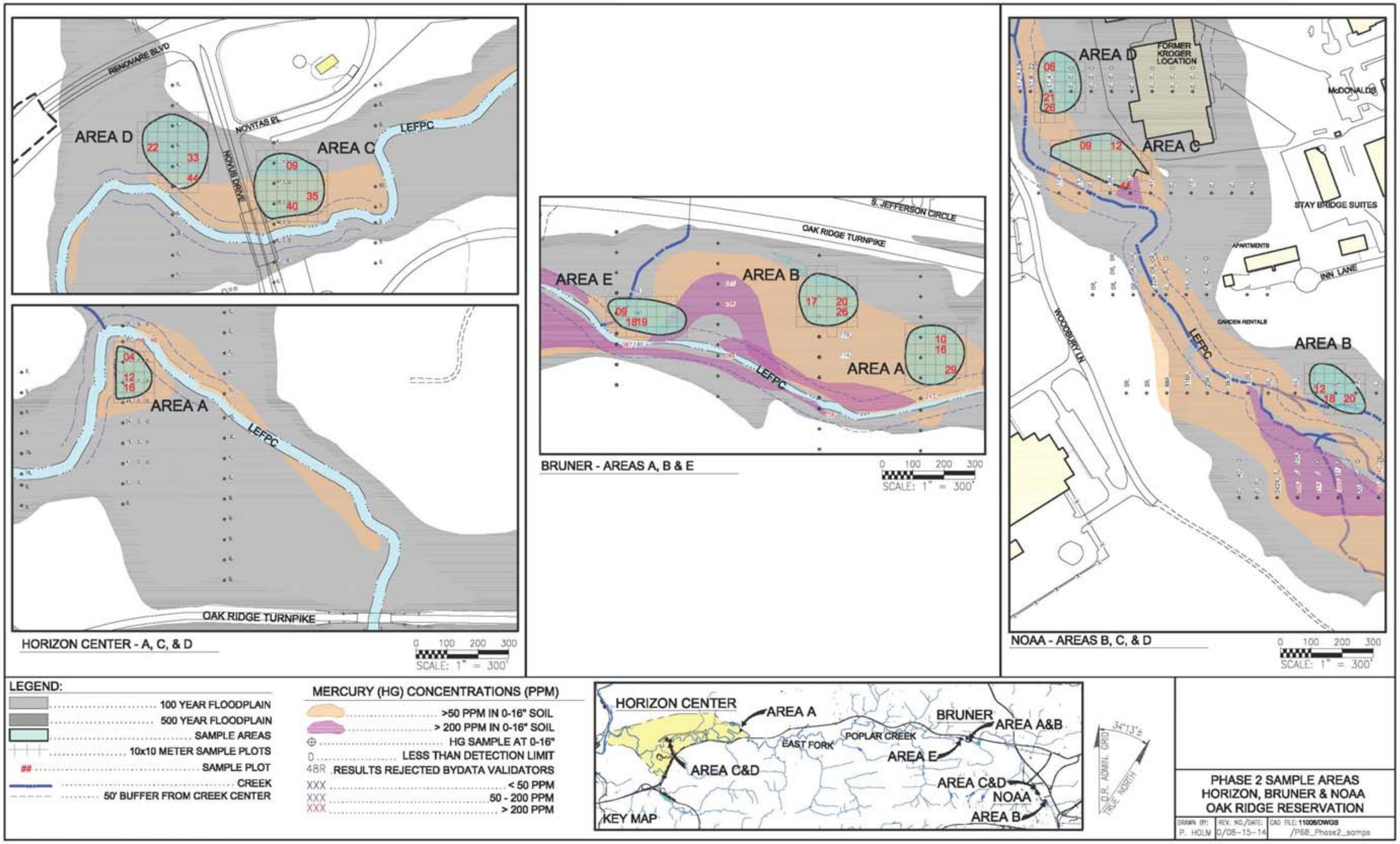


Figure C-7. Soil sampling areas at Horizon Center, Bruner, and NOAA.

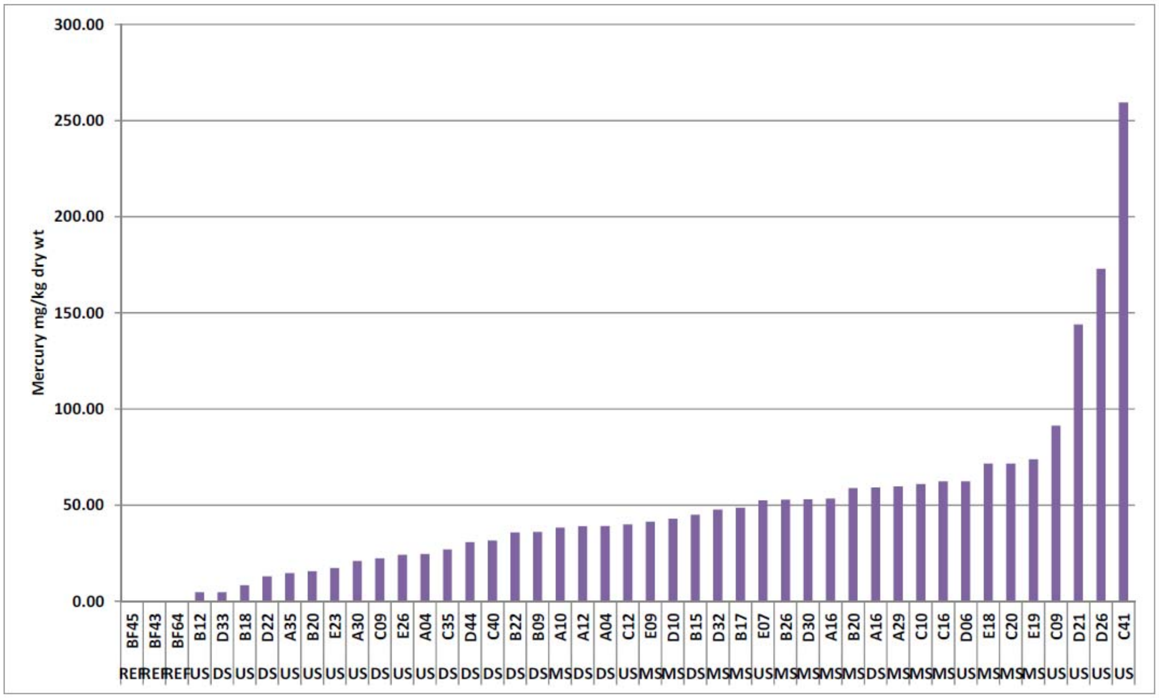


Figure C-8. Mean total mercury concentrations for soil samples collected from each sampling plot. US, MS, and DS correspond to upstream, midstream, and downstream LEFPC locations, respectively, and REF corresponds to the reference site, Brushy Fork.

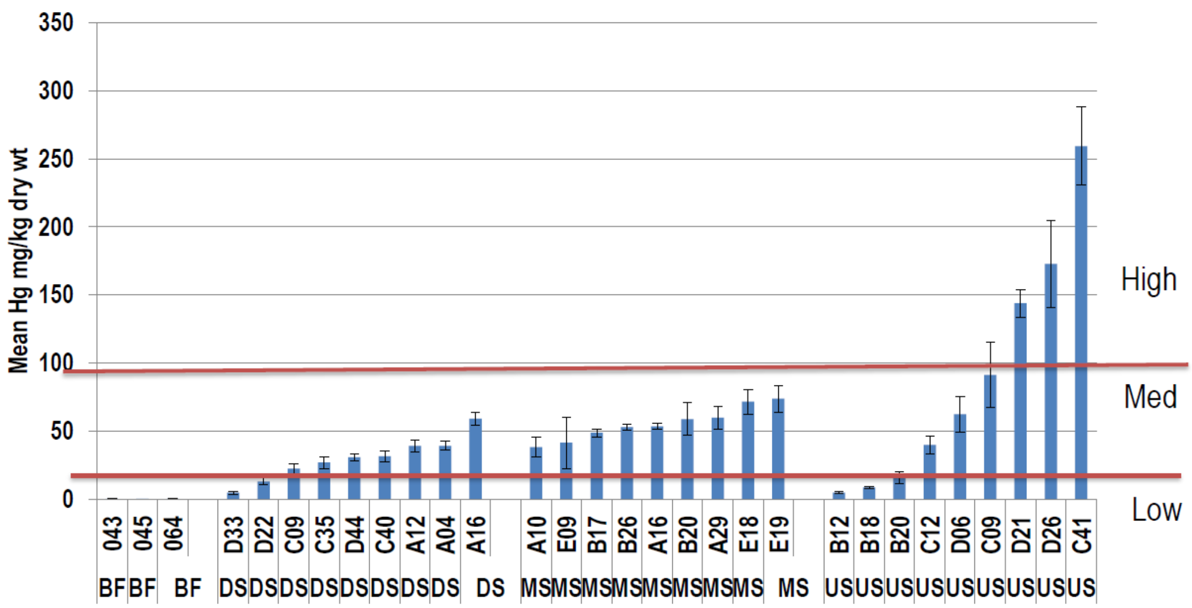


Figure C-9. Mean total mercury concentrations for selected sampling plots. US, MS, and DS correspond to upstream, midstream, and downstream LEFPC locations, respectively, and REF corresponds to the reference site, Brushy Fork.

Invertebrate reconnaissance

In June through September 2014, a reconnaissance survey of floodplain invertebrates in LEFPC was conducted to determine the availability and identity of potential target species of terrestrial invertebrates for inclusion in the final phase of sampling for the FY2015 LEFPC Mercury (Hg) Uptake Study. The focus of the reconnaissance collections was on four target invertebrate groups living on, in, or closely associated with floodplain soils: worms (or oligochaetes), spiders, detritivores, and herbivores. The primary objectives of the survey were to identify potential target species within each of the four target groups, estimate the relative availability of species within the various target groups, and identify the most suitable collection techniques for the target taxa.

More than 5000 invertebrates were collected from all LEFPC sites and the Brushy Fork reference site, representing at least 18 major taxonomic groups. Many of the taxa were very small (i.e., < 5mm length), particularly the mites (Acari), beetles (Coleoptera), springtails (Collembola), true flies (Diptera), true bugs (Hemiptera), and wasps/bees/ants (Hymenoptera). Larger mature specimens of some of the small taxa collected through mid-July were found in September [crickets/grasshoppers/katydids (Orthoptera); this may be especially notable and of interest in the final selection of taxa to use as the representative for the herbivore group. Overall, a large portion of the taxa collected were either omnivores or predators (e.g., many of the beetle species), and thus, would not be suitable as target taxa for this study.

Of the four targeted groups, the isopod, *Trachelipus rathkei* (Isopoda, sowbug, pillbug, rollie pollie), was identified as a good target detritivore. This species was either observed at, or collected from, every plot. Although there was much size variation in specimens due to age and/or sex differences, weights of a few specimens that were weighed averaged 47.6 mg (wet mass) each, in which case, it would require collecting 20-30 specimens for a sample weight (wet weight) of 1.0 g. Thus, the modest size (relative to other invertebrates) and common wide distribution of this species make it the best option as a target species representing detritivores.

Worms (oligochaetes) were either collected or observed at all locations, although they were generally less common at NOAA and Brushy Fork. There appeared to be 2 or more species of worms present in every area, including at least one species in the family Megascolecidae and up to 5 species in the family Lumbricidae, although one of the larger species appeared to be most common. These taxa were generally found at the interface between leaf litter and the soil's surface.

More than 20 species of spiders were collected across all sites. Wolf spiders (family Lycosidae), which are ground dwellers, were the most prominent group of spiders. More than 10 species of wolf spiders were collected, and there appears to be at least one relatively distinct species that is common and relatively abundant at most or all plots.

Strictly herbivorous invertebrate taxa proved to be the most challenging to collect. Several types of crickets were collected, with large camel crickets (Rhaphidophoridae) and small ground crickets (Nemobiinae) being widespread and common. One of the most common groups of herbivores found at all plots was true bugs (order Hemiptera) within the suborder Auchenorrhyncha. This group of insects consists of mostly small species such as, for example, leafhoppers (Cicadellidae), tree hoppers (Membracidae), and plant hoppers (Fugoromorpha). Even though the majority of specimens collected were small, their widespread distribution and general abundance would make them a possible representative for the herbivore feeding guild.

Use of a sweep net, pitfall traps, and searching were found to be the most effective collection methods for target invertebrate groups. The effectiveness of searching may be improved by using common garden tools, such as a small hand trowel, that could, for example, facilitate collection of earthworms and other arthropods such as isopods and spiders.

Sampling and Analysis Plan

With the results of the FY 2014 soil surveys and invertebrate reconnaissance, a more complete sampling and analysis plan for the invertebrate collection in 2015 was completed. The *Sampling and Analysis Plan for the Lower East Fork Poplar Creek Mercury Biouptake Study* (DOE/OR/01-2669&D1) was submitted to EPA and TDEC in November 2014. The Plan provides detailed rationale, sampling and analysis plans, and quality assurance protocols for both the FY 2014 and FY 2015 work.

REFERENCES

DOE/OR/01/2669&D1. *Sampling and Analysis Plan for the Lower East Fork Poplar Creek Mercury Biouptake Study*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1119&D2. *East Fork Poplar Creek—Sewer Line Beltway Remedial Investigation Report*, 1994, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/02-1185&D2&V2. *Feasibility Study for the East Fork Poplar Creek—Sewer Line Beltway*, 1994, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Albers, Peter H. Michael T. Koterba, Ronald Rossmann, William A. Link, John B.French, Richard S. Bennett, and Wayne C. Bauer. 2007 Effects of Methylmercury on Reproduction in American Kestrels. *Environmental Toxicology and Chemistry*, 26 (9): 1856–1866.

Bergeron CM, Hopkins WA, Todd BD, Hepner MJ, Unrine JM. 2011. Interactive effects of maternal and dietary mercury exposure have latent and lethal consequences for amphibian larvae. *Environ Sci Technol* 45(8):3781-7.

ACTION PLAN 3
Review of Cs 137 Action Level

STATUS: Closed
FYR ISSUE: OF-4
CERCLIS OU: #24

ISSUE: The ^{137}Cs action level used by the Watts Bar Interagency Working Group (WBIWG) should be reviewed in light of the various changes in the risk assessment process and cancer slope factors.

BACKGROUND: The ROD for the Lower Watts Bar Reservoir (LWBR) requires institutional controls to prevent exposure to lake sediments that are contaminated with ^{137}Cs. The WBIWG, established by the Watts Bar Reservoir Permit Coordination Interagency Agreement in 1991, established a procedure for interagency coordination and review of permitting and other activities that could result in the disturbance, resuspension, removal, and/or disposal of contaminated sediments in the Watts Bar Reservoir. This agreement identified the cooperative efforts of DOE, EPA, U.S. Army Corps of Engineers (USACE), Nashville District, the Tennessee Valley Authority (TVA), and Tennessee Department of Environment and Conservation (TDEC). Any requests for sediment-disturbing activities by the public and government agencies are submitted to the WBIWG for approval, which involves a review of sediment sampling results to determine that the ^{137}Cs concentration is at or below the risk-based action level of 11 pCi/g.

The 11 pCi/g action level was developed outside of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) documentation (ORNL 1994) in 1991. The 2011 FYR recommended that, given the changes in risk methods and ^{137}Cs toxicity data, the WBIWG action level should be reviewed to insure that it is protective of human health.

PLAN/SCHEDULE: The 11 pCi/g ^{137}Cs action level has been in place for a long period of time and has been used to make many decisions about sediment dredging. Review of this action level was completed with this in mind, and therefore a conservative CERCLA Reasonable Maximum Exposure (RME) approach that utilized a single set of conservative risk factors is not appropriate for this stage of the process. Instead, DOE used a stochastic approach making use of the range of potential exposure and risk factor values. The steps involved with this approach included:

1. Review the current action level;
2. Develop a “simple” Monte Carlo run for the ^{137}Cs action level using the new models and new toxicity information;
3. Reporting results in the 2013 RER Action Plan #3.

The steps have been completed and the reporting of results is provided below. This Action Plan #3 from the *2011 Third Reservation-wide CERCLA Five-year Review* is now closed.

Reporting of Results

Executive Summary

The new model, new toxicity information, and real data and information on typical dredging activities in the LWBR over the past 20 years were used to develop a Monte Carlo statistical analysis of the range of potential protective action levels. The analysis shows that the range of safe levels is 5.5 to 22.3 pCi/g, suggesting the 11 pCi/g action level is sufficient for reviewing typical residential dock dredge permit requests. The analysis does suggest that additional review steps should be taken for larger industrial dredge requests. In these cases where the WBIWG receives requests for larger commercial dredges

(> 1000 m^3 or approximately 1300 yd^3), additional steps should be taken to review these requests, particularly related to review and input on the issue of where and how dredge materials will be disposed of in these cases. Reuse of these dredge materials in areas where land use is not residential, e.g. recreational areas, may be acceptable. Higher action levels would be protective for these recreational uses since many of the conservative exposure assumptions other than slab size used to develop the 11 pCi/g level (e.g., the exposure frequency of 350 days/year) would not be applicable to recreational use.

Findings

Changes to the Risk Model Used to Identify the ^{137}Cs Action Level

The ^{137}Cs plus daughters (+D) action level for dredged sediments (11 pCi/g) used by the WBIWG was developed outside of the official CERCLA documentation in 1991 (ORNL 1994). The action level was calculated using the available risk models in 1991 and was based on a residential land use scenario and a target cancer risk of 1E-4. Given the changes in risk methods and ^{137}Cs +D toxicity data, the WBIWG action level was evaluated to ensure that it is still protective under CERCLA. The current EPA Radionuclide PRG Model and ^{137}Cs +D toxicity data were used in a Monte-Carlo simulation to determine the range of likely protective levels. The current evaluation also used a residential land use scenario and a target cancer risk of 1E-4.

EPA Radionuclide PRG Model

The EPA publishes generic PRGs or action levels for radiological constituents that are risk-based activity concentrations (in pCi/g) that can be used to screen potentially contaminated media. Radiological PRGs combine current EPA toxicity values with standard exposure equations and factors that represent reasonable maximum exposure (RME) conditions to estimate contaminant activities in soil that the agency considers protective of humans over a lifetime. The activity concentrations are based on direct exposure pathways (ingestion, inhalation, external exposure, and produce consumption) for which generally accepted methods, models, and assumptions have been developed. The drawback with the generic PRGs for radionuclides is that the parameters used do not account for any site-specific characteristics. Two parameters for which site-specific parameter values are key in estimating a ^{137}Cs action level for soil include the extent of contamination (e.g., area and thickness of contamination in the soil) and the indoor gamma shielding factor (which accounts for attenuation of gamma radiation by building materials).

As a result, the EPA publishes a radionuclide PRG calculator function at the *EPA Preliminary Remediation Goals for Radionuclides* website (EPA 2012) that allows for site-specific input parameters to be used in order to calculate site-specific action levels. The radionuclide PRG calculator and the associated equations are the source of the PRG model used in this assessment; however, instead of using the online PRG calculator, the EPA equations were entered into Crystal Ball, a Monte-Carlo simulation program, to perform a stochastic evaluation of potential ^{137}Cs +D action levels. A range of site-specific input parameters for the area and thickness of the contaminated soil and the indoor gamma shielding factor were used in this evaluation. In addition to these two parameters, the “area correction factor” and “particulate emission factor” are dependent on the area of contamination; therefore, these parameters are also site-specific. The original target cancer risk of 1E-4 was used. All other input parameters used in the evaluation are the standard exposure factors typically used in the PRG calculator.

Monte-Carlo Simulation

For this assessment, a Monte-Carlo simulation was run to calculate the PRG for ^{137}Cs +D using Decisioneering Crystal Ball Risk Assessment software. Crystal Ball works with data in MS Excel spreadsheets and expands the analysis capability beyond the traditional point estimates, range estimates, and "what if" scenarios, by helping to define the variables that contribute most to uncertainty – referred to as the sensitive parameters. Using a range of values and the likely shape of the probability distribution curve for a given parameter, Crystal Ball can run thousands of simulations to determine the probability that a certain forecast value will fall within a specified range. Therefore, the probability that the action level of 11 pCi/g will fall within the range of likely protective levels can be determined.

Monte-Carlo simulation is appropriate for managing uncertainty in complex situations because it accounts for the variability of key factors. For this assessment, only the area of soil contamination (slab size) and the gamma shielding factor parameters were given a range of values and probability distribution. Site-specific, constituent-specific, and standard parameters used in the Monte-Carlo simulation are described below. The area correction factor and particulate emission factor are automatically calculated based on the area of soil contamination (slab size) and therefore are also shown as a range of values.

Evaluation of Risk Parameters used to Identify the ^{137}Cs Action Level

Site-Specific Parameters

Site-specific parameters used in this evaluation include the area and thickness of soil contamination (and related area correction factor and particulate emission factor), and the indoor gamma shielding factor.

The area of soil contamination or slab size is based on reported dredge volumes listed on dredge permit applications received by the TVA for the Watts Bar Reservoir between 2010 and 2012. On most of the permit applications, the expected volume of dredged sediment is provided. A majority of the dredge requests are related to installation of small, residential/recreational docks. Many of the applications indicated that the dredged material would be placed within the applicants' yard. Based on the reported volume of dredged sediment, and an assumed land application thickness of 15 cm (5.9 in.), the range in the soil contamination area or slab size was determined to be 30.6 m^2 to 765 m^2 (329.4 ft^2 to 8234 ft^2), with an estimated average area of soil contamination or slab size of 522 m^2 (5618 ft^2). For the Monte-Carlo simulation, a triangular distribution for the area was assumed with the average area selected as the most likely result. The range in the soil contamination area (slab size) was used as the minimum and maximum values. This soil contamination area also factors into the calculated area correction factor and the area used to calculate the particulate emission factor. While the area correction factor and the area used to calculate the particulate emission factor varied for each simulation based on the area selected during the Monte-Carlo simulation, neither of these parameters had distributions defined in Crystal Ball. The particulate emission factor was also dependent on the climatic zone selected for the calculation. For this assessment, the climatic zone of Atlanta, Georgia was selected as recommended by the online EPA radionuclide PRG calculator.

On an infrequent basis, the WBIWG is approached with a commercial dredge request. These types of requests are rare, and as expected, address larger dredge volumes. Review of these requests showed potential dredge volumes resulted in slab areas ranging from 7,650 m^2 (3011 ft^2) to 10,900 m^2 (4291 ft^2), with a likely value of 9,258 m^2 (3644 ft^2).

The indoor gamma shielding factor accounts for attenuation of gamma radiation by building materials and the resulting reduction in dose to a potential receptor while indoors. The shielding factor is one of the most important parameter values impacting the calculation of the ^{137}Cs +D PRG because the external dose pathway dominates the risk for this constituent. The default indoor gamma shielding factor used in the EPA radionuclide PRG calculator is 0.4; however, residual radioactivity computer code (RESRAD) uses a default gamma shielding factor of 0.7 and historically gamma shielding factors as high as 0.8 were used. Gamma shielding factors are also reported to be as low as 0.2 for heavily constructed (block and brick) homes (EPA 1981). A study titled *Development of Site-Specific Shielding Factors for Use in Radiological Risk Assessments* conducted by the Nuclear Regulatory Commission (NRC) calculated many site-specific gamma shielding factors for various building types and exposure scenarios (NRC 2010). Building types included slab on grade with wood siding, slab on grade with brick siding, basement foundation, crawlspace foundation. Exposure scenarios included general contamination (house is located in the center of a 10,000 m^2 [107639 ft^2] area of contamination) and an elevated area of contamination (a 100 m^2 [1076 ft^2] elevated area directly under the house). The weighted mean gamma shielding factors for various composites of these scenarios were below 0.4. For the Monte-Carlo simulation, a triangular distribution for the gamma shielding factor was assumed with 0.4 selected as the most likely result. The minimum and maximum gamma shielding factors used for the triangular distribution were 0.2 and 0.8, respectively.

Site-specific parameter values for slab size and gamma shielding are summarized in Table 1.

Table 1. Summary of site-specific parameters

Parameter	Unit	Minimum value	Maximum value	Most likely value
Slab Size – typical residential dredge (area of contamination)	m^2	30.6	765	522
Slab Size – typical residential dredge (area of contamination)	ft^2	329.4	8234	5619
Gamma Shield Factor – indoor	unitless	0.2	0.8	0.4

Radionuclide-Specific Parameters

Radionuclide-specific parameters including the decay constant, wet soil to plant transfer factor, and slope factors used in this assessment are provided on Table 2. With the exception of the external slope factor, each of these radionuclide-specific parameters is the default values used in the EPA Radionuclide PRG calculator. The external slope factor used in this evaluation is the value from the EPA PRGs for Radionuclides website (EPA 2012) that is based on an assumed thickness of 15-cm (5.9 in.) throughout the entire area of contamination. Neither range estimates nor distributions were identified for these radionuclide-specific parameters for the Monte-Carlo simulation.

For this investigation, ^{137}Cs +D slope factors were used to account for the daughter products of ^{137}Cs. Select radionuclides and radioactive decay chain products are designated in the generic PRG table with the suffix "+D" (plus daughters) to indicate that the cancer risk estimates for these radionuclides include contributions from their short-lived decay products, assuming equal activity concentrations (i.e., secular equilibrium) with the principal or parent nuclide in the environment. The "+D" indicates that associated decay products with half-lives less than 6 months are included in the PRG. In the case of ^{137}Cs, the short-lived daughter radionuclide, ^{137}Bismuth, emits the majority of gamma radiation associated with ^{137}Cs, hence the use of the +D slope factor is essential.

Table 2. Constituent-specific Parameters for ^{137}Cs +D

Parameter	Value	Unit
λ (decay constant)	2.31E-02	1/yr
SFext (slope factor external) – 15 cm	2.27E-06	(risk/yr)/(pCi/g)
SFs (slope factor ingestion)	4.33E-11	risk/pCi
SFi (slope factor inhalation)	1.19E-11	risk/pCi
SFf (food slope factor)	3.74E-11	risk/pCi
TFp (wet soil to plant transfer factor)	0.04	unitless

Standard Exposure Factors/Parameters

Standard exposure factors/parameters used in this assessment are provided on Table 3. Each of these exposure factors/parameters are default values in the EPA Radionuclide PRG calculator. Neither range estimates nor distributions were identified for these standard exposure factors/parameters for the Monte-Carlo simulation.

Table 3. Standard Parameters

Parameter	Value	Unit
t_r (time - resident)	30	yr
ED_r (exposure duration - resident)	30	yr
ET_r (exposure time - resident)	24	hr/day
ET_{r-o} (exposure time - outdoor resident)	0.073	hr/hr
ET_{r-i} (exposure time - indoor resident)	0.684	hr/hr
ED_{r-c} (exposure duration - resident child)	6	yr
ED_{r-a} (exposure duration - resident adult)	24	yr
EF_r (exposure frequency - resident)	350	day/yr
IRS_{r-a} (soil intake rate - resident adult)	100	mg/day
IRS_{r-c} (soil intake rate - resident child)	200	mg/day
IRF_{r-a} (fruit consumption rate - resident adult)	20.5	mg/day
IRF_{r-c} (fruit consumption rate - resident child)	5.4	mg/day
IRV_{r-a} (vegetable consumption rate - resident adult)	10.4	kg/yr
IRV_{r-c} (vegetable consumption rate - resident child)	3.8	kg/yr
IRA_{r-a} (inhalation rate - resident adult)	20	m^3/day
IRA_{r-c} (inhalation rate - resident child)	10	m^3/day
IFF_{r-adj} (age-adjusted fruit ingestion factor - resident)	17.48	kg/yr
IFV_{r-adj} (age-adjusted vegetable ingestion factor - resident)	9.08	kg/yr
IFS_{r-adj} (age-adjusted soil ingestion factor - resident)	120	mg/day
IFA_{r-adj} (age-adjusted soil inhalation factor - resident)	18	m^3/day
CPF_r (contaminated plant fraction)	0.25	unitless

Results of Monte-Carlo Simulations

- Based on the results of the Monte-Carlo simulation, the range of the potential PRG is 5.49 to 22.27 pCi/g with an average of 9.88 pCi/g (Table 4).

Table 4. Monte-Carlo Statistics

Statistics	Value	Unit
Trials	10000	---
Mean	9.88	pCi/g
Median	9.61	pCi/g
Mode	---	---
Standard Deviation	2.34	---
Variance	5.49	---
Skewness	0.74	---
Kurtosis	3.53	---
Coeff. of Variability	0.24	---
Range Minimum	5.49	pCi/g
Range Maximum	22.27	pCi/g
Range Width	16.78	---
Mean Std. Error	0.02	---

Figure 1 shows the distribution of potential PRGs calculated in the Monte Carlo simulation. There is a 28% chance that the action level is greater than 11 pCi/g. Therefore the action level of 11 pCi/g falls within the range of likely protective levels.

- There is an 80% chance the potential PRG falls between 7 and 13 pCi/g

- There is a 66% chance the potential PRG falls between 8 and 13 pCi/g

- There is a 50% chance the total PRG is between 9 and 13 pCi/g

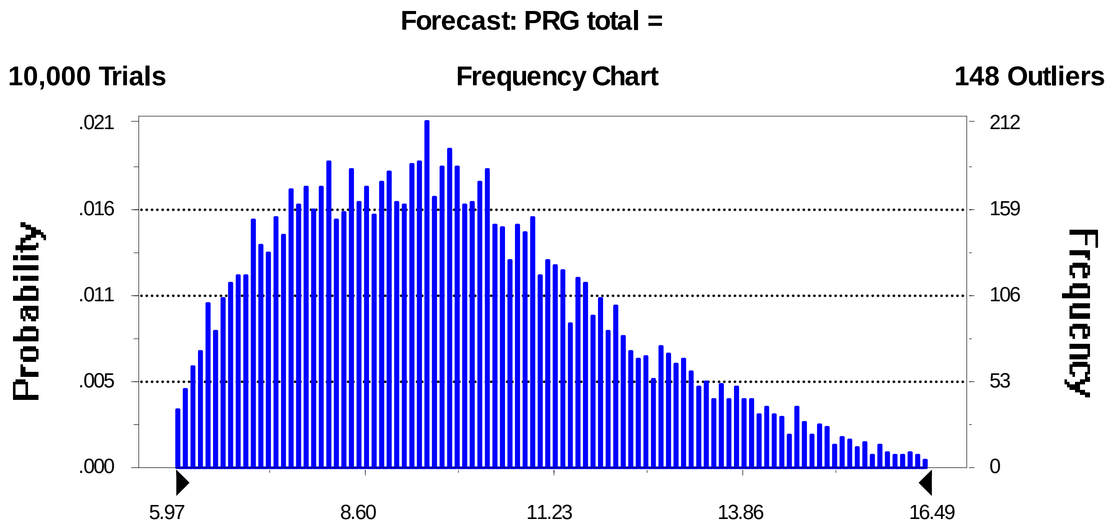


Figure 1. Distribution in the Total PRG

A single model run was performed using the larger commercial dredge volumes. When these volumes are used to define slab size in the model, the potential action levels are less (e.g., < 11 pCi/g).

Conclusions

The current 11 pCi/g action level used by the WBIWG to review residential dredge permit requests continues to be protective of human health. The WBIWG should continue to compare this value with available historical data (and new data as deemed necessary) to insure dredging activities are safe. However, in cases where the WBIWG receives requests for larger commercial dredges (> 1000 m^3 or approximately 1300 yd^3), additional steps should be taken to review these requests, particularly related to review and input on the issue of where and how dredge materials will be disposed of in these cases. Reuse of these dredge materials in areas where land use is not residential, e.g., recreational areas, may be acceptable. Higher action levels would be protective for these recreational uses since many of the conservative exposure assumptions other than slab size used to develop the 11 pCi/g level (e.g., the exposure frequency of 350 days/yr) would not be applicable to recreational use.

References

EPA 1981. *Population Exposure to External Radiation Background in the United States*, ORP/SEPD-80-12, Environmental Protection Agency, Office of Radiation Programs, Washington, D.C., April.

EPA 2012. *USEPA Preliminary Remediation Goals for Radionuclides*, Available at: <http://epa-prgs.ornl.gov/radionuclides/>.

NRC 2010. *Development of Site-Specific Shielding Factors for Use in Radiological Risk Assessments*, Nuclear Regulatory Commission, March.

ORNL 1994. *Data Summary for the Near-Shore Sediment Characterization Task of the Clinch River Environmental Restoration Program*, ORNL/ER-264, Oak Ridge National Laboratory for the U.S. Department of Energy Office of Environmental Management, October.

ACTION PLAN 4
Solid Waste Storage Area (SWSA) 4 Downgradient Trench Performance

STATUS: Closed
FYR ISSUE: MV-1
CERCLIS OU: #29

ISSUE: During FY 2009 and FY 2010, the GW level control in the Solid Waste Storage Area (SWSA) 4 downgradient trench in Melton Valley (MV) showed short-term problems following significant rainfall events. This indicates the possibility that contaminated GW may be discharged to the Intermediate Holding Pond for periods of time when water level control in the trench is inadequate. There are currently three wells not attaining their target level concentrations as stipulated in *The Record of Decision for Interim Actions for the Melton Valley Watershed* (DOE 2000) (Section 3.2.2.2).

BACKGROUND: The SWSA 4 downgradient GW collection trench was designed and built to capture GW seepage from beneath the SWSA 4 cap. The design did not utilize a seepage barrier outside the capped area but rather relied upon maintaining a gradient control between the in-trench water level and water levels outside the unit beneath the former Intermediate Holding Pond. Siltation of the gravel backfill in the downgradient trench reduces the efficiency of the downgradient trench extraction wells, therefore not attaining the target concentrations.

PLAN/SCHEDULE: A project has been implemented to redevelop all the GW extraction wells in the SWSA 4 downgradient trench and to replace failed pumps to improve remedy performance. The project was completed in February 2013. Monitoring of GW levels in and around the trench will continue to determine the effectiveness of the remedy at containing contaminated GW beneath the downgradient cap edge. This Action Plan #4 from the *2011 Third Reservation-wide CERCLA Five-Year Review* is now closed.

ACTION PLAN 5
Bethel Valley (BV) ROD Goal

STATUS: Closed
FYR ISSUE: BV-1
CERCLIS OU: #30

ISSUE: The Bethel Valley (BV) ROD (DOE 2002) goal for SW of "achieve at least 45% risk reduction at 7500 Bridge" is difficult to use as a quantitative measure of performance due to:

(1) uncertainty related to the exact baseline risk values against which to measure this reduction, and

(2) lack of clarity in the ROD on sampling and statistical approach for measuring changes.

BACKGROUND: One of the remediation goals in the BV ROD is:

> *The selected remedy will also reduce risk in surface water at the 7500 Bridge by at least 45% relative to 1994 levels. The 7500 Bridge is the point at which surface water exits Bethel Valley and enters Melton Valley. Based on the anticipated effectiveness of the Melton Valley remedy, the 45% risk reduction is necessary to meet the Melton Valley watershed ROD goal of protecting the off-site resident user of surface water at the confluence of White Oak Creek with the Clinch River."*

PLAN/SCHEDULE: DOE will review the intent of the goal in the ROD and clarify the approach that will be used in future RERs and FYRs. Possible outcomes of the review could include:

- Definitive 1994 baseline contaminant masses and/or concentrations;
- A more clear definition of the quantitative approach for measuring the 45% risk reduction;
- A target concentration level for each contaminant detected at 7500 Bridge, along with clarity on the type of SW sample needed to confirm compliance;
- A target annual contaminant mass release for each contaminant detected at 7500 Bridge,
- Etc.

<u>History of the Issue</u>

The BV ROD (DOE 2002) identified several remedial action objectives (RAOs) for protection of SW bodies. Only the RAO relevant to this Action Plan will be discussed; "Achieve at least 45% risk reduction at the 7500 Bridge" (DOE 2002).

At stated in the BV ROD:

> *"This goal is a direct result of a goal in the Melton Valley watershed ROD to protect an off-site residential user of surface water at the confluence of White Oak Creek and the Clinch River. The Melton Valley watershed ROD established a remediation level of 1x10-4 ELCR (annual average) at the confluence. Because White Oak Creek receives water from Bethel Valley and Melton Valley watersheds, risk contribution from both watersheds are taken into account. Assuming 1994 baseline conditions,*

and assuming the Melton Valley remedy achieves at least an 82% reduction of the Melton Valley contribution to the residential risk at the confluence, then the Bethel Valley remedy must achieve a 45% risk reduction in surface water exiting Bethel Valley in order for the Melton Valley ROD goal of protection of the off-site resident to be met."

Additionally the BV ROD states:

"*The 45% risk reduction will be based on the combined risk from ^{90}Sr and ^{137}Cs*".

FINDINGS

Findings are discussed below under headings that correspond to the "possible outcomes of the review" identified under "**PLAN/SCHEDULE**" on p. 1 of this Action Plan.

Definitive 1994 baseline contaminant masses and/or concentrations. The FY 1994 data shown in Table 1 were first published in an Environmental Restoration Monitoring and Assessment report (DOE 1995), a precursor to the RER, and represent "1994 baseline conditions".

Table 1. Contaminant concentrations and flux at 7500 Bridge and White Oak Dam, 1994 [a]

Parameter	Units	1994	
		7500 Bridge	White Oak Dam
Strontium-90 concentration/total contaminant mass flux	pCi/L/(Ci)	67/(0.75)	180/(3.37)
Cesium-137 concentration/total contaminant mass flux	pCi/L/(Ci)	59/(0.66)	33/(0.62)

[a]**Source:** Table 3.3 in DOE 1995.

WOD = White Oak Dam

Although conditions in BV relative to MV have changed since 1994, the ultimate purpose of setting the 45% risk reduction goal at the 7500 Bridge in BV was to ensure that the downstream MV ROD goal of protection the off-site resident is met. As shown in Table 2 below from Chapter 3 of the 2013 RER, regardless of the risk reduction realized at the 7500 Bridge, the goal to protect an off-site resident at the confluence of White Oak Creek (WOC) and the Clinch River (as measured at White Oak Dam [WOD]) has been achieved. This goal is evaluated based on an evaluation of average annual concentrations for ^{90}Sr, ^{137}Cs, and ^{3}H.

Table 2. Summary of FY 2012 radiological contaminant levels at White Oak Dam integration point in Melton Valley

WHITE OAK DAM			
Monthly composite date	^{90}Sr	^{3}H	^{137}Cs
27-Oct-11	61	25,000	17.8
30-Nov-11	59	32,000	26.7
29-Dec-11	52	16,000	9.6
26-Jan-12	37	5,500	32.5
29-Feb-12	41	4,600	12.4
29-Mar-12	30	7,000	20.7
26-Apr-12	44	13,000	9.6
31-May-12	38	16,000	27.9
28-Jun-12	48	39,000	31.5
26-Jul-12	49	53,000	24.1
30-Aug-12	47	**61,000**	13.9
27-Sep-12	42	**60,000**	30.0
Average concentration (pCi/L)	46.7	27,000	28.2
ROD Goal	85	58,000	150

Activity values are pCi/L measured in monthly continuous flow composite samples.

^{137}Cs = cesium-137
^{3}H = tritium
^{90}Sr = strontium-90

Bold value indicates sample concentration exceeds *Melton Valley ROD goal.*

A more clear definition of the quantitative approach for measuring the 45% risk reduction. Table 3 shows the concentration comparison provided in Chapter 2 of the FY 2013 RER. As risk is driven by contaminant concentration, evaluation of the 45% risk reduction goal by evaluation of reduction in average (arithmetic mean) annual contaminant concentration is appropriate. Other SW within the BV Watershed allows tracking of contaminant discharges from various source areas. This quantitative approach for measuring the 45% risk reduction has been used annually and is the recommended approach for evaluation in future RERs and the next FYR.

Table 3. 7500 Bridge risk-reduction goal evaluation

Year	Average strontium-90 (Goal = 37 pCi/L)[b]	Average cesium-137 (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
2011	**54**	< 16
2012	33	<15

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

[a]*Record of Decision for Interim Actions in Bethel Valley Watershed* (DOE 2002) baseline year.
[b]Goal = 45% reduction in average concentrations measured during baseline year.

A target concentration level for each contaminant detected at 7500 Bridge, along with clarity on the type of SW sample needed to confirm compliance. The target concentration levels (pCi/L) for ^{90}Sr and ^{137}Cs (37 pCi/L and 33 pCi/L, respectively) to meet the 45% risk reduction goal are shown in Table 3. These values represent a 45% reduction of the 1994 contaminant concentrations (see Table 1). For ^{90}Sr the value is 67 pCi/L x .55 = 37 pCi/L and for ^{137}Cs the value is 59 pCi/L X .55 = 33 pCi/L.

With regard to the type of SW sample needed, the following is stated in the BV ROD (DOE 2002, p. 2-162):

> *"Samples to demonstrate compliance with the 45% risk reduction will be taken at the 7500 Bridge or equivalent integration point. If the continuous samples 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."*

The current sampling approach, a monthly flow-paced composite sample at the 7500 Bridge, will continue to be used to measure compliance. This sampling approach produces an average constituent concentration result that inherently accounts for impacts of flow rate on concentrations over time. The sampling approach is also conservatively reflective of how a SW intake system for a public water supply would be sampled.

A target annual contaminant mass release for each contaminant detected at 7500 Bridge. Development of a target annual contaminant mass release for ^{90}Sr and ^{137}Cs is neither necessary or appropriate. It is recommended the 45% risk reduction goal continue to be evaluated in the RER and FYR as shown in Table 3 by comparing concentration data from monthly flow-paced composite sampling to target concentrations of ^{90}Sr and ^{137}Cs.

RECOMMENDATION

It is recommended that the 45% risk reduction goal in the BV ROD continue to be evaluated in future annual RERs and FYRs using the current approach documented in Table 3 above. The FY 1994 data shown in Table 1 will continue to be used to represent "1994 baseline conditions". The target concentration levels (pCi/L) for ^{90}Sr and ^{137}Cs (37 pCi/L and 33 pCi/L, respectively) to meet the 45% risk reduction goal will continue to be used for comparison evaluation.

It is also recommended that the current sampling approach, a monthly flow-paced composite sample at the 7500 Bridge, continue to be used to measure compliance. The approach is consistent with ROD language, produces an average constituent concentration result that inherently accounts for impacts of flow rate on concentrations over time, and is conservatively reflective of how a SW intake system for a public water supply would be sampled. Development of a target annual contaminant mass release for ^{90}Sr and ^{137}Cs is neither necessary or appropriate.

Although conditions in BV relative to MV have changed since 1994, the ultimate purpose of setting the 45% risk reduction goal at the 7500 Bridge in BV was to ensure that the downstream MV ROD goal of protection the off-site resident was met. As shown in Table 2 above, regardless of the risk reduction realized at the 7500 Bridge, the goal to protect an off-site resident at the confluence of WOC and the Clinch River (as measured at WOD) has been achieved based on an evaluation of average annual concentrations for ^{90}Sr, ^{137}Cs, and ^{3}H. This Action Plan #5 from the *2011 Third Reservation-wide CERCLA Five-Year Review* is now closed.

REFERENCES

DOE 1995. *Fourth Annual Environmental Restoration Monitoring and Assessment Report (FY 1995), Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1413&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002. *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee*, DOE/OR/01-1862&D4, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2011. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Volume 1 – Main Text*, DOE/OR/01-2516&D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

ACTION PLAN 6
Corehole 8 Plume Collection System Upgrade

STATUS: Closed
FYR ISSUE: BV-2
CERCLIS OU: #35

ISSUE: Corehole 8 Plume collection system operation and maintenance issues are preventing it from currently meeting the Removal Action Report (RmAR) performance goals.

BACKGROUND: For several years leading up to the 2011 Third Reservation-wide CERCLA FYR for the DOE ORR a deterioration in performance of the Corehole 8 plume collection system was observed and reported in annual RERs. System performance deteriorated to the extent that the BV ROD goal for risk reduction at the 7500 Bridge was not met due to releases attributable to ^{90}Sr originating from Corehole 8 plume discharges into First Creek.

PLAN/SCHEDULE: During FY 2011 and 2012 DOE conducted a large scale upgrade to the Corehole 8 plume collection system. The upgrade included installing 2 bedrock plume extraction wells, and replacing all of the system's electrical, mechanical and control components. The upgraded and refurbished system was brought into full operation in mid-March 2012. Ongoing monitoring of contaminant discharges into First Creek shows that the ^{90}Sr discharges have been reduced to levels measured prior to the onset of system performance deterioration. Strontium-90 concentrations at the 7500 Bridge now meet the risk-based performance goals for 45% reduction. This Action Plan #6 from the *2011 Third Reservation-wide CERCLA Five-Year Review* is now closed.

Monitoring of system performance and contaminant discharges to First Creek will continue and will be reported annually in the RER.

ACTION PLAN 7
East End Volatile Organic Compound (EEVOC) Plume Point of Compliance

STATUS: Closed
FYR ISSUE: UEF-2
CERCLIS OU: #42

ISSUE: The East End Volatile Organic Compound (EEVOC) Plume Action Memorandum (AM) does not clearly indicate the intended point of compliance (POC) for measuring compliance with ambient water quality criteria (AWQC).

BACKGROUND: There is no location clearly indicated in the EEVOC Plume AM as the POC for monitoring compliance with the carbon tetrachloride AWQC that is established as an ARAR in the AM. Under Tennessee law, compliance with AWQC for effluent discharges is typically measured beyond the edge of a designated mixing zone. Although the EEVOC Plume engineering evaluation/cost analysis (EE/CA) clearly indicated that compliance with the carbon tetrachloride AWQC would be attained instream downstream from the discharge point, this language was not carried through to the AM.

In March 2013, DOE issued a Non-Significant Change (NSC) to the EEVOC Plume AM to clarify that, pursuant to TDEC 1200-04-03-.05(2), the POC for monitoring compliance with the AWQC will be at Lake Reality Bypass (LRBP) 1 [“EEVOC Effluent (Mixing Zone)”], which is downstream from the EEVOC Plume treatment system and beyond the edge of a mixing zone in the concrete-lined portion of UEFPC. An erratum to the RmAR was also issued in March 2013 to clarify POC language in that document.

Although carbon tetrachloride concentrations exceeded the Tennessee recreational (organisms only) water quality standard (16 μg/L) nine out of twelve months in 2010 in the EEVOC plume treatment system effluent as measured where it is collected directly from the treatment system prior to discharge, the instream concentration as measured at LRBP-1 is below the carbon tetrachloride AWQC.

PLAN/SCHEDULE: DOE has issued a NSC to the EEVOC plume AM and an erratum to the RmAR that specify an in-stream POC for monitoring compliance with the AWQC. Monitoring of the POC will be reported on in the annual RER. This Action Plan #7 from the *2011 Third Reservation-wide CERCLA Five-Year Review* is now closed.

ACTION PLAN 8
Bear Creek Valley (BCV) Chemicals of Concern

STATUS: Closed
FYR ISSUE: BCV-1
CERCLIS OU: #32

ISSUE: The Bear Creek Valley (BCV) Phase I ROD does not provide a comprehensive list of contaminants of concern (COCs) and related remediation levels (RLs) to evaluate compliance with ROD goals. This was the first "watershed" ROD and did not include these levels.

BACKGROUND: In the process of developing both the 2006 and 2001 FYRs, risk assessors found it difficult to assess progress towards protectiveness because the BCV Phase I ROD does not clearly identify the full list of COCs in BCV. The situation is confounded by BCV being divided into three zones.

The MV, BV, and East Tennessee Technology Park (ETTP) RODs clearly identify the COCs for each media in tables within the RODs. The BCV Phase I ROD does not.

Because the strategy for closure of BCV is long-term, this issue does not impact current activities. However the review of the BCV Phase I ROD is difficult to complete and it will be an issue as planning for future RODs and actions occur in BCV.

PLAN/SCHEDULE: The DOE will develop a list of COCs for BCV media to be used in the next FYR for the BCV Phase I ROD. This list will be valley-wide—not by zone—and will be available prior to planning for the next FYR and for planning future events. This effort will entail the following:

1. Review the RI and FS COC lists for BCV.

2. Review (compiled/reported) environmental data for SW and GW, including Environmental Management Waste Management Facility (EMWMF) data, collected since 1995. (Note: The project team will not review raw data in the Oak Ridge Environmental Information System [OREIS].)

3. Develop the following BCV COC lists:

   - SW;
   - GW; and
   - Soil

4. Report on status in the 2013 RER.

At the same time, DOE will identify activities that will need to occur in the development of final RODs for BCV.

HISTORY OF THE ISSUE

Initially, in the BCV cleanup approach under the CERCLA effort, it was assumed that the BCV ROD would address all the findings of the original watershed-scale RI and FS. As such, a broad range of RAOs was developed to evaluate remedial alternatives. However, as discussions progressed among the Federal Facility Agreement (FFA) parties, it was determined that a first Bear Creek ROD would address "Phase I" remedial actions (RAs) including the S-3 Ponds and the Boneyard/Burnyard (BYBY), but remediation decisions at the Bear Creek Burial Grounds (BCBG) and final remediation goals for GW would be deferred.

The legacy of the early watershed-scale work and a desire to perform the initial source actions in the context of broad watershed-scale goals resulted in the Phase I ROD containing:

1. Specific performance measures for the Phase I source actions (Table 1),
2. General references toward meeting generic watershed-scale goals in SW and GW throughout the valley (Table 2), and
3. Expected outcomes of the selected remedy with some cleanup levels identified for GW and SW by Zone and source area (Table 3).

The primary goal of each of the actions under the Phase I ROD was to reduce the worst off-site contaminant migration, which was identified to be uranium releases to SW in Bear Creek from the S-3 Ponds and BYBY (Table 1). The Phase I ROD identified both source-specific areas (North Tributary [NT]-1, NT-3) and a watershed-scale POC (Bear Creek kilometer [BCK] 9.2). Three additional COCs (cadmium, nitrate, and mercury) were found to be present either as a human health or ecological risk via the same flowpaths as uranium and, hence, also received specific RLs.

Table 1. Site-specific goals for BCV Phase I ROD remedial actions at the S-3 Site Pathway 3 and the BYBY

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/year.
Reduce concentration of cadmium in NT-1 and upper Bear Creek to meet AWQC (0.25 µg/L).[a]	Reduce concentration of mercury in NT-3 to meet AWQC (51 ng/L).[b]
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] The *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), originally established the cadmium concentration performance standard as the criterion maximum concentration of 3.9 µg/L and criterion continuous concentration of 1.1 µg/L. This standard changed to the continuous criterion concentration of 0.25 µg/L due to changes in the promulgated AWQC.

[b] The Phase I ROD originally established the mercury concentration performance standard as the recreation water organisms criterion of 12 ng/L. This standard changed to 51 ng/L due to changes in the promulgated AWQC.

AWQC = ambient water quality criteria
BCK = Bear Creek kilometer
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
FFA = Federal Facility Agreement
NT = North Tributary
U = uranium

Table 2. Watershed groundwater and surface water goals for the BCV Phase I ROD[a]

Area of the valley	Current situation	Goal
Zone 1 – western half of BCV	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 BCV	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 *Record of Decision for the Phase 1 Activities in Bear Creek Valley* [(DOE 2000) page 2-13].

AWQC = ambient water quality criteria
BCV = Bear Creek Valley
MCLs = maximum contaminant levels
ROD = Record of Decision
SDWA = Safe Drinking Water Act

Table 3. Expected outcome of the selected remedy, BCV watershed[a]

	Zone 1	Zone 2	Zone 3		
			S-3 Site/Pathway 3	BYBY/OLF Area	BCBGs
Cleanup levels, residual risk	- MCLs in groundwater - AWQC in surface water - risk to residential receptor below RAO of 1E-5	- TBD for groundwater - AWQC in surface water - risk to residential receptor below RAO of 1E-5	- TBD for groundwater - AWQC in surface water - direct exposure risk to industrial/terrestrial receptors eliminated - risk to industrial receptor below RAO of 1E-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 1E-5	N/A

[a]Source: from *Record of Decision for the Phase 1 Activities in Bear Creek Valley* [(DOE 2000) Table 2.22].

AWQC = ambient water quality criteria
BCBG = Bear Creek Burial Ground
BCV = Bear Creek Valley
BYBY = Boneyard/Burnyard
MCLs = maximum contaminant levels
N/A = not applicable
NT = North Tributary
OLF = Oil Landfarm
RAO = remedial action objectives
SDWA = Safe Drinking Water Act
TBD = to be determined

As shown in Table 2, the BCV Phase I ROD identifies broad GW quality goals. Table 3 shows expected outcomes of the BCV Phase I ROD in terms of cleanup levels and residual risk in Zones 1 and 2 and the S-3 Site and BYBY source areas in Zone 3. Despite the ROD language that states final GW remediation goals are deferred, the ROD identifies maximum contaminant levels (MCLs) for GW in Zone 1 as an expected outcome for cleanup. The ROD also identifies AWQC in SW in Zones 1 and 2 and at the S-3 Site and BYBY in Zone 3, as expected outcomes for cleanup, The ROD does not provide the specific requirements for achieving goals and expected outcomes that are usually identified in RODs, (e.g. there are no specific COCs or compliance points for the Phase I actions related to the MCLs, AWQC, and residual risk levels).

The ambiguity related to the broad GW and SW goals listed in Table 2 and expected outcomes listed in Table 3 leads to the question – what type of analysis against these goals and expected outcomes should be performed during the Phase I ROD FYR?

FINDINGS

Historical, pre-decision CERCLA documents and more recent studies were reviewed for further insight on this issue.

Review of COC lists from BCV CERCLA documents

The RI for BCV (DOE 1997a) contains a fairly comprehensive list of BCV COCs. These COCs are identified by source area/environmental media/land use receptors so there are numerous lists identified in Appendix F Tables and Exhibits F.1 through F.4 of the RI (the Baseline Risk Assessment). These tables indicate the following:

- There are three separate zones in BCV: Zone 1 residential, Zone 2 recreational, and Zone 3 industrial.
- All of the sites/soils interim actions are in Zone 3, the industrial zone where the source units are located. Most of the performance monitoring for the interim ROD addresses a limited set of COCs in SW in Zone 3 and at the interface between Zones 2 and 3 (the BCK 9.2 monitoring location).
- Zone 2 is slated for future recreational use (short-term) and future residential use (long-term) and based on review of the RI appears to only have COCs based on protection of fish. Currently, limited SW sampling occurs for comparison to AWQC.
- Zone 1 is designated for residential use, but it is very difficult to tell from the RI appendices what COC identification work was done for Zone 1.
- There are no soil COCs listed in the ROD. Soil COCs, as depicted in the RI, vary by land use and by areas within Zone 3 (Table 4). This list appears to be incomplete for Zones 1 and 2, possibly due to lack of soil data in those areas. In order to guide a final status closure survey in Zones 1 and 2, soil COCs would need to be identified in a final ROD.
- GW and SW COCs were developed in the RI using available data. For this review, using the GW and SW COC lists from the RI, contaminant data from the RI were re-evaluated using multiple screens (various risk levels and MCLs). Attachment 1 provides these lists and the subsequent reanalysis. The variations on the lists depending on which screen is performed show the importance of identifying final endpoints (target risk levels and/or MCLs) and the final COC list in BCV.

Although some GW modeling was performed in the RI, modeling of potential plume migration downgradient in the Maynardville from Zone 3 to Zones 1 and 2 was limited to use of a water balance model to predict mixing and dilution. A better understanding of future plume migration is necessary to identify final GW COCs in Zones 1 and 2.

Table 4. Summary of soil COCs listed in the BCV RI

Site	Zone 1 – Unrestricted residential	Zone 2 – Recreational	Zone 3 – Industrial
S-3	NA	NA	Be, PCB, Cs, Np, Pu, Ru, Tc, Th-228/230, U-234/235/238
OLF	NA	NA	As, Co, Rb, Thallium-208
SL-1	NA	NA	None
BYBY	NA	NA	Sb, As, Be, Hg, SVOCs (see below), PCB, U-234/235/238
BG	NA	NA	U-234/235/238, Be, U-total, benzene, Benzidine, PCB, TCE
DARA	NA	NA	Dioxins, PCBs, U

Semivolatile organic compounds (SVOCs) = benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)flouranthene, dibenzo(*a,h*)anthracene, indeno(1,2,3)pyrene; Be = beryllium; PCB = polychlorinated biphenyl; Cs = cesium; Np = neptunium; Ru = ruthenium; Tc = technetium; Th = thorium; U = uranium; As = arsenic; Co = cobalt; Rb = rubidium; Sb = antimony; Hg = mercury; and NA = not applicable in remedial investigation.

BCV = Bear Creek Valley
BG = Burial Ground
BYBY = Boneyard/Burnyard
COC = chemical of concern
DARA = Disposal Area Remedial Action
TCE = trichloroethene

The RI was also reviewed to ascertain if the COC issue was further refined through the CERCLA process. The FS acknowledged the variety of the COC lists from the RI and developed short lists of "indicator COCs" for human health (p. 2-9 of the FS, DOE 1997b). Again, these lists were developed for the FS; however, since the ROD focused on a small subset of the potential actions for the valley, these short-list COCs were not carried into the ROD.

Although these COCs were not adopted in the Phase I ROD, they serve as a good list of indicator chemicals for the valley:

- Groundwater: ^{238}U, ^{234}U, 1,1-dichloroethene (DCE), 1,2-DCE, tetrachloroethene, vinyl chloride, barium, cadmium, and nitrate, plus trichloroethene (TCE) and ^{99}Tc.
- Soil: ^{238}U and polychlorinated biphenyls (PCBs).
- SW: Same as GW, minus barium
- Sediment: ^{238}U and PCBs.
- Fish: PCBs and mercury.

This FS indicator COC list and the reanalysis of the RI COC lists in Attachment 1 indicate that the FS did not include several chemicals that have been detected in BCV above their respective MCLs. Additional chemicals that were detected above their MCL include:

- Beryllium, mercury, bis(2-ethyhexyl) phthalate, methylene chloride, radium (as compared to the total alpha MCL), benzene, chloroform, 1,1,1-trichloroethane (TCA), 1,1,2-TCA, and 1,2-dichloroethane (DCA).

<u>Review (Compiled/Reported) Environmental Data for SW and GW</u>

In addition to the RI and FS, additional documents were consulted to determine if more recent sampling efforts confirm the RI and FS COC list. Data from the Y-12 Groundwater Protection Program (GWPP) Annual Reports in 2009, 2010, and 2011 (B&W Y-12 2009, B&W Y-12 2011, B&W Y-12 2012) and from the EMWMF Annual Reports for Detection Monitoring from 2001 through 2009 (BJC 2004, BJC 2006, BJC 2007, BJC 2008, BJC 2009, and BJC 2010) were reviewed.

The GWPP reports have a large amount of GW data analysis (e.g., the 2009 report contains over 2000 pages of statistical analysis and trend charts) that is focused on trends for a limited analyte list, primarily nitrate, uranium, gross alpha, gross beta, and volatile organic compounds (VOCs). Analytes evaluated in the GWPP are included in the Bear Creek RI COC list.

The EMWMF detection monitoring process has a very different definition for “COC” (e.g., a COC is a chemical identified in the waste streams accepted at the facility [along with constituents detected in leachate samples]). Over the years the EMWMF COC list has grown to a very large list of chemicals and radionuclides that have or may have been disposed in the facility. In addition, because detection monitoring is designed to identify detections “above background baseline” monitoring, chemicals identified in this analysis are chemicals that exceed their background threshold limit value (TLV) or project quantitation limit, not chemicals that pose a potential risk as defined by CERCLA. In 2003 to 2004, there were sporadic exceedances of TLVs (^{129}I, ^{228}Ra, ^{230}Th, ^{232}Th, tritium, TCE, and inorganics), but they were not confirmed in following years. SW data collected by the EMWMF show the following chemicals have exceeded their respective AWQC at least once over the years: lead, zinc, copper, pesticides and PCBs, alpha, beta, ^{90}Sr, and tritium. These chemicals are monitored under the EMWMF ROD and will need to be considered during the development of the final ROD for BCV but should not be included in the review of the Phase I ROD.

CONCLUSIONS

The exercise of identifying COCs for the Phase I ROD partially turned into an exercise in better understanding the scope of the Phase I ROD. The RI and FS attempted to address all containment sources, all environmental media, and all zones of the valley in the first ORR watershed-scale ROD. However, the specific Phase I ROD scope addressed a small subset of sources (S-3 and BYBY), COCs (uranium, nitrate, cadmium, and mercury), and environmental media (SW). The whole process resulted in a hybrid set of specific source action COCs and RLs along with more general, less-defined COCs for other media and areas and generic goals or “expected outcomes.”

<u>Recommended Approach for 2016 FYR</u>

Based on the above, it is recommended that the following approach be used to evaluate the status and effectiveness of the Phase I ROD in the 2016 FYR:

1. To evaluate protectiveness of the Phase I ROD, the 2016 analysis should use the specific performance goals selected for the S-3 Site and BYBY RAs for uranium, nitrate, cadmium, and mercury in SW.

2. To address progress toward meeting the RLs yet to be established in the Final ROD and the expected outcomes of the BCV Phase I ROD shown in Table 3, it is recommended that the following list of COCs be monitored in SW and GW the year before the FYR at a minimum and compared to MCLs, AWQC, and risk-based levels. This comparison should take place for each of Zones 1, 2, and 3 to provide updated baselines indicating where drinking water levels, AWQC, and risk-based levels have and have not been achieved:

   - Radionuclides: ^{238}U, ^{234}U, ^{99}Tc, and radium (as compared to the total alpha MCL).

   - Organics: 1,1-DCE, 1,2-DCE, TCE, tetrachloroethylene, VC, methylene chloride, 1,1,1-TCA, 1,1,2-TCA, 1,2-DCA, benzene, chloroform, and bis(2-ethyhexyl) phthalate.

   - Inorganics: barium, cadmium, and nitrate, plus beryllium, mercury, and nitrate.

   There is a great deal of interaction between shallow GW and SW in BCV, resulting in gaining and losing reaches along streams. As a result, the same list of COCs is recommended for GW and SW monitoring. It is also recommended that the COC list be reevaluated over time, as appropriate, depending on monitoring results and actions in the area.

The following items are missing from the Phase I ROD and will need to be developed for the Final ROD:

- A list of soil COCs and related industrial-based RLs for Zone 3, and RLs for Zones 1 and 2. The basis for these levels will be defined as part of the final ROD.

- A list of sediment COCs and related RLs for the Bear Creek floodplain and creek banks. The basis for these levels will be defined as part of the final ROD.

- A final list of valley-wide GW COCs and RLs in the various zones in BCV. Although it is suggested by the Phase I ROD that MCLs will apply to GW in Zone 1 (Picket A), the ROD will need to confirm this and will also need to specify what levels are acceptable in Zones 2 and 3 (Pickets B and C), based either on potential for migration or on limited uses other than residential.

- A final list of valley-wide SW COCs, RLs, and points of compliance. As suggested by the Phase I ROD, these levels will likely reflect AWQC.

This Action Plan #8 from the 2011 Third Reservation-wide CERCLA Five-Year Review is now closed.

REFERENCES

Babcock & Wilcox Technical Services (B&W) Y-12 2009. *Y-12 Groundwater Protection Program Groundwater Monitoring Data Compendium Revision 3.* Prepared by Elvado Environmental LLC Under Subcontract No. 4300068789 (Y/TS-1983/R3/V1).

B&W Y-12 2011. *Calendar Year 2010 Groundwater Monitoring Report, U.S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee, December 2011.* Prepared by Elvado Environmental LLC Under Subcontract No. 4300073231 (Y/SUB/11-073231/1).

B&W Y-12 2012. *Calendar Year 2011 Groundwater Monitoring Report, U.S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee, December 2011*. Prepared by Elvado Environmental LLC Under Subcontract No. 4300073231 (Y/SUB/12-073231/1).

Bechtel Jacobs, LLC (BJC) 2004. *Annual Report for Detection Monitoring at the Environmental Management Waste Management Facility*, BJC/OR-2125, prepared for Duratek Federal Services by SAIC, Oak Ridge, TN.

BJC 2006. *Annual Report for 2004–2005 Detection Monitoring at the Environmental Management Waste Management Facility, Oak Ridge, Tennessee*, BJC/OR-2394, Bechtel Jacobs Company LLC, Oak Ridge, TN.

BJC 2007. *Annual Report for 2005-2006 Detection Monitoring at the Environmental Management Waste Management Facility, Oak Ridge, Tennessee*, BJC/OR-2741/R1, Bechtel Jacobs Company LLC, Oak Ridge, TN.

BJC 2008. *Annual Report for 2006-2007 Detection Monitoring at the Environmental Management Waste Management Facility, Oak Ridge, Tennessee*, BJC/OR-3006, Bechtel Jacobs Company LLC, Oak Ridge, TN.

BJC 2009. *Annual Report for 2007-2008 Detection Monitoring at the Environmental Management Waste Management Facility, Oak Ridge, Tennessee*, BJC/OR-3216, Bechtel Jacobs Company LLC, Oak Ridge, TN.

BJC 2010. Annual Report for 2008-2009 Detection Monitoring at the Environmental Management Waste Management Facility, Oak Ridge, Tennessee, BJC/OR-3385, Bechtel Jacobs Company LLC, Oak Ridge, TN.

Department of Energy (DOE) 1997a. *Report on the Remedial Investigation for Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1455/D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997b. *Feasibility Study for Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, , DOE/OR/02-1525/V1&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

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 2012. *2011 Third Reservation-wide CERCLA Five-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2516&D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

ATTACHMENT 1

Table 1. S-3 Ponds Groundwater COCs

COC	95% UCL (mg/L or pCi/L)	95% UCL >1x10-6 RSL?	95% UCL >1x10-5 RSL?	95% UCL >1x10-4 RSL?	MCL (mg/L or pCi/L)	95% UCL >MCL?
Barium	1.56E+02	Barium	Barium	--	2.00E+00	Barium
Beryllium	1.92E-02	Beryllium	--	--	4.00E-03	Beryllium
Boron	3.63E-01	--	--	--	NA	--
Cadmium	2.69E-01	Cadmium	Cadmium	--	5.00E-03	Cadmium
Chromium	2.40E-02	Chromium	Chromium	Chromium	1.00E-01	--
Fluoride	2.99E+00	Fluoride	--	--	NA	--
Manganese	1.01E+01	Manganese	Manganese	--	NA	--
Mercury	5.20E-03	Mercury	--	--	2.00E-03	Mercury
Nickel	3.29E+00	Nickel	Nickel	--	NA	--
Nitrate (as N)	2.11E+03	Nitrate (as N)	Nitrate (as N)	--	1.00E+01	Nitrate (as N)
Nitrite (as N)	6.70E+00	Nitrite (as N)	--	--	1.00E+00	Nitrite (as N)
Strontium	8.80E+01	Strontium	--	--	NA	--
Total Uranium	2.56E+00	Total Uranium	Total Uranium	--	3.00E-02	Total Uranium
1,1-Dichloroethene	2.63E-03	--	--	--	7.00E-03	--
2,4-Dinitrophenol	3.20E-02	2,4-Dinitrophenol	--	--	NA	--
Benzene	2.61E-03	Benzene	--	--	5.00E-03	--
Bis(2-ethylhexyl)phthalate	1.83E-02	Bis(2-ethylhexyl)phthalate	--	--	6.00E-03	Bis(2-ethylhexyl)phthalate
Chloroform	6.20E-03	Chloroform	Chloroform	--	8.00E-03	--
Di-n-octylphthalate	2.79E-03	--	--	--	NA	--
Methylene Chloride	2.42E-02	Methylene Chloride	--	--	5.00E-03	Methylene Chloride
Tetrachloroethene	4.21E-01	Tetrachloroethene	Tetrachloroethene	--	5.00E-03	Tetrachloroethene
Trichloroethene	5.28E-03	Trichloroethene	Trichloroethene	--	5.00E-03	Trichloroethene
Vinyl Chloride	5.04E-03	Vinyl Chloride	Vinyl Chloride	Vinyl Chloride	2.00E-03	Vinyl Chloride
Americium-241	3.14E+01	Americium-241	Americium-241	--	NA	--
Cesium-137	6.00E+00	Cesium-137	--	--	NA	--
Neptunium-237	5.87E+02	Neptunium-237	Neptunium-237	Neptunium-237	NA	--
Radium (total alpha)	3.51E+01	--	--	--	5.00E+00	Radium (total alpha)
Strontium-90	1.92E+02	Strontium-90	Strontium-90	Strontium-90	NA	--
Technetium-99	6.94E+04	Technetium-99	Technetium-99	Technetium-99	NA	--
Thorium-228	3.20E+00	Thorium-228	--	--	NA	--
Tritium	4.10E+03	Tritium	Tritium	--	NA	--
Uranium-234	3.14E+03	Uranium-234	Uranium-234	Uranium-234	NA	--
Uranium-235	3.53E+02	Uranium-235	Uranium-235	Uranium-235	NA	--
Uranium-238	7.48E+03	Uranium-238	Uranium-238	Uranium-238	NA	--

NA = Not Available

Table 2. S-3 Ponds Surface Water COCs

COC	95% UCL (mg/L or pCi/L)	95% UCL >1x10-6 RSL?	95% UCL >1x10-5 RSL?	95% UCL >1x10-4 RSL?	MCL (mg/L or pCi/L)	95% UCL >MCL?
Barium	3.08E-01	--	--	--	2.00E+00	--
Beryllium	2.25E-04	--	--	--	4.00E-03	--
Cadmium	9.78E-03	Cadmium	--	--	5.00E-03	Cadmium
Fluoride	6.15E-01	--	--	--	NA	--
Manganese	1.15E+00	Manganese	--	--	NA	--
Nitrate (as N)	9.74E+01	Nitrate (as N)	--	--	1.00E+01	Nitrate (as N)
Total Uranium	6.10E-02	Total Uranium	--	--	3.00E-02	Total Uranium
Tetrachloroethene	2.85E-03	--	--	--	5.00E-03	--
Strontium-90	1.39E+00	Strontium-90	--	--	NA	--
Technetium-99	3.27E+02	Technetium-99	Technetium-99	--	NA	--
Uranium-233/234	2.83E+01	Uranium-233/234	Uranium-233/234	--	NA	--
Uranium-235	1.60E+00	Uranium-235	--	--	NA	--
Uranium-238	5.87E+01	Uranium-238	Uranium-238	--	NA	--

NA = Not Available

Table 3. Oil Landfarm, Boneyard/Burnyard, and Sanitary Landfill Groundwater COCs

COC	95% UCL (mg/L or pCi/L)	95% UCL >1x10-6 RSL?	95% UCL >1x10-5 RSL?	95% UCL >1x10-4 RSL?	MCL (mg/L or pCi/L)	95% UCL >MCL?
Barium	3.45E-01	--	--	--	2.00E+00	--
Beryllium	4.40E-04	--	--	--	4.00E-03	--
Boron	3.55E-01	--	--	--	NA	--
Cadmium	3.29E-03	--	--	--	5.00E-03	--
Chromium	3.00E-02	Chromium	Chromium	Chromium	1.00E-01	--
Fluoride	4.00E-01	--	--	--	NA	--
Manganese	1.09E+00	Manganese	--	--	NA	--
Mercury	3.12E-03	Mercury	--	--	2.00E-03	Mercury
1,1-Dichloroethene	2.97E-02	--	--	--	7.00E-03	1,1-Dichloroethene
1,2-Dichloroethane	4.90E-03	1,2-Dichloroethane	1,2-Dichloroethane	--	5.00E-03	--
Benzene	6.91E-03	Benzene	Benzene	--	5.00E-03	Benzene
Carbon Tetrachloride	3.26E-03	Carbon Tetrachloride	--	--	5.00E-03	--
Chloroform	1.01E-02	Chloroform	Chloroform	--	8.00E-03	Chloroform
Methylene Chloride	8.21E-02	Methylene Chloride	--	--	5.00E-03	Methylene Chloride
PCB-1254	4.50E-04	PCB-1254	PCB-1254	--	5.00E-04	--
Tetrachloroethene	1.01E-01	Tetrachloroethene	Tetrachloroethene	--	5.00E-03	Tetrachloroethene
Trans-1,2-Dichloroethene	1.37E-01	Trans-1,2-Dichloroethene	--	--	1.00E-01	Trans-1,2-Dichloroethene
Trichloroethene	1.29E-01	Trichloroethene	Trichloroethene	Trichloroethene	5.00E-03	Trichloroethene
Vinyl Chloride	9.69E-03	Vinyl Chloride	Vinyl Chloride	Vinyl Chloride	2.00E-03	Vinyl Chloride
Cesium-137	4.60E+00	Cesium-137	--	--	NA	--
Lead-212	1.56E+01	Lead-212	--	--	NA	--
Neptunium-237	2.40E-01	--	--	--	NA	--
Potassium-40	1.51E+02	Potassium-40	Potassium-40	--	NA	--
Thorium-228	1.29E+00	Thorium-228	--	--	NA	--
Thorium-230	2.14E+00	Thorium-230	--	--	NA	--
Uranium-234	1.30E+03	Uranium-234	Uranium-234	Uranium-234	NA	--
Uranium-235	2.89E+01	Uranium-235	Uranium-235	--	NA	--
Uranium-238	7.21E+02	Uranium-238	Uranium-238	Uranium-238	NA	--

NA = Not Available

Table 4. Oil Landfarm, Boneyard/Burnyard, and Sanitary Landfill Surface Water COCs

COC	95% UCL (mg/L or pCi/L)	95% UCL >1x10-6 RSL?	95% UCL >1x10-5 RSL?	95% UCL >1x10-4 RSL?	MCL (mg/L or pCi/L)	95% UCL >MCL?
Arsenic	8.16E-04	Arsenic	Arsenic	--	0.01	--
Barium	2.75E-01	--	--	--	2	--
Cadmium	7.52E-03	Cadmium	--	--	0.005	Cadmium
Fluoride	1.16E+00	Fluoride	--	--	NA	--
Nitrate (as N)	4.93E+01	Nitrate (as N)	--	--	10	Nitrate (as N)
Total Uranium	2.24E-01	Total Uranium	--	--	0.03	Total Uranium
Strontium-90	9.30E-01	Strontium-90	--	--	NA	--
Technetium-99	8.41E+01	Technetium-99	--	--	NA	--
Uranium-233/234	5.62E+01	Uranium-233/234	Uranium-233/234	--	NA	--
Uranium-235	5.26E+00	Uranium-235	--	--	NA	--
Uranium-238	1.11E+02	Uranium-238	Uranium-238	Uranium-238	NA	--

NA = Not Available

Table 5. Bear Creek Burial Grounds Groundwater COCs

COC	95% UCL (mg/L or pCi/L)	95% UCL >1x10-6 RSL?	95% UCL >1x10-5 RSL?	95% UCL >1x10-4 RSL?	MCL (mg/L or pCi/L)	95% UCL >MCL?
Barium	2.83E-01	--	--	--	2.00E+00	--
Beryllium	3.45E-04	--	--	--	4.00E-03	--
Cadmium	3.74E-03	--	--	--	5.00E-03	--
Chromium	3.48E-02	Chromium	Chromium	Chromium	1.00E-01	--
Fluoride	1.14E+00	Fluoride	--	--	NA	--
1,1,1-Trichloroethane	5.68E-01	--	--	--	2.00E-01	1,1,1-Trichloroethane
1,1,2-Trichloroethane	2.27E-02	1,1,2-Trichloroethane	1,1,2-Trichloroethane	--	5.00E-03	1,1,2-Trichloroethane
1,1-Dichloroethane	6.46E-01	1,1-Dichloroethane	1,1-Dichloroethane	1,1-Dichloroethane	NA	--
1,1-Dichloroethene	5.41E-01	1,1-Dichloroethene	--	--	7.00E-03	1,1-Dichloroethene
1,2-Dichloroethane	1.85E-02	1,2-Dichloroethane	1,2-Dichloroethane	1,2-Dichloroethane	5.00E-03	1,2-Dichloroethane
1,2-Dichloroethene	1.47E-01	1,2-Dichloroethene	--	--	7.00E-02	1,2-Dichloroethene
Benzene	4.38E-02	Benzene	Benzene	Benzene	5.00E-03	Benzene
Chloroform	3.92E-02	Chloroform	Chloroform	Chloroform	8.00E-03	Chloroform
Methylene Chloride	2.63E-02	Methylene Chloride	--	--	5.00E-03	Methylene Chloride
Tetrachloroethene	3.15E+00	Tetrachloroethene	Tetrachloroethene	Tetrachloroethene	5.00E-03	Tetrachloroethene
Trans-1,2-Dichloroethene	4.24E+00	Trans-1,2-Dichloroethene	Trans-1,2-Dichloroethene	--	1.00E-01	Trans-1,2-Dichloroethene
Trichloroethene	1.66E+00	Trichloroethene	Trichloroethene	Trichloroethene	5.00E-03	Trichloroethene
Trichlorofluoromethane	8.19E-01	--	--	--	NA	--
Vinyl Chloride	2.71E-01	Vinyl Chloride	Vinyl Chloride	Vinyl Chloride	2.00E-03	Vinyl Chloride
Cesium-137	5.77E+00	Cesium-137	--	--	NA	--
Potassium-40	1.29E+02	Potassium-40	Potassium-40	--	NA	--
Thorium-228	1.20E+00	Thorium-228	--	--	NA	--
Uranium-238	9.31E-01	Uranium-238	--	--	NA	--

NA = Not Available

Table 6. Bear Creek Burial Grounds Surface Water COCs

COC	95% UCL (mg/L or pCi/L)	95% UCL >1x10-6 RSL?	95% UCL >1x10-5 RSL?	95% UCL >1x10-4 RSL?	MCL (mg/L or pCi/L)	95% UCL >MCL?
Beryllium	2.28E-04	--	--	--	0.004	--
1,1,2-Trichloroethane	2.00E-03	1,1,2-Trichloroethane	--	--	0.005	--
1,1-Dichloroethene	8.72E-03	--	--	--	0.007	1,1-Dichloroethene
1,2-Dichloroethane	2.95E-03	1,2-Dichloroethane	1,2-Dichloroethane	--	0.005	--
1,2-Dichloroethene	2.11E-01	1,2-Dichloroethene	--	--	0.07	1,2-Dichloroethene
Benzene	2.58E-03	Benzene	--	--	0.005	--
Chloroform	4.39E-03	Chloroform	Chloroform	--	0.008	--
Tetrachloroethene	6.17E-02	Tetrachloroethene	--	--	0.005	Tetrachloroethene
Trichloroethene	4.84E-02	Trichloroethene	Trichloroethene	Trichloroethene	0.005	Trichloroethene
Vinyl Chloride	1.70E-02	Vinyl Chloride	Vinyl Chloride	Vinyl Chloride	0.002	Vinyl Chloride
Potassium-40	1.30E+02	Potassium-40	Potassium-40	--	NA	--
Thorium-228	3.09E-01	--	--	--	NA	--
Uranium-233/234	1.34E+01	Uranium-233/234	Uranium-233/234	--	NA	--
Uranium-238	3.77E+01	Uranium-238	Uranium-238	--	NA	--

NA = Not Available

ACTION PLAN 9
S3 POND PATHWAYS 1-3

STATUS: Closed
FYR ISSUE: BCV-2
CERCLIS OU: #32

ISSUE: Bear Creek NT-1 currently exceeds the AWQC of 0.25 µg/l for cadmium, which is an applicable or relevant and appropriate requirement in the *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant* (Phase I ROD), and the operable unit is not protective of ecological receptors. Uranium activity at Bear Creek Kilometer (BCK) 9.2 remains above acceptable levels for residential and industrial human receptors; however, there currently is no unacceptable human exposure.

BACKGROUND: Under the *Action Memorandum for the Bear Creek Valley Tributary Interception Trenches for the S-3 Uranium Plume* GW from pathways 1 and 2 from the S-3 Pond were collected and treated. Due to the low quantity of uranium removed and the indiscernible reduction of uranium flux at BCK 12.34, the system was shut-down. Consequently, cadmium exceeds the AWQC, and uranium activity remains above acceptable levels. The Phase I ROD includes a RA for S-3 Pond and monitoring at BCK 12.34. Approximately 51% of the uranium appears to come from NT-8 that drains the BCBGs, for which there is no remedial decision. A significant amount of uranium comes from the S-3 Ponds. In order to develop a comprehensive remediation strategy, pathways 1 and 2 will be combined with pathway 3 as a RA under the Phase I ROD.

PLAN/SCHEDULE: Monitoring for uranium and cadmium at BCK 12.34 will continue, and the results will be reported in annual RERs. The S-3 Pond RA and future decisions for an NT-8 early action are currently scheduled in FFA Appendix J for FY 2022 and the BCV Burial Grounds RA is currently scheduled in FFA Appendix J for FY 2024. These projects will be considered and prioritized annually in accordance with the *Federal Facility Agreement*. This Action Plan #9 from the *2011 Third Reservation-wide CERCLA Five-Year Review* is now closed.

APPENDIX D
OAK RIDGE RESERVATION GROUNDWATER PROGRAM

This page intentionally left blank.

Development of an interagency approach for addressing Oak Ridge Reservation (ORR) groundwater contamination was completed in fiscal year (FY) 2013 and resulted in an ORR Groundwater Strategy (*Groundwater Strategy for the U.S Department of Energy Oak Ridge Reservation* [DOE/OR/01-2628/V1&V2&D2]) that was agreed to by the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Tennessee Department of Environment and Conservation (TDEC) in FY 2014. The ORR Groundwater Strategy provides a comprehensive framework for early actions and long-term implementation to support decision-making for ORR groundwater.

During FY 2014, implementation of three key recommendations identified in the ORR Groundwater Strategy was initiated:

1) formation of an ongoing ORR Groundwater Program to implement the ORR Groundwater Strategy;

2) planning for an Offsite Groundwater Quality Assessment; and

3) development of a Regional Groundwater Flow Model for the ORR and surrounding environs.

Work completed and accomplishments are summarized in the following sections.

ORR Groundwater Program. During FY 2014, senior groundwater personnel and other resources were assigned to initiate the ORR Groundwater Program as part of the Water Resources Restoration Program (WRRP). In addition to the projects described below, ORR Groundwater Program activities will include groundwater monitoring based on planning, modeling, and investigation needs and co-sampling with the TDEC/DOE Oversight office (see below). ORR Groundwater Program investigations will be integrated with remedy effectiveness and trend monitoring conducted by the WRRP.

Co-sampling with TDEC/DOE Oversight Office. During 2014, seven wells located off-site and to the southwest of the ORR (four residential wells [RWA-101, RWA-104, RWA-121, and RWA-124] and three Tennessee Valley Authority wells [OW-422D, OW-422L, and TVA Pump Test Well]) were co-sampled with staff from TDEC (Figure D.1). All wells were sampled at least once during the period March – April 2014. Three residential wells (RWA-101, RWA-104, and RWA-121) were sampled one additional time during the period June – July 2014.

In general, DOE and TDEC results are comparable to each other. Experience with the co-sampling also resulted in some minor adjustments to the analyte list for the upcoming Off-site Groundwater Assessment, most notably some transuranic radionuclides were added and detection limits for transuranic radionuclides were lowered.

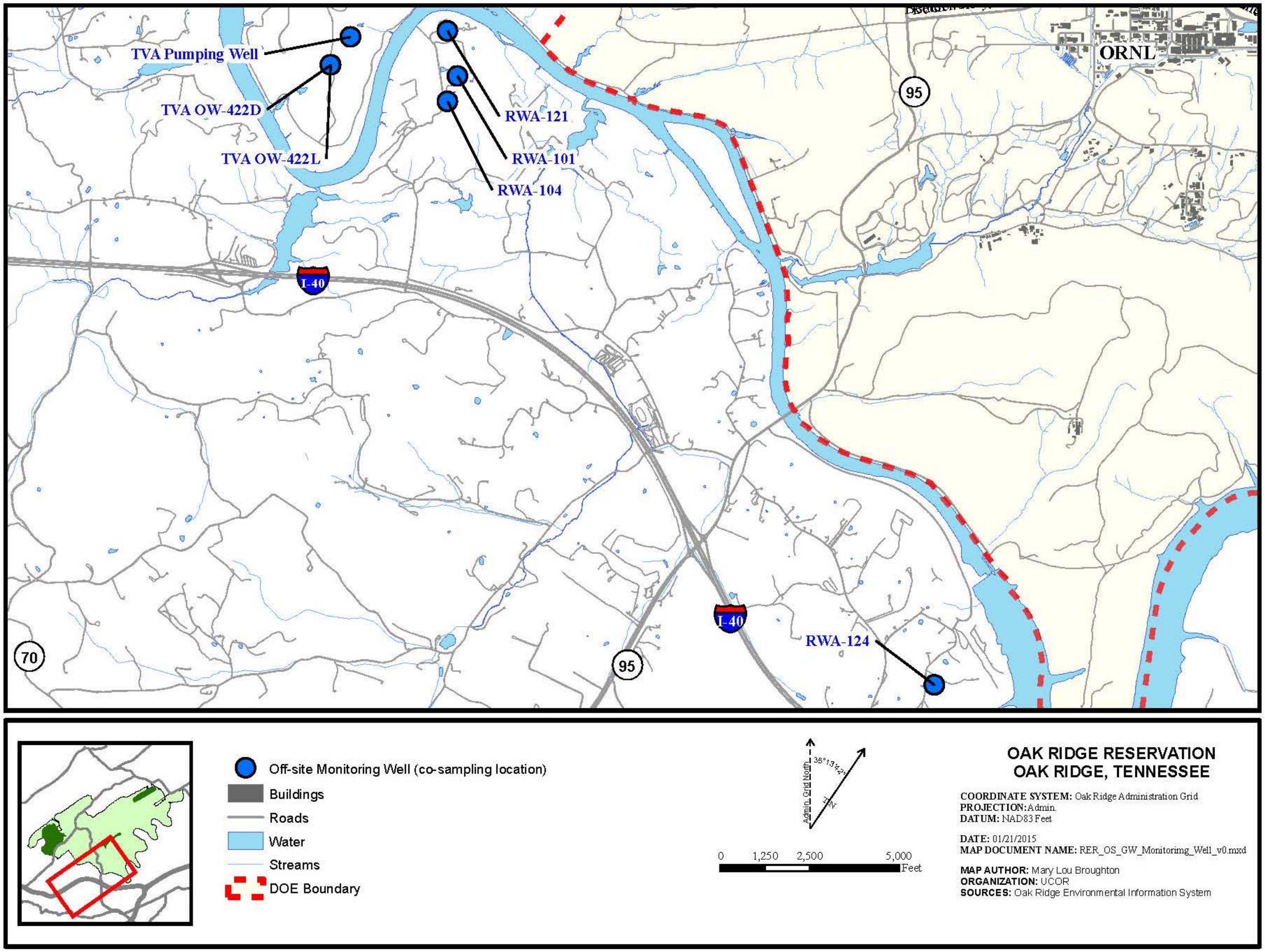


Figure D.1. Off-site groundwater monitoring locations co-sampled with TDEC/DOE Oversight Office.

Off-site Groundwater Quality Assessment. Evaluation of results from the first sampling event of the Off-site Groundwater Assessment completed in spring 2015 is underway. The project is a cooperative DOE, EPA, and TDEC effort. The approximate area being investigated is located west and north of the Clinch River at the western boundary of the ORR (Figure D.2). A second sampling event is planned for the summer of 2015. Ongoing evaluation of results includes comparison to screening levels for protection of human health and the environment and review of data for indicators of potential contaminant sources and pathways (e.g., potential ORR contaminants, potential migration beyond the Clinch River, potential naturally-occurring substance, etc.). A report on the study is planned for the first quarter of FY 2017.

Data Quality Objectives workshops were held in November and December 2013 to define the type, quality, and quantity of data needed to evaluate off-site groundwater quality and movement. A list of potential well and spring sampling locations was developed. Agreement was reached on a suite of radionuclides, metals, anions, and volatile organic chemicals to be analyzed, analytical laboratory methods and detection limits, and quality assurance and data management protocols.

At the end of FY 2014 and beginning of FY 2015, DOE began the process of contacting property owners, visiting potential sampling locations to evaluate suitability for sample collection, and finalizing access agreements and the list of sampling locations. Field sampling began in January 2015. After sampling and laboratory analysis are complete, results will be verified, validated, and evaluated to determine follow-on actions, if any.

Under a separate project discussed in Chapter 3 of this RER, WRRP continues to conduct off-site groundwater monitoring in an area adjacent to Melton Valley to the southwest of the Clinch River (*Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan*, [DOE/OR/01-1982&D3]).

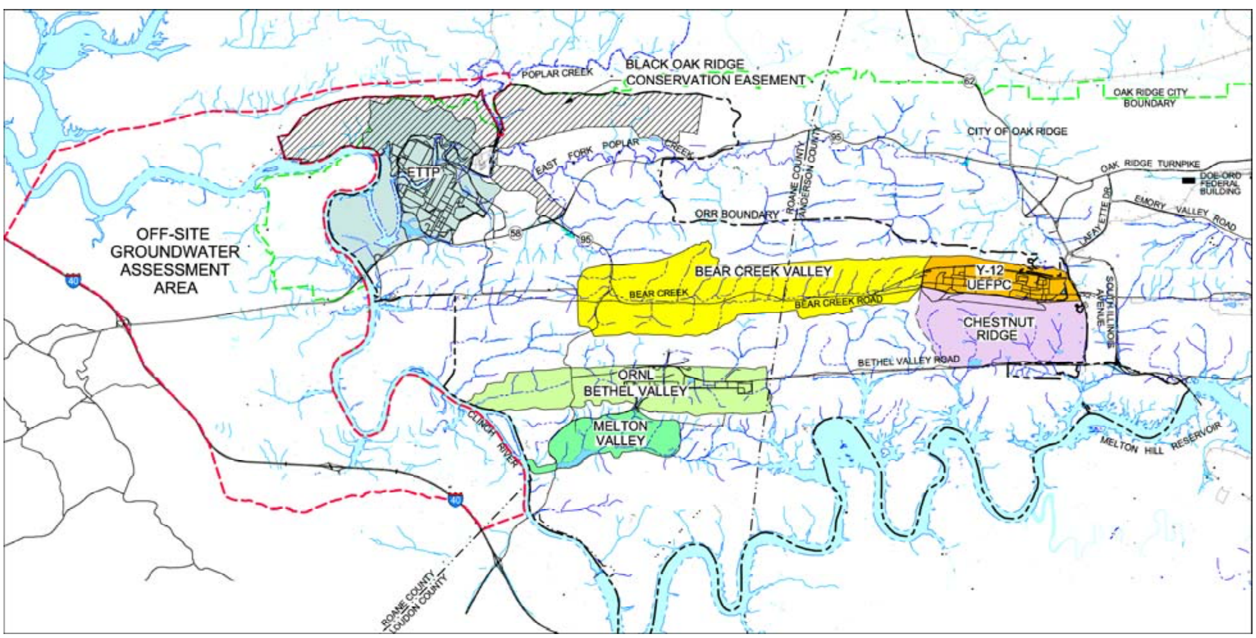


Figure D.2. Approximate area addressed by the Off-Site Groundwater Assessment. Also illustrated are the administrative watersheds associated with the three ORR facilities

ORR Regional Groundwater Flow Model. The ORR Groundwater Program initiated a multi-year effort to develop a regional groundwater flow model for the ORR and adjoining environs. The goal of this effort is to develop a model that can be used to describe likely regional groundwater flow conditions and can be used as background for development of more detailed site-specific models at remedial action sites on the ORR. The model will be used to conduct numerical “what if” scenario evaluations to provide limitations and insight into the behavior of natural flow processes on the ORR. The model is not intended to be used to describe specific, small scale groundwater flow behavior, but rather is intended to provide background and boundary conditions necessary for more detailed, smaller scale models.

An initial step of the groundwater flow modeling project was formation of a Technical Advisory Group (TAG). The TAG consists of a Programmatic committee and Technical committee (Figure D.3) and DOE contractor support for meeting facilitation and preparation of meeting materials.

- The Programmatic committee consists of DOE, EPA, and TDEC representatives. The Programmatic committee is responsible to identify short-term and long-term goals (consistent with policy) for groundwater modeling in support of ongoing Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) activities consistent with the Federal Facility Agreement (FFA) across the reservation.

- The Technical committee consists of three industry experts in various aspects of groundwater modeling and local scientists from DOE contractor organizations and TDEC. One of the industry experts is a representative from the U.S. Geological Survey who also serves as an interface and liaison between the TAG and the Oak Ridge Site-specific Advisory Board. The Technical committee is responsible for the evaluation, selection, and implementation of one or more groundwater models and to provide technical recommendations.

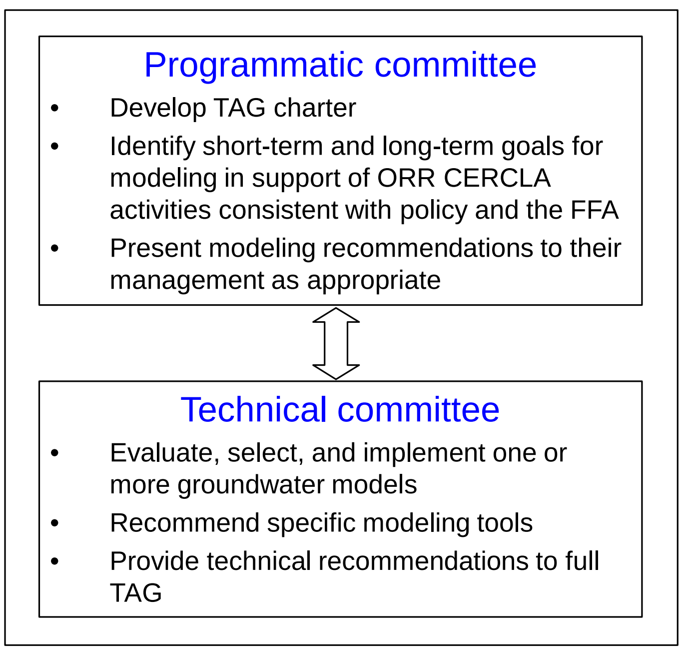


Figure D.3. Organization of the ORR Groundwater Model Technical Advisory Group

At the kick off meeting for the full TAG in June 2014, a field trip was made to observe in outcrop local rock formations that are the principal water-bearing strata of interest in the subsurface (Figure D.4), a draft TAG charter was distributed for review, and a number of decisions and modeling approaches to be considered were identified. Technical committee members then held a series of conferences approximately monthly until the full TAG reconvened in September 2014. At the September 2014 meeting of the full TAG, the TAG charter was finalized and model development progress was presented along with resolution of identified issues, TAG technical input, and recommendations for model development path forward. Several key decision and issues addressed during regional model development are discussed in the following five sections.

Figure D.4. Technical Advisory Group members observing a rock formation outcrop

Areal Domain of Regional Model. After considering several options, the Technical committee of the TAG recommended regional groundwater model boundaries as illustrated in Figure D.5 It was acknowledged that these boundaries are a starting point for model development and there may be reasons to adjust the boundaries that become apparent as model development proceeds.

The eastern boundary is placed at the Clinch River, which is assumed to be a known or relatively constant head boundary (controlled by the managed level of Melton Hill Lake). Similarly, the west boundary is placed at the Tennessee River with a known and relatively constant head boundary determined by the level of Watts Bar Lake. The northern boundary is placed at the Kingston Fault, a major regionally persistent Valley and Ridge Fault that will be treated as no-flow boundary. The southern boundary is placed principally along the Clinch River that forms a constant head boundary (as determined by the managed level of Melton Hill Lake) for part of the boundary. The remainder of the southern boundary is placed arbitrarily through the Knox Group, to the north of the regionally-persistent Beaver Valley Fault. The bottom of the model is placed at sea level. As the upper fresh water system is where most water flow occurs, sea level is a good place to start for the regional model. This model limitation can be addressed in future models that have variable density capabilities to address the very saline, higher density water below sea level.

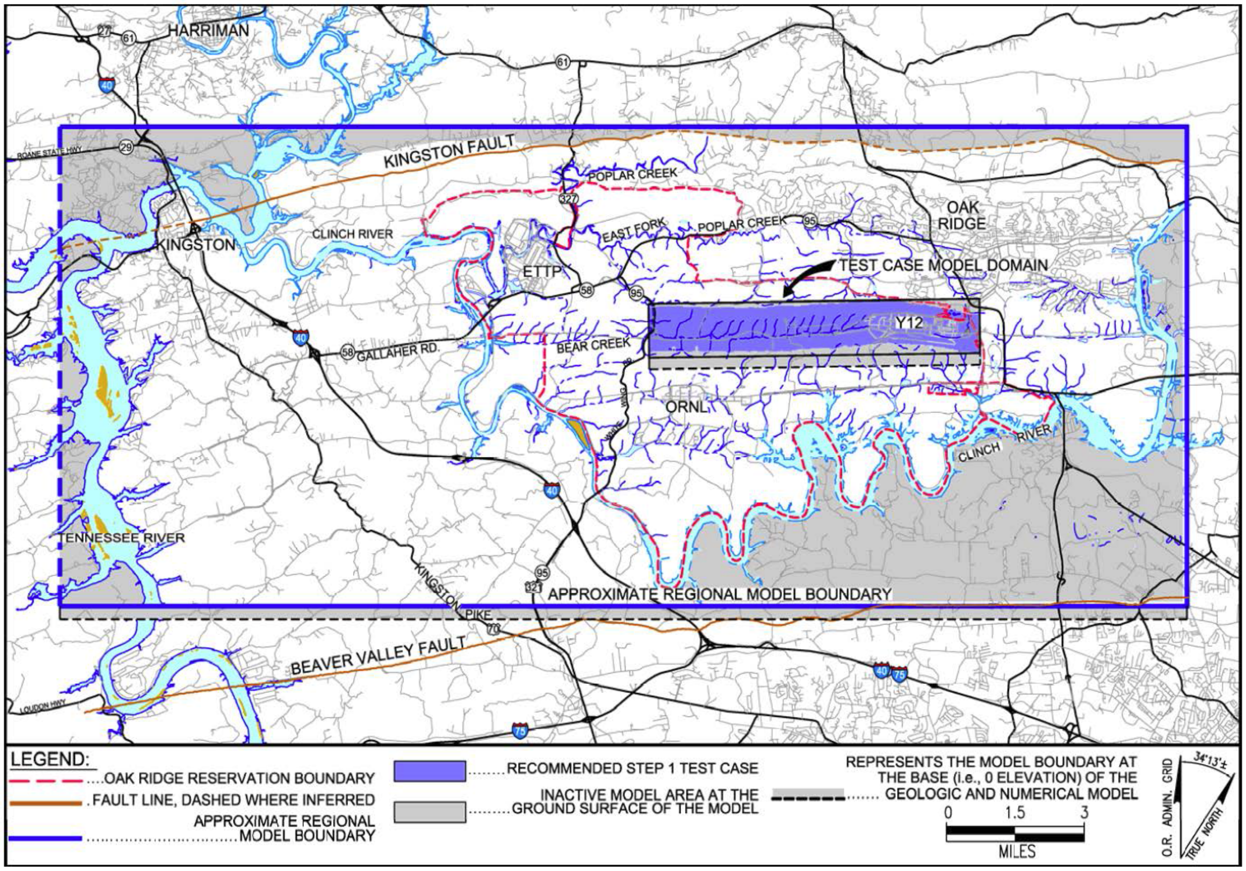


Figure D.5. Approximate area of the Oak Ridge Regional groundwater model. Approximate area of the Test Case is illustrated with dark blue shading

Collection and Analysis of Hydrogeologic Data. Oak Ridge hydrogeology is complex with dipping beds, multiple generations of fractures, cross cutting structures, and lithologic heterogeneity. Accurate depiction of the complex hydrogeology subsurface is essential to accurate modeling of sub-surface groundwater flow. There have been numerous studies of the geology and hydrology of the ORR conducted over the years. However, many of these studies were completed 20 – 30 years ago. An extensive data compilation effort for the regional flow model was conducted in FY 2014. Data needs for model development were identified followed by identification of data sources in a variety of forms and collection of data including:

- Surface geology, hydrology, and topography
- Subsurface geology (well construction data, boring logs)
- Subsurface characteristics (hydraulic conductivity, porosity, fractures)
- Water balance information (rainfall, stream data, etc.)
- Model calibration targets (water level, river stage, spring elevation)

Data analysis work focused on Test Case Model data needs, including:

- Geologic formation dip/slope
- Y-12 hydraulic conductivities (K)
- Y-12 water levels
- Water balance, recharge

Based on TAG recommendations, the modeling team currently is testing the combined use of EarthVision®[1] and MODFLOW-USG (see *Model Selection* below) to develop the regional-scale model. EarthVision® software is being used to organize and represent subsurface geology. EarthVision® has the capability, once loaded with available hydrogeologic data, to produce input files for the modeling software. Figure D.6 is an example of the depictions of subsurface geology created using the EarthVision® software. Manipulation of the data with EarthVision® also allows development of various options for modeling portions of the ORR subsurface lacking appreciable data coverage.

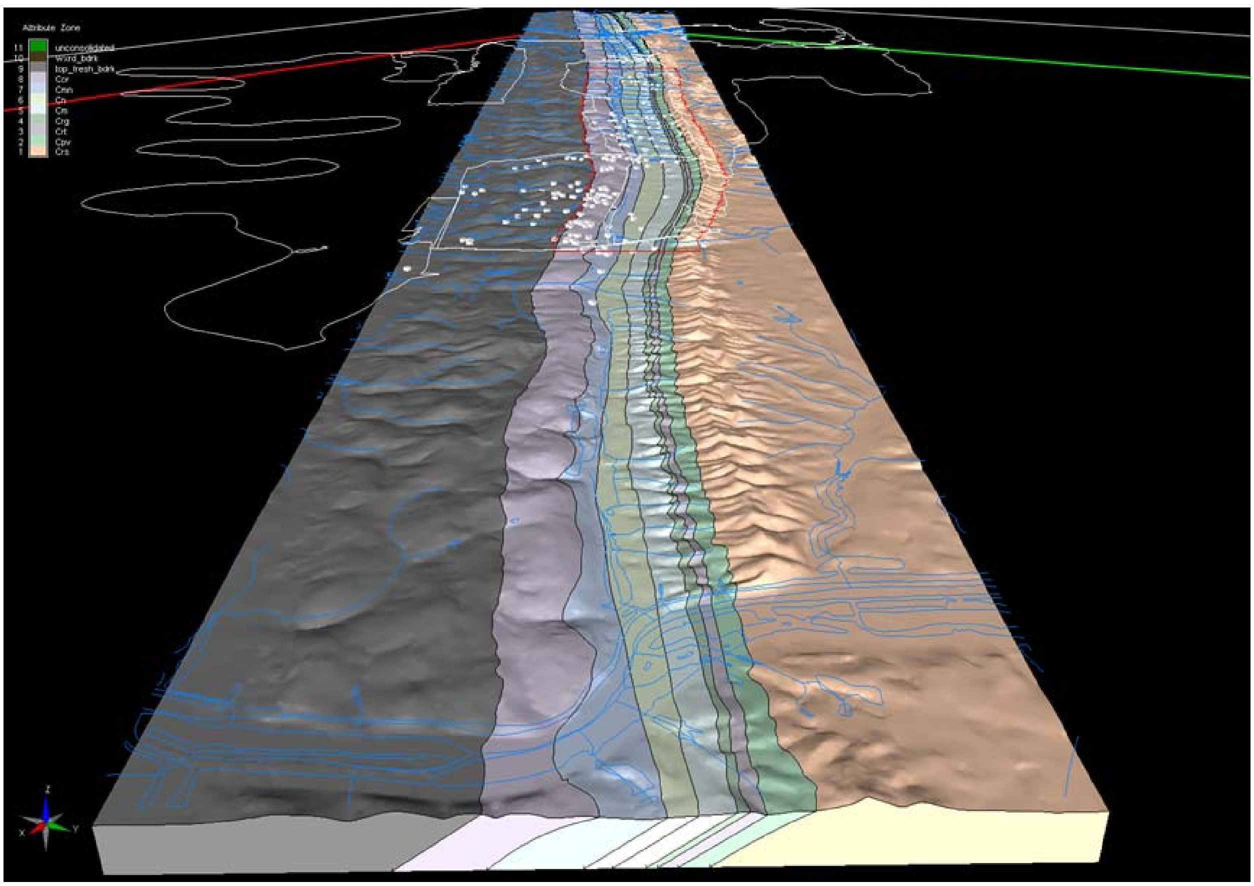


Figure D.6. EarthVision® model of the subsurface geology within the Test Case domain within and immediately adjacent to Union Valley (foreground) and Bear Creek Valley (distance). View to southwest.

[1]Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

*Model Selection***.** The TAG and modeling team conducted an extensive evaluation of available groundwater flow models. Considerations were given to the flexibility of the model to successfully represent various, and complex subsurface hydrogeology; ease of execution; technical rigor; availability (public domain or private domain), ease of interface with pre- and post-processing software, and availability of diverse and continuing technical support, and availability of a broad user community. Evaluation of these criteria, along with the extensive expertise of the three outside members of the Technical committee, resulted in selection of MODFLOW-USG for detailed evaluation and use in a development of Test Case model prior to full-scale commitment for the regional model. MODFLOW-USG is the latest version of a long series of progressively more sophisticated groundwater flow modeling codes developed by the U. S. Geological Survey over the past three decades.

Test Case. Prior to full scale development of the regional groundwater flow model, it was the consensus of the modeling team and the TAG to first develop a Test Case groundwater flow model for a smaller portion of the entire model area. Such a test case would familiarize the model team with the details of MODFLOW-USG execution, provide an opportunity to fine-tune transfer of hydrogeologic data from EarthVision® to MODFLOW-USG, use of pre- and post-processing software, and provide a test for operation of specific MODFLOW-USG capabilities such as the Stream Package and Connected Linear Network (CLN) module. Review of available geologic (e.g., locations of formation contacts in the subsurface and borehole lithologic and geophysical logs) and hydrologic data (e.g., stream flow and hydraulics head in groundwater wells) indicated the greatest density of data points was in Bear Creek and Union Valleys, occupied in part by the Y-12 National Security Complex. The location and extent of the area modelled by the Test Case is illustrated in Figure D.5. A typical cross section illustrating active and non-active cells overlaid on the site geology for the Test Case is illustrated in Figure D.7.

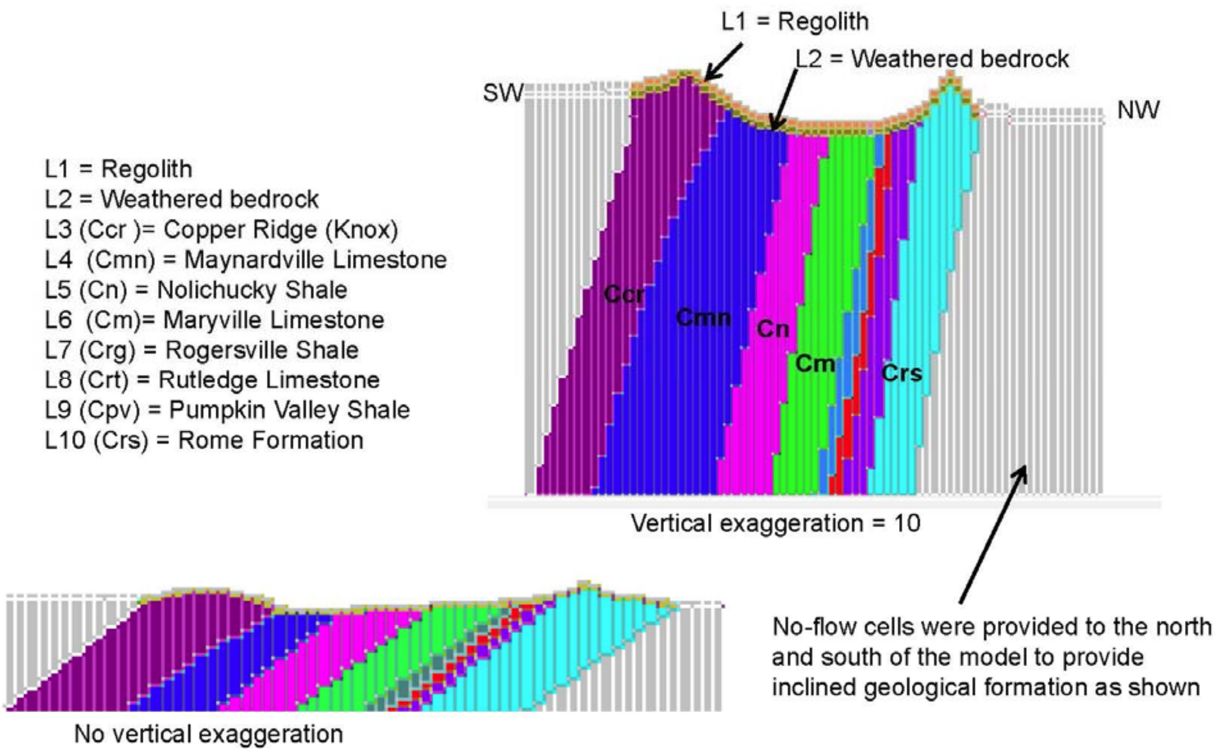


Figure D.7. Model cross-section in Groundwater Vistas (pre-processor for MODFLOW-USG) based on subsurface data compiled in EarthVision®. Model layers (L1 through L10) and no-flow inactive cells are illustrated.

Conduit Flow. Conduit flow in the carbonate rich formations in the subsurface of the ORR exhibit widely varying degrees of karstification and development of conduits. Locally extensive networks of conduits are thought to exist with carbonate formations. Such networks can profoundly impact groundwater flow behavior and require special modeling approaches and techniques. The CLN module in MODFLOW-USG can be used to accomplish modeling of network flow in the subsurface. Because both the CLN module and the MODFLOW-USG code itself are relatively recent releases, testing has been limited. Results to date from the Test Case suggest the CLN module will provide the needed capabilities to successfully model conduit flow processes where applicable.

REFERENCES

DOE/OR/01-1982&D3. *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan*, 2012, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2628/V1&V2&D2. *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee, Volumes 1 and Volume 2*, 2014, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

This page intentionally left blank.

DOE/OR/01-2675&D2

RECORD COPY DISTRIBUTION

File–DMC–RC

UCOR
URS | CH2M
Oak Ridge LLC

Comment Resolution Form

Document Number:	Document Title:		
DOE/OR/01-2675&D1	2015 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee		
Name of Reviewer:	**Organization:**	**Comments Received:**	**Response to Comments Transmitted:**
Jeffrey L. Crane	U.S. Environmental Protection Agency	June 2015	September 2015

Comm. #	Section/ Page	Comment	Response
GENERAL COMMENTS			
1		Fiscal Year 2015 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee (DOE/OR/01-2675&01), dated March 2015 (RER) does not identify any new issues for Oak Ridge Reservation (ORR). While some on-going/older issues are identified and tracked in the RER, the list of issues in Table 1.2, 2015 RER issues and recommendations, should be expanded to ensure future RERs meet their goal of evaluating the performance of completed and ongoing CERCLA actions. Several potential trackable issues not identified in Table 1.2 are described below:	Clarification. Monitoring requirements are documented in approved watershed Comprehensive Monitoring Plans (CMPs). Creation of a trackable RER issue is not necessary for continued performance by DOE of CERCLA-required monitoring and other long-term stewardship requirements and annual reporting in the RER. Additionally, the FFA has other mechanisms that are the appropriate platform for programmatic tracking of priorities, sequencing, and schedules. In order to define items that rise to the level of being a trackable RER issue with formal follow-up, text will be added after the first sentence in Section 1.7: "Beginning with the 2015 RER, a trackable RER issue is defined as an item identified in the effectiveness evaluation that: • is for a completed CERCLA action • does not meet a performance standard or goal specified in a ROD or completion document (e.g., ROD, PCCR, etc.). For example, monitoring results exceed a performance level over a period of time or an engineering control or LUC was not performed as specified and a timely repair was not able to be made. • does not already have an identified path forward through planned remedy maintenance actions or designated future CERCLA actions. Other factors may be considered when determining if an item is a trackable RER issue (e.g., unusual climatic conditions, intermittent nature of exceedance, etc.). Observations from monitoring data (e.g., trends) and stewardship tracking are highlighted in the Executive Summary of the RER." A separate table may be added in future RERs as necessary to continue to capture "other items" identified in the annual evaluation that do not rise to the level of "trackable RER issues." "Other items" would include recommendations such as a change to a watershed CMP for monitoring (e.g., to evaluate a trend that does not exceed a ROD goal) or a change to an inspection frequency.
1a	Section 2.2.1.2.2, Page 2-59	Groundwater, under the subheading SWSA 3 and Raccoon Creek Exit Pathway indicates that during June Fiscal Year (FY) 2014 Strontium-90 (^{90}Sr) was detected in wells 4645 and 4646 at 2.15 and 2.84 picocuries per liter (pCi/L), respectively and that these are the first detections of ^{90}Sr in these two wells. While it is also noted in this section that wells 4645, 4646, and 4647	Clarification. Based on the response to General Comment 1, the observed contaminant levels do not constitute a trackable issue; however, this observation is highlighted in the Executive Summary. Groundwater monitoring and reporting for the Raccoon Creek exit pathway is required per the Bethel Valley Burial Grounds PCCR. The monitoring has been conducted and

Comm. #	Section/ Page	Comment	Response
		installed in 2010 to monitor groundwater in the Raccoon Creek headwater did not contain contaminants above drinking water criteria in 2014, as this is the first detection in these wells, the elevated ^{90}Sr activity requires continued monitoring and therefore should be identified as a trackable issue.	reported since the installation of the subject wells and is expected to continue indefinitely. Further, potential groundwater contaminant transport in western Bethel Valley is one of the pathways specifically identified in the Groundwater Strategy for future investigation under the Groundwater Program prioritization.
1b	Section 2.6.1.2.1.2.1, Page 2-26	Watershed-Scale Surface Water Monitoring Results indicates a sample collected from Outfall 207 in January 2014 contained elevated ^{90}Sr activity, and ^{90}Sr discharges from Outfall 304 had increased. While a subsequent investigation identified a failed sump pump at one of the closed and remediated liquid low-level waste (LLLW) tank farms as the problem, the elevated ^{90}Sr activity requires continued monitoring and therefore should be listed as a trackable issue.	Clarification. DOE does not consider the Outfall 207 and 304 contaminant discharges to be annual RER trackable issues. The contaminant levels did not approach the Bethel Valley IROD goal of 1E-4 recreational risk to human health under the recreational scenario either when mixed instream in White Oak Creek (in waters of the state as set forth as the goal in the ROD) or at the outfall. The DOE EM Program is engaged in ongoing surveillance and maintenance activities in the area to minimize impacts to groundwater and surface water.
1c	Section 2.6.1.2.1.2.1, Page 2-37	Watershed-Scale Surface Water Monitoring Results indicates the past several years there have been several mercury detections at levels several times the ambient water quality criteria (AWQC) of 51 nanograms per liter (ng/L), yet this issue is not listed as a trackable item. The elevated mercury detections above the AWQC criteria indicates this is a trackable item and therefore should be listed as such.	Clarification. One of two samples collected from Fifth Creek in FY 2014 exceeded the AWQC for mercury (51 ng/L); however, during FY 2014 DOE did not detect mercury at levels in excess of the AWQC (51 ng/L) at the 7500 Bridge. DOE has been proactive in identifying mercury sources at ORNL and taking measures to minimize the impact of mercury on the aquatic ecosystem as demonstrated through the decrease in both aqueous and bio-uptake data. Although the actions stipulated in the Bethel Valley Interim ROD for treatment of basement sump groundwater at Building 4501 have been completed, other sources of mercury contamination in soil throughout the site will be addressed in future actions under the Bethel Valley Interim ROD. As stated in the ROD (Section 2.12.7.3). *"The surface water remediation levels will be met within 10 years from completion of source actions in Bethel Valley.*" Based on the response to General Comment 1, this is not a trackable RER issue. Monitoring will continue in accordance with the approved *Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-2478&D1).
1d	Section 2.6.1.2.1.2.1, Page 2-44	Watershed-Scale Surface Water Monitoring Results indicates the ^{90}Sr and Uranium 233/234 ($^{233/234}$U) activities measured at well 4570 exhibited increasing trends during FY 2014. The increasing trend in concentration indicates this is a trackable item.	Clarification. Based on the response to General Comment 1, this is not a trackable RER issue since it is not a performance standard exceedance for a completed action and is not highlighted in the Executive Summary because it is not a significant trend. The Corehole 8 Plume collection system met its performance goal in FY 2014 and contributed to the risk reduction goal being met downstream at the 7500 Bridge. Monitoring and reporting of data from well 4570 and several other wells associated with the Corehole 8 plume is a requirement of the approved *Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan for the Oak Ridge Reservation Oak Ridge, Tennessee*. (DOE/OR/01-2478&D1). The Corehole 8 plume was identified in the ORR Groundwater Strategy for further investigation and potential actions to be performed in the sequence assigned during implementation of the ORR Groundwater Program. DOE acknowledges the increasing trends of ^{90}Sr and $^{233/234}$U and will continue the required monitoring and reporting.

Comm. #	Section/ Page	Comment	Response
1e	Section 3.2.1.2.2.2, Page 3-32	Groundwater-Level Control in Hydrologic Isolation Units indicates that during FY 2014, 90% (47 of the 52) of the wells located beneath caps and used to monitor hydrologic isolation effectiveness met their target groundwater elevations; however, five wells (i.e., Wells 0850 and 4127 in SWSA 6, and wells 0955, 0958, and 1071 in SWSA 4) did not meet the goal. The noncompliance of these five wells with target elevations requires additional monitoring, and therefore should be designated as a trackable issue.	Agree. In the case of the several wells that have chronically exceeded target groundwater elevations within Melton Valley hydrologically isolation areas, a review of conditions and potential modifications to monitoring are justified. The following text will be added after the 1st sentence beginning "During FY 2014" in the 2nd paragraph on p. 3-32: "For the five locations that did not attain the ROD goal, an issue has been identified on Table 3.11 to review conditions, including potential modifications to monitoring and applicable CERCLA documentation." Similar text will be added at the end of the 2nd bullet on p. ES-3. A current issue will be added to Table 3.11 and Table 1.2 as follows: **"Issue:** Several wells in Melton Valley have chronically not attained the ROD goal for groundwater level within hydrologically isolated areas. **Recommendation:** Two wells in SWSA 6 and 3 wells in SWSA 4 have not attained the ROD goal for groundwater level control inside hydrologically isolated areas. A review of conditions, including potential modifications to monitoring and applicable CERCLA documentation, is planned. **Responsible parties:** DOE **Target response date:** FY 2016"
1f	Section 3.2.1.2.2.3, Page 3-43	Groundwater Quality states six wells have increasing trends for radionuclides; however, it is not clear how these increasing trends of contamination in the Seepage Pits and Trenches Area are being evaluated going forward and why this not identified as a trackable issue. Further, as specifically noted in this section, the cause of the increases is not known. The increasing trends for radionuclides require additional monitoring and therefore should be listed as a trackable item.	Clarification. In the referenced RER section there are 6 increasing contaminant trends that are observed in 3 of the 13 wells that are monitored in the immediate vicinity of the Seepage Pits and Trenches. One well (1752) on the southeast side of Trench 5 accounts for 4 of the increasing trends. Surface water monitoring at WCTRIB-1 nearby shows decreasing contaminant trends since MV closure. The other two groundwater trends occur in separate wells on the east side of Trench 7 beneath the capped area extending eastward to the groundwater seepage collection sump at the former ^{60}Co seep. Groundwater from that area is captured in the groundwater collection system and is sent for treatment. Based on this information DOE does not consider these trends to be issues requiring tracking. The following text concerning these observations will be added after the 3rd full sentence at the top of p. 3-43: . "These wells are located on the eastern sides of Trench 5 (well 1752) and Trench 7 (wells 1712 and 1784). Groundwater levels in these wells that exhibit increasing contaminant trends are lower than groundwater elevations in wells along the western sides of the trenches which suggests that the affected groundwater seeps eastward. In the case of well 1752 the likely discharge area for the groundwater seepage would be into the surface water in the stream at WCTRIB-1. Contaminant concentrations in that stream have decreased since Trench 5 remediation. In the case of the two wells at Trench 7, the likely discharge area is beneath the extended Trench 7 cap to the east where a groundwater collection trench and sump was installed to capture contaminated groundwater and route it to treatment. No apparent impact is evident in adjacent monitoring areas. Monitoring of these wells will continue consistent with the *Melton Valley Watershed Remedial Action Report*

Comm. #	Section/ Page	Comment	Response
			Comprehensive Monitoring Plan (DOE/OR/0-1-1982&D3)."
1g	Section 3.2.1.2.2.3, Page 3-56	Groundwater Quality indicates that the occurrence of ^{90}Sr in the on-site exit pathway well 4537 sampling zone is a high priority issue in the development of the ORR Groundwater Strategy; however this item is not included in Table 1.2 as a trackable item.	Clarification. Uncertainties about potential off-site migration guided selection of the first priority project under the ORR Groundwater Strategy, an Off-site Groundwater Assessment. Implementation of the project is underway in accordance with an approved Remedial Site Evaluation (RSE) Work Plan and results will be documented in an RSE Report. Results will be evaluated to determine the next focus areas for strategy implementation and select the next project(s). Monitoring of exit pathway wells will continue per the approved *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/0-1-1982&D3). DOE does not consider this to be a trackable RER issue. However, consistent with the response to General Comment 1, a summary of results of the Melton Valley on-site exit pathway and off-site wells is included in the Executive Summary.
1h	Section 4.2.1.2.2, Page 4-42	Groundwater notes that the scarcity of groundwater monitoring opportunities in the area west of the Bear Creek Burial Grounds (BCBG) was identified as an issue in previous RERs and in the Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation (DOE/OR/01-2628/V1&V2&D2); however, this is not included as an issue in the current RER. The lack of groundwater monitoring opportunities in the area west of Bear Creek should be included in the list of trackable items.	Clarification. Since this topic was identified and carried as an issue for some years leading up to the establishment of the ORR Groundwater Strategy and the topic was specifically included as an item to be addressed through implementation of that strategy, DOE closed the issue in the RER. The installation of additional monitoring wells west of the Bear Creek Burial Grounds will be addressed in the prioritized sequence of work in the ORR Groundwater Program. DOE does not consider this to be a trackable RER issue. However, consistent with the response to General Comment 1, the evaluation of potential pathways and installation of additional wells in Zone 1 (west of the BCBG) is included in the Executive Summary.
1i	Section 8.4.5.2.2	Status of Requirements, states, "To continue to address the system scaling issues, a process improvement initiative was approved and initiated at the CWTS facility in late September 2014. Process testing and implementation actions continue into October and November 2014." However, the effectiveness of the process system changes is not included as a trackable issue in the RER. This issue should be tracked.	Clarification. CWTS operational scaling issues are a topic that should be evaluated and discussed in future RERs as has been the case for numerous years. Consistent with the response to General Comment 1, the ongoing operation of the collection and treatment system and protectiveness of water quality in Mitchell Branch are included in the Executive Summary. However, DOE does not consider this to be a trackable RER issue since the performance goal to meet hexavalent chromium AWQC levels in Mitchell Branch is being consistently met. The CWTS is being evaluated in the 2016 Five-year Review.
1j	Section 8.6.3.3, Page 8-85	Distribution of ^{99}Tc in ETTP Site Groundwater indicates that groundwater sampling for Technetium-99 (^{99}Tc) in wells with detections will continue, but this is not included as a trackable issue in the RER. The monitoring for ^{99}Tc remains a concern and therefore should be tracked.	Clarification.Tc-99 levels in ETTP groundwater are a concern and therefore will continue to be a parameter that is monitored and discussed in future RERs. Consistent with the response to General Comment 1, ^{99}Tc monitoring is included in the Executive Summary. However, DOE does not consider this to be a trackable RER issue since it is not a performance standard concern from a completed CERCLA action. CERCLA actions at the site are not complete. Groundwater decisions are to be determined in a future CERCLA Sitewide Record of Decision.
1k	Table 8.7	Mercury results from storm water monitoring conducted at ETTP outfalls in FY 2014, shows a number of outfalls and multiple samples with mercury	Clarification. Mercury levels in the ETTP storm water outfall measurements are a concern that will continue to be monitored and discussed in future RERs as

Comm. #	Section/ Page	Comment	Response
		concentrations above the AWQC of 51 ng/L. Mercury detections above the AWQC in ETTP outfalls merit continued evaluation and therefore should be included as a trackable item.	has been the case for several years. Consistent with the response to General Comment 1, stormwater outfall and surface water monitoring for mercury is included in the Executive Summary. However, DOE does not consider this to be a trackable RER issue since it is not a performance standard concern from a completed CERCLA action. CERCLA actions to address legacy mercury contamination are not complete and a future CERCLA Sitewide Record of Decision will be made for the surface water pathway.
1l	Section 8.6.4.4, Page 8-98	Mercury, under the subheading, Mercury - Ongoing Monitoring and Future CERCLA Actions indicates during the interim period prior to future CERCLA actions, surveillance and maintenance (S&M) operations will be conducted in a manner to minimize any disturbances that could increase releases of mercury. This ongoing action should be included as a trackable item. Revise the RER to add the above items as trackable issues in Table 1-2, or clarify why they should not be included.	Clarification. See response to General Comment 1k. DOE does not consider future S&M actions to be a trackable RER issue. Mercury releases from ETTP storm water outfalls are a concern that will continue to be monitored and discussed in future RERs as has been the case for several years. This will include a discussion of future S&M actions that might disturb mercury contamination areas that result in a mercury release.
2		The RER does not provide any discussion regarding the quality of the data used to support the evaluation of remediation effectiveness. For instance, the RER does not state if data collected as part of this remediation effectiveness assessment underwent data validation and whether all data were deemed usable. Additionally, the RER does not include a data quality assessment discussion which assesses whether the data were reconciled with the data quality objectives (DQOs) such that all data quality indicators (e.g., procedural requirements, field and laboratory quality control requirements) were met. Revise the RER to include information about whether the data were verified and/or validated, and whether a data quality assessment was conducted to ensure the usability of the data for the intended purposes.	Clarification. As stated in the last sentence of the first paragraph on p. 1-9, "All data used in the RER are collected in accordance with the watershed-specific monitoring plans and the *Quality Assurance Project Plan for the Water Resources Restoration Program* (UCOR-4049), or, are data collected by other programs in accordance with a quality assurance project plan that meets equivalent standards and requirements." The following text will be added after this sentence to provide additional information. "The Quality Assurance Project Plan (QAPP) has been developed to identify and implement quality assurance requirements for use in sample collection, laboratory analysis, and data management of groundwater, surface water, sediment, and biota activities performed under the WRRP. The QAPP identifies the procedures that will be followed in the collection, custody, and handling of samples, as well as verification and validation of environmental/laboratory data, used in the WRRP. Appendix F of the QAPP also contains specific SAP/QAPP checklists approved by the U.S. Environmental Protection Agency (EPA). The QAPP meets the requirements of the EPA (EPA/240/B-01/003), *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5),* and integrates with the current *Data Management Implementation Plan for the Water Resources Restoration Program, Oak Ridge, Tennessee* (UCOR-4160)." All CERCLA actions and their respective decision and post-decision documents, Data Quality Objectives (DQOs), and performance criteria are listed in the annual RER. Current monitoring data are then reconciled with the provided performance criteria of the remedy.
3	Sections 2, 3, 4, 5, and 6	Add new subsections to Sections 2, 3, 4, 5, and 6 that lists and describes all activities where CERCLA-derived wastes under remedial and removal actions are handled by on site permitted operations. DOE's letter of October 22, 2012 in response to EPA's letter of October 1, 2012 identifies examples of these activities. Any permitted activity that manages CERCLA-derived waste that is	Clarification. This comment is the subject of ongoing discussions by the FFA parties. The outcome will be reflected in the FY 2016 RER as appropriate.

Comm. #	Section/ Page	Comment	Response
		not included in the RER is expected to be off site operations that must comply with CERCLA Off Site Rule (40 CFR 300.440).	
4		Although recent progress has been made addressing the matter of how slabs would be managed at ETTP after D&D and prior to remedial action, an informal dispute resolution agreement has not been finalized to address why an Appendix D to the RER is no longer necessary how contaminated slabs would be handled at the ORR.	Clarification. The ETTP D&D and Remedial Action Project Teams recently reached agreement on management of slabs and are in the process of implementing the agreement. The results of implementing this agreement will be reflected in the FY 2016 RER. Tables 2.1 and 8.1 will be revised to show "TBD" for the "Other LTS required" for potentially contaminated slabs. The following footnotes will be added to Table 2.1 and similarly to Table 8.1 (see responses to TDEC specific comments 30 and 32): "This completion document includes "Other LTS" requirements for potentially contaminated slabs, e.g., slab monitoring, access controls, inspection, etc. Interim LTS requirements for potentially contaminated slabs following building demolition are the subject of an informal dispute. Until the informal dispute is resolved, the "Other LTS" requirements for potentially contaminated slabs are not known and are TBD. The "Monitoring/Other LTS" requirements in a completion document have been superseded, or replaced, by the requirements in the subsequent, referenced completion document."
5	Figure 6.20	Figure 6.20 depicts a decline in taxonomic richness in benthic macroinvertebrate communities at reference Station BFK 7.6.The taxonomic richness has not yet recovered from impacts of increased rainfall in early 2009. Please expand on stressors impacting the reference station.	Clarification. BFK 7.6 exhibits annual variability, thus it is generally best to look across all available years to interpret results and not just periods of shorter duration. The number of EPT taxa/sample in 2010 was twice that found in 2009. Furthermore, the number of EPT taxa/sample from 2009-2014 was within the range found from 1986-2008. Brushy Fork is by no means a pristine reference site, but it does represent what might be expected in a mid-sized valley stream in east Tennessee in the absence of significant industrial discharges. Brushy Fork site is a 4th order site that has a watershed area of ~40 km^2. Virtually the entire stream flows through a low density rural valley landscape where considerable clearing has occurred for agricultural and non-agricultural purposes.
6		Mercury in UEFPC and Lower East Fork Poplar Creek (LEFPC) appears to be mobilized by creek flows and transported downstream to Poplar Creek. Action Plan 1 in Appendix C of the RER addresses 2011 Five Year Review (FYR) issue OF-2, which pertains to mobilization of mercury at a watershed scale. Data collection and systems-based modeling will be used to model sediment transport and refine source estimates. The evaluations will be conducted over the period leading up to the 2016 Five-Year Review. The scope of Action Plan	Clarification. The scope of Action Plan 1 was based on definitions of issues from the 2011 Five Year Review. At that time the TDEC was not contemplating discontinuation of flow augmentation so such an assessment was not scoped in the Action Plan. To the extent possible the Action Plan 1 report will discuss observations of the effects of termination of flow augmentation on the mercury transportation and bioaccumulation in LEFPC, however that Action Plan scope was agreed on several years ago. As indicated in the response to Specific

Comm. #	Section/ Page	Comment	Response
		1 should be expanded to address the effects of flow augmentation.	Comment 20, post flow-augmentation data is being considered in the model.
SPECIFIC COMMENTS			
1	Executive Summary, Page ES-6	Under the subheading, Upper East Fork Poplar Creek, the first bullet describes the mercury concentration at Station 17 in comparison to the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area (DOE/OR/01-1951&03) [Phase I ROD] goal of 200 ng/L. However, as meeting the AWQC of 51 ng/L was identified as a long term goal in the Phase I ROD, it appears the AWQC should be discussed as well. Revise the Executive Summary; Section 6.2.1.2.1.1, Surface Water Quality Goals and Monitoring Requirements; and, Section 6.2.1.3, Performance Summary, to also include a discussion of Station 17 mercury concentrations in comparison to the AWQC.	Clarification. The Statement of Basis and Purpose of the UEFPC Phase I ROD states that the RAO for surface water is to restore surface water to human health recreational risk-based values for mercury at Station 17 [200 parts per trillion (ppt)]. UEFPC Phase I ROD Appendix B Chemical-Specific ARARS/TBC states "the selected remedy will not attain instream the *Recreation* (organisms only) AWQC for mercury (51 ppt), which is the most stringent criterion for mercury. The *Recreation* (organisms only) AWQC is for protection of human health from consumption of organisms (e.g., fish). Under the National Contingency Plan at 40 *CFR* 300.430(f)(1)(ii)(C)(1), an alternative that does not meet an ARAR may be selected when the alternative is an interim measure and the ARAR will be attained or waived as part of a total (i.e., final) remedial action. Thus, a waiver under CERCLA 121(d)(4)(A) will be invoked as part of this remedy because the AWQC for mercury will not be met in this interim action. On completion of these source control actions, a risk-based surface water remediation goal for mercury (200 ppt) is expected to be met instream at Station 17 in the interim." Based on this agreed decision DOE has not established attainment of the 51 ppt total mercury concentration AWQC as a ROD goal. No text modification is planned.
2	Table 1.3, Closed-out RER issues in 2014, Issue 1	The increasing trend for ^{90}Sr observed during FY 2012 and FY 2013 Homogeneous Reactor Experiment (HRE) tributary monitoring downstream of the HRE facility was closed out based on a downward trend during FY 2014; however, it is not clear why this issue was closed out based on a single year of monitoring. Further, as DOE conducted surface water sampling during FY 2014 that identified the probable source of increased ^{90}Sr as contamination entering a tributary immediately northeast of the HRE facility near an abandoned and remediated LLLW transfer pipeline, it appears this issue should continue to be tracked and not closed. Revise Table 1.3, and other applicable sections of the RER to address this issue.	Clarification. The increasing trend in HRE Trib ^{90}Sr levels was identified by DOE in the 2014 RER as evidence of the pro-active approach by DOE in assessing the remedy monitoring data. The issue was considered closed by DOE because the ^{90}Sr levels in the stream remain far less than the ROD goal for tributary water quality levels and, consistent with the response to General Comment 1, HRE tributary monitoring is included in the Executive Summary. Monitoring in the HRE Tributary will continue consistent with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/0-1-1982&D3). The final three sentences of paragraph 1 on Page 3-25 will be replaced with the following: "The appearance of elevated ^{90}Sr in the stream near this area suggests that contamination may be moving through the remediated areas from locations further away along the pipeline. At no time did contaminant concentration levels in the HRE Tributary approach the ROD risk-based goals for surface water upstream of White Oak Dam (Table 3.6), however DOE was proactive in following up on the apparent trend to determine source of contamination. Monitoring in the HRE tributary will continue consistent with the *Melton Valley Watershed Remedial Action Report Comprehensive Monitoring Plan (*DOE/OR/0-1-1982&D3). This closes an issue identified in Table 3.11."

Comm. #	Section/ Page	Comment	Response
3	Table 1.3, Closed-out RER issues in 2014, Issue 4	Exceedances of the AWQC levels at Outfall 05A was closed out based on future monitoring, remediation and demolition in the area; however, it is not clear why this issue was closed out with continued exceedances at Outfall 05A. It appears this issue should continue to be tracked in the RER until to the sources are addressed. Revise Table 1.3, and other applicable sections of the RER to address this issue.	Clarification. Mercury levels in ETTP storm water Outfall 05A monitoring are a concern that will continue to be monitored and discussed in future RERs as has been the case for several years. Consistent with the response to General Comment 1, stormwater outfall and surface water monitoring for mercury is included in the Executive Summary However, DOE does not consider this to be a trackable RER issue since it is a not a performance standard concern for a completed CERCLA action. Legacy mercury contamination will be addressed in future CERCLA D&D actions for the K-1203 sewage treatment facilities and future Zone 2 EU Z2-12 soil evaluations. A future Sitewide Record of Decision will address the surface water pathway.
4	Table 1.4., 2011 FYR summary of issues and recommend-ations and follow-up actions	Issue BCV-2, which includes uranium activity at Bear Creek kilometer (BCK) 9.2 above acceptable levels for residential and industrial human receptors and as noted in the Executive Summary, indicates that 75% of the uranium flux originating in the BCBG is described as "Closed" in the RER; however, it is not clear why this issue was closed. As the uranium activity continues to be elevated, it appears this issue should continue to be tracked and not closed. Revise Table 1.4 to indicate the status of this issue or propose continued tracking of all 2011 Five-Year Review (FYR) issues.	Clarification. DOE considers issue BCV-2 closed because: • Source control actions stipulated in the Bear Creek Valley Interim ROD are not yet complete. Implementation of CERCLA actions in Bear Creek Valley, including full implementation of the Bear Creek Valley Phase I ROD-stipulated actions and a future BCBG ROD will be per the agreed FFA schedule. • Continued monitoring of the uranium flux at BCK 9.2 and elsewhere in Bear Creek Valley is required per the *Bear Creek Valley Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-2457&D2/A1). Creation of a trackable issue is not necessary for required monitoring performance. • BCV-2 issue and Action Plan 9 were identified as closed in the 2013 D2 RER (DOE/OR/01-2594&D2) approved in November 2013 and has remained closed in subsequent RERs. At that time, an NT-8 early action was included in the FFA Appendix J schedule. In subsequent years during tri-party negotiations on priorities and funding, the NT-8 early action was removed from the FFA schedule. The EPA FFA Project Manager can raise the issue for consideration during FFA prioritization discussions. However, consistent with the response to General Comment 1 and as noted in this comment, the uranium flux contribution at BCK 9.2 originating from the BCBG is included in the Executive Summary.
5	Section 2.2.1.2.2, Groundwater, Page 2-50	This section states, "The post-injection monitoring results of the field-scale amendment injections in the 7000 Area of ORNL [Oak Ridge National Laboratory] have indicated that anaerobic reductive dechlorination can be successfully implemented at full scale for treating TCE in groundwater in the 7000 Area." However, this section does not describe when the full-scale remediation is planned or prioritized under the Groundwater Strategy Document. Further, this section does not discuss if additional rebound sampling is proposed or if the Treatability Study (TS) is complete. Revise this section to provide additional information on rebound sampling for the TS and to include the proposed schedule for implementing final remediation of the 7000 Area.	Clarification. As indicated in response to General Comment 1, DOE does not consider the annual RER to be the appropriate platform for programmatic schedule tracking. The FFA has other mechanisms that provide ongoing updates to the regulators of the program priorities, sequencing, and scheduling. Groundwater Program implementation priorities and sequencing will be communicated as that program evolves. Continued monitoring of wells at the ORNL 7000 Area is summarized in the *Bethel Valley Administrative Watershed Remedial Action Report Comprehensive Monitoring Plan for the Oak Ridge Reservation Oak Ridge, Tennessee* (DOE/OR/01-2478&D1).

Comm. #	Section/ Page	Comment	Response
			The following text will be added to the end of the 7000 Area plume discussion on p. 2-50: "The *Treatability Study Work Plan for 7000 Area in Bethel Valley, Oak Ridge, Tennessee* (DOE/OR/01-2475&D2) stipulated monitoring of VOCs, field parameters, biodegradation parameters, and genetic indicators for 1 year post-injection of the biostimulants. Thus, the treatability study ended in January of 2012 which was 1 full year post-injection. The report (*Treatability Study for the Bethel Valley 7000 Area Groundwater Plume Oak Ridge National Laboratory Oak Ridge, Tennessee* [DOE/OR/01-2566&D1]) issued in 2012 recommended continued monitoring without stipulating a duration. DOE continued that full scale monitoring through FY 2014 to obtain a more robust dataset to document the microbial processes. In FY 2015 DOE discontinued analysis of phospholipid fatty acids (PLFA) and hydrogen gas because those analyses are rather expensive and numbers of *Dehalococcoides* had shown significant declines. DOE continues to monitor field parameters, VOCs (including ethane, ethylene, and methane), total and ferrous iron, anions (including alkalinity, chloride, fluoride, sulfate, nitrate-nitrite, and sulfide), total organic carbon, and abundance of *Dehalococcoides* which is the functional microbial genera responsible for degradation of TCE and its transformation compounds. Starting in FY 2016 DOE will analyze groundwater at the ORNL 7000 Area for VOCs including chlorinated organics and their transformation products as well as methane/ethylene/ethane to track ongoing degradation and rebound in the plume. Additional remedial actions on the ORNL 7000 TCE plume will be conducted as a matter of prioritization in the ORR Groundwater Program and in accordance with the agreed FFA schedule."
6	Section 3.2.1.2.1.3, page 3-25	The cause of the increasing Sr90 trend was investigated in 2014. The RER states the Sr90 levels "decreased somewhat" in 2014. This does not appear to be a sufficient basis for closing this issue.	Please see the response to Specific Comment 2.
7	Section 4.3	Bear Creek Valley (BCV) has no issues and recommendations in Table 4.12. However, a number of release concerns have been identified in the past and issues have been raised, evaluated and closed without actions planned to address the releases. The uranium flux in Bear Creek decreased slightly in FY 2014 (95.6 kg/yr) but remained above the ROD goal, which specified a flux less than or equal to 34 kg/yr. Tributary NT-8 from the Bear Creek Burial Grounds (BCBG) was identified as a significant source of uranium flux to the Bear Creek. In FY 2014, continuous flow-paced monitoring of NT-8 indicated that 72 kg of uranium was discharged to Bear Creek in FY 2014. Actions have been proposed by DOE in the following documents: • The Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation (DOE/OR/01-2628&D2) recommended taking action. • The Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the ORR (DOE/OR/01-2664&D1) recommends a specific action to address the NT-8 release.	Clarification. See response to Specific Comment 4. DOE does not consider the ongoing discharges of uranium in excess of the Bear Creek Valley Interim ROD Goals to be a trackable RER issue because: • There are multiple sources of uranium that contribute to the BCK 9.2 total uranium discharge. • Not all ROD-stipulated actions to reduce uranium discharge in Bear Creek have been implemented which renders remedy evaluation somewhat premature. • As noted in the comment, the uranium source(s) affecting NT-8 are not included in any CERCLA decision to date. In 2008, DOE evaluated and proposed remedial action for the source area in the *Focused Feasibility Study* for the *Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2382) and *Proposed Plan for the Bear Creek Burial Grounds at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2383). However, DOE and the regulators have not reached agreement on a CERCLA action to address

Comm. #	Section/ Page	Comment	Response
		NT-8 drains the BCV Burial Grounds, which are not under an existing ROD. Uranium activity at BCK 9.2 was identified as 2011 FYR Issue BCV-2 in Table 1.4. Action Plan #9 was completed and closed out. The contribution from NT-8 has increased from 51% in 2011 to 75% in 2014. Action Plan #9 should be revisited to see if its recommendations would change given the increasing uranium activities in 2014. The uranium concentrations in surface water are increasing over time. Identify an RER issue the increasing contribution from Tributary NT-8 to the uranium flux to Bear Creek (Table 4.7). Describe activities, including those activities necessary DOE can initiate that would support prioritization leading to implementation of this work. This should be in the context of, follow on to Action Plan #9 and/or a new issue in this RER, and should be consistent with DOE's recommended actions under the two documents listed above. The following comments raise concern about ongoing releases that exceed goals in existing RODs and should be retained in the RER table as issues that are required to be addressed individually or collectively.	the Bear Creek Burial Grounds area. • The referenced FFS for Water Management for Disposal of CERCLA Waste on the ORR recommended that source water to the NT-8 discharges not be co-treated with EMWMF/EMDF waters and suggested an alternative solution which requires reaching a separate CERCLA decision by the FFA parties to implement an action on this contamination source.
7a		Uranium isotope concentrations at the BCK 9.2 Integration Point in BCV Zone 2 were above the risk-based concentration in 2014 for ^{238}U with activities similar to those observed since 2010. The uranium activities at the Integration Point were identified as 2011 FYR Issue BCV-2. This should be an open issue.	Please see responses to Specific Comments 4 and 7.
7b		Cadmium concentrations in Bear Creek surface water at Stations NT-1 and BCK 12.34 continued to exceed the ambient water quality criterion. The source of cadmium is the material disposed in the S-3 Ponds. This should be an open issue.	Clarification. DOE does not consider this to be a trackable RER issue. However, consistent with the response to General Comment 1, it is included as a monitoring observation in the Executive Summary. Remedial action on S-3 Ponds Pathway 3 was stipulated in the Bear Creek Valley Phase I ROD. That action has not yet been designed and implemented to allow remedy evaluation. Monitoring and reporting of cadmium in NT-1 and in Bear Creek will continue as required by the *Bear Creek Valley Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-2457&D2/A1).
7c		The uranium flux measured at NT-3 in 2014 (1.87 kg/yr) met the ROD goal of achieving a uranium flux less than 4.3 kg/yr. The uranium flux at NT-3 was down from 22.3 in 2013.The reduction in uranium flux was due to remedial actions at the Bone Yard/Bum Yard (BY/BY). The reduction in the uranium flux was accompanied by a shift in the isotopic composition, suggesting ongoing contributions from another source. This source was identified as the western side of the Unit 6 Landfill. The Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee, has proposed a project to investigate the uranium fluxes entering NT-3 from the Unit 6 Landfill. This should be an open issue.	Clarification. DOE does not consider the NT-3 uranium discharge flux to be a trackable RER issue because the topic has been identified, investigated as to probable source, and a project has been identified in the Groundwater Strategy to be performed in the sequence assigned during implementation of the ORR Groundwater Program. Data obtained during FY 2014 and thus far in FY 2015 show that the ROD goal is being attained since annual rainfall has diminished back to the approximate average level. Monitoring and reporting of the performance of the Boneyard/Burnyard remedial action continues as required in the *Bear Creek Valley Remedial Action Report Comprehensive Monitoring Plan* (DOE/OR/01-2457&D2/A1).

Comm. #	Section/ Page	Comment	Response
7d		Mercury concentrations in NT-3 are measured to monitor the effectiveness of the remediation of the BY/BY. Remedial actions at the BY/BY had a stated goal to reduce the concentration of mercury in Station NT-3 to meet the AWQC, which was 12 ng/L (ppt) at the time. The highest mercury concentration detected at NT-3 in FY 2014 was 11.5 ppt. The methylmercury concentration at NT-3 was 0.49 ppt, which is high compared to methylmercury concentrations elsewhere on the ORR. Conditions in the revegetated stream might promote mercury methylation. This should be an open issue.	Clarification. Ambient Water Quality Criteria are identified as water quality goals in ORR RODs. As such, as promulgated criteria are updated by regulating agencies the relevant goal values for ORR decision documents also are revised. Thus, the relevant AWQC for total mercury is 51 ng/L. Since completion of the BY/BY remedial action, the surface water in NT-3 has attained the AWQC. Methylmercury is not regulated by statute or regulation. DOE does not see an RER trackable issue at NT-3 related to AWQC.
7e		Biological monitoring is conducted in Bear Creek to evaluate progress toward achieving the fish-tissue based AWQC of 0.3 µg/g mercury in fish. The fish tissue concentrations of mercury are monitored in rockbass at downstream Station BCK 3.3 of the BCV watershed operable unit. Rockbass mercury concentrations decreased in FY 2014 from concentrations observed in FY 2013. Rockbass mercury concentrations were 0.68 µg/g in fall 2013 and 0.69 µg/g in spring 2014. Concentrations remain above the AWQC. Concentrations in rockbass and redbreast sunfish are variable from year to year but do not appear to be decreasing. This should be an open issue.	Clarification. Consistent with the response to General Comment 1, the presence of elevated mercury concentrations in rockbass at BCK 3.3 is included in the Executive Summary. However, DOE does not consider the mercury trends in Bear Creek fish to be a trackable issue because 0.3 µg/g mercury in fish tissue is an EPA-recommended AWQC used for screening level comparison in evaluation of results. It is not a promulgated AWQC or ROD-specified performance standard. Monitoring of mercury in fish in Bear Creek is performed to measure changes to quality of aquatic habitats as compared to reference sites. Continued baseline monitoring will provide useful information in defining future CERCLA decisions in BCV.
7f		Cadmium concentrations in Bear Creek surface water in Zone 3 at NT-1 and at BCK 12.34 continued to exceed the AWQC in FY 2014 (Figure 4.8). Cadmium concentrations in surface water decreased downstream and were below the AWQC in BCV Zone 2. BCV Zone 3 fish have tissues with elevated concentrations of nickel, cadmium, and uranium at BCK 12.4 relative to downstream stations in Bear Creek and the reference station. Cadmium concentrations in stoneroller minnows have declined since 2004. Benthic communities at BCK 12.4 and NT-3 are impacted relative to conditions at the reference stations. This should be an open issue.	Clarification. The biological monitoring results indicate there are negative impacts to Bear Creek, but DOE does not consider this to be a trackable issue because there is not a performance standard specified in the BCV Phase I ROD for metal concentrations in fish. Additionally, CERCLA actions specified in the BCV Phase I ROD are not yet complete. Continued baseline monitoring will provide useful information in defining future CERCLA decisions in BCV.
8	Section 5.4.1.3, Page 5-22	The RER identified no current issues for Chestnut Ridge. Arsenic concentrations are monitored at the entrance and exit of the Filled Coal Ash Pond (FCAP) wetland, which operates passively to treat influent metals by promoting sedimentation. Concentrations of arsenic have reduced by 90% or more from concentrations prior to the remediation. Arsenic was detected at 0.012 mg/L in the filtered, dry-season, influent sample at Station MCK 2.05. The concentration of arsenic in the filtered influent sample was similar to maximum concentrations observed in filtered MCK 2.05 samples prior to remediation (0.011 mg/L).Arsenic was not detected in filtered effluent samples of water exiting the wetland. Prior to the remediation, concentrations of arsenic in filtered samples were not reduced upon passage through the wetland. The treatment wetland is performing better than pre-remediation. However the arsenic concentrations in unfiltered, effluent samples exiting the wetland are above the AWQC. Text in Section 5.4.1.3, Performance Summary, Page 5-22, is confusing. The text stated that the arsenic in the filtered effluent sample exiting the wetland was below the AWQC. It is not clear that arsenic is only associated with the suspended particles in the	Clarification. Table 5.6 contained two improperly flagged filtered sample results for arsenic at MCK 2.0 which will be corrected in the D2 RER. Both of the filtered results previously indicated to be non-detect results were actually detected values. In Table 5.6, the filtered result for arsenic for MCK 2.0 from March 18 will be changed from "0.0059 U" to "0.0059" and the filtered result for arsenic for MCK 2.0 from September 4 will be changed from '<0.0066' to '0.0066". The second paragraph on page 5-18 will be replaced with the following: "The historic data presented in Figure 5.6 show that elevated measurements in the upstream location (MCK 2.05) are almost ten times higher for iron than observed downstream of the wetland and for arsenic the upstream locations average 15 times higher than downstream. Since FY 2011 field filtered and unfiltered aliquots from both the upstream and downstream sample sites have

Comm. #	Section/ Page	Comment	Response
		sample when arsenic was detected in the filtered influent sample. Please revise text on Page 5-22 and Page 5-18. Table 5.6 lists the filtered concentration of arsenic at MCK 2.0 as <0.0066 but does not include a "U" qualifier. The table is unclear whether arsenic was detected in the filtered effluent sample.	been analyzed for metals. The arsenic concentrations at the upstream (pre-treatment) site have averaged 0.225 mg/L total and 0.009 mg/L dissolved (n = 13 with 4 non-detect results at 0.005 mg/L in the filtered aliquots). The arsenic concentrations at the downstream (post-treatment) site have averaged 0.015 mg/L total and 0.007 mg/L dissolved (n=7 with 2 non-detect results at 0.005 mg/L in the filtered aliquots). Based on the sampling for the FY 2011 through FY 2014 period, the passive wetland treatment area reduces total arsenic concentrations by about 93% with associated reductions of dissolved arsenic of about 19%. Over the 5 year sampling period, approximately 70% of the arsenic is associated with filterable solids at the upstream sample site and approximately 48% is associated with filterable solids at the downstream site." The third and fourth sentences in Section 5.4.1.3 Performance Summary and in the third bullet on p. ES-6 will be replaced with the following: "Based on the sampling for the FY2011 through FY 2014 period, the passive wetland treatment area reduces total arsenic concentrations by about 93% with associated reductions of dissolved arsenic of about 19%.".
9	Section 6.2.1.2.1.2, Page 6-17	Flow augmentation to UEFPC just downstream of Outfall 200 was discontinued in May 2014 under the new NPDES permit for Y-12. Absent flow augmentation of East Fork Poplar Creek, the variability of stream flow has increased, and this has potentially led to increased stream-bed scour. The 5 g/day of mercury released from contaminated stream-bed sediment during periods of high flow in 2014 is above typical releases for the creek. Flow augmentation was originally intended to dilute the mercury concentrations in surface water. Concern over the potential for augmented flows to scour stream bank sediments may have been a factor in the decision to end flow augmentation. Reduced flows could have had the unintended consequence of increasing the stream-bank and/or stream-bed sediment flux of mercury to downstream reaches.	Comment noted. Monitoring and reporting of mercury results in the RER will continue per the *East Fork Poplar Creek and Chestnut Ridge Administrative Watersheds Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee* (DOE/OR/01-2466&D2).
10	Section 6.2.1.2.1.2 Surface Water Monitoring Results, Page 6-18	This section discusses the Big Springs Water Treatment System (BSWTS) and states, "Although one of the weekly composite samples exceeded the 0.2 ug/L [micrograms per liter] effluent goal during FY 2014, the result is thought to be a result of either a sampling or laboratory problem since operational monitoring during the same week revealed no elevated mercury concentrations downstream of the carbon treatment media." However, the text does not provide adequate detail to support the conclusion that this sample was sampling or laboratory error. For example, there is no discussion of whether the laboratory was contacted to help determine if it was a laboratory error, if sampling procedures/log books were checked to confirm if it was potentially a sampling error, or if it may have resulted from matrix interference. Revise this section to provide additional information on the elevated sample results from the BSWTS effluent.	Clarification. Upon receipt of the initial analytical result for the subject sample the lab was requested to re-analyze the sample for confirmation. The sample was re-analyzed by the laboratory with matrix spike/matrix spike duplicate (MS/MSD) for quality control and passed this quality control check. At that point UCOR communicated the elevated result for the week ending 2/5/2014 to the facility operations manager to inquire whether there had been upset conditions during the monitoring period. No upset or off-normal conditions were reported for the time period. Operational grab sample data collected on 2/4/2014 provided by the operations personnel showed process internal and effluent results lower than the weekly composite sample result for the effluent. The statement already provided in the RER, "Although one of the weekly composite samples exceeded the 0.2 µg/L effluent goal during FY 2014, the result is thought to be a result of either a sampling or laboratory problem since operational monitoring during the same week revealed no elevated mercury concentrations downstream of the carbon treatment media" accurately documents the event.

Comm. #	Section/ Page	Comment	Response
11	Table 6.5	This table provided the annual uranium and mercury fluxes and average concentrations at Station 17. Since 2014, the average mercury concentration was measured and reported by the ORR Environmental Management (EM) program. The sensors used by the EM Program are located in a different position in the stream cross section and measure a higher average mercury concentration than was previously monitored by continuous mercury monitoring performed by the Y-12 Environmental Compliance Program. The difference in measurements can make it difficult to compare the trends.	Comment noted.
12	Table 6.5	Uranium flux at Station 17 and uranium concentrations in surface water (Table 6.5) were similar to quantities detected in recent years. The uranium flux and concentrations were reduced somewhat from FY 2013 fluxes. Uranium contamination in UEFPC originates from groundwater seepage. The maximum detected uranium concentration (25.5 µg/L) was below the MCL of 30 µg/L. The MCL is used as a screening value. There are no ROD cleanup levels for uranium concentrations in surface water. Given that the MCL does not relate to ecological protectiveness, a screening value to screen for ecological protectiveness should be sought when comparing the uranium concentrations in surface water.	Clarification. The RAO for the selected remedy in the UEFPC Phase 1 ROD was ". . .to restore surface water to human health recreational risk-based values at Station 17." Although boron, cadmium, lithium, uranium, zinc, and PCBs were identified as COCs for ecological receptors, mercury was the only surface water contaminant of concern for which a cleanup goal (200 ppt) was determined. As stated in Appendix B (ARARs) of the Phase I ROD, "The numeric ambient water quality criteria (AWQC) and narrative criteria for the protection of human health and aquatic organisms under Rules of the TDEC Chap. 1200-4-3-.03 are ARARs that will be addressed as part of the final action for UEFPC." The Phase I ROD for UEFPC is an interim ROD and there is no AWQC for uranium metal or for individual uranium isotopes. DOE regards the MCL for uranium (30 µg/L) as an appropriate comparative screening criterion for the Phase I ROD.
13	Section 6.2.1.3	The concentrations of mercury in UEFPC fish have yet to meet the EPA-recommended fish-tissue based AWQC. Mercury concentrations in redbreast sunfish from Station EFK 23.4 have not responded to the reductions in the last 3 years in the average mercury concentrations at Station 17 since cleanout of the WEMA storm drains (Figure 6.16). Redbreast sunfish collected from Station EFK 24.2 have responded to the recent trend of increasing and then decreasing mercury concentrations in surface water at Station 17. The differences might be in the fish species or in the station location.	Clarification. The trends from EFK 24.2 show mean concentrations in redbreast sunfish only. The trends from EFK 23.4 show mean concentrations in rock bass, but if the occasional redbreast sunfish is encountered, we have included the data for comparison. The difference in response to changes in water concentration could indeed be due to differences in species and location. Redbreast are lower in the food chain, so we would expect changes in mercury bioaccumulation to become apparent faster in these fish than in rock bass.
14	Section 6.2.1.3	PCB concentrations in redbreast sunfish and rockbass have declined in recent years since 1998 at Station EFK 23.4 (Figure 6.18). Total PCB concentrations in sunfish fillets at EFK 23.4 increased in 2014 (0.86 µg/g), but remain lower than levels observed in the mid-1990s (Figure 6.18). The concentration of PCBs in fish fillet was less than the remediation goal for fish fillet at the ETTP K-1007-Pl Pond, where the goal was 1 µg/g. The applicability of the fish fillet goal from the ETTP K-1007-Pl Pond to UEFPC is unknown. Multiple goals may be appropriate depending on the regulatory program and receptor.	Clarification. The results were compared to the agreed upon CERCLA goals in the ETTP ponds for screening purposes only. No PCB goals in fish have been established in upper EFPC. Target goals for PCBs can vary depending on the regulatory program and site-specific assessments of risk.

Comment Resolution Form

Comm. #	Section/ Page	Comment	Response
15	Sections 7.3.1.2 and 7.5	No issues were reported in the RER for off-site actions. The concentrations of mercury in fish of LEFPC and in Poplar Creek at the confluence with LEFPC exceeded EPA's recommended fish-tissue based AWQC of 0.3 µg/g. Concentrations of mercury in fish tissue have potentially increased in recent years at downstream Station EFK 6.3. Apparent increases in fish tissue concentrations at Station 6.3 might be due to changes in fish species available for monitoring. Mercury concentrations in redbreast sunfish of Poplar Creek at Station PCM 5.1 increased in FY 2014 to 1.09 µg/g. Concentrations of mercury in redbreast sunfish at Station PCM 5.1 appear to be increasing (Figure 7-9). Figure 7.4 shows that the mercury concentrations in redbreast sunfish are higher at PCM 5.1 than fish tissue concentrations in LEFPC. The mercury impacts to fish tissue concentrations appear to be spreading downstream into Poplar Creek. The influence of the zone of contaminated sediments might be expanding downstream due to continued sediment transport from Upper and Lower East Fork Poplar Creek. This is an extension of the 2011 FYR Issue OF-2 having to do with the potential for mobilization of mercury from creek bed sediments and creek bank sediments.	Clarification. The OF-2 Issue was defined for East Fork Poplar Creek only. Poplar Creek mercury trends may be due to changes in source loading, or potentially due to in-stream changes that have enhanced mercury methylation or bioaccumulation. If Poplar Creek fish increases were related to the temporary spike of mercury from Y-12 during storm drain clean out actions in 2011, we would expect mercury in fish to decline over time similar to fish levels upstream. Future monitoring will evaluate whether the observed trends continue.
16	Section 7.4	TDEC has set a target for Polychlorinated Biphenyls (PCBs) in fish fillets at 0.02 µg/g for evaluating impairment of the resource in the context of developing a TMDL. The PCB concentrations in fishes of Watts Bar Reservoir have declined considerably since the 1980s and 1990 but are above the TDEC target, which is more conservative than previous values.	Clarification. Yes, as discussed in Section 7.3.1.2, regulatory guidelines have changed dramatically over the years. Temporal trends show, however, that concentrations in fish have decreased significantly over time and continue to steadily decrease.
17	Section 8.4.2	The remedy for the K-1007-P1 Holding Pond is in its operational phase. Operational monitoring is designed to test how well the remedy has met its goal of altering conditions to provide a pond habitat characterized by emergent aquatic vegetation, clear water, and dominant sunfish populations. FY 2014 marked the sixth year of operational monitoring after application of piscicide in 2009. Operational monitoring measures water quality, vegetative cover, fish community, and effectiveness of animal control. Performance monitoring will be conducted once operational monitoring has demonstrated that ecological enhancements have been implemented as intended, resulting in the desired end-state of a heavily-vegetated pond dominated by sunfish and unfavorable to undesirable fishes. The rotenone application in 2009 eliminated certain undesirable fishes that accumulated high concentrations of PCBs-gizzard shad, largemouth bass, smallmouth buffalo and common carp. The four undesirable fishes, threadfin shad, and several other species reentered the pond during a weir break in May 2010. Subsequent fish removal efforts have targeted the four original undesirable species plus threadfin shad. Over 3,500 gizzard shad and over 600 largemouth bass have been removed from the pond since 2010. Nevertheless, in FY 2014 gizzard shad continued to show steady increases in	Clarification. Fish removal as part of the 2009 action had multiple objectives. A primary objective was the removal of grass carp; a species thought to be the major cause of no vegetation in the pond. Removal of that species was successful, allowing for the extensive growth of pond vegetation over the last few years. Bass and shad are also undesirable species that were removed from the pond, but there was never an expectation that the action could totally prevent shad and bass from entering the pond in the future. The hope is that vegetation growth would extend over the entire pond at some point, helping limit shad populations as they desire open water habitat. The pond is still in transition and is being actively managed, with continued changes in plant vegetation, water chemistry characteristics, and fish populations. It will take several years before we can say that the pond ecosystem has stabilized. It is still reasonable to believe that the pond will ultimately reach its desired end state. As such, DOE does not consider this to be a trackable RER issue. The overall goal for the remediation of the P1 Pond was to reduce PCB concentrations in both fillets and whole body fish; substantial progress has been made towards meeting both of these goals.

Comm. #	Section/ Page	Comment	Response
		biomass (Figure 8.20). Gizzard shad currently make up 73% of total fish biomass. The remedy was intended to enhance the pond ecology to create conditions unfavorable to gizzard shad and preferable to sunfish by promoting dense vegetation. The pond has become revegetated and water quality has improved; however, ecological enhancements in conjunction with fish removal efforts were unsuccessful in controlling gizzard shad in FY 2014. The pond has yet to stabilize to the desired end state required by the remedy. The concentrations of total PCBs in filets and whole-body bluegill sunfish from the K-1007-P1 Holding Pond have decreased from the concentrations prior to implementation of the remedy. Average concentrations of total PCBs in whole-body bluegill sunfish were 3.21 µg/g in 2014, down from 4.3 µg/g in 2013.The total PCB concentrations in bluegill sunfish filets met the 1 µg/g target for the second year in a row. Whole-body total PCB concentrations remain above the ecological cleanup goal of 2.3 µg/g. Even if fish tissue concentrations reach their goals, the Removal Action Work Plan required reaching the desired end state for the ecological enhancement before evaluating performance with respect to reductions in fish tissue concentrations. This should be an open issue.	However, consistent with the response to General Comment 1, the following will be added as a bullet in the ETTP section of the Executive Summary: "Performance monitoring at the K-1007-P1 Holding Pond began in 2010. The mean fillet concentration is below the target of 1 µg/g total PCBs in fish fillets in this pond. Whole body fish concentrations, however, remain above the 2.3 µg/g target. Clam studies continue to indicate that storm drains are a source of PCBs to the K-1007-P1 Holding Pond, but the magnitude of this PCB source appears to be diminishing over time. Resuspension of contaminated sediments in the pond are a more likely important source of PCBs to fish. The removal action at the K-1007-P1 Holding Pond was 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."
18	Figure 8.20	The figure should be revised to correct the y-axis scale. A broken y-axis scale is unnecessary if the gizzard shad biomass is less than 1,000 g/min effort. Please revise the figure.	Agree. The figure will be revised.
19	Section 8.6.4.4, Mercury, Page 8-93	Storm water outfalls to Mitchell Branch have been sampled using an improved analytical method with a lower detection limit since 2010 under a NPDES permit. Mercury concentrations in storm drains have frequently exceeded the 51 ppt AWQC since monitoring was initiated, particularly at Storm Drains SD 180 and SD 190 (Figure 8.50). However, mercury concentrations at the storm drains met the AWQC in 2014. Mercury concentrations in Mitchell Branch surface water are measured at the K-1700 weir (Figure 8.51). Concentrations of mercury in surface water at the K-1700 weir have frequently exceeded the AWQC of 51 ppt but were below it in 2014. Mitchell Branch receives contributions from the SD 180 and SD 190 storm drains, but other sources downstream (seeps, eroding stream bed deposits, and other outfalls) also contribute to the Mitchell Branch exit pathway. Mercury concentrations in sunfish fillets from downstream locations were above the fish-tissue based AWQC of 0.3 µg/g mercury in fish in 2014. Mercury concentrations in surface water of the Outfall 05A were higher than usual in FY 2013, which was identified as an issue in the 2013 RER. Change-out of a pump before the sampling in 2013 apparently disturbed legacy sources of mercury in sediments of the storm drain causing the increase. Mercury concentrations in the water of Outfall 05A returned to their normal levels in FY 2014. The mercury monitoring results above the AWQC in	Clarification. See response to General Comment 1k and Specific Comment 3. DOE does not consider this to be a trackable RER issue. Continued mercury trend monitoring is important for storm water outfalls 180, 190, and 05A. These monitoring efforts will continue and will be discussed in future RERs until evaluations and actions as needed are completed. A future Final Sitewide Record of Decision will address the surface water pathway.

Comm. #	Section/ Page	Comment	Response
		the Mitchell Branch area and sewage treatment plant (STP) Outfall 05A area were appropriately identified as an ETTP issue in Tables 1.3 and 8.9. Continued trend monitoring will be important for prioritizing this open issue.	
20	Appendix C	The Y-12 NPDES permit included a target median annual daily mercury load of 2.42 g/d at Station 17. The daily median mercury load was 11.9 g/d at Station 17 in FY 2014 (Table 6.3). Of the 11.9 g/day, about 5 g/day is being released from contaminated sediments downstream from Outfall 200. The contribution of in-stream sediments to the mercury load at Station 17 is not insignificant. The recent end to flow augmentation has changed the dynamics of sediment erosion and deposition in East Fork Polar Creek. Erosion of bed sediments in East Fork Poplar Creek and transport of eroded sediment downstream was identified by 2011 FYR issue OF-2. Action Plan #1 was initiated. Please describe how Action Plan #1 will address the new hydrodynamic variables.	Clarification. The defined relationships used in the watershed mercury model (generated to address Action Plan 1) considered recent changes in flow and mercury flux to downstream waters.
21	Appendix C, Page C-6, Action Plan 1	East Fork Poplar Creek (EFPC) Streambed and Bank Sediments, includes Figure C-2, Average bank erosion rate a 1 km intervals from EFK231 to the confluence with Poplar Creek; however, a corresponding figure showing a plan view of Poplar Creek with the bank erosion sample locations is not provided. As such, an assessment of the bank erosion rate, with respect to features of the site cannot be made. For clarity, provide a figure showing a plan view of Poplar Creek with the bank erosion sample locations.	Clarification. The graphs shows calculated average erosion rates for the entire length of creek, based on interpretation of each 1 second frame of video from the kayak surveys. There are therefore no sample locations to map. East Fork maps showing fish sample locations, based on kilometer distances upstream of the mouth, can be found in Chapters 6 and 7.
22	Appendix C, Page C-6, Action Plan 1	East Fork Poplar Creek (EFPC) Streambed and Bank Sediments, states, "Field observations suggested the second major mechanism was material that slumped down the streambank from higher locations. Material slump was likely brought on by frost heave and undercut by the flowing creek." However, details on the field observations are not provided to support these statements. Further, it is not clear if the study should be expanded upstream to confirm these statements. Revise Action Plan 1 to provide additional details on the observed slumping and how this affects the overall assessment of streambed and sediment loss. In addition, clarify if additional studies are proposed upstream to assess sediment loss at these locations	Clarification. Multiple mechanisms for soil loss are discussed. The frost heave comment was based on professional judgement as the material slump occurred during a 90 day winter period when there was unusually cold weather. Frozen soils were also observed during this period. Additional bank soil studies are being conducted.
	References	Cosio, C., Flück, R., Regier, N., and V.I. Slaveykova. 2014. Effects of macrophytes on the fate of mercury in aquatic systems. *Environ. Tox. Chem.* 9999:1-13. Mathews, T., G. Southworth, M. Peterson, W. Roy, R. Ketelle, C. Valentine, S. Gregory. 2013. Decreasing aqueous mercury concentrations to achieve safe levels in fish: examining the water-fish relationship in two point-source contaminated streams. *Sci. Tot. Environ.* 443:836-843. Southworth, G.R., Peterson, M.J., and M.G. Ryon. 2000. Long-term increased bioaccumulation of mercury in largemouth bass follows reduction of waterborne selenium. *Chemosphere* 41(7): 1101-1105.	

UCOR
URS | CH2M
Oak Ridge LLC

Comment Resolution Form

Document Number:	Document Title:		
DOE/OR/01-2675&D1	2015 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee		
Name of Reviewer:	**Organization:**	**Comments Received:**	**Response to Comments Transmitted:**
Randy C. Young	Tennessee Department of Environment and Conservation	July 2015	September 2015

Comm. #	Section/ Page	Comment	Response
GENERAL COMMENTS			
1		State monitoring indicates that re-mobilized mercury laden sediments continue to exceed consensus criteria in LEFPC by a factor of over 20 times (TDEC EMR 2013, 2014). The results, so far, indicate that remediation of EFPC itself should be immediately considered. Results in this RER also document continued impairment of LEFPC and infer that more immediate action is needed. With more investigation, we may also suggest that CERCLA remedies to these downstream water bodies should be reevaluated.	Clarification. Prior to initiation of cleanup activities for LEFPC the FFA parties must complete the CERCLA process that establishes remediation levels and response actions for the CERCLA unit. Currently DOE is implementing a project based on the 2011 CERCLA Five Year Review to develop a much better understanding of contaminant sources and processes that affect the LEFPC (see Action Plan 1 in Appendix C of the RER). The results of that investigation will aid decision makers in moving toward a final decision.
2		The Bear Creek Valley (BCV) sources continue to pollute Bear Creek and its fishery. Levels of mercury, PCBs, and other contaminants in fish tissue continue to indicate impairment of Bear Creek, making it impossible to remove it from the states list of impaired water bodies (303d list). Since Bear Creek is a tributary of LEFPC, it is prudent to consider the two as a single watershed unit for the protection of surface water resources. This would best assure that Poplar Creek and the Clinch River are protected and improved to meet quality standards and criteria. We expect future CERCLA documentation to address this.	Clarification. DOE's CERCLA strategy for the ORR, which is a watershed based approach, is well tailored to meeting the goal set forth in this comment. Final surface water decisions for EFPC and Bear Creek will allow for the integrated approach (including fish concentrations as appropriate). Ongoing monitoring of surface water in Bear Creek demonstrates that the surface water total mercury concentrations are less than the 51 ng/L AWQC level.
3		Since the *Record of Decision for Phase I Activities in Bear Creek Valley* was signed, the Zone 3 Watershed Flux goal of less than 34 kg/year has continuously been exceeded at BCK 9.2 (FY 2014 was 96 kg) since FY 2001. During 2014 monitoring of NT-8, there was approximately 72 kg of uranium discharged directly to Bear Creek from the burial grounds, and the level of release seems to be trending upwards since monitoring data was started in FY 2008. Implementation of a surface water action at NT-8 is a potential project identified in the *Groundwater Strategy for the US Department of Energy Oak Ridge Reservation.* The State deems the priority of this project as high. DOE should have a project in Appendix J of the FFA to address this increasing release from the Bear Creek Burial Grounds.	Clarification. Appendix J of the FFA contains a project for a future BCBG ROD that is considered in annual tri-party negotiations of priorities and funding. The TDEC FFA Project Manager can raise the NT-8 issue for consideration during FFA prioritization discussions. For additional information about uranium discharges at NT-8 and prioritization, please see responses to EPA Specific Comments 4 and 7.
4		For this RER, associated CERCLA five-year reviews, and all subsequent CERCLA risk analysis for the ORR, the chemical toxicity of uranium must be included. Depending on enrichment, the hazard quotient (HQ) analysis threshold can be exceeded before a carcinogenic radiological threshold. This is most prudent to correct in Bear Creek Valley where NT8 releases uranium into Bear Creek. It is relevant to both human and ecological risk assessment. This RER acknowledges that BCV uranium releases do not meet IROD goals.	Clarification. The evaluations performed in the RER are specific to the BCV Phase I ROD established goals for the chemicals of concern. These performance levels (goals) for CERCLA actions identified in decision documents are used for performance monitoring, where indicated. Indeed, the watershed scale sampling and analysis plans do include uranium as part of the MET 1 analyte list of metals for most of the watersheds. Where uranium is a COC, appropriate environmental media data is evaluated

Comm. #	Section/ Page	Comment	Response
		However, the chemical toxicity of uranium was not considered in combination with the other contaminants.	against performance goals in the RER, as well as in the Five Year Review. As noted in the comment, uranium toxicity can, in some cases, be a more important health impact than the carcinogenic impact associated with the isotopic component of uranium, particularly when exposure to uranium is combined with other toxic metals. However, in general the risk-based performance goals for carcinogens are lower than those for non-carcinogens due to the assumption of the linear non-threshold dose-response model used by EPA in deriving cancer slope factors. While evaluation and potential action under CERCLA for sources contributing contaminants to NT-8 and subsequently into Bear Creek in BCV is a future action, the impact of uranium as a potential COC, both carcinogenic and non-carcinogenic, will be evaluated per the CERCLA process.
5		Areas designated as recreational or unrestricted use seem to have no organized overall strategy for meeting these goals. A ROD for the Bear Creek Valley watershed should be implemented before more disposals are done in BCV. Cumulative impacts and compensating source control/removal at NT8 specifically should be considered. The deferred feasibility study for the Bear Creek Burial Grounds should be readdressed.	Clarification. The BCV Phase I ROD includes end use designations and actions designed to be protective of those uses as will the future Bear Creek Burial Grounds ROD. Please see responses to EPA Specific Comments 4 and 7 regarding discharges at NT-8 and FFA prioritization.
6		All water resource related ARARs should be considered for surface waters and ground waters. The DOE preference to defer groundwater contradicts protection of water resources and delays source control.	Clarification. If the reviewer is referring to deferring groundwater projects, the ORR Groundwater Strategy document (DOE/OR/01-2628/V1&D2) was developed and agreed to by the FFA parties to document a path forward for managing legacy groundwater challenges. Implementation of the Strategy recommendations began in FY 2014. As early groundwater actions are identified and agreed to by the FFA parties, they will be implemented in accordance with CERCLA and the FFA. Water related ARARs specific to the particular water resource will be analyzed and included in the CERCLA documentation for the action addressing that water resource, per NCP and FFA protocol.
7		Source areas continue to contaminate terrestrial wildlife on the reservation as evidenced by radiological screening of deer at the TWRA check station. Our whitetail deer data indicate that areas between and down gradient of the Melton Valley burial caps are still sources of contamination to whitetail deer. Combined with our GIS mapping of female deer we can, with less certainty, infer that the Bear Creek Burial Grounds are also a source to contaminant whitetail deer. This is an element of resource protection and human health risk assessment that should be explored and included in future CERCLA Five Year reviews.	Clarification. Ecological assessments will be included in future decision documents for Bear Creek Valley, Melton Valley, and Bethel Valley. During these evaluations risk to ecological receptors will be evaluated.
8		Since the EMWMF as-built location includes an underflow drain, a DOE LFRG performance assessment of EMWMF at the as-built location is requested, including quantification of the threat to future residents who may use the underflow as water supply.	Clarification. The DOE requirement for the DOE Order 435.1 performance assessment was previously fulfilled and accepted by DOE. The underdrain was later incorporated into the associated groundwater model and evaluated at that time in accordance with the DOE O 435.1 requirements. No additional evaluation is expected at this time.

Comm. #	Section/ Page	Comment	Response
SPECIFIC COMMENTS			
1	Page iii, Contents	Acronyms begin on page xvii. Please correct.	Agree. Revision will be made.
2	Page xiv, Table 4.1.2	The page number here should be "4-56". It is currently just "56". Please correct.	Agree. Revision will be made.
3	Page ES-4, 2nd paragraph	The second paragraph beginning "The MCL for antimony was exceeded in one off-site well..." is repeated from ES-3. last paragraph. Please correct.	Agree. The paragraph starting at the bottom of p. ES-3 and ending at the top of p. ES-4 will be deleted.
4	Page ES-10, 6th & 7th references	These references are the same.	Agree. Revision will be made.
5	Page 1-2, last paragraph	Please include some discussion about contaminants entering groundwater and possibly moving beyond the Clinch River.	Clarification. Beginning on p. 3-46, Chapter 3 of the RER (Melton Valley) contains a detailed evaluation of monitoring results from on-site exit pathway wells and off-site wells across the Clinch River from the ORR. Section 1.2.1 ORR Groundwater Strategy in Chapter 1 of the RER contains a summary of the key strategy recommendations, including the Off-site Groundwater Assessment, and Appendix D ORR Groundwater Program provides a status of strategy implementation. The following will be added at the end of the last paragraph on p. 1-2: “Additionally, implementation of an ORR-wide strategy is underway to prioritize and address groundwater contamination and includes a study of off-site groundwater (Section 1.2.1 and Appendix D).” To reflect the ongoing evaluation of data from the off-site study, the first paragraph on p. D-5 under <u>Off-site Groundwater Quality Assessment</u> will be replaced with the following: “Evaluation of results from the first sampling event of the Off-site Groundwater Assessment completed in spring 2015 is underway. The project is a cooperative DOE, EPA, and TDEC effort. The approximate area being investigated is located west and north of the Clinch River at the western boundary of the ORR (Figure D.2). A second sampling event is planned for the summer of 2015. Ongoing evaluation of results includes comparison to screening levels for protection of human health and the environment and review of data for indicators of potential contaminant sources and pathways (e.g., potential ORR contaminants, potential migration beyond the Clinch River, potential naturally-occurring substance, etc.). A report on the study is planned for the first quarter of FY 2017.”
6	Page 2-31, Paragraph 3, Lines 2-3	Should the acronym for Bethel Valley Burial Grounds given here as BCBGs be BVBGs? Also, should it be added to the acronyms?	Agree. Revision will be made.

Comm. #	Section/ Page	Comment	Response
7	Page 2-44, Plume Collection Performance Summary	What impact might the utility leak mentioned on page 2-37 (paragraph 3, lines 11-12) have had on the Corehole 8 results for S-90 during late 2014?	Clarification. There is no indication that the utility line valve leak had any effect on the Corehole 8 plume.
8	Page 2-61, last paragraph	It might be helpful here to indicate what the current recommended limit for PCB in fish flesh is.	Agree. The following will be added after the last paragraph: "How do the current PCB results in fish compare to the latest fish consumption guidelines? Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criterion for total PCBs is 0.00064 µg/L under the recreation designated use classification and is the target for PCB-focused Total Maximum Daily Loads, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon; TDEC 2010a,b,c). In the state of Tennessee, assessments of impairment for water body segments as well as public fishing advisories are based on fish tissue concentrations. Historically, the FDA threshold limit of 2 µg/g in fish fillet was used for advisories, and then for many years an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. Most recently, the water quality criterion (0.00064 µg/L for total PCBs) has been used by TDEC to calculate the fish tissue concentration triggering impairment and a Total Maximum Daily Load (TMDL; TDEC 2007) under its TMDL Program, and this concentration is 0.02 mg/kg in fish fillet (TDEC 2010a,b,c). TMDLs are used to develop controls for reducing pollution from both point and non-point sources in order to restore or maintain the quality of a water body and ensure it meets the applicable water quality standards. The fish PCB concentrations in the WOC watershed are still well above the calculated TMDL concentration. "
9	Page 2-63, Figure 2.24	It would be helpful here to include the current recommended limit for PCB in fish flesh on this graph.	Clarification. As indicated in the response to Specific Comment 8, the fish limit for PCBs varies, depending on the determined site specific risk and the regulatory organization. At the lowest level used for the region's reservoir TMDLs (0.02 ppm), the limit line would not be distinguishable from the x axis.
10	Page 3-23, Table 3.6, Column 4, Minimum Detection Limits	What are the units for these detection limits?	Clarification. The units are listed in Column 2 of Table 3.6. No text revision is needed.
11	Page 3-75, Section 3.2.2.2, Status of Requirements, Paragraph 1	The LUCAP with a Memorandum attached was a 1999 document. The one cited here appears to be a 2010 document. This paragraph may need adjustment.	Clarification. In 2010 the LUCAP Appendix B was revised to include the latest Melton Valley LUCIP LUC table. The LUCAP states that *"Appendix B of this document contains the unit-specific LUCIPS. As they are finalized, Appendix B will be updated to reflect any additions or deletions that require LUCs as part of the selected remedy."* No text revision is needed.

Comm. #	Section/ Page	Comment	Response
12	Page 3-80, Section 3.3.3.1, Other LTS Requirements, Line 4	Should auxiliary charcoal bead" be "auxiliary charcoal bed"?	Agree. Revision will be made.
13	Page 4-29, Paragraph 1, Line 11	A citation for the 2011 RER should be included here as it is in the Chapter 4 References.	Agree. Revision will be made.
14	Page 4-32, Paragraph 2, Line 6	Should "...sufficient water to provided samples..." be "...sufficient water to provide samples..."?	Agree. Revision will be made.
15	Page 4-32, Last Paragraph, Line 3	Should "...petroleum hydrocarbons in that slowly leaches from..." be "...petroleum hydrocarbons that slowly leach from..."?	Agree. Revision will be made.
16	Page 4-33, Last Paragraph, Line 10	Should "...at concentrations of 0.55 and 0.45 mg/L in in January..." be "...at concentrations of 0.55 and 0.45 mg/L in January ..."?	Agree. Revision will be made.
17	Page 4-44, Paragraph 1, Line 2	As the first occurrence of GWPP, should this acronym be defined here?	Agree. Revision will be made.
18	Page 4-47, Last Paragraph, Lines 10-16	It would be helpful here to indicate the level of PCBs that is of concern in fish flesh.	Agree. The following text describing the range of PCB limits in fish will be added after the last paragraph: "While regulatory guidance and human health risk levels have varied widely for PCBs over the years, in the recent years in the state of Tennessee, the water quality criterion (0.00064 µg/L for total PCBs) has been used by TDEC to calculate the fish tissue concentration triggering impairment and a Total Maximum Daily Load (TMDL; TDEC 2007) under its TMDL Program, and this concentration is 0.02 mg/kg in fish fillet (TDEC 2010a,b,c). TMDLs are used to develop controls for reducing pollution from both point and non-point sources in order to restore or maintain the quality of a water body and ensure it meets the applicable water quality standards. The fish PCB concentrations in Bear Creek are still well above the calculated TMDL concentration."
19	Page 4-48, Figure 4.15	The title for the figure indicated that the data are graphed for 1990-2014. Only data from 2004-2014 are included in the graph. Please correct.	Agree. The revision will be made.
20	Page 4-50, Figure 4.18	The title for the figure indicated that the data are graphed for 1994-2014. Data from 1992-2014 are included in the graph. Please correct.	Clarification. The scale starts at 1992, but the first results presented are from 1994. No change is needed.

Comm. #	Section/ Page	Comment	Response
21	Page 6-24, Figure 6.9, Horizontal axis	There are two “Oct 13” and two “Aug 14” points on this axis. Is that correct?	Clarification. The graph axis will be modified to eliminate the redundant labels.
22	Page 6-34, Paragraph 1	Based on the limited data and the relation of previous data to Hg in water, can the suggestion that redbreast are responding to Hg in water levels be considered valid?	Clarification. Each data point represents the mean of 6 individual fish. The differences seen are statistically significant. We are suggesting that decreases in inorganic mercury concentrations in fish are more likely than methylmercury decreases. During the storm drain clean out, there is reason to believe that the form of mercury accumulated in the redbreast observed had a higher proportion of inorganic mercury. This would explain the fact that these fish responded to water concentration changes. We have further evidence from individual fish that were tagged and released into the creek that mercury concentrations in the same individual fish decreased when aqueous concentrations were decreasing. This is compelling evidence that the fish were indeed responding to changes in aqueous mercury.
23	Page 6-35, Paragraph 1, Lines 2-4	Is the statement 'A recent study examined the relationship between aqueous total mercury and mercury in fish from three mercury contaminated streams on the ORR (East Fork Poplar Creek, WOC, and Mitchell Branch) and one reference site (Hinds Creek) (Mathews et al., 2013)" accurate? The title of the article indicates that only two streams were studied and the abstract makes no mention of Mitchell Branch.	Yes, it is accurate. The paper focuses on two streams (East Fork and White Oak Creek), as mentioned in the title and abstract. However, in the final synthesis to support our conclusions about EFPC and WOC, we included data from Hinds Creek and Mitchell Branch.
24	Page 6-38, Figure 6.20, Footnote b	"EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, and caddisflies" should be "EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies and caddisflies".	Agree. Revision will be made.
25	Page 6-39, Bullet 2	Is the redbreast data sufficient to suggest that the mercury levels in fish are responding to the levels in water?	Yes, see response to Specific Comment 22.
26	Page 7-1, Paragraph 2, Line 5	The report cited here is a 2004 report and not a September 1999 report. Please clarify.	Clarification. The second sentence in Paragraph 2 will be revised as follows: “In September 1999, the monitoring plans for the Clinch River/Poplar Creek and LWBR were combined in the *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&D2), now referred to as the *Lower Watts Bar Reservoir and Clinch River Poplar/Creek Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee (*DOE/OR/01-1820&D3), to better identify and evaluate changes in contaminants of concern concentrations in fish.” References in Section 7.6 will be updated accordingly.
27	Page 7-1, Last Paragraph, Lines 5-6	The renaming of a document that does not have the same name as given on page 7-28 of the references is very confusing. Also the copy of DOE/OR/01-1820&D3 available from the DOE Information Center does not have the title given here. Please clarify.	Clarification. As described in the response to Specific Comment 26, references in Section 7.6 will be updated. Document DOE/OR/01-1820&D3 issued in 2004 that is available in the DOE Information Center online catalog and is titled *Combined Monitoring Plan for the Lower Watts Bar Reservoir and Clinch River/Poplar Creek Operable Units at the Oak Ridge Reservation, Oak Ridge, Tennessee.* As explained in Section 1.3.1.1 Watershed-scale

Comm. #	Section/ Page	Comment	Response
			Monitoring Plans of the RER, a determination was made in FY 2013 that the watershed-scale monitoring plans would now be primary FFA documents. Table 1.1 on p. 1-11 provides a crosswalk of the primary document titles agreed to for the plans, the document number, and the previous document titles. An erratum to document DOE/OR/01-1820&D3 was issued in FY 2013 with a title change to *Lower Watts Bar Reservoir and Clinch River Poplar/Creek Watershed Remedial Action Report Comprehensive Monitoring Plan, Oak Ridge, Tennessee*.
28	Page 7-5, Figure 7.2, Clinch River/Poplar Creek box, 4th bullet	Should "irregators be "irrigators"?	Agree. Revision will be made.
29	Page 7-7, 2nd Last Paragraph, Lines 12-15	Are any of the data further downstream in Poplar Creek and in the Clinch River for redbreast sunfish? Figure 7.4 on page 7-11 only shows results for bluegill at PCM 1 and CRM 11. Do bluegill typically accumulate mercury to a lesser extent than redbreast and rockbass?	Clarification. The habitat further downstream in Poplar Creek and the Clinch River is more suitable to bluegill. Redbreast are not typically encountered at these sites, though we do opportunistically collect this species if encountered. As mentioned in the 2nd paragraph of Section 7.2.1.2.1, bluegill do accumulate less mercury than the other two species.
30	Page 8-2, Table 8.1	Monitoring requirements identified in PCCRs associated with demolition projects at the ETTP should be included in Table 8.1. It is not appropriate to just start identifying that no monitoring was identified in the document. This has occurred for the following PCCRs: K 1064 Peninsula Area, K-29, K 1420, FY08 LR/LC, FY09 LR/LC, Poplar Creek 3 High Risk Facilities, and FY11 LR/LC.	Clarification. Table 8.1 will be revised to show "TBD" for the "Other LTS required" for potentially contaminated slabs. The following footnote will be added to Table 8.1: "[d]This completion document includes "Other LTS" requirements for potentially contaminated slabs, e.g., slab monitoring, access controls, inspection, etc. Interim LTS requirements for potentially contaminated slabs following building demolition are the subject of an open issue identified in Table 8.9. Until this issue is resolved, the "Other LTS" requirements for potentially contaminated slabs are not known and are TBD." Issues 2 – 4 in Table 8.9, and similarly in Table 1.2, deal with the management of potentially contaminated slabs, and these issues will be combined into a single issue and corresponding action/recommendation as follows:. Issue: "There are several issues associated with the interim management of potentially contaminated slabs at ETTP. Monitoring requirements identified in demolition completion documents have been changed or eliminated following a remedial action decision for the area without appropriate interaction. The frequency of radiological monitoring by the Radiation Protection Program has changed without notification to the Regulators. Fixatives placed over radiological contamination do not have specified inspection and maintenance requirements." Action/Recommendation: Discussions are ongoing among the FFA parties

Comm. #	Section/ Page	Comment	Response
			to develop an approach for managing potentially contaminated slabs at ETTP, and the outcome will be documented in the next RER. The final paragraph of Section 8.5.1 will be revised as follows: "Interim LTS requirements for slabs following building demolition are the subject of an open issue identified in Table 8.9. The ETTP D&D and Remedial Action Project Teams have reached agreement on the management of slabs and are in the process of documenting and implementing the agreement. The results of implementing this agreement will be reflected in the next RER." The 4th bullet on p. ES-9 of the Executive Summary beginning "Interim LTS requirements for slabs" will be similarly revised.
31	Page 8-9, Footnote b, Line 1	Should "...certified in the CERCLA actin completion document..." be "...certified in The CERCLA action completion document..."?	Agree. Revision will be made.
32	Page 8-5, Table 8.1, last column	Monitoring/Other LTS requirements for the K-25 Auxiliary Facilities Group II, Phase II Building Demolition, K-1064 Peninsula Area removal action are superseded by RmAR (DOE/OR/01-2339&D1). Identify what that RmAR is and how monitoring requirements were superseded by that document. The RmAR is not identified in the reference section at the end of Section 8.	Clarification. The RmAR referenced in Table 8.1 is the *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). This RmAR documents demolition of the entire scope in Group II, Phase II. The following footnote will be added to Table 8.1: "[k]The "Monitoring/Other LTS" requirements in a completion document have been superseded, or replaced, by the requirements in the subsequent, referenced completion document." Due to the extensive number of document numbers listed in RER tables, an editorial decision was made that the reference list at the end of each chapter contain documents called out in the text but not those only listed in tables. Documents not listed at the end of the chapter can be retrieved from the DOE Information Center online catalog using the document number. See the response to Specific Comment 30 for the management of potentially contaminated slabs.
33	Page 8-7, Table 8.1, last column	Monitoring/Other LTS requirements for the K-25 Group II, Phase 3 Building Demolition, Remaining Facilities removal action. FY 2007 PCCR LR/LC Facilities are superseded by K- 1007 Ponds/ Powerhouse PCCR (DOE/OR/01-2294&D2/A2). Explain what monitoring requirements were superseded by the referenced PCCR.	Clarification. The *Addendum 2 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/A2) documents a No Further Action decision for the K-770 EU Group (EUs Z1-27, -28, -29, -30, -31, -32, and -33) for unrestricted industrial land use to 10 feet below ground surface. Therefore, the K-736 slab that is in this EU Group does not require any monitoring under CERCLA. See the response to Specific Comment 30 for the management of potentially contaminated slabs.

Comm. #	Section/ Page	Comment	Response
34	Page 8-8, Table 8.1, last column	Monitoring/Other LTS requirements for the K-25 Group II, Phase 3 Building Demolition, Remaining Facilities removal action, FY 2009 PCCR for LR/LC Facilities are superseded by the K-25 Completion Report (DOE/OR/01-2651&D1) and FY2010 PCCR for EU Z2-31 (DOE/OR/01-2452&D1). Explain what monitoring requirements were superseded by the referenced PCCRs.	Clarification. The *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) documents the removal of the K-1035 slab and the remediation of the surrounding area. Therefore, any slab monitoring requirements are superseded. Following demolition, the K-1204-3 slab was in the demolition zone of Building K-25. Following demolition of Building K-25, the *Completion Report for Building K-25 at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2651&D1), now a D2 document, stated that provisional engineering and land use controls will remain in place on the Bldg. K-25 footprint (including the K-1203-3 slab) until evaluated under the Zone 2 ROD. Therefore, the monitoring requirements in the FY 2010 PCCR were superseded by the K-25 Completion Report. EUs Z2-21, -21, and -22, including the K-1204-3 slab, are being evaluated under the Zone 2 ROD. See the response to Specific Comment 30 for the management of potentially contaminated slabs.
35	Page 8-9, Table 8.1, Footnote g	Please revise this statement to indicate that controls were removed because the slab was removed.	Agree. Footnote g will be revised as follows: "Controls were removed because the slab was removed as documented in the *Addendum to the Phased Construction Completion Report for the K-1007 Ponds Area and North Area in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2294&D2/A1)."
36	Page 8-19, second bullet, Line 4	Regarding the statement "...include a groundwater soil screening level for 99Tc...", what is a groundwater soil screening level for $_{99}$Tc? Please clarify.	Clarification. As described in the Zone 2 ROD and Zone 2 RDR/RAWP, soil screening levels are used to determine if soil contamination has the potential to be a source of groundwater contamination that will cause an exceedance of maximum contaminant levels. When the soil is characterized per the Zone 2 RDR/RAWP, the concentrations are compared to the screening levels. If the screening levels are exceeded, then modeling is performed to determine if the soil is a potential source of groundwater contamination. The soil screening levels are contained in the Zone 2 ROD. Since Tc-99 did not represent a sufficient risk to the industrial worker when the Zone 2 ROD was signed, soil screening levels were not included. Subsequently, soil screening levels were calculated and included in a revised Zone 2 RDR/RAWP with involvement by EPA and TDEC.
37	Page 8-35, Paragraph 1, Line 10	Should "...biodegration..." be "biodegradation"?	Agree. Revision will be made.
38	Page 8-69, 4th Paragraph, Line 4	Should "...for all four quarters of 2013…" be "...for all four quarters of 2014."?	Agree: Revision will be made. As previously noted, the hexavalent chromium in-stream sampling results at the MIK 0.79 point of compliance were non-detect values at a detection level of 0.006 mg/L for all four quarters of 2014.

Comm. #	Section/ Page	Comment	Response
39	Page 8-82, 8.6.3.1 Background, Paragraph 14, Lines 2-4	Are the summary of 99Tc in the environment and the Tank waste document the same document? Please explain why "(PNNL; PNNL-15372" is used here.	Yes. The PNNL document was a readily available resource that provided reasonably up to date information on technetium environmental chemistry as well as the Eh/pH diagram used as background in the graph in Figure 8.43. The text reads "(PNNL; PNNL-15372)" because the acronym for Pacific Northwest National Laboratory is defined before the reference call-out for PNNL-15372.
40	Page 8-82, Section 8.6.3 or Page 8-98, Section 8.6.4.5	Please include discussion in Section 8.6.3 or 8.6.4.5 regarding source-term 99Tc in the soils on the east side of the former K-25 Building. Have samples been taken around the K-25 pad and underneath the poly liner that sealed the underlying soils in place near the former cascades? The possible impact of the remaining source-term should be characterized.	Clarification. Zone 2 soil investigations for EUs in the K-25 East Wing slab footprint are ongoing. The ETTP Zone 2 soils ROD includes a process to assess potential impact of contaminated soil on groundwater to allow determination of soil contaminant levels and volumes requiring removal to protect groundwater quality. Results of those investigations will be included in reports to the ETTP Project Team under the ETTP Zone 2 ROD implementation.
41	Page 8-93, Figure 8.49, Legend, Line 2	Should "Cr IV=11µg/L" be "Cr VI=11µg/L"?	Agree: WQC for Cr VI= 11µg/L. The figure will be revised.
42	Page 8-103, Figures 8.55 & 8.56	Please provide the significance of the red dotted lines be included in these graphs?	Clarification. The significance of the red line in these graphs will be added. On Figure 8.55 the red dotted line signifies the EPA-recommended AWQC for mercury in fish fillets (0.3 µg/g). On Figure 8.56 the red dotted line signifies the remediation goal for K-1007-P1 Pond on the ETTP site (1 µg/g in fish fillets).
43	Page 8-105, Figure 8.58, Footnote	"EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, caddisflies, and stoneflies." should be "EPT = Ephemeroptera, Plecoptera, and Trichoptera, or mayflies, stoneflies, and caddisflies."	Agree. Revision will be made.
44	Page 8-108, Table 8.9	The following should be added to the list as a concern: Group 2, Phase 1 Building Demolition (Main Plant) slabs have residual radiological contamination remaining, but there are no monitoring requirements identified.	Clarification. An overall issue for the management of potentially contaminated slabs will be added to Table 8.9. See response to Specific Comment 30.
45	Page 8-112, 2nd reference	"DOE/OR/01-2418" is not cited in this chapter.	Agree. Reference will be deleted.
46	Page B-21, Figure B.2.1	The genus name "dehalococcoides" should be italicized or underlined and the "d" capitalized.	Agree. Revision will be made.
47	Page C-5, Quantification of stream bank erosion	In this section it is stated that erosion pins were used to estimated bank erosion rates in the period November 2013 through about June 2014 (based on 252 days of deployment). During this period auxiliary flows of approximately 4.5 million gallons/day were halted on or about May 1, 2014. It is also stated in this section that the major erosion occurred between November 2013 and April 2014 (a period when the auxiliary flow was still maintained). Have or can the erosion estimates be adjusted to account for the	Clarification. The bank erosion measurements were directly determined, and flow is not used to calculate erosion. Flow information is useful of course in evaluating when erosion occurs, especially during high storm flow. As stated in the text, most of the erosion observed during this period occurred prior to flow augmentation shut-off.

Comm. #	Section/ Page	Comment	Response
		dramatic change in flow volumes?	
48	Page C-8, Evaluation of Shallow Groundwater Connections to EFPC	As with the above mentioned bank erosion studies sampling for this study was overlapped the stopping of the auxiliary flow of 4.5 million gallons/day on May 1, 2014. What impacts might the auxiliary flow have had on the shallow groundwater? Were there any dramatic changes after May 1? When sampling of East Fork began, the auxiliary flow may have an important effect on EFPK chemistry. How will or can data be adjusted to account for potential impacts of the auxiliary flow and its halting?	Clarification. There was no obvious change in groundwater chemistry associated with flow augmentation shutoff. Groundwater studies are ongoing and monitoring over longer time frames may be the most useful in evaluating groundwater-surface water chemical interactions.
49	Page C-9, Watershed modeling	Many of the factors being considered in the model could be impacted by the startup and halting of auxiliary flow. Data from before the startup of the flow, vs. during the period of the flow, vs. after the flow was halted could differ dramatically. How can or will this data be adjusted to account for these differences?	Clarification. We now have a year of monitoring data post-flow augmentation shutoff. The most recent post-flow augmentation data is being considered in generating the processes and relationships used in the model.
50	Page C-27, Table 1	Based on the title of this table, should data for 2012 be included here?	Clarification. The title of Table 1 will be revised to delete "versus 2012". Data from 2012 is shown in subsequent tables. Footnote a to Table 1 will be revised to read: "**Source:** Table 3.3 in DOE 1995." Reference DOE 1995 on p. C-30 will be corrected as follows: "DOE 1995. *Fourth Annual* . . . , DOE/OR/01-1413&D1, U.S. Department of Energy, . . . "