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Strategic Plan for Mercury Remediation at the Y-12 National Security Complex Oak Ridge, Tennessee

This document is approved for public release per review by:

Lawrence M. Sparks 1/24/2014

Lawrence M. Sparks Date
DOE ORO Classification Officer

Professional Project Services, Inc. (Pro2Serve®)
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Strategic Plan for Mercury Remediation at the Y-12 National Security Complex Oak Ridge, Tennessee

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Prepared by
Professional Project Services, Inc. (Pro2Serve®)
Oak Ridge, Tennessee

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CONTENTS

FIGURES

TABLES

ACRONYMS

AFRI	Applied Field Research Initiative
AM	Action Memoranda/Memorandum
ARAR	applicable or relevant and appropriate requirements
ARRA	American Recovery and Reinvestment Act of 2009
ARTD	Applied Research and Technology Development
ATSDR	Agency for Toxic Substances and Disease Registry
ATS	Alternative Treatment Standards
AWQC	ambient water quality criteria
BCV	Bear Creek Valley
BSWTS	Big Spring Water Treatment System
CD	Critical Decision
CDR	Conceptual Design Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CMTS	Central Mercury Treatment System
CR/PC	Clinch River/Poplar Creek
CWA	Clean Water Act of 1972
D&D	deactivation and demolition
DOE	U.S. Department of Energy
DQO	data quality objective
EE/CA	Engineering Evaluation/Cost Analysis
EFPC	East Fork Poplar Creek
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
ETTP	East Tennessee Technology Park
EU	exposure unit
FFA	Federal Facility Agreement
FRS	Field Research Station
FS	Feasibility Study
FY	Fiscal Year
FYR	Five-Year Review
GAC	granular activated carbon
IFDP	Integrated Facility Disposition Program
IROD	Interim Record of Decision
LDR	land disposal restriction
LEFPC	Lower East Fork Poplar Creek
LLW	low-level waste
LM	legacy material

LMR	legacy material removal/disposition
LUC	Land Use Control
NNSA	National Nuclear Security Administration
NPDES	National Pollutant Discharge Elimination System
O	Order
OF 200 MTF	Outfall 200 Mercury Treatment Facility
OREM	Oak Ridge Office of Environmental Management
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORR Landfills	ORR Industrial Landfills
OU	Operable Unit
PCCR	Phased Construction Completion Report
PIDAS	Perimeter Intrusion Detection and Assessment System
ppm	parts per million
ppt	parts per trillion
PTW	principal threat waste
QAPP	Quality Assurance Program Plan
RAO	Remedial Action Objective
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RDWP	Remedial Design Work Plan
RER	Remedial Effectiveness Report
RI	Remedial Investigation
RmAWP	Removal Action Work Plan
RMPE	Reduction of Mercury in Plant Effluents
RCRA	Resource Conservation and Recovery Act of 1976
ROD	Record of Decision
S&M	surveillance and maintenance
SAP	Sampling and Analysis Plan
SC	Office of Science
SFA	Science Focus Area
SPSS	sulfur polymer solidification/stabilization
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TM	Technical Memorandum
UEFPC	Upper East Fork Poplar Creek
U.S.	United States
UTS	Universal Treatment Standards
VPD	venting, purging, draining
WAC	waste acceptance criteria

WEMA	West End Mercury Area
WHP	Waste Handling Plan
Y-12	Y-12 National Security Complex

EXECUTIVE SUMMARY

The United States (U.S.) Department of Energy (DOE) Oak Ridge Office of Environmental Management, along with the Tennessee Department of Environment and Conservation (TDEC), and the U.S. Environmental Protection Agency (EPA), has identified mercury contamination at the Y-12 National Security Complex (Y-12) as the greatest environmental risk on the Oak Ridge Reservation (ORR). The historic loss of mercury to the environment dwarfs any other contaminant release on the ORR. Efforts over the last 20 years to reduce mercury levels leaving the site in the surface waters of Upper East Fork Poplar Creek (UEFPC) have not resulted in achieving acceptable mercury concentrations in fish throughout the creek. Additionally, very recent increases in surface water mercury flux leaving the site have been noted, and are attributed to storm sewer system cleanup activities funded under the American Recovery and Reinvestment Act of 2009. This observed, albeit temporary, increase in mercury flux raises a concern that future demolition and remediation activities are likely to increase the mercury flux at Station 17 (just upstream of the point the creek becomes publicly accessible). Large-scale demolition of several process facilities – totaling approximately 1.8 million square feet – that historically became contaminated with radioisotopes and mercury, along with the accompanying soil remediation activities, will include removal and/or stabilization/containment of major mercury sources while generating waste debris and soil. Some portion of this waste (possibly large) will require treatment prior to disposal under the land disposal restrictions.

Future demolition/remediation projects require development and planning activities in preparation for the execution of these projects, most notably activities aimed at defining waste treatment/disposal/endstates resulting from mercury remediation. Strategic planning for mercury remediation at Y-12 includes the following actions:

- Implement near-term mercury reduction actions to achieve a decrease in mercury flux in East Fork Poplar Creek.
- Assess progress in terms of both mercury surface water concentrations and fish mercury tissue responses, and implement further interim actions as deemed necessary through tri-party agreement.
- Identify, develop, and apply the best technologies for remediation of mercury contamination.
- Prepare, from regulatory and technical standpoints, for execution of large-scale demolition and remediation activities as well as for the management of resultant contact water, debris, and soil that will require treatment and disposal.
- Sequence the large-scale demolition and remediation work efficiently.
- Comply with applicable state and federal agreements and regulations.

Remediation and mitigative activities to date have, in a few instances, resulted in unintended consequences as noted (e.g., mercury flux temporarily increased due to the storm sewer system cleanup). As another example, flow augmentation, implemented to improve water quality in UEFPC, has caused resuspension of creek sediments and, therefore, increased mercury flux exiting the site boundaries. Consequently, combinations of efforts under an adaptive management approach are needed to effectively advance mercury cleanup at the site and address continued, elevated fish mercury concentrations.

A centrally located water treatment facility for mercury removal is proposed as a key component of this strategy. This facility will serve multiple purposes, including reducing mercury flux at Station 17 (through achieving a reduction of mercury in the headwaters of UEFPC) and providing for future mercury removal from contact water (e.g., storm water or decontamination water in contact with mercury-contaminated material/waste) generated during future demolition and remediation activities.

Other near-term completed and continuing efforts supporting the mercury cleanup include:

- Treatability studies/demonstrations to determine waste forms for contaminated soils that meet waste acceptance criteria for the on-site disposal facility, the Environmental Management Waste Management Facility, as well as regulatory land disposal restrictions and other applicable regulatory requirements.
- Ongoing free mercury removal from storm sewer systems, modification of building/other drainage to redirect storm runoff away from known/suspected mercury-contaminated areas, and targeted legacy material disposition.
- Development of required planning documents with an emphasis on producing documents that will serve multiple areas/projects as appropriate.
- Ongoing studies and proposed future efforts to better understand processes that control mercury uptake in fish and distribution in the environment.

These efforts have been and will continue to be implemented in a phased, adaptive approach to reduce uncertainties, to better define and target fish mercury reductions, and increase efficiencies in characterization, targeted removal and treatment, and waste disposition.

As a National Priorities List site, with cleanup implemented under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and governed by the Federal Facility Agreement among DOE, EPA, and TDEC, a prescriptive documentation and communication process is followed to plan, reach approval, implement, and monitor the scope of CERCLA response actions on the ORR. The activities this plan addresses will mitigate mercury contamination sources, remediate soils for federally-controlled industrial use, and reduce water-borne contamination leaving the site. No single solution exists to solve the mercury contamination issue at Y-12; a multi-pronged, adaptive approach is necessary in order to reach endstates that are acceptable on many levels and to all stakeholders. Given the enormity of mercury cleanup, it is essential that economies of scale be implemented and the remediation/waste disposition path forward be well defined and in place prior to initiation of further cleanup.

1. INTRODUCTION

This document presents the United States (U.S.) Department of Energy (DOE) Oak Ridge Office of Environmental Management (OREM) Strategic Plan to safely and cost-effectively remediate mercury contamination at the Y-12 National Security Complex (Y-12) and, as necessary, downstream in East Fork Poplar Creek (EFPC), which is the result of decades of nuclear weapons development at the site. Y-12 is one of four production facilities in the National Nuclear Security Administration's (NNSA) Nuclear Security Enterprise with a unique emphasis in the processing and storage of uranium, and development of technologies associated with those activities. Decades of precision machining experience, and earlier isotope enrichment activities, make Y-12 a production facility with capabilities unequaled nationwide, yet have left the site with a legacy of contaminated facilities requiring replacement and/or demolition, and soils and ground/surface water in need of remediation mainly due to the presence of mercury. This strategy takes into account completed work regarding environmental mercury reduction, and ongoing and proposed near-term actions to reduce mercury in the environment, as well as presents the complete long-term scope and schedule of projects to remove/stabilize the building and soil mercury sources. Several key factors and goals guided the development of this mercury remediation strategy:

- Mercury contamination at Y-12 has been ranked as the greatest environmental risk at the Oak Ridge Reservation (ORR). *Goal: propose mercury reduction projects to (a) take actions to achieve near-term results in reducing the amount of mercury leaving the site and mercury concentrations in fish and (b) plan for large-scale mercury cleanup projects in an effort to reduce risk and ultimately protect human health and the environment.*
- Cleanup is implemented under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), in accordance with the Federal Facility Agreement (FFA) among the U.S. Environmental Protection Agency (EPA), Tennessee Department of Environment and Conservation (TDEC) and DOE (DOE 1992). *Goal: propose activities that meet, or make progress toward meeting, regulatory requirements and approved endstates (e.g., state water quality standards).*
- Cleanup is integrated with NNSA's ongoing missions. *Goal: coordinate mercury remediation activities with ongoing missions work.*
- Strategy considers actions to reduce overall cost to the taxpayer. *Goal: propose actions that will consider ways to save costs such as (a) sequence work to produce efficiencies, (b) combine projects to achieve economies-of-scale, (c) develop technologies to reduce costs/increase efficiencies, and (d) plan and define risk mitigation activities and opportunities*.

The Agency for Toxic Substances and Disease Registry (ATSDR) recently completed an in-depth study to determine the human health effects of mercury releases from the Y-12 site; it conclusively determined that no adverse human health effects have been suffered due to "most past and current exposure pathways" of mercury releases (ATSDR 2012). However, as much as two million pounds of mercury were lost to the environment or are unaccounted for during its historical use at the site. Mercury that has persisted in the environment continues to have impacts which must be addressed, as evidenced by a temporarily increased mercury flux leaving the site due to remediation activities focused on source removal and the plateauing of fish mercury concentrations in recent years. Fish mercury concentration is directly related to human health concerns through ingestion pathways. While comforting to know that human health has not been affected to date, it is imperative to preserve this record with a strategy that acknowledges potential future risks and provides appropriate plans and funding for risk avoidance or mitigation while addressing the environmental impact.

This strategy aims to accomplish the given goals through an adaptive management[1] plan that includes:

- Completion of early action tasks to reduce mercury leaving the plant boundary from the average of 18 grams per day measured over the last seven years (at the National Pollutant Discharge Elimination System [NPDES] location, Station 17)[2].
- Identification of desirable studies in terms of data gathering/analyses and technology development/demonstration to better understand mercury-water-fish relationships and support building demolition and soil remediation projects.
- Prioritization and sequencing of these projects while considering cost efficiencies that may be implemented.

A roadmap for the strategic process is given that counts risk management, technology development, regulatory considerations, and re-baselining among its steps. Figure 1 illustrates the many issues and actions regarding mercury remediation that this strategy aims to address.

As an adaptive plan, this strategy is expected to evolve as results of implemented actions are obtained and assessed, and modifications are proposed as necessary. It will be updated to serve as a flexible, yet stable roadmap for the progress to be made in remediating mercury at Y-12 and in affected portions of the EFPC area.

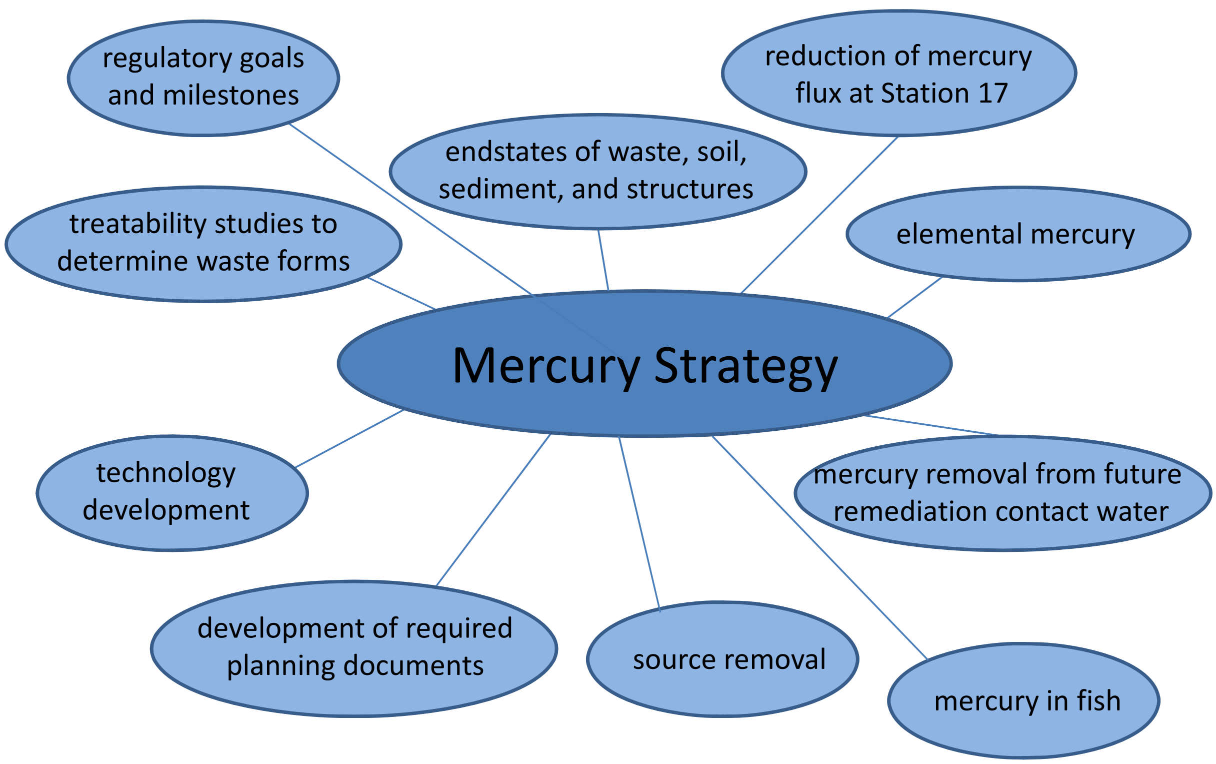

Figure 1. Issues and Actions Addressed by the Mercury Strategic Plan

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[1] As used here "adaptive management" encompasses the concept of decision-making under uncertainty about the outcomes of specific actions with the goal of identifying effective environmental remedies based on observing effectiveness of interim actions as well as on results of scientific research comparing multiple causative hypotheses; e.g., waterborne versus sediment-borne mercury as the dominant source of mercury in fish.

[2] NPDES location is in mid-channel at Station 17.

2. BACKGROUND

2.1 Y-12 SITE HISTORY

Releases of mercury during operations at Y-12 in the 1950s and early 1960s resulted in contamination of environmental media and facilities within the complex, as well as downstream water bodies including EFPC and the Lower Watts Bar Reservoir. Subsequent transport from these sources continues to threaten the creek and ecological receptors both on-site and off-site. Remediation efforts, which began in the 1980s, have reduced waterborne mercury concentrations both within the Y-12 facility and in the EFPC ecosystem, but elevated levels of mercury remain in the soil, sediment, water, and biota, as well as in the building structures and equipment where the mercury operations took place. Industrial development and separation processes using mercury were conducted in several buildings, including Buildings 9201-2 (Alpha-2), 9204-4 (Beta-4), 9201-4 (Alpha-4), and 9201-5 (Alpha-5), beginning in the 1950s and were discontinued in 1963. Building 81-10 (only the slab remains today) in the southern portion of Y-12 housed equipment (roaster and condenser) to recover mercury. These facilities are shown on the map, Figure 2, along with other major mercury-related site facilities/features. Figure 3 shows photographs of the four large mercury-use buildings. The estimated total historical release of mercury to air, surface water, and soil at Y-12 is provided in Table 1 (UCC 1983).

Table 1. Historical Losses of Mercury at Y-12[a]

Mercury Losses	Major Pathway	Mercury (Pounds)	Mercury (Kilograms)
Lost to air (1950 – 1963)	Ventilation systems	~51,000	23,000
Lost to East Fork Poplar Creek (1950 – 1982)	Process waste stream	~239,000	109,000
Lost to soils at Y-12 Complex	Accidents/spills	~428,000	195,000
Lost to sediment in New Hope Pond	Building drains	~15,000	7,000
Not accounted for [b]	Not received, buildings, other	~1,292,000	587,000
Total		**~2,025,000**	**921,000**

[a]Mercury at the Y-12 Plant, a Summary of the 1983 UCC-ND Task Force Study, Y/EX-23, November 1983. (UCC 1983)
[b]This mass of unaccounted for mercury has been estimated at closer to 650,000 lbs, when historical knowledge regarding shortage of receipts, losses to building structures, and other specific losses are taken into account. (UCC 1983)

The EFPC can be divided into several discrete sections. The portion that occurs within the Y-12 Plant (approximately 1.5 miles in length) is referred to as the Upper EFPC ([UEFPC], see Figure 2). The EFPC from Bear Creek Road to its confluence with Poplar Creek near the East Tennessee Technology Park (ETTP) is generally referred to as Lower EFPC ([LEFPC], about 14 miles in length, see Figure 2 inset), and it passes through the city of Oak Ridge. UEFPC leaves the ORR, entering public property shortly downstream of Station 17. Outfall 200, just east of the major processing facilities within Y-12, is the headwaters of UEFPC. A complex underground storm sewer system draining the West End Mercury Area (WEMA), as shown in Figure 2, feeds Outfall 200.

Although impacted to much less extent by mercury use at Y-12, Bear Creek, with its origin just west of the Y-12 Plant, displays elevated mercury levels in some surface waters, and fish living in Bear Creek currently exceed the methylmercury regulatory target of 0.3 mg/kg in tissue (SAIC 1997, Mathews et al. 2013).

While the release of high concentrations of mercury from the plant stopped in 1963, mercury continues to be released into EFPC from various point and nonpoint sources. Dry weather loading of mercury to the

UEFPC has multiple sources, including infiltration of contaminated shallow groundwater into the storm sewer system, dissolution of mercury from the contaminated pipes, advection of contaminated sediment into the surface flow, and emergence of contaminated groundwater from the karst system in springs and seeps (DOE 1994a). Further information on historical releases and sources is available in *Conceptual Model of Primary Mercury Sources, Transport, Pathways, and Flux at the Y-12 Complex and Upper East Fork Poplar Creek, Oak Ridge, Tennessee* (ORNL 2011). Mercury loading in LEFPC is summarized in *Sources of Mercury to East Fork Poplar Creek Downstream from the Y-12 National Security Complex: Inventories and Export Rates* (ORNL 2010) as well as in Mathews et al., 2013.

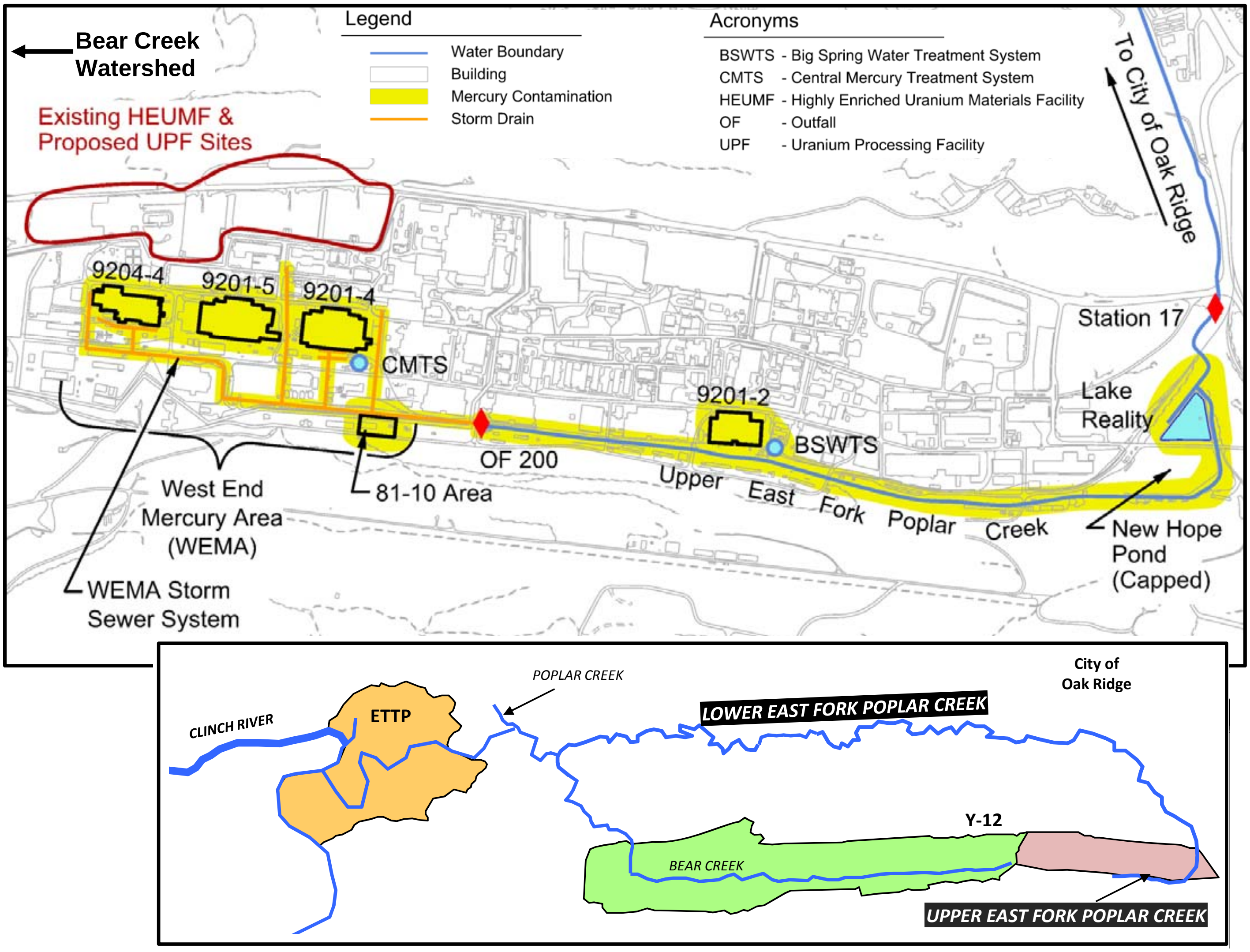


Figure 2. Y-12 Site Layout Showing Major Features in UEFPC Watershed and Expected Areas of Mercury Contamination (Inset map shows all of East Fork Poplar Creek, including LEFPC)

Figure 3. Mercury-Use Buildings at Y-12

2.2 REGULATORY FRAMEWORK FOR CLEANUP

The ORR and portions of the LEFPC Operable Unit (OU)[3] were placed on the National Priorities List in 1989. The FFA, which coordinates the corrective actions under Resource Conservation and Recovery Act of 1976 (RCRA) with CERCLA response actions, became effective on January 1, 1992. Parties of the FFA agreed that implementation of CERCLA actions would be in compliance with RCRA and other appropriate environmental laws as applicable and relevant or appropriate requirements (ARARs) to be specified in the CERCLA decision documents, including requirements for waste characterization, treatment to meet land disposal restrictions (LDRs), and waste handling, storage, and disposal.

[3] The LEFPC release site OU, outside of the ORR, is limited to areas (soil, sediment, and groundwater) within the 100-year floodplain and does not extend to areas outside the floodplain, with the exception of soils that may have been taken from the floodplain and used in other areas as fill (e.g., Sewer Line Beltway) (DOE 1995b). The CERCLA risk assessment process confirmed that Sewer Line Beltway soils present no significant risk (DOE 1994b,c).

2.2.1 Comprehensive Environmental Response, Compensation, and Liability Act

Remediation of the ORR, from a CERCLA regulatory standpoint, is divided up by watersheds. There are two watersheds at Y-12, Bear Creek and UEFPC. UEFPC activities are addressed in this strategy since it is the watershed most affected by mercury contamination; the LEFPC OU is addressed as well. Cleanup projects in the Bear Creek Watershed are addressed as part of the overall Y-12 project prioritization and sequencing discussed in Chapter 4; effects of the mercury cleanup on Bear Creek are also examined.

Per CERCLA, a Remedial Investigation (RI) of the UEFPC watershed was completed in 1998, which identified and defined areas of mercury contamination (as well as all other contamination) and established risks associated with that contamination (SAIC 1998). Alternatives for remediation of all watershed media were evaluated and screened in a Feasibility Study (FS) (BJC 1999). A phased, interim decision approach was developed with the regulators and an FS Addendum (BJC 2000) was subsequently prepared for the initial CERCLA decision, an interim action for remediation to protect surface water. A Proposed Plan (DOE 2001) was prepared and the selected remedy was documented in the Phase I Interim Record of Decision (IROD) (BJC 2002), which focused on addressing contamination that contributed to surface water contamination. A Focused Feasibility Study was prepared for the next phase, which addressed interim actions to remediate soil contamination to protect industrial workers, groundwater, and surface water, and the site was broken into exposure units (EUs), as shown in Figure 4 (BJC 2004). A Proposed Plan, which documented the selected cleanup alternatives, was issued and the Phase II IROD was approved (DOE 2005a) [see Section 2.2.1.1]. Building deactivation and demolition (D&D) decisions were subsequently addressed in an Engineering Evaluation/Cost Analysis (EE/CA) and Action Memorandum (AM) [see Section 2.2.1.2].

Likewise, the CERCLA sequence of RI, FS, Proposed Plan, and Record of Decision (ROD) was followed for the LEFPC OU (DOE 1994b, 1994c, 1994d, 1995a, 1995b).

2.2.1.1 Soils, Sediments, and Subsurface Structures

Remediation of the UEFPC watershed is being conducted in stages using a phased approach under multiple CERCLA decision documents. The Phase I IROD was signed in May 2002 (BJC 2002). Phase I presents selected interim actions for remediation of mercury-contaminated soil, sediment, and groundwater discharges that contribute contamination to surface water. An Explanation of Significant Difference (ESD) to the UEFPC Phase I IROD was issued in Fiscal Year (FY) 2011 (EDI 2011). The ESD removed WEMA capping and WEMA horizontal wells from the selected remedy in the IROD, because they were envisioned as the remediation for WEMA soils prior to the subsequent plan to D&D additional former mercury-use buildings in the area (introduced through the Integrated Facility Disposition Program [IFDP], see Section 2.3). D&D of buildings will allow access to mercury-contaminated soils beneath and adjacent to the structures (addressed by the Phase II IROD).

The Phase I IROD Remedial Action Objective (RAO) is to restore surface water to human health recreational risk-based values at Station 17. An interim goal of 200 parts per trillion (ppt) mercury concentration in surface waters of UEFPC at Station 17 was identified, based on achieving acceptable mercury concentrations in fish tissues for human consumption, and a waiver from the 51 ppt ambient water quality criteria (AWQC) for mercury was granted.

The Phase I IROD remedy addresses those soils and sediments that contribute to surface water contamination as principal threat waste (PTW)[4] including: (1) the WEMA (soils in the immediate vicinity, storm sewer sediments, and shallow groundwater captured by currently operating sumps), (2) sediment in exposed portions of the UEFPC stream channel, and (3) sediment within Lake Reality.

[4] Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. (EPA 1991)

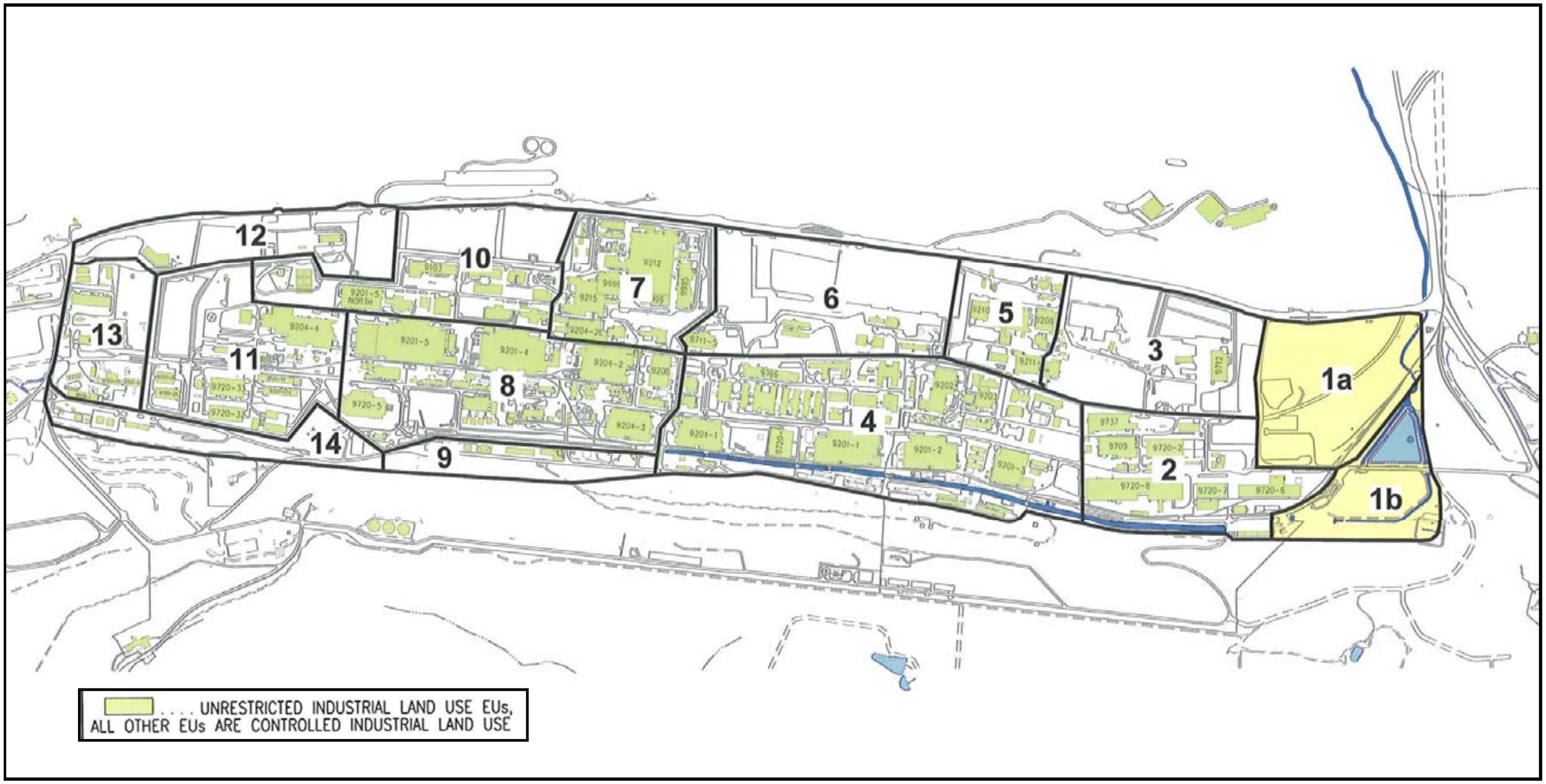


Figure 4. Exposure Units in the UEFPC Contamination Area

EU 11 and EU 8 contain the three large mercury-use facilities. Beta-4 (in EU 11), and Alpha-5 and Alpha-4 (in EU 8) will be demolished as part of this mercury remediation strategy. The 81-10 Area, also a mercury-contaminated area, is located in EU 9. Alpha-2, the fourth mercury-use facility that will be demolished as part of this mercury remediation strategy, is located in EU 4. UEFPC passes through EU 4 and EU 2, as well as EU 1a and EU 1b.

WEMA soils were to be addressed in this Phase I IROD through capping of the WEMA area and addition of horizontal wells, which would have provided an interim solution to mobilization of PTW. However, with the removal of that action, the Phase II IROD becomes the decision document for those soils (see below). The Phase I remedy included several actions that have since been completed:

- Alpha-2 water treatment system (Big Spring Water Treatment System [BSWTS])
- Land use controls
- WEMA storm sewer cleaning
- Short- and long-term studies (involving treatment of water/soils for mercury)

Other Phase I IROD actions that are ongoing or have yet to be completed include:

- Soil/sediment removal in UEFPC and Lake Reality
- Continued monitoring of effectiveness of remediation at various locations

Mercury-contaminated soils and subsurface structures that are not addressed in the Phase I IROD are addressed in the Phase II IROD, as that document states, "[The Phase I IROD] *addresses interim actions for remediation of principal threat waste, mercury-contaminated soils, sediments, and point groundwater discharges that contribute contamination to surface water."* and *"The focus of this second phase of remediation is interim actions for the remediation of the balance of contaminated soil, scrap, and buried materials at Y-12."*

Phase II IROD actions that have since been completed include:

- Y-12 Salvage Yard scrap removal
- Y-12 Salvage Yard soil remediation
- Land use controls (e.g., property record restrictions and notices, zoning notices, excavation/penetration permit program)

Ongoing or not completed actions in the Phase II IROD include:

- Characterization of media
- Excavation of accessible soils (in time all soils will become accessible) exceeding remediation levels, to a depth of 2 ft for controlled industrial land use (EUs 2 through 14) and a depth of 10 ft for unrestricted industrial land use (EUs 1a and 1b, see Figure 4)
- Excavation of accessible soils (in time all soils will become accessible), exceeding remediation levels for protection of groundwater and surface water, to water table or bedrock

The Phase II IROD was finalized and approved by regulators in April 2006 (BJC 2006). The focus of the second phase is remediation of the balance of contaminated soil, scrap, subsurface structures (including slabs and currently inaccessible soils under buildings), and buried materials within the Y-12 Complex. As stated in the bullet above, this IROD addresses all soils in UEFPC, which includes those PTW soils in the WEMA area (originally addressed by interim actions in the Phase I IROD that were subsequently removed, namely WEMA capping) that are currently inaccessible, but will become accessible through eventual demolition of buildings in that area.

The RAO of the Phase II IROD is to protect industrial workers from exposure to hazardous substances in the uppermost two feet of soils, and protect surface water and groundwater by reducing existing contamination of the solid matrix of the site (i.e., soil, sediment, buried waste, and subsurface structures). Soil remediation levels and the calculation methods/modeling are established in the Phase II document.

A Remedial Action Work Plan (RAWP) has been completed to address soil, sediment, buried waste, and subsurface structure remediation at Y-12, based on the defined EUs (EDI 2010a). Addressing smaller, individual remediation projects, typically by EU, will thus be the regulatory strategy approach moving forward. Appendices will be added to the RAWP as the remediation strategies progress for specific EUs (characterization and remediation). A breakdown of the Y-12 site by EU is shown in Figure 4. The strategy presented in this document (Chapter 3) addresses required CERCLA documentation for media from this point forward.

The LEFPC ROD addressed remediation of floodplain soils, which were identified in the RI baseline risk assessment as presenting unacceptable risks – due to mercury – to human health (e.g., hazard index exceeding 1 and/or carcinogenic risk exceeding 10^{-4}) and to ecological receptors. Per the LEFPC ROD, a mercury remediation goal of 400 mg/kg was determined to be protective and 35,600 yd^3 floodplain soils exceeding that level were excavated in 1996-1997, resulting in 45,000 yd^3 of disposed waste soil. Groundwater and sediments were not identified as posing a risk to human health or ecological receptors; surface water (for all three decision documents, Phase I and II IRODs and LEFPC ROD) was not considered as it is deferred to future decisions (see Section 2.2.1.3).

In both IRODs, soil remediation levels are noted as possibly requiring reassessment when final groundwater and surface water decisions are made. As stated in the Phase I IROD, *"This selected remedy is considered to be an interim action and will be completed, evaluated, and used as the basis for determining what, if any, additional remedial actions may be necessary to meet final goals."*, and per the Phase II IROD, *"If final land use, surface water, or groundwater decisions require additional soil remediation, it will be addressed as part of those future action(s)."* (BJC 2002, 2006)

2.2.1.2 Buildings

Building demolitions are addressed in the aforementioned EE/CA (EDI 2010b), which was subsequently followed by submission of an AM (DOE 2010b) documenting the decision regarding building demolition. Several time-Critical AMs addressing a limited number of buildings and a Removal Action Work Plan (RmAWP) addressing the remainder of the buildings including those in the UEFPC watershed area was issued (EDI 2010c). The strategy presented in this document (Chapter 3) addresses required CERCLA documentation for building D&D from this point forward.

2.2.1.3 Ground and Surface Waters

A final groundwater ROD for UEFPC will be developed following the remediation of UEFPC soils, sediments, and subsurface structures. Groundwater in LEFPC was not identified as a risk in the investigations (e.g., Carmichael 1989) conducted for that OU. A final surface water decision for the EFPC (Upper and Lower) will be reached after the completion of the source control actions within the Y-12 site and will be followed by the Clinch River/Poplar Creek (CR/PC) Surface Water ROD. The CR/PC Surface Water ROD will be determined after completion of all ORR upstream source remediation and final watershed decisions at the three Oak Ridge sites (Y-12, Oak Ridge National Laboratory [ORNL], and ETTP). An ORR-wide groundwater strategy is currently under development, with the understanding that many mercury remediation actions have not yet been initiated. Mercury-associated remediation of known sources (e.g., buildings and soil) is planned under specific projects to begin in approximately FY 2025 and complete in FY 2039, based on current planning and funding assumptions.

2.2.2 Resource Conservation and Recovery Act

RCRA governs operations at facilities that generate, treat, store, dispose, or transport materials that meet the RCRA regulatory definition of a hazardous waste. The ORR currently has a RCRA operating permit, and Hazardous and Solid Waste Amendments corrective action permit covering all such facilities located within the ORR boundaries. RCRA also includes certain requirements that may be applicable whether the remedial activities are conducted under RCRA or CERCLA authority. The most significant of these are the LDRs given under 40 Code of Federal Regulations Part 268 (40 Code of Federal Regulations [CFR] §

268). Regarding mercury, LDRs specify the use of particular technologies and standards to meet, including Universal Treatment Standards (UTS) or optional Alternative Treatment Standards (ATS) that are specific to soil that must be attained before the waste may be land disposed.

Mercury-contaminated media at Y-12 (e.g., soils, buildings, debris, etc.) were closely reviewed in 2005 for applicability of the U-151 listed waste code under RCRA. This extensive due diligence review considered hundreds of documents and expert testimony, and concluded that Y-12 media and debris contaminated with mercury should not carry the U-151 code with the possible exception of Building 9720-26 (DOE 2005b). Those mercury-contaminated wastes that may be applicable to the Y-12 site cleanup are given in Table 2, along with the treatment standard to be attained to meet LDRs.

2.2.3 Clean Water Act

Point source discharges to UEFPC are subject to the Clean Water Act of 1972 (CWA) through NPDES permits. The NPDES permit at Y-12 was recently renewed (October 2011) and places considerable emphasis on reducing mercury flux in UEFPC. The newly-issued permit contains activities that are consistent with modification of actions required in previous NPDES permits, while others are enforcement of CERCLA actions to address mercury reduction. In November 2011, DOE and NNSA filed an appeal to remove the performance of CERCLA actions from the permit, which were already subject to enforcement under CERCLA and the ORR FFA. As of the date of this report, this appeal is still unresolved.

CERCLA actions considered in this mercury plan will comply with all substantive requirements of federal and state environmental laws and regulations identified as ARARs in CERCLA decision documents, or obtain waivers in accordance with CERCLA Section 121(d)(4)(D), where needed.

Table 2. Nonwastewaters Contaminated with Mercury and Corresponding RCRA, LDR, UTS, or ATS

Waste Type	Treatment Standard and/or Technology
Per 40 CFR § 268.40 Applicability of Treatment Standards	
Nonwastewaters that exhibit, or are expected to exhibit, the characteristic of toxicity for mercury based on the Toxicity Characteristic Leaching Procedure (TCLP) in SW846; and contain greater than or equal to 260 mg/kg total mercury that also contain organics and are not incinerator residues. (High Mercury-Organic Subcategory)	Incineration (IMERC) or Retort/ Thermal Desorption (RMERC)
Nonwastewaters that exhibit, or are expected to exhibit, the characteristic of toxicity for mercury based on the TCLP in SW846; and contain greater than or equal to 260 mg/kg total mercury that are inorganic, including incinerator residues and residues from RMERC. (High Mercury-Inorganic Subcategory)	RMERC
Nonwastewaters that exhibit, or are expected to exhibit, the characteristic of toxicity for mercury based on TCLP in SW846; and contain less than 260 mg/kg total mercury and that are residues from RMERC only. (Low Mercury Subcategory)	0.20 mg/L TCLP and meet 40 CFR§ 268.48 standards (UTS)
All other nonwastewaters that exhibit, or are expected to exhibit, the characteristic of toxicity for mercury based on TCLP in SW846; and contain less than 260 mg/kg total mercury and that are not residues from RMERC. (Low Mercury Subcategory)	0.025 mg/L TCLP and meet UTS
Elemental mercury contaminated with radioactive materials	Amalgamation (includes use of sulfur compounds)
Per 40 CFR § 268.45 Treatment Standards for Hazardous Debris	
Hazardous Debris	Extraction Technologies or Immobilization Technologies; and must meet specified performance and/or design and operating standards of 40 CFR§268.45
Per 40 CFR § 268.49 Alternative LDR Treatment Standards for Contaminated Soil	
Contaminated Soil	Treatment must achieve 90 percent (%) reduction in contaminant concentrations as measured in leachate from the treated media, tested according to TCLP, but does not have to reduce original contaminant below 10-times the UTS limits in 40 CFR§ 268.48.

2.3 DOE FRAMEWORK FOR CLEANUP

Scope, schedule, and budgets for the cleanup of Y-12, ORNL, and ETTP sites are addressed by DOE OREM through the development of project definitions (based on tri-party agreed upon actions, see Section 2.2) that are then assembled into an overall OREM Baseline. Much of the Y-12 and ORNL cleanup scope was introduced and received Critical Decision (CD)-0 approval, *Approve Mission Need*, on July 20, 2007 and CD-1 approval, *Approve Alternative Selection and Cost Range*, on November 17, 2008, in accordance with DOE Order (O) 413.3A *Program and Project Management for the Acquisition of Capital Assets* (DOE 2008a) under the auspices of the IFDP. This extensive cleanup scope is in the process of being added to the OREM Baseline as discrete projects, and was added to FFA-related scope and schedules in Appendices C, E, and F shortly after CD-1 approval. Further project-specific CD approvals (levels 2, 3, and 4) will be pursued in accordance with DOE O 413.3B (DOE 2010a), which replaced DOE 413.3A. Chapter 4 addresses the project-specific activities proposed for Y-12 in detail. Generally, these projects are organized around building complexes; for example, the Beta-4 Complex D&D Project will demolish Building 9204-4 and accompanying ancillary facilities. Remediation of currently inaccessible soils beneath the buildings will be addressed in a separate soil remediation project logically following the D&D project. The prioritization and sequencing of all these projects – multiple complexes' D&D, soils remediation, etc. – is strategically based on risk and funding, and is a subject discussed in Chapter 4 as well.

2.4 INTERFACES

OREM has cleanup responsibility for the entire ORR. Their mission at the three sites is completed under a single budget and, while a consistent OREM mission is applied to all sites, budgets are still subject to competing site-specific needs, missions and goals, and required results. OREM is responsible for integrating the three site drivers into a single, overall plan and budget based on priorities involving risk, regulatory commitments, and mission needs.

Interfacing with the Y-12 site landlord, NNSA, is essential to ensuring successful execution of both entities' missions. For example, NNSA is planning and actively seeking funding for modifications to the Perimeter Intrusion Detection and Assessment System (PIDAS), which is the protective security boundary that currently encompasses three of the four major mercury-contaminated processing facilities (Beta-4, Alpha-5, and Alpha-4). Therefore, additional costs associated with executing cleanup projects within the PIDAS are not currently accounted for in facility demolition estimates for Beta-4 and Alpha-5, due to NNSA's future plans to reduce the PIDAS footprint prior to the start of demolition of these facilities.

Interfacing with regulatory entities, TDEC and EPA Region 4, is of utmost importance in executing this mercury cleanup strategy and achieving the response action goals set forth in the CERCLA decision documents. CERCLA remediation activities require submittals of various documents – Waste Handling Plans (WHPs), Sampling and Analysis Plans (SAPs), Remedial Design Reports, Work Plans, etc.,– that are reviewed and approved by the regulators, showing their involvement in the decision-making process. The strategy accounts for development of these plans and regulator interactions prior to executing the actions.

Stakeholder participation and understanding is essential for DOE to achieve acceptance of its cleanup mission. Effective communication plays an important role in integrating regulators and the public into the decision-making process. Implementation of public involvement activities will be consistent with the FFA-approved *Public Involvement Plan for CERCLA Activities at the U.S. Department of Energy Oak Ridge Reservation* (DOE 2011) and DOE P 141.2, *Public Participation and Community Relations* (DOE 2003). Interactive communication will enable all parties to understand disparate views and to achieve agreement for the most appropriate path forward.

2.5 COMPLETED WORK

Previous and ongoing progress toward the ultimate goal of mercury remediation at Y-12 is summarized in Table 3. Most recently, funding from American Recovery and Reinvestment Act of 2009 (ARRA) enabled the completion of several activities as noted at the end of the table; however, the bulk of the work remains to be completed and is addressed by this strategic plan.

Table 3. Chronology of Significant Mercury Cleanup Activities

Year(s)	Project	Summary of Significant Actions	References
1985 to 1999	Building remediation activities	• Elimination of mercury sources and rerouting of process pipe in Buildings 9201-2, 9201-4, 9201-5 and 9204-4; decontamination of facilities/equipment and equipment removal; treatment of sump water in 9201-2 using activated carbon	• *Reduction of Mercury in Plant Effluents (RMPE) Program in the mid- to late 1990s* (DOE 1998g) • *Removal Action Report for Building 9201-4 Exterior Process Piping Removal at the Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR/02-1650&D1
1986 to 1987	Storm drain cleaning/lining; removal of mercury-contaminated sediment	• 5,600 ft of storm sewers cleaned • 8,400 ft of storm sewers relined • 500,000 lbs of sediment removed	• RMPE Program Activity • UEFPC RI page 3-33 (SAIC 1998)
1988	Construction projects result in mercury-contaminated soil removal	• Removal and disposition of soil in high mercury-contamination areas due to construction of PIDAS	• RMPE Program Activity
1988 to 1989	New Hope Pond closure (replaced by Lake Reality)	• Located near eastern boundary of Plant • Unlined settling basin intended to remove suspended sediments from UEFPC prior to discharge from the Y-12 Plant • Constructed in 1962 • Sediments dredged in 1973 and placed in Chestnut Ridge Sediment Disposal Basin • Closed and capped in 1989	• *Removal Action Report for the Oak Ridge Y-12 Plant East End Volatile Organic Compound Plume, Oak Ridge, Tennessee,* DOE/OR/01-2297&D1 • *Post-Closure Permit for the Upper East Fork Poplar Creek Hydrogeologic Regime (New Hope Pond and Eastern S-3 Site Plume) , U.S. DOE, Y-12 National Security Complex, Oak Ridge, Tennessee,* EPA ID No. TN3-89-009-0001, TN Permit No. TNHW-113 • *Closure Plan for New Hope Pond,* Y/SUB/87-86020C/3 (DOEIC = F.0603.080.0510)
1988 to 1995	Pipe rerouting: North-South Pipe replaced in 1988	• Rerouting and removal of process piping • 2,000 ft of North-South Pipe containing mercury-contaminated sediment abandoned and replaced with new pipe • North-South Pipe conveys UEFPC in western area of complex	• RMPE Program Activity • UEFPC RI Page 3-33 (SAIC 1998)

Table 3. Chronology of Significant Mercury Cleanup Activities (Continued)

Year(s)	Project	Summary of Significant Actions	References
1992	Tank remediation (removal of 30,000 lb mercury-contaminated sediment)	• Three, concrete settling tanks (2101-U, 2104-U, 2100-U) contributed to mercury releases in UEFPC • Tanks were cleaned to remove mercury-contaminated water and sediment • Approximately 30,000 lbs of mercury-contaminated sediment removed	• *Post-Construction Report for the Mercury Tanks Interim Action at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1169&D1
1982 to 1994	Reduction of mercury in plant effluent (Lake Reality by-pass; trial treatment of Outfall 51)	• Initiated in 1982 by CWA • Two phases focused on mercury sources • Greater than 90% methylmercury reductions achieved • Storm sewer cleaning/relining • Rerouting process water and UEFPC • Focused water treatment	• Lake Reality by-pass project completed in 1998, which rerouted UEFPC flow around Lake Reality and reduced the flux of methyl mercury (a form more susceptible to bio-uptake) in water downstream of Lake Reality by approximately 90%
1996 to present	Flow augmentation	• Implemented to protect stream water quality per the 1995 NPDES permit • A flow of 5 million gallons per day (mgd) at Station 17 needed for protection • Flow management began in 1996 and adds approximately 4.5 mgd • Maintained by pumping water from Clinch River to Outfall 200 (North/South pipe)	
1996 to present	Central Mercury Treatment System operation	• NPDES Permit Compliance Program Phase 2 Action to reduce discharges at Outfall 551 • Located in Building 9623 and began operation in 1996 • Treats contaminated sump water from Buildings 9201-4 and 9201-5 • Treatment of Building 9201-5 sump halted in 2007	• *Non-significant Change to the Phase I Interim Source Control Actions in UEFPC*, April 2007
1995 to 1997	EFPC floodplain soil removal	• 1994 RI/FS; 1995 ROD • Public input raised cleanup level based on mercury form (sulfide) to 400 ppm • Excavation of approximately 35,000 cubic yards of mercury-contaminated floodplain soil (45,000 cubic yards upon disposal) • Surface water decision deferred	• *Remedial Action Report on the Lower East Fork Poplar Creek Project, Oak Ridge, Tennessee*, DOE/OR/01-1680&D1
1997	Basin 9822 Remediation	• Mercury/PCB source adjacent to 81-10 Mercury Roaster • 1997 Action Memo • Basin water & sediment removed/treated • Basin demolished/filled • 81-10 sump cleanout/closure included	• *Removal Action Report for the 9822 Sediment Basin and Building 81-10 Sump at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1763&D2
1999	RI/FS completed for UEFPC		

Table 3. Chronology of Significant Mercury Cleanup Activities (Continued)

Year(s)	Project	Summary of Significant Actions	References
2001	UEFPC Bank Stabilization	• CERCLA Treatability Study • Stabilized stream bank to reduce erosion • Reduced storm event driven releases of mercury	• *Treatability Study Report for the Upper East Fork Poplar Creek Bank Stabilization at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR/01-1890&D1
2002	Phase I IROD approved		
2005 to present	Big Spring Water Treatment System operation	• Located near Alpha-2 • Began operation in August 2005 • Removes mercury using granular activated carbon • Treats approximately 300 gallons per minute	• *Phased Construction Completion Report for the Big Spring Water Treatment System at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2218&D1
2006	Phase II IROD approved		
2008	IFDP CD-1 approved (addresses D&D of more than 100 buildings and multiple remedial action sites at Y-12)		
2009 to present	ARRA Projects (WEMA Storm Sewer Project; Scrap Yard Removal; Beta-4 and Alpha-5 Legacy Material Removal (LMR); Alpha-5 Building Characterization) **See Section 3.4.1 for details on other ARRA actions for mercury remediation.**	• WEMA Storm Sewer Project - Video inspection of 15,600 ft storm sewer - Cleaning of 8,100 ft of storm sewer - Relining of 1,200 ft of storm sewer - Disposition/treatment of mercury-contaminated media and wastewater • Y-12 Scrap Yard (Old Salvage Yard) - Characterization results show no soil treatment prior to disposal required • Completion of Alpha-5 and partial Beta-4 legacy material (LM) disposition (approximately 22,000 yd^3 total removed) • Completion of Alpha-5 building characterization • Actions as discussed in Section 3.4.1	• *Phased Construction Completion Report for the West End Mercury Area Storm Sewer Remediation at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2526&D2 • *Phased Construction Completion Report for the Y-12 Old Salvage Yard Soil Remedial Project, Y-12 National Security Complex,* DOE/OR/01-2564&D1 • *Removal Action Report for the Removal of Legacy Material from Buildings Beta 4 (9204-4) and Alpha 5 (9201-5) at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-2519&D2 • *Characterization Report for Alpha 5 Building 9201-5 at the Y-12 National Security Complex, Oak Ridge, Tennessee Volume I,* DOE/OR/01-2540&D2

2.6 MERCURY REMAINING IN THE ENVIRONMENT

As noted in Section 2.1, many tons of mercury have been lost to the surrounding Y-12 environment – air, soil, sediment, buildings, and water. Much of that contamination is believed to be contained in the soils surrounding and under the process buildings. A site conceptual model that identifies the major mercury sources, transport pathways, and flux has been developed (ORNL 2011). Major sources delineated in the model include soils, creek sediments, buildings, and subsurface structures (storm drains, piping, sumps, and tanks). Mercury leaves the Y-12 site primarily through surface waters in UEFPC. Transport pathways are very complex as is the mercury chemistry and behavior in the environment. The amount of mercury leaving the site per a given time period (or flux) is quite variable.

2.6.1 Mercury in Subsurface Soils

Mercury in the subsurface soils at Y-12 is present in many forms (see recent Soil Treatability Study, [UCOR 2012b], for additional information). Most typically (due to its stability) the mercury II valence state versus the mercury I valence state is found, from the more soluble inorganic mercury (II) compounds (e.g., mercuric oxide, HgO) to the least soluble, mercuric sulfide (HgS, cinnabar), as well as (more sparingly) organic methylmercury compounds and, finally, a portion is present as elemental mercury. Depending on the location, any of these mercury compounds may be dominant in soils (with the exception of methylmercury, which is typically present in very low concentrations in soils, usually representing far less than 1% of total mercury).

Elemental mercury's unique properties of high density, surface tension, volatility, and occurrence as a liquid at room temperature lead to both challenges and advantages during its characterization and treatment in subsurface environments. As a liquid it is perhaps the ultimate dense non-aqueous phase liquid due to its very high density (13.5 g/cc) and relatively low solubility (60 μg/L). Its high surface tension (487 dynes/cm), highest of all common liquids at room temperature, offsets the effects of its high density and downward mobility to some degree by causing spills of the liquid to break up into small beads that stick to surfaces and retard its downward migration in porous media (e.g., soil). Elemental mercury is also reasonably volatile and reaches near saturation values in stagnant air (15 mg/m^3) that are hazardous to human health. Thus, it can migrate in the subsurface as a gas in the soil gas matrix as well as dissolved in groundwater, and can present inhalation issues during remediation. Under mildly anoxic subsurface conditions elemental mercury is thermodynamically stable, but on exposure to air with normal oxygen content it can be oxidized to forms (HgO, HgOCl) that are far more soluble in water than the elemental form. One further complication arises from the observation that certain subsurface bacteria (iron reducers) are capable of reducing mercury II ion to elemental mercury (Barkay et al 2009). At higher levels of mercury contamination, development and expression of the *mer* operon, a mercury-resistance gene, also facilitates mercury reduction. Thus, even where a subsurface mercury source is not initially elemental, microbial-driven processes can generate elemental mercury in the subsurface.

Total mercury concentrations in soils in the WEMA and around Alpha-2 range in the few mg/kg (ppm) to thousands of ppm. Mercury remediation of subsurface sources has been very limited, to date. The majority of this work remains planned under future actions.

2.6.2 Mercury in Water and Sediments

Considerable progress has been made in reducing the amount of mercury leaving the site through UEFPC since the 1980s as shown in the trends of Figure 5. However, EPA evaluates mercury levels in fish tissue as an indication of the "health" of a water body, and these levels have not seen a corresponding decrease within the fish of EFPC as shown in the figure. Additionally, concern has been raised over the increase seen in mercury leaving the site in the last several years (refer to Figure 6) which, from 2008 to 2010, may be partially explained in terms of increased rainfall (mercury flux correlates with rainfall due to the increase in flow and turbidity, which causes mercury flux increases due to higher solids content where mercury preferentially resides). The significant increase in 2011 is attributed to the WEMA storm system cleanout, which resulted in disturbances of storm drain sediments, a primary mercury source. As seen in Figure 6, mercury flux has continued to drop since the cleanout, although rainfall for the three-year period has slightly increased during that time (60 inches for 2011, 62 in 2013, and almost 64 in 2013). Mercury flux continues to be a significant issue and reduction of mercury leaving the site has been identified as a high environmental risk requiring near-term action. A complete discussion of mercury flux is given in the annual Remedial Effectiveness Report (RER) (UCOR 2012a).

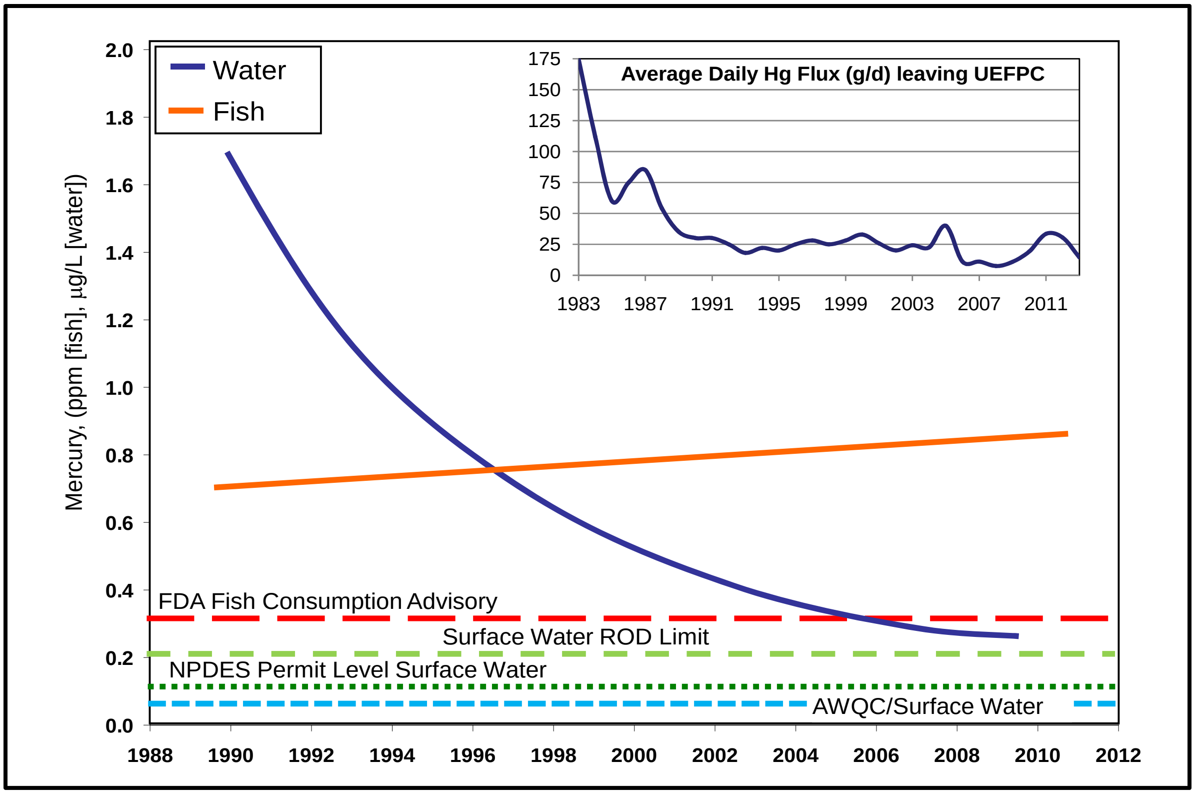


Figure 5. Station 17 Historic Mercury Loading to UEFPC (Water and Fish) and Current Standards

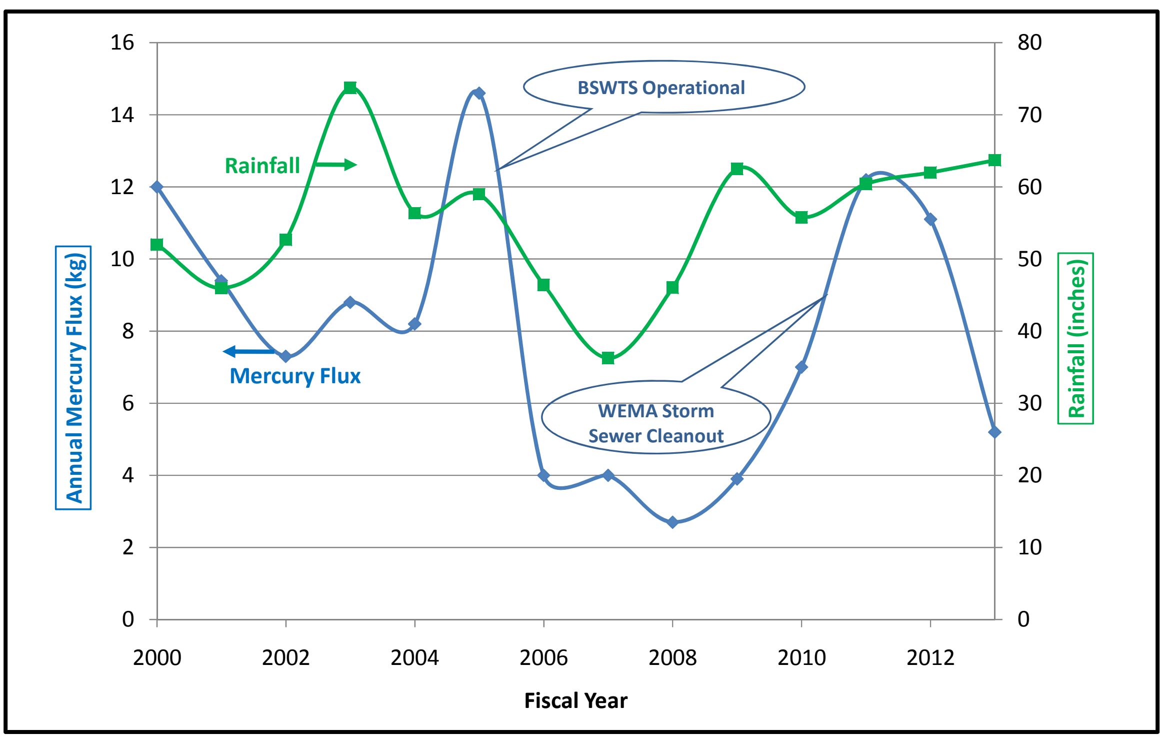


Figure 6. Annual Mercury Flux at Station 17

The 2011 ORR Five-Year Review (FYR), (SAIC 2011) noted that the LEFPC ROD protectiveness has been deferred based on continued elevated fish mercury levels and recent studies that indicate some terrestrial biota that are prey (spiders) for higher organisms (birds) continue to accumulate mercury. Additionally, the Phase I IROD is not currently protective as presented in the FYR, based on continued high mercury flux/concentration as measured at Station 17. Two action plans were developed in the 2012 RER (UCOR 2012a) and reported on in the 2013 RER (UCOR 2013) to address these protectiveness issues. Those plans are included here in Attachment A, and are discussed further in Section 3.4.2.2.

Several conclusions are drawn in the Y-12 Site Conceptual Model report (ORNL 2011) regarding mercury sources contributing to surface water contamination, a few of which are quoted here in italics. Additional clarification is added in brackets.

- *Of the known mercury inputs into UEFPC, Outfall 200 (representing combined inputs from the WEMA and other upstream areas) is by far the most important current source of mercury to creek water. Depending on flow conditions, Outfall 200 represents approximately 70-80% of the flux observed at Station 17. This is a change from 10 years ago when Outfall 200 was thought to represent approximately 20% of the flux to Station 17* [when other fluxes were still present (e.g., Outfall 51 near Alpha-2)].

Data collected during 2012 showed a significant decrease in the Outfall 200 average mercury flux from 31 g/day in 2011 to 7 g/day. Conversely, the Station 17 average mercury flux decreased by only 3 g/day, from 33 to 30 g/day, during the same time frame. This phenomenon may be attributed to the WEMA storm sewer cleanout conducted in the previous year. Recent efforts to remove elemental mercury from WEMA (see the Free Mercury Removal project discussed in Section 3.4.1) also may be contributing to the reduction in the Outfall 200 flux. Given more time, the Station 17 flux may also ultimately decrease. These occurrences demonstrate that creek sediment, rainfall influences, etc., can become more weighty contributors to mercury presence in the creek under some circumstances, and highlights the potentially unpredictable effects that remediation activities, soil and sediment disturbances, and possible other fluctuations can have on mercury flux in various locations throughout the flow regime.

The following observation, quoted from the Conceptual Model report, demonstrates one such influence:

- *Under base flow conditions, stream sediment provides the second most important continuing source of mercury into creek water (upstream of Outfall 109). Flow management* [augmentation of flow to UEFPC with Clinch River flow] *appears to have increased flux from this sediment source* [due to the disturbance and re-suspension of sediment caused by the introduction of the high augmentation flow.]

Other conclusions drawn from the report include:

- *Sediments in UEFPC may* [also] *act as a sink for mercury under dry-weather conditions* [especially in the absence of flow augmentation] *with sediments and suspended solids moving downstream and contributing to high flux numbers during extremely high flow conditions (Southworth et al. 2009, Southworth et al. 2010). Mercury flux monitoring at Station 17 is affected both by large changes in water flow volumes and by impacts to mercury concentration from short-term spikes of particle-associated mercury (DOE 2011). Ungauged flux downstream of Outfall 109 to Station 17 represents a very uncertain and poorly-understood contribution to the UEFPC mass balance during wet-weather periods. Further complicating the downstream mass balance is the fact that year-to-year variation in export estimates at Station 17 is very large and dependent on the sources and handling of data used to generate the estimate (e.g., grab samples vs. composites, inclusion or exclusion of very high spikes, and averaging methods).*
- *Shallow groundwater near Big Spring is known to be a substantial mercury source that highlights the need for continued operation of Big Spring Water Treatment System (BSWTS). The primary*

groundwater sources to the BSWTS, whether originating from 81-10, the WEMA area, or the Alpha-2 area, are not well understood.

- *BSWTS has been successful at removing approximately 2–3 g/d of mercury that entered UEFPC prior to BSWTS start-up, as well as substantially reducing the average mercury concentration in the creek. Over much of its operation, BSWTS has removed a much higher amount of mercury from groundwater than was anticipated.*

The behavior of mercury in UEPFC between Outfall 200 and Station 17 is complex. As noted already the mercury mass balance for this reach is dynamic and controlled in large part by timing and duration of dry weather and storm flows, as well as whether flow augmentation is operational. The reach effectively stores significant amounts of the mercury discharged during dry weather flow in bed sediments and then releases all or portions of it during storm flow. The reach provides trapping of particle-associated mercury (including free-phase mercury) between storm events as well as opportunities for solution-phase (dissolved) mercury to partition to bed sediments and suspended particles. The latter behavior is illustrated by the observation that dissolved mercury at Outfall 200 accounts for more than 80% of total mercury under dry weather flow conditions, and 66-72% of total mercury under all flow conditions. In contrast, the dissolved percentage for all flows at Station 17 is 5% with dry weather flow conditions characterized by somewhat higher dissolved percentage. Some solution-phase mercury is also lost from the creek due to reduction of ionic mercury to the volatile elemental form and evasion[5] from creek water. These processes make calculation of short-term mass balances, which do not include storage and evasion terms, meaningless. The relevance of this behavior to remediation strategies is that it makes assessment of the effectiveness of any applied remedy more difficult, or at least requires that only long-term observations be used. Clearly, the effectiveness of remedies applied upstream of Outfall 200 should be much less difficult to assess at Outfall 200, while those applied at (e.g., proposed mercury treatment facility) or downstream of Outfall 200 and assessed at Station 17 will require careful consideration of this complex behavior.

Taken as a whole, these and previous discussed observations – decreases in mercury flux have not resulted in corresponding fish mercury level declines; cleanup of storm sewer systems seem to have triggered temporary increases in mercury flux; flow augmentation, introduced as a response to improve water quality, is thought to result in increased mercury flux at Station 17; a significant 75% decrease in mercury flux at Outfall 200 was noted from 2011 to 2012 after storm sewer cleanup, but not followed by a corresponding decrease in mercury flux at Station 17 – all demonstrate the uncertainty and variability in environmental mercury response when cleanup steps are initiated. Ultimately, source removal will lead to reduced mercury levels in the environment, but in the meantime, interim cleanup actions can influence mercury transport in a sometimes uncertain, and even negative, manner.

The relationship of mercury in fish tissue to mercury in water is complex and not well understood in spite of many years of monitoring both water and fish, during which time mercury in water has been significantly decreasing as already described (e.g., see Figure 5 for Station 17). The relationship is non-linear as seen in recent data from both EFPC and other streams on the ORR (Figure 7). In the 1980s when mercury concentrations in UEFPC were considerably higher but decreasing, it appeared that a linear relationship existed between water and fish tissue, at least in the upper reach of EFPC. Based on that relationship, it was anticipated that reducing mercury in water to <200 ppt would result in fish tissue values decreasing to less than 0.4 mg/kg, the tissue standard of that time period and the basis for the interim ROD for UEFPC. Mathews et al. (2013) recently published a detailed summary of the history of efforts to reduce mercury concentrations at Station 17 and the responses in fish tissue concentrations at several downstream locations that followed these efforts. These authors also examined the relationship

[5]Evasion is the physical transfer of a dissolved substance (in this case elemental mercury) from water to air. Note that this process was evaluated (Southworth 1997, Southworth et al. 2009) during field testing of the chemical reduction-air stripping concept and found to be minor.

between water and fish concentration in White Oak Creek as it has evolved during similar efforts to reduce mercury concentrations in water at the ORNL facility. Results for both streams support this non-linear relationship between mercury water concentrations and fish concentrations. Both the Mathews et al. paper, and another recent ORNL publication (Southworth et al. 2013), also mention that fish tissue concentrations in LEFPC are not being entirely controlled by waterborne mercury from the plant site. They note that more than 80% of the mercury loading from the EFPC watershed (at confluence with Poplar Creek) is derived from floodplain soils and downstream creek sediments due to storm flow erosion of bed sediments and bank soils. The recent longitudinal pattern of mercury in fish in EFPC (Figure 8) shows that mercury in fish now increases with distance from Station 17, although historical data trends were reversed and indicative of point source dilution. This recent pattern is very similar to that for another river (South River, Virginia; Flanders et al. 2010) with floodplain soil mercury contamination similar to LEFPC but without significant point source loading from the facility that originally released the mercury. Research on both rivers is pointing to eroding stream banks as the main source of mercury in fish in the downstream reaches of these rivers.

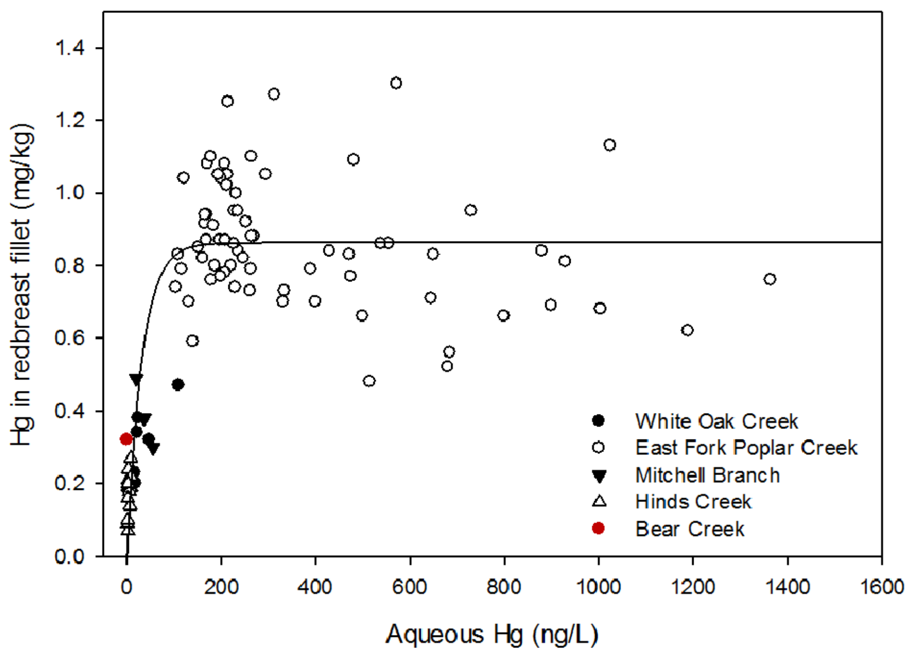


Figure 7. Mercury Concentrations in Water and Redbreast Sunfish Collected on the ORR, 1997-2012

Each data point represents the mean total mercury concentration in six redbreast sunfish at each sampling season and the mean aqueous concentration for the previous season. An exponential model fit is shown by the line in the graph (from Mathews et al 2013).

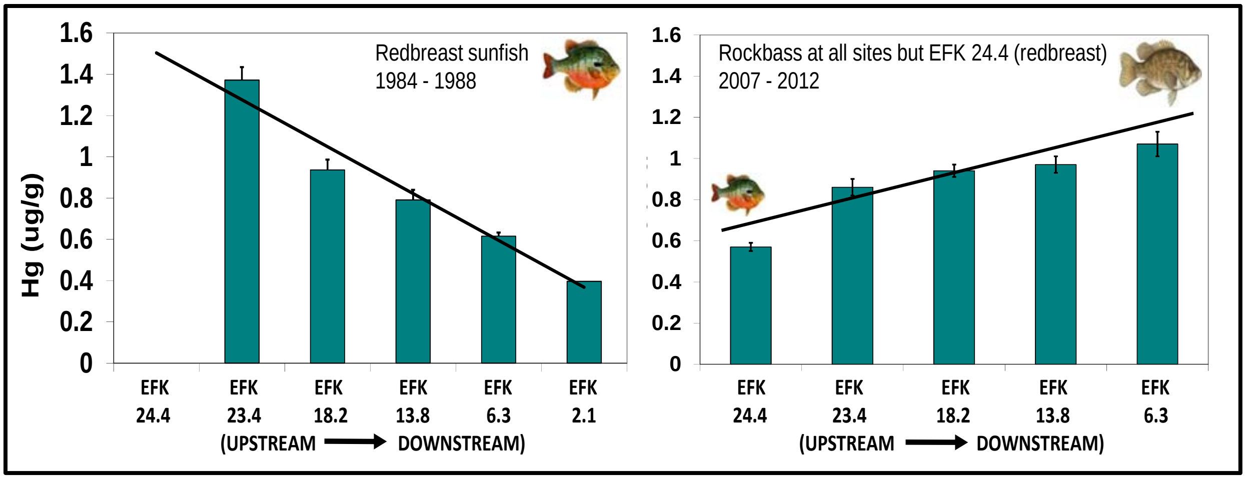


Figure 8. East Fork Poplar Creek Mercury in Fish, Spatial Trends
Average seasonal mercury concentrations in fish in EFPC as noted. (from Peterson 2013)

3. PATH FORWARD – STRATEGIC PLANNING

Based on the observations and issues regarding mercury in the environment on the Y-12 site and downstream in LEFPC as measured to date, namely that mercury levels in fish tissue are not declining as anticipated and mercury flux remains elevated, several significant measures are being implemented and will be consistent with an adaptive approach to introduce further actions based on results of these staged measures.

For one, NNSA recently submitted plans to relocate and/or reduce raw water addition to UEFPC based on previous studies that showed a reduction in flow augmentation can achieve a corresponding reduction in mercury flux in UEFPC (ORNL 2009). In response to those plans, TDEC recently submitted a letter to NNSA directing them to shut down flow augmentation. While flow augmentation cessation is not a foregone conclusion at this time, some modifications will be forthcoming and will no doubt have a ripple effect on mercury flux in the creek. Additionally, OREM has proposed and completed the conceptual design for a surface water treatment facility, the Outfall 200 Mercury Treatment Facility (OF 200 MTF) to be located at Outfall 200. As it becomes operational, this facility will provide a reduction of mercury loading to UEFPC. In terms of future operation, the OF 200 MTF will provide the capability to remove mercury from contact water generated during major, planned source removal actions such as building demolition. In order to meet fluctuating inputs and goals, the facility will be designed with modular, scalable features (see Section 3.4.2 for a more detailed description of the facility). As the facility is brought on-line and is operated to reach steady state, observations of responses may dictate that further action(s) is required. The planned actions, along with any further actions identified as necessary through proposed studies, will address water-borne mercury. Research supported at ORNL under both the Environmental Management Applied Research and Technology Development (ARTD) Program and the Office of Science's (SC) Science Focus Area (SFA) will continue to address the underlying mechanisms, and controls on those mechanisms driving mercury uptake by fish in EFPC. Proposed studies in this area are outlined further in this document, with the expectation that any necessary additional remediation activities on the lower creek can be identified and applied soon after upstream sources are controlled.

Effectively addressing the mercury sources is, ultimately, the goal of the mercury cleanup efforts at Y-12, while the efficacy of the cleanup will be measured in terms of fish tissue methylmercury concentrations. Source removal/stabilization – that is, demolition/removal of mercury-use building debris and excavation/ stabilization/disposal of soils and sediments – is very costly and time-consuming. Therefore, as only one of many urgent missions that OREM is responsible for completing on the Reservation, it will be undertaken as soon as current, committed missions are completed and funding becomes available. Prior to initiating the large source removal projects, a plan for managing treatment and disposal of the expected soil and debris waste must be in place to allow for seamless removal, staging as needed, treatment, and final disposal. Typically, this information is contained in the RmAWP, RAWP, and WHP. A pertinent study has been recently completed that considers the regulatory path and approvals, treatment methods and facilities, disposal locations, and costs associated with management of mercury-contaminated soil, *Treatment Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge* (UCOR 2012b). A similar study for mercury-contaminated debris may be advantageous.

In the meantime, two significant measures are planned, flow augmentation relocation or even cessation and OF 200 MTF, that will reduce mercury loading to UEFPC and thus mercury contamination leaving the site. Several smaller-scale initiatives (e.g., mercury traps in storm sewers) have also been implemented and are discussed further in Section 3.4.1. Based on an adaptive approach, ongoing field and laboratory evaluations and modeling efforts (action plans are given in Attachment A) – to refine mercury source contributions, methylation and bioaccumulation processes, and reduce uncertainties regarding protectiveness of efforts taken to date as well as future efforts – may dictate the need for further actions (see Section 3.4.2.2 for more details). Also in Section 3.4.2.2 is a list of proposed studies to examine other possible actions that might be implemented following the OF 200 MTF startup. A CERCLA Alternatives Evaluation is proposed that will summarize results of studies/efforts in the FY 2021 time frame, and propose future actions that might be deemed necessary. Within this plan, any further actions are not currently accounted for in terms of the planned funding profile and schedule. Therefore, implementation of additional actions outside of this plan will necessarily result in extension of the proposed schedule for planned source remediation (e.g., building demolition and soil/sediment remediation). A combination of actions, large and small, thus makes up the strategy for mercury cleanup at the Y-12 complex, which under current planning assumptions is projected to be completed in FY 2039.

3.1 STRATEGIES TO CONTROL MERCURY RELEASES

Activities to control and/or reduce mercury concentrations (and loading) in Y-12 Plant groundwater and surface water have been grouped into five generic strategies:

- Water Management
- Capture and Treat
- Source Removal
- Source Isolation
- Technology Development

Figure 9 shows a high-level organization of these generic strategies and summaries of recently completed scope and future work to be accomplished under the mercury strategy presented here and discussed in subsequent sections.

Water Management encompasses the concept of “clean water through clean conduits.” Historically, water management has played a major role in reducing losses of mercury into the plant drainage network, by identifying alternate paths for clean water flow around conduits known to be contaminated with mercury. Redirecting roof drainage and cooling systems condensate away from building sumps represent good examples of effective water management for contaminant mass transport control. Operation of building sumps has consequences to contaminant mass transport control. These sumps and their pumps were installed to maintain dry basements in buildings such as 9201-4 and 9201-5 (9201-5 sumps are currently not being used due to the potential for accumulation of methanol in sump water, rendering it not amenable to treatment in the current system; see Table 3). They at least partially regulate water table elevations in their proximity and thus may limit contact of groundwater with mercury-contaminated soil and building materials. This connection with mercury loading to UEFPC has been recognized and evaluated previously (e.g., at Alpha-2).

Additionally, water management encompasses the future routing of clean stormwater around active building demolition, as possible, as well as around other (soil) remediation activities (e.g., through the use of tents, straw bales, sand bags, etc.).

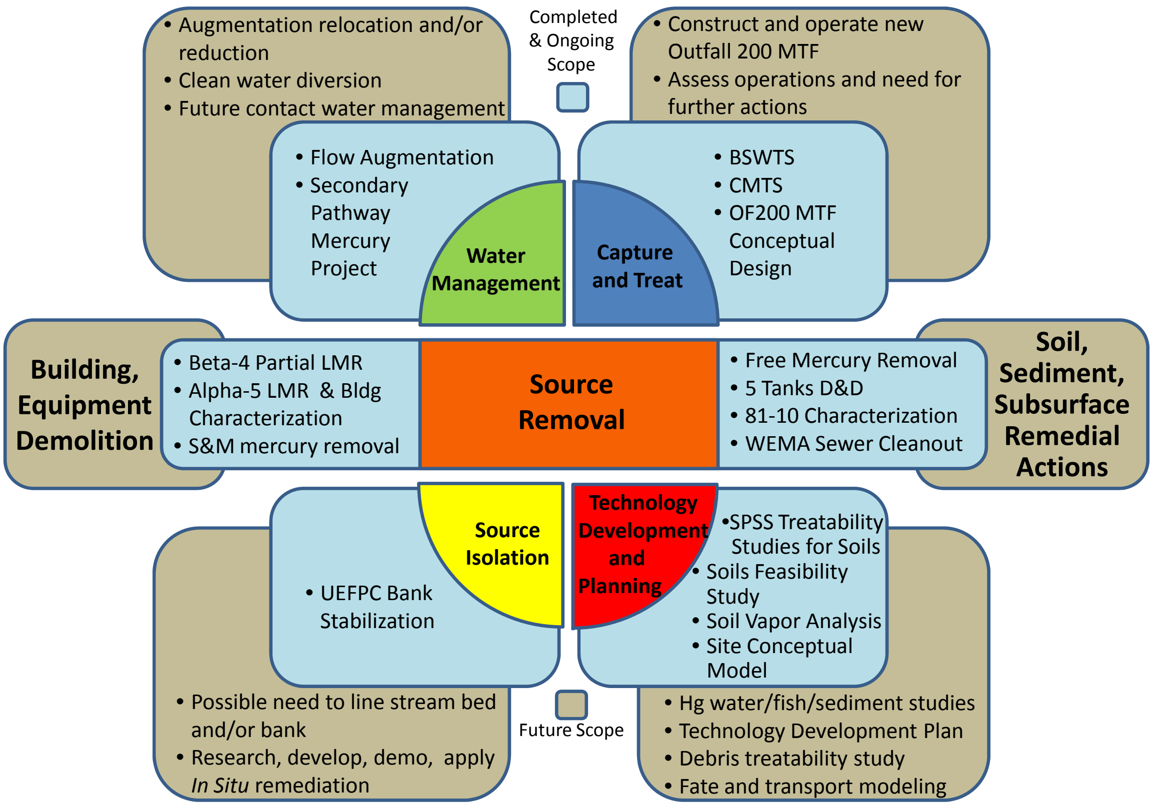


Figure 9. Multi-layered Approach to Mercury Remediation – Recently Completed Scope and Future Scope

Capture and Treat is the proposed action to achieve reduction of mercury in UEFPC. It has been practiced very successfully at Y-12 but at considerable cost. Both distributed (BSWTS) and centralized (Central Mercury Treatment System [CMTS]) systems have been installed at Y-12 and planning for an additional system is ongoing (OF 200 MTF). Selection of cost-effective treatment is important, as is siting (i.e., design capacity can be reduced if location of capture is situated as close to an undiluted source as practical). Modular and scalar design and construction of water treatment systems, as is planned for the OF 200 MTF, can allow for flexibility in terms of plant efficiency and capacity.

Capture and Treat methods will be used during future demolition projects to manage expected contact water. Existing facilities (CMTS, BSWTS) both may be used during demolition and remediation work to treat contaminated-groundwater or contact water as might be encountered, and as is planned for operation of the OF 200 MTF.

Source Containment/Isolation is achieved by construction of physical barriers around soil/waste such that water cannot enter the containment area. It may entail surface capping and/or impermeable wall installation, as was completed in the UEFPC bank stabilization effort some years ago. To be effective in some cases it may need to be combined with Water Management or Capture and Treat strategies. This category may also include *in situ* stabilization wherein soil or waste is modified in place using physical (e.g., freezing) or chemical methods with the goal of reducing solubility/leaching of contaminants.

Source Removal involves activities such as soil/debris excavation, storm sewer sediment cleanout, building demolition, and elemental mercury trapping/removal from plumbing and equipment. Targeting removal actions within known or suspected flow paths of water is critical to assure success in reducing concentrations in the receiving stream. Flow paths may vary temporally as well as spatially and thus sources may not always be within a flow path. It is also important to recognize that a given percent reduction in source inventory of mercury (mass) does not usually translate into a similar percent reduction in water-borne mercury concentrations (i.e., achieving a 95% reduction of mercury in soils does not guarantee a 95% reduction in water-borne mercury concentrations or loading). As seen in the strategy figure, source removal encompasses D&D of the four large process building complexes, as well as remediation of the associated soils. Some ongoing source removal includes removal from storm sewer systems using traps and ongoing removal during building surveillance and maintenance (S&M) activities. Sediments will be addressed in out-years.

Technology Development is an overarching strategy supporting effective implementation of the four strategies above. Technologies exist for mercury-contaminated media treatment that can be considered “off-the-shelf,” including retorting, amalgamation, and excavation with relocation to appropriate landfills (if treatment standard limits are met). The proven technologies of retorting and amalgamation have high-energy demand, and are not cost effective or practical for the potentially large volumes of waste anticipated during source removal. Several commercial vendors have proven technologies for treating high concentration, mercury-contaminated soils. Likewise, macroencapsulation of debris is acceptable as a treatment step. Exploratory treatment is necessary to establish remedial effectiveness, expected costs, and regulatory agreement. As indicated previously, studies examining treatment for soils have been initiated (UCOR 2012b).

Mercury presents unique challenges in both characterization and treatment but offers opportunities for innovation, which take advantage of its chemistry. Since elemental mercury has a significant vapor pressure at room temperature it can often be located by air sampling, including in the subsurface (soil gas), affording real-time delineation of this form of mercury in soil and building spaces.

Ongoing studies looking at fish-mercury relationships in the EFPC system are aimed at supplying information to better understand methylation and bioaccumulation processes, and further examine mercury source contributions in the ecosystem to quantitatively refine the site conceptual model and help direct remediation more accurately. These and other technology development initiatives (see Section 3.5 for a full discussion of technology development initiatives) are ongoing or planned, and may be applied to mercury remediation at Y-12. Additionally, several proposed studies, some in the technology development arena, are presented in the strategy (Se6ction 3.4.2.2) that may lead to significant future actions aimed at mercury flux and fish/surface water mercury concentration reductions. These offer opportunities to reduce cost and increase effectiveness of remediation.

3.2 STRATEGIC ROADMAP

Strategic management of remediation projects/activities involving mercury-contaminated media – soil and sediments, subsurface structures, water, and buildings – is essential to OREM reaching an acceptable endstate at the site in an orderly, integrated, timely, compliant, and cost-effective manner. The strategy considers all the support aspects/activities of physical cleanup, including:

- Regulatory approach/submittals and defined endstates
- DOE-required project scope/funding request submittals and approvals

- Technology development evaluations in support of cleanup efforts
- Project prioritization and sequencing
- Scope and method of accomplishment
- Schedule and cost
- Mitigation strategies to address risks and issues
- Implementation strategies for identified opportunities
- Monitoring of remediation effectiveness

Figure 10 is a high-level overall schedule communicating the strategic roadmap for mercury remediation at Y-12. On the left of the strategic schedule, activities are grouped by the five generic strategies: four (water management, capture and treatment, source isolation, and source removal) that physically control mercury releases both on- and off-site through implementation of organized projects and the fifth – technology development – which includes activities and studies that support the other four physical strategies. Support activities (e.g., regulatory documentation and DOE capital project submittals) are also noted. This schedule is referred to throughout the subsequent sections.

Understanding the desired endstates for waste, buildings, soils/sediments, and water is a primary data point needed to fully address building demolition and media remediation. To that end, endstates are discussed in Section 3.3, followed by strategy implementation in Section 3.4; technology development in Section 3.5; regulatory strategy is presented in Section 3.6; and risks/opportunities follow in Section 3.7.

3.3 ENDSTATES

Successfully completing the mercury cleanup at Y-12 relies heavily on achieving tri-party approved, affordable, and environmentally protective endstate criteria for soil and sediment as determined by land use expectations, and endstates (e.g., acceptable disposition) for remediation and building demolition waste. Building/debris waste "endstates" are described in the AM; soil, sediment, and surface water interim remediation goals/states are defined in the Phase I and II IRODs. Land use expectations do not determine groundwater and surface water resource classifications and, therefore, final goals. Final decisions for groundwater and surface water, which could potentially include reclassification of surface water or groundwater resources, have yet to be determined (TBD) and will be addressed in future RODs.

3.3.1 Media Interim and Final Endstates

Table 4 summarizes interim and final endstates for groundwater, surface water, soils, sediments, buildings, and waste contaminated with mercury – for the Y-12 site (WEMA) and Upper and Lower EFPC. Subsurface soils containing mercury that will remain in place (following interim actions) per agreements in the Phase I and II IRODs may be addressed by future groundwater and surface water RODs, and so are noted by "TBD" in the final endstate column of Table 4 (note, TBD applies if *in situ* treatment is applied), as are the groundwater and surface water final endstates. Future determinations for water quality criteria may be made based on meeting the criterion of 0.3 mg methylmercury/kg in fish tissue.

Of particular note is the interim goal of 200 ppt mercury in UEFPC surface water. As discussed in the tri-party workshop of August 13, 2013, the AWQC of 51 ppt mercury is the applicable ARAR (whereas the 200 ppt is a waiver to that goal, presented in the Phase I ROD) and as such is the ultimate in-stream goal, but it is recognized by all parties that achieving that goal will take time, and a phased approach that implements several varied actions will be required.

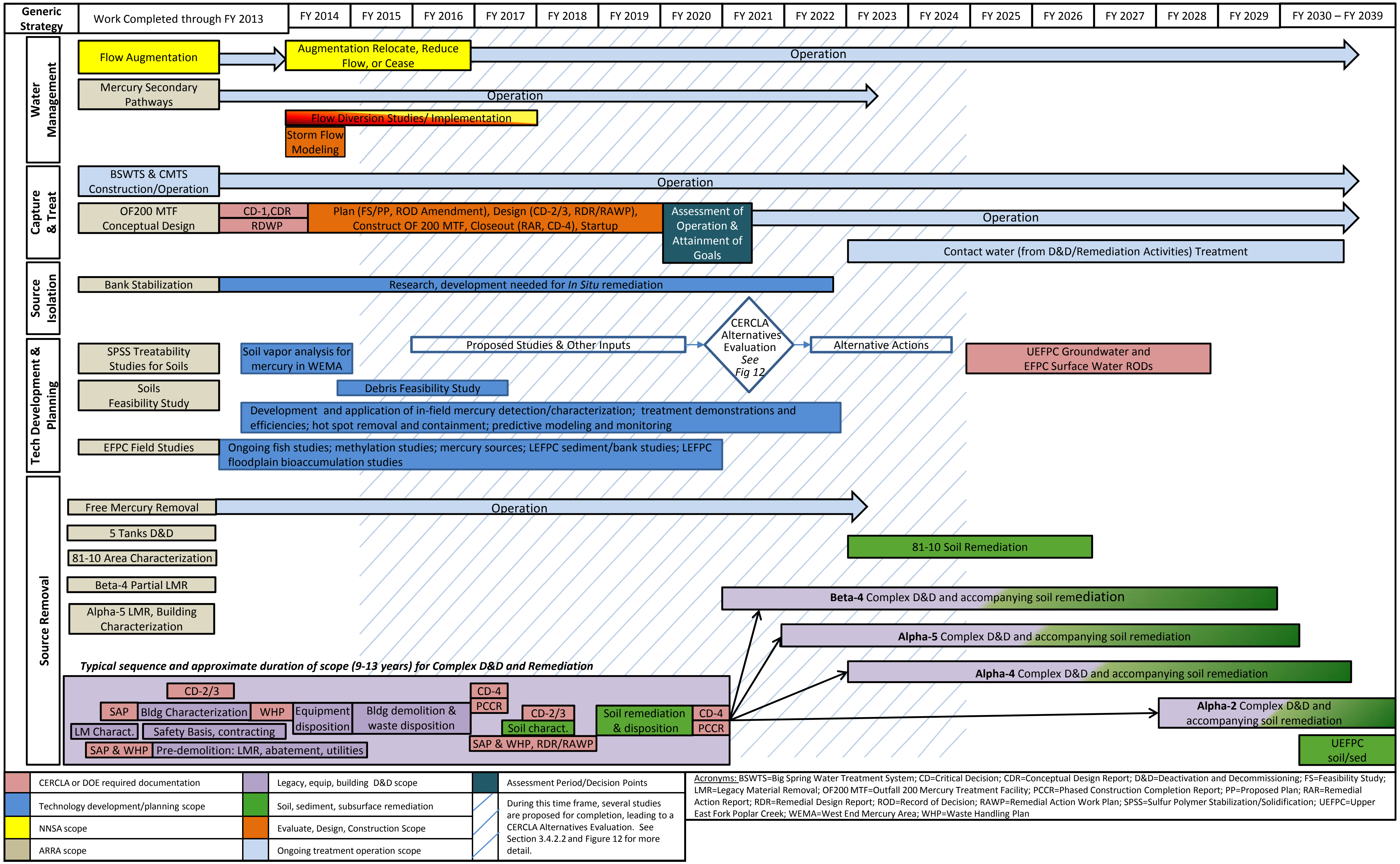


Figure 10. Strategic Schedule for Mercury Cleanup at Y-12

Table 4. Media and Waste Interim and Endstates for Mercury Remediation

Media	Interim state/Goal	Final Endstate/Goal	Decision Document(s)
UEFPC groundwater (except Outfall 51)	• Treatment by CMTS (ongoing) • Land Use Controls (LUCs) (ongoing) • Monitoring near deep soil excavation for minimum of five years	• TBD	• Phase I IROD • Phase II IROD • Future final UEFPC groundwater ROD
UEFPC groundwater discharge at Outfall 51 and Alpha-2 sumps (treated by BSWTS)	• 200 ppt mercury (ongoing)	• TBD	• Phase I IROD • Future final UEFPC groundwater ROD
UEFPC surface water	• LUCs (ongoing) • 200 ppt mercury as measured at Station 17 (not yet achieved) • Monitoring (at Station 17, midpoint of UEFPC channel, at storm sewer system outfalls, at treatment system effluents) • Monitoring to assess reduction of mercury in fish and effectiveness of actions (ongoing)	• 51 ppt mercury • TBD, to be based on fish tissue 0.3 mg/kg mercury	• Phase I IROD • Future final EFPC surface water ROD
LEFPC groundwater	• Does not present risk	• NA	• LEFPC ROD
LEFPC surface water	• LUCs • Monitoring	• 51 ppt mercury • TBD, to be based on fish tissue 0.3 mg/kg mercury	• LEFPC ROD • Future final EFPC surface water ROD
Fish	• Controls per 1983 TDEC advisory signs (ongoing)	• 0.3 mg/kg mercury in tissue	
LEFPC soil (floodplain)	• NA	• Remove soils exceeding 400 ppm mercury	• LEFPC ROD
LEFPC sediment	• Does not present risk	• NA	• LEFPC ROD
UEFPC soil	• LUCs (ongoing) • Remove soil to 2 ft in EUs 2-14 and to 10 ft in EUs 1a and 1b that exceed mercury remediation levels (model derived)	• TBD	• Phase II IROD • Future final EFPC surface water ROD
UEFPC soil affecting groundwater and surface water	• LUCs (ongoing) • Remove to water table or bedrock to protect against unacceptable releases to groundwater or surface water (as determined by model)	• TBD	• Phase II IROD • Future final EFPC surface water ROD
UEFPC sediment	• Remove streambed sediments to bedrock, 1-6 ft; remove soil from banks	• TBD	• Phase I IROD • Future final EFPC surface water ROD
UEFPC Lake Reality sediment remaining	• Remove lake bed sediment to 1 ft depth	• TBD	• Phase I IROD • Future final EFPC surface water ROD
WEMA soils	• Originally addressed in Phase I IROD through WEMA capping; default to Phase II IROD through statements in Phase II IROD saying all “soils that are inaccessible and become accessible” are included in Phase II IROD	• TBD	• Phase I IROD • Phase II IROD • Future final EFPC surface water ROD
WEMA storm sewer sediment	• Flush sediment from piping/reline sewers (completed) • Treat sediment if necessary to meet LDRs (completed) • Meet waste acceptance criteria (WAC) of disposal site and dispose of sediment (completed)	• TBD	• Phase I IROD
Removed soil/sediment waste (all sources)	• NA	• Treat if necessary to meet LDRs • Meet WAC of disposal site and dispose	• Phase I IROD • Phase II IROD
Buildings	• NA	• Demolish to on-grade slab	• AMs and RmAWP for building demolition
Building slabs	• To be defined in building D&D design and documented in future addenda to the building RmAWP	• TBD	• Future addenda to building RmAWP
Demolition/remediation contact water	• NA	• Treatment by OF 200 MTF, CMTS, and/or other systems	• Future addenda to building RmAWP
Debris waste (building/equipment/ legacy waste)	• NA	• Treat if necessary to meet LDRs • Meet WAC of disposal site & dispose	• AMs and RmAWP for building demolition or other decision documents for equipment and/or legacy • WHPs

NA = not applicable.

3.3.2 Remediation Waste Endstates

Endstates for waste debris and soil resulting from demolition and remediation are discussed in terms of the waste's disposition: on-site, off-site, and treatment, if needed.

3.3.2.1 On-Site Disposal

As the most cost effective measure available, this strategy assumes the majority of the low-level waste (LLW) and mixed (LLW and hazardous) waste resulting from future demolition and remediation activities will be dispositioned at the on-site CERCLA facility, the Environmental Management Waste Management Facility (EMWMF) located in Bear Creek Valley (BCV), as specified in the RODs and AM, provided EMWMF WAC are met. The EMWMF is projected to reach capacity in FY 2023, after which time a future replacement CERCLA facility is assumed to be available, currently also proposed to be located in BCV. Its availability is scheduled to overlap the closure of EMWMF, and thus consistently provide an approved, on-site disposal location. This planned, future on-site disposal facility is currently being proposed through the CERCLA process, and is fully planned in CERCLA documentation and addressed in subsequent milestones (DOE 2012a). It has been included in the OREM baseline as three projects, and is included in Chapter 4 of this document. For purposes of this strategy, the on-site CERCLA disposal facilities – current and future – are referred to only as the EMWMF.

Non-hazardous, non-radioactive waste generated during future demolition and remediation activities will be disposed of at ORR Industrial Landfills (ORR Landfills), which are assumed to have sufficient capacity throughout the Y-12 cleanup efforts. ORR Landfills are the preferred disposal alternative for mercury-contaminated wastes (debris and soil) that have been treated to meet LDRs, are not LLW or RCRA hazardous, and meet the ORR Landfills WAC.

All mercury-contaminated waste planned for disposal in the CERCLA disposal facilities in BCV will comply with ARARs specified in decision documents for those facilities. In general, those ARARs approach protection of human health and the environment from multiple perspectives:

- Design of the landfill (e.g., liner and caps), along with assessment of the design (including defining WAC) and all appropriate approvals of that design to achieve protectiveness assurance.
- Treatment of the waste to assure containment within the landfill, most notably the LDRs.
- Protection of human health and the environment through release restrictions, e.g., managed through treatment of leachate as necessary to meet discharge limits.
- Containment assurances through proper closure, as well as post-closure maintenance.
- Institutional controls and monitoring during operation, closure and post-closure. These processes help assure the containment of the waste, and interception of exposure pathways. Ongoing monitoring (e.g., groundwater monitoring) to indicate any unexpected deviations early-on provides assurance that issues that may develop are dealt with in a timely manner.

3.3.2.2 Off-Site Disposal

Off-site disposal is available for mercury-contaminated LLW (mixed waste) provided the waste has been treated to meet LDRs and meets facility WAC, per the CERCLA bias against off-site land disposal of untreated waste [300 CFR 430(f)(ii)(E)] and requirements under the off-site rule (300 CFR 440). For example, the Nevada National Security Site can accept treated mixed waste that meet the WAC, and commercial facilities can provide the treatment as well as, in some cases, disposal for mixed wastes. However, the future volumes of debris and soils projected to be generated at Y-12 may be impractical to send off-site from a cost perspective. Therefore, it is of value to investigate providing treatment on-site for mercury-contaminated waste, to avoid the transportation to and from commercial off-site treatment facilities. Unless on-site facilities for treatment are provided and approved, commercial facilities are the only treatment option available.

3.3.2.3 Land Disposal Restrictions

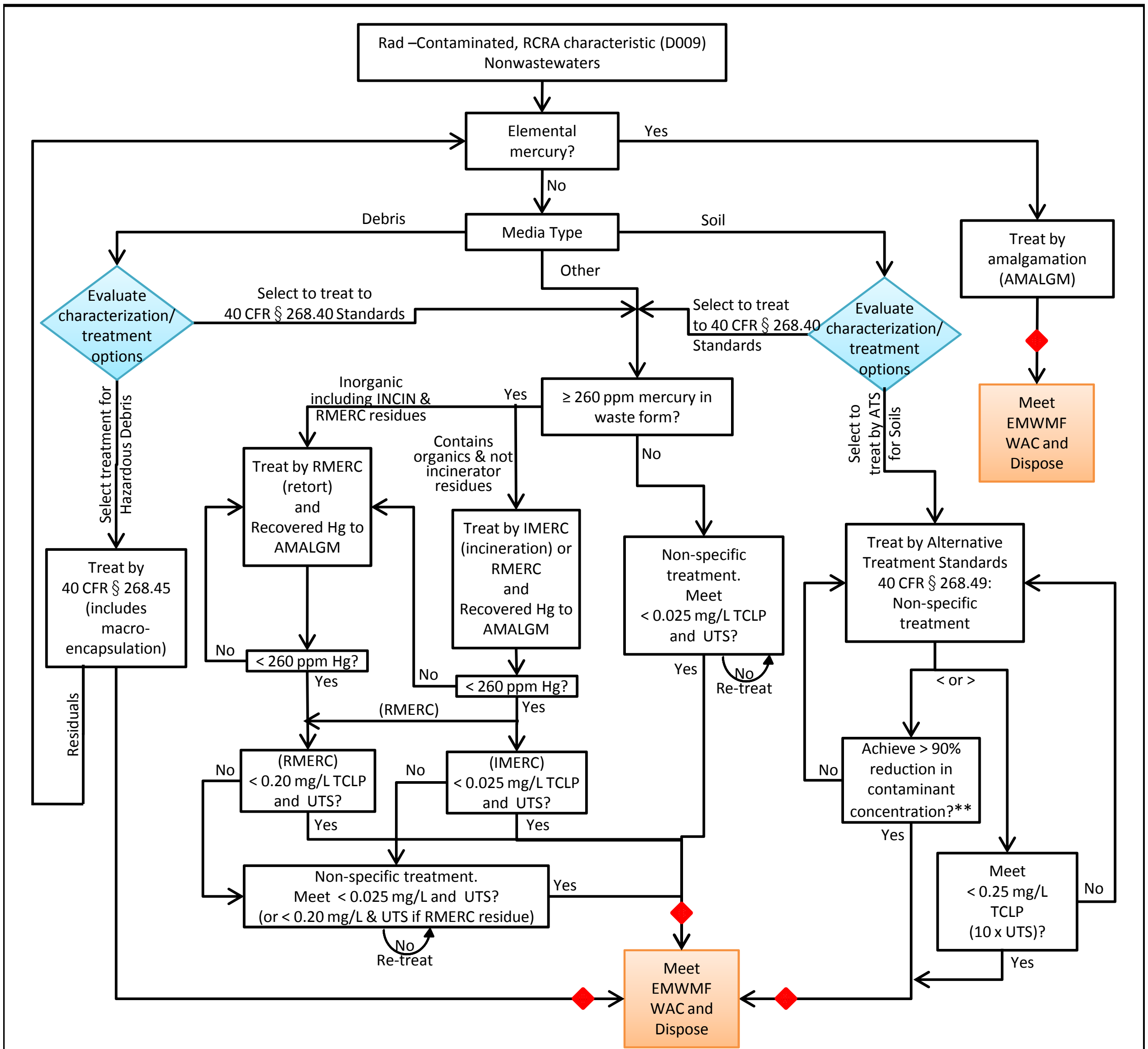
Meeting LDRs for disposal of mercury-contaminated media poses a significant challenge when considering the large volumes, and thus high projected costs.

The on-site disposition path (EMWMF) is subject to ARARs (e.g., LDRs) summarized in the appropriate decision documents. Meeting LDRs will be accomplished by applying appropriate treatment technologies as presented in the regulations (40 CFR § 268). A logic diagram summarizing the treatment options and standards that must be met, per LDRs, for wastes containing mercury is given in Figure 11. This diagram assumes that the waste is also LLW and is thus ultimately disposed at EMWMF (ORR Landfills may be substituted for EMWMF if waste meets ORR Landfill WAC). Additionally, it is assumed that, if present, other, underlying hazardous constituents present at concentrations above their respective UTS limits are treated to meet LDRs as needed, prior to entering this flowchart, or are managed along with the mercury (e.g., lead and other characteristically hazardous metals would be stabilized along with mercury in macroencapsulation).

To the extent that waste characteristics are known at this time, several technologies to treat the wastes and meet LDRs for mercury exist; however, difficulties and uncertainties may emerge because of the large volumes of waste that could possibly require treatment, resulting in higher costs, and possible unknowns that have yet to be uncovered. The logic diagram includes "blue" decision diamonds, where, for debris and soil, decisions must be made as to what treatment will be used and which standards met. For debris and soil, alternative treatments offer more flexibility and potential cost savings than the traditional treatments, retort (e.g., thermal treatment to vaporize mercury) and incineration.

Decisions regarding what treatment to use, whether to perform treatment on-site (requires construction of facilities, consideration of executing time frames, regulatory framework required) or off-site (vendor location, requires transportation considerations), and where to dispose of the waste must be made. Decisions will require supporting evidence for their selection – treatability studies showing appropriate treatment standards have been met, possible pilot demonstrations, and evaluations particularly of the costs involved for the various options. The completed soils treatability study addresses this type of information for mercury treatment of soil and underlying hazardous constituents (UCOR 2012b); a summary of the study is given in Section 3.4.4.1. A similar study, as previously mentioned, is desirable for debris. The current, assumed disposition path for mercury-contaminated, LLW debris is macroencapsulation (per 40 CFR 248.45) and disposal in EMWMF. As characterization data become available, refinements to these studies may be made to serve as useful tools in planning building demolition and remediation.

WHPs will address the selected treatment path and ability to meet treatment standards, and are required if waste is dispositioned on-site at EMWMF as noted by the red diamonds in the figure. Regulatory interaction and acceptability at EMWMF are provided through their review and approval of the WHPs. Once a decision is made regarding treatment paths for debris and soil, and fully evolved through demonstrations/scale-up etc., selected treatment paths must be integrated into the disposal facilities' future plans. These activities have not been completed yet, and until they are, the only option available once a mercury-contaminated waste has been generated is off-site commercial treatment. To be considered cost-effective, on-site treatment for mixed waste soil, sediment, and debris is likely to be dependent upon generating a moderate to large quantity of mixed waste at a sustained level over an extended period of time (five or more years); provisions for on-site treatment of *intermittent and/or low quantities* of mixed waste soil and sediment may not be cost-effective.



Acronyms

AMALGM=Amalgamation
ATS=Alternative Treatment Standards
EMWMF=Environmental Management Waste Management Facility
IMERC=Incineration

LDR=Land Disposal Restrictions
ppm=parts per million
RCRA=Resource Conservation and Recovery Act
RMERC=Retort

TCLP=Toxicity Characteristic Leaching Procedure
UTS=Universal Treatment Standards (in 40 CFR§268.48)
WAC=Waste Acceptance Criteria

◆ = Regulatory approval via Waste Handling Plan required to dispose of waste forms at EMWMF.

** See *Guidance on Demonstrating Compliance with the Land Disposal Restrictions (LDR) Alternative Soil Treatment Standards*, EPA530-R-02-003, July 2002.

Figure 11. LDR Logic Diagram for Treatment of Radioactive Waste Contaminated with Mercury

Making decisions will require consideration of the data along with appropriate studies to weigh and determine the best value to the government and tax payers, and propose the most suitable endstate that will meet regulatory requirements and disposal facility WAC. This whole process – characterization, treatability studies/demonstrations, engineering/alternative studies, and regulatory involvement in the decision process – to ultimately determine the endstates for the waste streams (debris and soils) will require coordination and interfacing of many parties. Documentation of these key steps and FFA tri-party concurrence are part of the regulatory process, which is described in Section 3.6.

Such studies/efforts have been initiated under a near-term project looking at treatment of soils, discussed in Section 3.4.1, and documented in *Treatment Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge* (UCOR 2012b). Long-term storage or hold-up of these waste streams has not been considered an option throughout this planning process; therefore, strategies for managing the waste should be in place prior to executing the mercury-use building demolitions, which will begin the generation of these waste streams. While waste endstates were briefly described in Table 4, more detail on those endstates, possible issues, and strategy approaches are given in Table 5.

3.4 STRATEGY IMPLEMENTATION

3.4.1 Near-Term Control of Mercury Releases in WEMA

Several projects to control mercury releases in WEMA were recently completed. These projects were funded with remaining ARRA funds in late 2012 and early 2013, and are listed in the strategy Figure 10 under the FY 2012 column and described further in Table 6. Regulatory documentation and the generic strategy category are noted in the table for each activity. These projects were recently completed with the exception of the OF 200 MTF, which included only development of the conceptual design of the facility and some sampling/analysis at the Outfall. Full design, construction, startup, and operation are addressed as a project to begin execution in FY 2015 as discussed in the next section. A second project introduced in Table 6, the Mercury-Contaminated Soils Treatability Study, is also expanded on here (See Section 3.4.4.1).

Table 5. Endstates for Mercury-Contaminated Waste

Waste	Current Defined Endstate	Endstate Achievable?	Strategy*
Building D&D Waste			
LM and Waste	Mercury-contaminated LM has been treated and disposed of off-site through commercial facilities.	Endstate disposal in approved off-site waste disposal facilities has been demonstrated.	Continue with removal and disposal as demonstrated. LM remains in Alpha-2, Alpha-4, and portions of Beta-4. As funding is available, some LM removal may be completed prior to pre-demolition scope.
Process Equipment and Piping	Requires venting, purging, draining (VPD) and/or recovery of source material. Source material managed as per LM above, or as elemental mercury per below. Equipment remaining as mercury-contaminated may be managed as per debris below.	Large-scale equipment demolition/disposal has not yet been demonstrated for mercury-use facilities, but has been demonstrated for other facilities on the Reservation. VPD of mercury-use equipment has been performed successfully in past.	VPD and decontamination of equipment and piping as needed to meet on-site disposal facility WAC. As possible, complete equipment removal and disposition activities for all facilities consecutively to reduce costs.
Deactivation Waste (e.g., asbestos-containing material, universal waste, beryllium waste)	If deactivation wastes meet EPA 40 CFR 268 definition of debris, may be managed per debris entry below. If not, must be treated off-site.	See debris below or LM above.	Continue with removal and disposal as demonstrated. As possible, consider completing pre-demolition waste removal and disposition activities for all facilities consecutively to reduce costs. See debris strategy below.
Debris and Rubble	Debris must meet LDRs for disposal at EMWMF. See logic diagram (Figure 11). Current baseline plan is to macroencapsulate mercury-contaminated debris at EMWMF.	Current defined endstate is macroencapsulation and disposal at EMWMF. Needs regulatory approval. Needs coordination with EMWMF.	Need to define volumes better and demonstrate production quantities achievable at EMWMF. May require demonstration/documentation to show macroencapsulation/ stabilization meets performance standards. Forecast of waste volumes destined for EMWMF needs to be clarified for planning purposes (e.g., macro-encapsulation of debris at EMWMF requires preplanning regarding placement in cell). May be desirable to develop a debris feasibility study.
Liquid (Elemental Mercury)	Treated to produce solid stable form (e.g., amalgamation or stabilization with sulfur polymer solidification/stabilization [SPSS]). Elemental Hg is sent to commercial facilities for treatment by amalgamation and off-site disposal.	Amalgamation is proven technology, but requires off-site treatment and disposal. Stabilization using SPSS technology achieved and variance granted to Brookhaven National Lab (EPA 1998) for use on elemental mercury.	Off-site amalgamation is proven and acceptable. Elemental mercury volumes are not expected to be large enough to make on-site treatment and disposal economically necessary or feasible.
Building Slab (Interim endstate following building demolition and prior to remediation)			
Building Slab Interim State	The state that building slab is left in, the interim state between building demolition being completed and subsequent soils/subsurface structure remediation, must be defined. Questions to address: Fill the basement/wind tunnels with clean fill dirt? Cover the slab? Control storm water infiltration into the wind tunnels? When to characterize remaining soil and subsurface structure?	There are no technology issues with achieving an endstate for the slab; however, the selected endstate may create additional waste depending on the approach. Are slabs to be used as laydown areas for subsequent work? Approach needs to be integrated with demolition and with subsequent soil/subsurface remediation.	The building slab intermediate state determination is a difficult question, and needs to be defined early in the process since the decision will affect so many aspects of both demolition and remediation, and can have a significant consequence to future work scope. The building sumps should be maintained and ability to treat in-leakage/groundwater in wind tunnels continued by appropriate treatment facilities. State of the slab should be defined in demolition "design", and documented in appropriate CERCLA documentation. Thought should be given and documented as to how to proceed with subsurface/surrounding soil characterization and remediation.
Soils, Sediments, Subsurface Structures			
Excavated Soil and Sediment Waste	Soil must meet LDRs for disposal at EMWMF. See logic diagram (Figure 11). Current baseline assumption is to treat an assumed portion of soil by low temperature thermal desorption. Needs further exploration as this is a very costly alternative.	Treatment per LDRs for soils is achievable; however, quantities of soil and sediment that require treatment may be excessive and expensive. Typical treatment is retort. Microencapsulation via SPSS has been demonstrated. Other stabilization treatment options exist as well.	Explore options (characterization to allow segregation) to minimize quantities requiring treatment. SPSS has been successfully demonstrated with Y-12 soils. Soils Feasibility Study explores options for on-site versus off-site treatment and disposition.
Excavated Subsurface Structure Waste	Same as building debris above.	See debris above.	See debris above.
In-situ Treated Soils and Sediments	*In situ* stabilization to prevent migration of mercury and other contaminants in surface or groundwater. Not currently defined as an endstate for any areas. Needs to be explored. May be very cost effective. If *in situ* treatment is used, performance monitoring/endstates must be defined.	Needs to be demonstrated in small and large-scale within the Y-12 site, preferably where performance can be effectively monitored and any unintended consequences mitigated, e.g., Alpha-2 basement or 81-10 Area. Approach and endstates would require regulatory approval.	Identify best available treatment technology through Technology Development component of strategy and conduct demonstration/pilot at Alpha-2 (See previous technology assessment for this area, BJC 1999b) or elsewhere. This technology has been successful in other locations, for other contaminants. Does present the possibility of significant cost savings.

*Regulatory concurrence is required at the various stages of these activities from characterization through assessment, decision, design, implementation, and final closeout, and is documented and submitted in appropriate plans and reports.

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Table 6. Near-Term Activities to Reduce Mercury Releases

Activity	Generic Strategy	Regulatory/DOE Submittal(s)
Outfall 200 Mercury Treatment Facility. Under ARRA funding, the conceptual design for a water treatment system to reduce mercury concentration in UEFPC has been developed. Outfall 200 is the integration point of many surface water and groundwater sources with a total base flow of approximately 1,500 gpm that can vary substantially based on weather conditions. The conceptual design included an alternatives analysis that explored various treatment options and configurations. Options were examined and compared based on criteria (such as complexity, secondary waste generation, technology readiness level, reliability, and cost). The effluent from the plant will be introduced back into UEFPC ~1,200 ft downstream. DOE-required documentation is being developed to support the capital project to construct and startup the facility. The RDWP was submitted to regulators, as was the CDR, in mid-FY 2013. Other CERCLA documents will be prepared for approval, as noted here.	Capture and Treat and Water Management	- CDR and RDWP (CH2MHill 2013, DOE 2013a)* - DOE CD-1 (4/2013) - Focused FS/ Proposed Plan (9/30/13)* - Amendment to UEFPC Phase I IROD (9/30/15)* - DOE CD-2/3 - Remedial Design Report (9/30/16)* - RAWP (9/30/17)*
Free Mercury Removal. This project removes free mercury from accessible areas of major storm drains at the site by having installed nine mercury traps at locations upstream from outfalls to UEFPC. These mercury traps, installed in manholes throughout the WEMA area, remove mercury through settling and separating mercury, which deposits in traps as the flow moves through the sewer system. A total of approximately 26 lbs of elemental mercury was recovered from major storm drain areas during 2012. Mercury will continue to be collected/removed from traps.	Source Removal	- Removal Action Report (DOE 2013b)
Mercury Secondary Pathways. The purpose of the Secondary Pathways project is to identify and correct potential water infiltration and mercury migration points at the three large former mercury-contaminated process buildings (Alpha-4, Alpha-5, and Beta-4). Secondary water infiltration around the three facilities was mitigated by modifying drains, drainage systems, and installing graded surfaces to ensure surface water runoff is appropriately routed to storm drains thereby reducing water percolation through mercury-contaminated soil. Resulting waste soils were packaged and will be shipped for treatment and/or disposal.	Water Management	- Phased Construction Completion Report (PCCR) (DOE 2013c)
Mercury-Contaminated Soils Treatability Study. This subproject evaluated technologies and capabilities to stabilize mercury-contaminated soil to meet LDRs. Three vendors received excavated mercury-contaminated soils from Y-12 and successfully completed demonstrations for treating the materials using sulfur polymerization solidification/ stabilization. All three treatability studies were successful in meeting the 40 CFR, Part 268.49 "Alternative Treatment Standard for Contaminated Soils" by achieving the required TCLP concentration of <0.2 mg/L for mercury. One additional technology, which did not receive a soil sample for demonstration, was recommended for further evaluation.	Technology Development	- Treatability Study Report (UCOR 2012b)
Disposal of Five Excess Tanks. The project has dispositioned five excess tanks from the Y-12 site. Characterization was completed; two tanks were disposed at the ORR Landfills, and three have been sent to an off-site vendor for disposal. About 650 pounds of elemental mercury were removed and disposed from these tanks.	Source Removal	- PCCR Addendum (DOE 2013d)
81-10 Characterization. Characterization of a limited area (known as the 81-10 Area) within EU 9 was completed. An area was designated for future excavation due to mercury contamination.	Source Removal	- Remedial Design Report (DOE 2012c)*

***Will require regulatory approval. Other CERCLA documentation given has already received approvals.**

3.4.2 Control of Mercury Releases to EFPC

The most pressing issue regarding mercury remediation centers around the pathway mercury travels to human receptors, that is, through fish consumption. Mercury, in its most toxic form, methylmercury, bioaccumulates in fish and in turn may be ingested by humans. It is unclear exactly what mercury form(s) contributes to methylmercury in EFPC – whether it is dissolved (filter-passing) mercury in water, various mercury forms attached to particles suspended in water, forms of mercury in the sediment matrix, or all of the above. Many environment/water-specific attributes, both chemical and biological, also play a role in methylmercury production: pH, suspended solids, dissolved organic matter, flow rate, anionic content, sediment-related biological attributes/interactions, etc. Once produced, methylmercury is taken up by organisms low on food chains (e.g., bacteria, algae, benthic invertebrates) and then magnified at each step in the food chain leading to fish and other higher organisms. Direct uptake of either inorganic mercury or methylmercury by fish is much less important than uptake via food. It is obvious that there is no silver bullet to reduce fish mercury concentrations for every water body, and likely no silver bullet for a single water body. With that in mind, an adaptive management approach is proposed, and remediation of EFPC begins with targeting a lower mercury concentration in UEFPC (to be initiated through construction of the OF 200 MTF) and continuing through research into mercury-environment interactions, followed by subsequent actions as needed and elucidated through these studies.

3.4.2.1 Outfall 200 Mercury Treatment Facility

A near-term ARRA-funded project provided the conceptual design of the OF 200 MTF, and recent tri-party discussions have endorsed a conceptual design based on a flowrate criteria of 3,000 gpm. This flowrate accommodates baseflow (currently approximately 1,500 gpm) with additional capacity to treat storm water flows. Reduction of mercury concentration in the effluent will be achieved by this facility, and in-stream goals will be documented as ARARs in a planned amendment to the Phase I IROD, which will also address RAOs for the treatment action. The in-stream ARAR goal of obtaining the recreational AWQC of 51 ppt mercury may have to be attained through a series of steps in the phased approach as discussed below, including actions aimed at reducing mercury concentrations in fish as well as in water.

Design

Conceptual design of the OF 200 MTF included an alternatives analysis to explore various treatment options for removal of mercury from water (e.g., reverse osmosis, chemical precipitation, granular activated carbon [GAC], ion exchange, and various combinations thereof). Grit removal and chemical precipitation/flocculation followed by filtration was selected on the basis of implementability, cost, and performance. In terms of performance, bench-scale testing using the selected process has demonstrated the ability to attain 51 ppt mercury in the effluent, but this efficiency has not been proven at full-scale. Based on modeling using historical data from a year with greater than normal rainfall (2003), it is estimated that the treatment system might remove 65% of the total mercury flux, and treat 69% of an average annual flow through Outfall 200.

In addition, the effluent discharge from the facility is currently designed (and will be confirmed in final design) to be reintroduced to UEFPC approximately 1,200 - 1,500 ft downstream of the outfall, thus bypassing a good portion of the creek bed that contains mercury-contaminated sediment that might otherwise be resuspended by the plant discharge.

Phased Approach

Baseflow collected within WEMA includes many sources such as process flows, cooling water, runoff, etc. A study is planned to evaluate the inputs and implement changes where possible to reduce this flowrate through means of diversion, recycle, or other appropriate methods (see Figure 10, Flow Diversion Studies). A reduction in base flow will allow for a greater storm treatment capacity, as well as provide more capacity for management of contact water generated during future demolition and remediation work.

Treating WEMA base flow and storm water is a challenging prospect due to the wide variation in flows (up to 40,000 gpm during heavy rainfall) and extremely low mercury concentration target. Predicting operation of a full-scale system is difficult, so it is recognized that, while bench-scale studies have proven the principle of mercury reduction to 51 ppt using chemical precipitation, achieving it in the full-scale system under the current design may prove more difficult. In the phased approach, system performance will be monitored for at least one year in order to ensure that a sufficient data set is collected to support future decisions. The need for an additional polishing step which could include GAC, membrane or other filters will be evaluated, including any necessary pilot studies that would be conducted at the operating facility. The need for an additional polishing step accompanied by treatability studies will be evaluated along with other potential remedial/mitigative actions (as discussed in the next section) to support a tri-party decision regarding a path forward. DOE's current cleanup baseline (in terms of proposed projects with estimated costs) accounts only for treatment facility construction and operation. Should additional actions need to be implemented per tri-party agreement following the evaluation, source demolition and/or remediation delays due to limited budgets may result.

The CD-1 submittal will document the Conceptual Design Report (CDR) per DOE requirements, and an enforceable FFA milestone for submittal of the CDR and Remedial Design Work Plan (RDWP) has been completed (CH2MHill 2013, DOE 2013a). The OF 200 MTF action will be addressed in CERCLA documents requiring regulatory approvals: Focused Feasibility Study/Proposed Plan, amendment to the UEFPC Phase I IROD, Remedial Design Report, and RAWP, and are scheduled as FFA Appendix E and J milestones (see Table 6).

Full system design is expected to proceed following the conceptual design, and result in a CD-2/3 submittal to fulfill DOE requirements and obtain construction start approval in accordance with DOE O 413.3B. The remainder of this scope, construction of the treatment system, will be executed as a capital project in accordance with DOE O 413.3B, ending with submittal and approval of CD-4. A final PCCR will document completion of the system construction under CERCLA.

3.4.2.2 Additional Interim Actions to Control Mercury Releases to EFPC

It is recognized that the final in-stream goal for EFPC is the recreational AWQC of 51 ppt mercury. The adaptive, phased management approach presented in this document will work toward achieving that goal. As discussed above, the OF 200 MTF construction/operation constitutes a major action toward obtaining that goal; however, additional interim actions, including possibly adding polishing operations to the OF 200 MTF, may be necessary to achieve 51 ppt mercury in-stream. Several further investigations are proposed here aimed at reducing mercury concentrations in fish, as opposed to focusing on lowering the water mercury concentrations.

Fish mercury levels are a concern as well in both Upper and Lower EFPC, and field/laboratory studies that may ultimately lead to a greater understanding of fish-mercury relationships, methylation, and mercury source contributions are ongoing (e.g., field studies, FYR Action Plans 1 and 2 – see Attachment A). Several additional studies/evaluations are outlined here that could lead to implementing viable alternatives that will contribute to goals of reducing mercury levels in fish, reducing mercury flux, and/or reducing mercury water concentrations. A tri-party decision point is planned to evaluate results from these studies as well as system performance of the OF2 00 MTF, and reach agreement on any additional actions that might be necessary in attaining these goals. Figure 12 is an illustration of the adaptive, phased approach to completing the OF 200 MTF activities, the ongoing EFPC field studies, the proposed studies, and other relevant actions that will contribute to a final CERCLA Alternatives Evaluation to define future actions. The proposed studies are assigned durations in the figure, and scopes are discussed below.

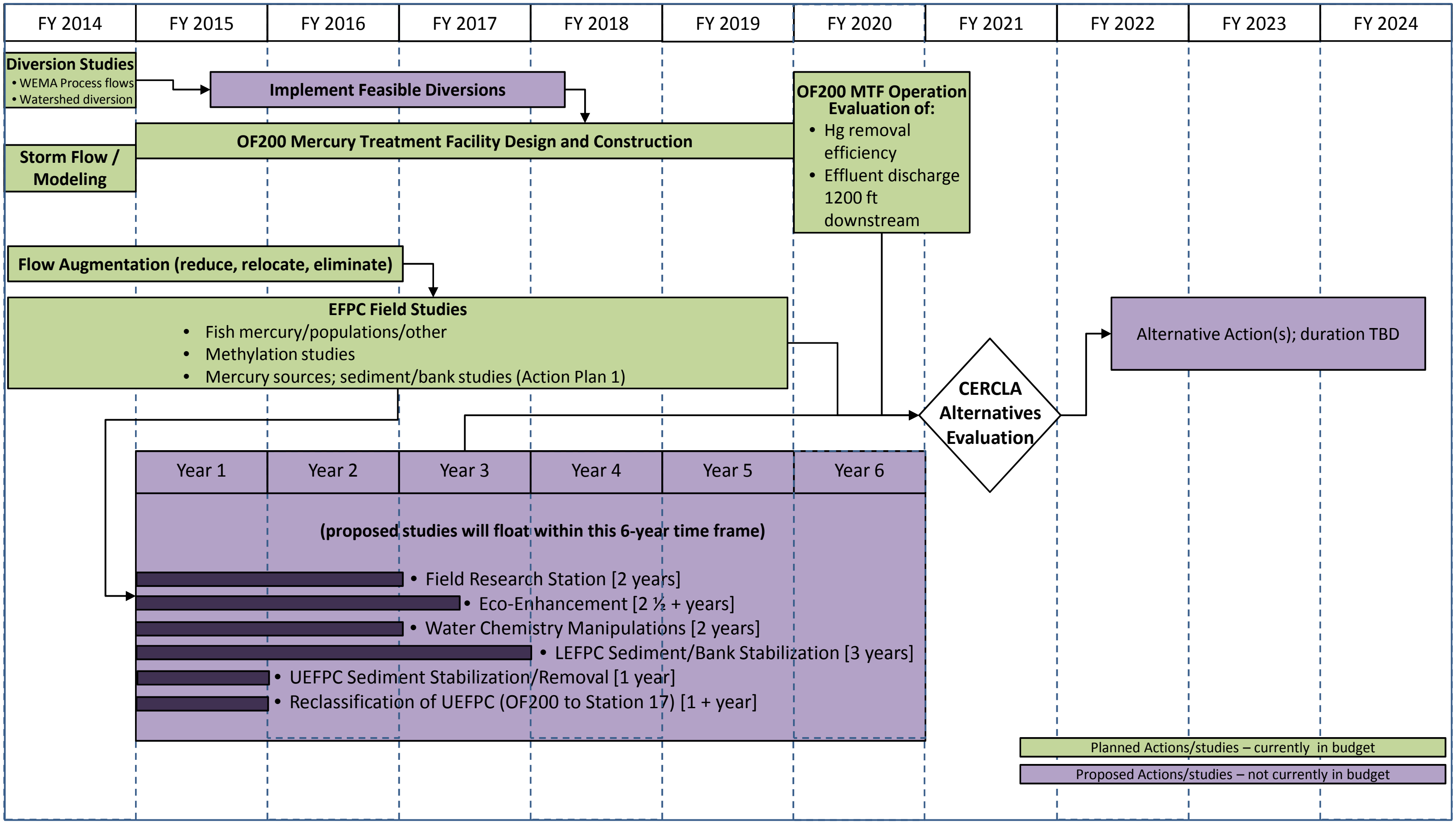

Figure 12. Ongoing Actions and Proposed Studies to Achieve Reductions in Fish and Water Mercury Concentrations and Mercury Flux in EFPC

Field Research Station

A Field Research Station (FRS) is proposed to be located near the Horizon Center site and adjacent to LEFPC. This FRS would consist of a pre-fabricated building that could serve as a near-stream research facility for mercury research. The facility design would allow LEFPC water to be brought into the facility for flow-through rapid testing and/or water chemistry manipulation and study, and provide infrastructure and bench-top sample processing for local ongoing studies (e.g., stream flow gauge monitoring, stream bank pin studies, and local groundwater wells). The FRS would provide a centralized, go-to location for regulator and other stakeholder observation, education, and tours. Multiple DOE programs have an interest in studies conducted in the area, as does the United States Geological Survey. An FRS at LEFPC would afford opportunities to advance research and development, education, and synergism between programs regarding mercury in the environment.

Ecological Management and Enhancement

Ecological management and enhancement approaches, including modifications of fish and plant communities and water quality, have been successfully used to decrease human health risks and enhance natural resources. This approach is particularly attractive in downstream water bodies, where contaminated sediment or soil is difficult or costly to remediate by conventional means. Proposed changes in flow augmentation (resulting in warmer temperatures), coupled with stream enhancements, may provide opportunities to change the EFPC stream fish population to one less susceptible to high mercury uptake. For example, mercury bioaccumulation in three sunfish species in the creek suggests that a 30-50% reduction in fish tissue levels could be realized with a change from a rockbass to a bluegill population. Enhancements ultimately could include fish overstocking, improvements in habitat that support low bioaccumulating fish, or plantings that stabilize stream and/or bank soils. The proposed approach is to first conduct an evaluation of the relevant literature and local data (including a recent stream habitat survey), followed by field tests that will help define the most effective potential enhancement strategy. Information from the ongoing LEFPC Mercury Bioaccumulation Action Plan #2 may be pertinent (see Attachment A). This task will be closely aligned with the FRS (where fish uptake testing could be done), as well as the bank stabilization/planting and water chemistry tasks. A recommended ecological enhancement approach would be developed for the CERCLA Alternatives Evaluation.

Water Chemistry Manipulation

Amendment of EFPC surface water chemistry may provide an opportunity to reduce the bioavailability of mercury/methylmercury, thus reducing those levels in fish tissue and lowering human health risks posed by consumption of fish. A literature search and report is suggested, to be followed by laboratory studies. Some relevant work with tracers in various surface waters has recently been completed by scientists at ORNL, with promising results that suggest differences in water chemistry can affect the behavior of both inorganic and methylmercury in water, which in turn affects the bioavailability and bioaccumulation of mercury. Follow-on work will investigate in more detail the factors controlling differences in mercury behavior in the different streams across the ORR (e.g., nutrient levels, metal concentrations, dissolved organic carbon) to gain a fundamental understanding of mercury dynamics in EFPC. Experiments will manipulate chemistry in water collected from EFPC to examine the effect on mercury and methylmercury behavior in the water column and bioaccumulation in aquatic organisms. In general, only chemicals already present in low concentrations in EFPC and other streams will be investigated.

LEFPC Sediment/Bank Stabilization

Stabilization of sediment and bank soils in EFPC can be achieved through the use of plants, trees, rocks, and/or man-made materials (liners – possibly impregnated with chemicals targeting mercury binding) and by slowing/redirecting flow. South River work in Virginia provides some good examples of methods used to reduce mercury flux. A literature search and report would be developed, followed by field studies employing selected approaches. Ongoing LEFPC bank erosions studies (under the FYR Action Plan #1) will provide input, hopefully pointing to those areas most in need of remediation. Results would be used to provide input to the CERCLA Alternatives Evaluation.

UEFPC Sediment Stabilization/Removal

Opportunities to manipulate flow in UEFPC and affect sediment stability would entail slowing flow (especially during storm events), possibly with baffling or engineered features. Some stabilization of sediments through the use of grout, or other materials (liners) is possible, but should be installed to also promote sediment settling. Utilizing Lake Reality as a storm catchment could be investigated; hydraulic flows, volumes, and detention times could be examined and possible approaches proposed. Some limited, targeted sediment removal might be a feasible action to be proposed through this study, but would require field work to determine the specific areas. This work would be initiated as a paper study with historical events examined and reported on, as well as research on features that might be added to manipulate the flow. Any opportunities identified for further review may require some field testing, which is not accounted for in this assumed duration, prior to being introduced through the Alternatives Evaluation.

Reclassification of UEFPC

Reclassification of UEFPC, from Outfall 200 to Station 17, would involve removing recreational and possibly other use classifications of this stretch of the creek. As a proposed study, research into the flows contributing to the total flow in this reach of the stream, future land usage designations, and ecological habitats would be completed. Effects of reclassification would be analyzed to help inform a decision by the state and EPA regarding reclassification. The advantages of reclassification could be significant. UEFPC flow is comprised of industrial discharges, groundwater discharges, runoff from precipitation, and flow augmentation. During periods with no precipitation runoff, flow augmentation typically is the largest volume source contributing to total flow. Cessation of flow augmentation, as is likely, would greatly affect the existing habitat in this area of the creek, and might further support reclassification. Additionally, operation of the OF 200 MTF, with its effluent currently planned to by-pass approximately 1,200 linear ft portion of the creek, may also have a significant effect. A duration of one year is allotted for the study; however, it is recognized that extensive time may be required in negotiations with regulators to address this action, and actual results of other actions (e.g., discharged effluent from treatment facility) that may influence decisions will not be measurable for some time (FY2020 timeframe). In the interim, a study to summarize and evaluate outcomes is suggested and can contribute to the CERCLA Alternatives Evaluation.

The above proposed studies, as well as the OF 200 MTF evaluation and results of planned and funded activities (e.g., EFPC field studies) will all feed into a CERCLA Alternatives Evaluation as shown in Figure 12. Proposed actions that might result from the Alternatives Evaluation are currently unplanned and unfunded within the Y-12 planning baseline profile; therefore, any additional actions identified have the potential to redirect funding away from planned mercury source demolition and remediation.

3.4.3 Building D&D

At the Y-12 site, building D&D encompasses the demolition of approximately 100 facilities that have been grouped into multiple distinct projects. Based on the facilities’ historical uses, four of those projects are considered to be part of the mercury strategy:

- Building 9201-4 (Alpha-4) Complex D&D
- Building 9201-5 (Alpha-5) Complex D&D
- Building 9204-4 (Beta-4) Complex D&D
- Building 9201-2 (Alpha-2) Complex D&D

The strategic schedule (Figure 10) includes executing these four D&D projects. Components of building D&D projects include development of regulatory and DOE documentation and approvals as noted in the schedule, as well as the activities described in the following three subsections.

3.4.3.1 Legacy Material Removal and Characterization

Legacy material characterization and legacy material removal/disposition (LMR*)* is the first step in preparation for demolition. LM encompasses any material, waste, or equipment contained within the excess facility that is physically easy to remove (e.g., is not large or fastened to flooring, walls, ceiling, etc. such that it would require tools to remove). LM requires characterization to determine the disposition pathway and development of a WHP should waste be sent to the on-site disposal facility, EMWMF, along with accompanying closeout reports as noted. To date, a significant amount of LM has been successfully disposed (see Figure 10, all LMR for Alpha-5 has been completed; Beta-4, second floor LMR has been completed and first floor and basement still remain). Note that waste not destined for EMWMF is generally documented in waste management plans prior to disposal, and summarized in closeout reports (e.g., PCCR). The remaining LMR scope for the facilities is expected to be accomplished using the same or similar methods.

Building characterization is completed once all LM has been removed, thus leaving a facility accessible for characterization of walls, floors, remaining process equipment (e.g., piping, large items), roof, etc. Alpha-5 has been completely characterized with the exception of the basement/wind tunnels (ORISE 2012). The process of characterizing Alpha-5 (including development and approvals of data quality objectives [DQOs], SAP, and Technical Memorandum [TM]) provides a sound basis for other facility (Alpha-4, Alpha-2, and Beta-4) planning and characterization, and the results are believed to be bounding since Alpha-5 historically suffered the most mercury-loss incidents. Characterization showed distinct hot spots within the facility that can guide limited segregation of higher-concentration debris prior to demolition. Additionally, concrete sampling demonstrated that mercury does not penetrate past the top 1-2 inches, which suggests scabbling or other separation/extraction techniques, if used, can provide a benefit by decreasing volumes of debris requiring treatment. A gap analysis was prepared for characterization of the remaining mercury-use facilities to aid in focusing future characterization efforts and avoid unnecessary sampling (ORISE 2013). A WHP(s) for the building(s) is then developed and must be approved by regulators prior to demolition. The RmAWP for building demolition at Y-12 has been completed and approved (EDI 2010c).

In order to commence with building demolition, which is capital work scope, CD-2/3 *Approve Project Baseline* and *Approve Start of Construction* documentation must be developed and approved per DOE O 413.3B. A reasonably sound engineering approach to demolition and waste management should be defined to develop a defensible baseline and request funding approval. Typically, development and approval of CD-2 information could take six months to a year for the large-scale demolition projects proposed. In addition, funding requests for capital work are made two years in advance, thus a large lead time (minimum two years) for CD-2/3 preparations are noted. The strategic schedule (Figure 10) shows CD-2 initiating well before demolition.

3.4.3.2 Pre-Demolition

Pre-demolition work – or deactivation – consists of venting, purging, and draining equipment; deactivation of utilities; hazard abatement (removal/disposition of asbestos-containing material, universal waste, etc.); surface stabilization of contaminants (mercury in walls may require stabilization prior to demolition; beryllium is stabilized with a fixative prior to invasive work; radioactive contamination is sometimes managed with a fixative spray); and possibly removal/disposal of some process equipment. Deactivation requires entrance to the building, and can pose problems when a building is allowed to deteriorate. A single WHP is typically completed and approved for pre-demolition and demolition waste.

3.4.3.3 Building Demolition

Building demolition, waste treatment/disposal, and project closeout will be accomplished as a capital project. As a capital project, building demolition must be preceded by development and approval of CD-2/3 baseline submittals as introduced above in Section 3.4.4.1. CD-3 approval, *Start of Construction*, will signal the start of demolition. Regulatory involvement will proceed through the Remedial Design Report. Building demolition includes activities such as:

- Mobilization/demobilization
- Removal/disposition of hot spots (segregation of waste) [alternatively this may be completed under pre-demolition]
- Removal/disposition of non-friable asbestos (e.g., transite siding)
- Removal/disposition of interior process equipment and structures
- Preparations for decontamination, dust suppression, and storm water runoff and containment
- Capture/storage and treatment of contaminated contact water (e.g., decontamination fluids, storm water contacting waste/debris that becomes contaminated, etc.)
- Demolition of exterior structures and disposition of resulting debris
- Decontamination/stabilization of remaining building slabs

Opportunities exist to reduce the cost and/or risk presented by building demolition. Careful planning and execution to minimize the generation of mercury-contaminated waste through selective treatment/hot spot removal and/or concrete scabbling and the application of fixatives (e.g., for mercury vapor control during demolition) will be completed. Management/treatment of storm water and mercury-contaminated decontamination water/dust suppression water during demolition activities may be required, and could be provided by the OF 200 MTF and/or other systems. Suppression of the groundwater table during demolition may need to be considered.

As discussed in Section 3.3, endstate definitions for waste and the remaining building slab will require significant preplanning and approvals. Removal of the buildings will give access to the subsurface structures and soils beneath the buildings.

3.4.4 Soil, Sediment, Subsurface Structure Remediation

Soils under buildings are presently not well characterized. Some data exist (BJC 1999b); however, depth and areal extent of mercury contamination under and around buildings (basements) remains largely unknown, and may be altered by demolition work. Conjecture based on masses of mercury lost to the environment (see Section 2.1), and specifically to the ground, lead to the belief that contaminated soil volumes may be excessive. A technology development project to look at soil concentrations in the WEMA area, via mercury vapor analysis, is ongoing and should give some indication regarding contamination levels and extent of contamination.

Ultimately, ongoing/current releases of mercury to UEFPC are mainly sourced in soil, sediments, and subsurface structures although all mercury in these media is not necessarily subject to mass transport to UEFPC under current conditions. Identification of mercury sources that are currently within transport pathways has been and continues to be a priority activity to achieve near-term reductions in releases.

Upon characterization, soil that exceeds the risk-based levels outlined in the Phase II IROD must be managed as waste. Only two generic options beyond capture and treatment of contaminated water contained in soil/sediment are available to deal with these sources: removal or isolation (including *in situ* stabilization). The treatment and disposal options for excavated mercury-contaminated soils are fully discussed in the *Treatment Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge* (UCOR 2012b), which is summarized in the subsection below. Those options include on-site treatment with SPSS and on-site disposal at EMWMF as well as other commercial treatment options with on-site and off-site disposal options. Isolation technologies may offer comparable environmental protection and at lower cost, but are not technologically mature and require further research and development before application can be considered (See Section 3.4.4.2). The current planned treatment for soil is defined (in the Phase II IROD and assumed in the CD-1 baseline) as removal up to 2 ft depth for EU 2 through EU 14 (includes WEMA) and 10 ft depth for EUs 1a and 1b to meet land use and groundwater protection criteria. Additionally, remediation of soil surrounding and beneath each mercury-use facility is sequenced to immediately follow demolition of that building.

If excavation is undertaken, care should be taken to avoid contact and accumulation of storm water with excavated areas (e.g., filling in areas as soon as possible). Seepage of groundwater and any collected storm water in excavated areas would require sampling for mercury contamination, and management of the water as necessary depending on results.

Some storm sewer (WEMA) sediments have already been removed (in 2011) using ARRA funding. Sediments in UEFPC will need to be removed or contained at some point. Although the current strategy is to conduct creek sediment remediation after all upstream remediation is complete, in order to avoid the possibility of re-contaminating cleaned creek beds, ongoing assessments may require that actions be taken earlier. Again, isolation or *in situ* technologies such as creek bed hydraulic barriers offer cost and remedial effectiveness, but require a significant amount of development before their feasibility is proven (see Section 3.4.4.2).

As with demolition, soil and sediment remedial actions will require the same regulatory interactions and approvals in the treatment decision making process, development of WHPs, and “design” parameters to be documented through attachment submittals to the UEFPC Soils RAWP (EDI 2010a).

3.4.4.1 Soils Treatability Study

Briefly summarized, this study (UCOR 2012b) provided Y-12 soils to three vendors to perform mercury treatability studies of their stabilization technologies. All three successfully demonstrated their stabilization methods by achieving <0.2 mg/L TCLP mercury for the treated waste forms, thus indicating the ability to meet LDRs for mercury. All vendors indicated that underlying hazardous constituents could be addressed, but some, organics in particular, would likely require supplemental treatment.

Soils samples contained mercury contamination; however, to ensure a representative and bounding test, the soils were further inoculated with elemental mercury up to 2,000 mg/kg and second samples to 10,000 mg/kg prior to delivery and testing by vendors. A fourth vendor had previously demonstrated stabilization of mercury-contaminated waste, but entered the study at a late date and, therefore, did not participate; however, the recommendation was made to further investigate that vendor’s treatment. While LDR attainment was proven by the tests, the study did recommend further assessment of the long-term stability of treated waste forms under representative disposal conditions. An assessment was made of possible treatment and disposal scenarios as well.

3.4.4.2 *In Situ* Treatment Options

In situ treatment of mercury-contaminated soils/sediments or substructures may be determined to be an option in some cases. If *in situ* treatment is applied, the treated media is not subject to LDRs. Variance requests to regulators addressing waste form endstates need to be investigated/applied for depending on results of these efforts.

Treatment of subsurface elemental mercury, beyond excavation with *ex situ* treatment and disposal, is an emerging science. *In situ* immobilization and *in situ* extraction using heat or chemicals represent two lines of research and development in this field, and are practiced by very few vendors (BJC 1999b; Cabrejo 2010). Thermal desorption coupled with vacuum extraction was identified as likely to be effective for basement soils in Building 9201-2 (Cabrejo, 2010). As shown by Svensson et al. (2006) materials such as elemental sulfur, FeS and FeS_2 can be reacted under certain geochemical conditions with elemental mercury to produce highly insoluble HgS. For an *in situ* application of any of these, some technical challenges exist including especially the means to deliver and mix the reactants in the subsurface. Recent nanotechnology research with iron sulfide nanoparticles (e.g., Bower et al. 2008; Gong et al. 2012) has shown promise in overcoming the deployment challenge. As well, scientists at Savannah River National Laboratory have identified a method of targeting mercury for sequestration in contaminated soil zones by use of sulfur-vapor heated gas (SRNL 2012).

The continuing emergence and field demonstration of innovative tools for remediation of elemental mercury in subsurface environments should make it possible in the near future to successfully identify and treat this form of mercury in even the most challenging locations at the Y-12 Plant. Work completed to date exploring options for *in situ* treatment of mercury has been limited, but it could conceivably provide significant savings in terms of transport, treatment, and disposal costs and should continue to be explored as an option for remediation of soils, sediments, and subsurface structures contaminated with mercury. Subsurface remediation at Y-12 is far enough in the future that advancements may yet be made, demonstration options are more than feasible, and it should remain a consideration in future analyses.

3.5 TECHNOLOGY DEVELOPMENT

DOE technology development activities related to the mercury cleanup at Y-12 are conducted under a two-pronged approach: basic, fundamental studies conducted under the DOE SC and applied technology activities conducted under DOE Office of Environmental Management. Integration of these two approaches is an ongoing responsibility of both Offices. Focusing integration of technology development into strategic planning is addressed in this section of the document.

A mercury-related SFA under DOE SC is aimed at enhancing a fundamental understanding of the environmental behavior (physical and chemical) of mercury, particularly in the LEFPC area. This mercury SFA is a multi-scale, multi-disciplinary, and multi-institutional research program led by researchers at ORNL that integrates geochemistry, microbiology, molecular biology and molecular simulations to understand mercury behavior in the field. Current efforts are aimed at identification of mercury source areas, mercury transport, storm flow impacts, methylation, and other factors that affect bioaccumulation. An objective of this effort is to draw conclusions/support theories that can be applied to guide and target future remedial actions.

Within the Environmental Management Program, the ARTD Program, whose mission is to transform science and innovation into practical solutions for environmental cleanup, conducts the Remediation of Mercury and Industrial Contaminants Applied Field Research Initiative (AFRI) at ORNL, whose purpose is to leverage field investigations and treatability testing involving mercury remediation of environmental media into practical solutions. Additionally, the AFRI provides the framework for leveraging and translating DOE SC investments (such as the SFA activity mentioned in the previous paragraph) into knowledge and technologies that can be used to address the Y-12 mercury challenge. Some of the proposed studies outlined in Section 3.4.2.2 would be accomplished under the auspices of the ARTD Program.

Remediation of the Y-12 site and EFPC ecosystem poses a long-term cleanup challenge. A number of previous efforts and reviews have identified science and technology needs relevant to the mercury cleanup challenge. These key knowledge and technology needs include the following activities:

- **Mercury Source Identification and Measurement** – Historically, the distribution of subsurface mercury at Y-12 has been characterized by conventional drilling techniques that employed direct-push sampling technology (Shelby tubes) in the soil overburden to minimize redistribution of the mercury due to drilling (e.g., Rothschild et al. 1984). As reported in the Rothschild study, only about 2% of the estimated losses by spills were located by this method. Subsequently various vendors have promoted the use of remote sensing using geophysical methods to identify subsurface accumulations of liquid mercury but none of these has proved very useful so far at Y-12 or elsewhere. More recent characterization technology involves soil gas sampling.

This technology is divided into two approaches: (1) passive sampling using sorbents installed in, and recovered, from borings (e.g., CH2M Hill 2012) and (2) active sampling/measurement in real time during drilling wherein either soil gas is extracted (enhanced by heating the probe, see Jackson 2011) and brought to a mercury vapor analyzer on the surface, or a "direct-push" electrical sensor provides selective response to presence of elemental mercury (SRNL 2011).

Supplemental characterization of mercury contamination in surface and subsurface sediments and near facilities within WEMA is ongoing. This activity will support refining the estimated amount of mercury-contaminated environmental media that will need to undergo treatment and disposal. The characterization involves using this real-time, vapor-phase measurement technique (Watson 2011).

- **Treatment of Mercury-Contaminated Debris, Soil, Sediment, Water –** Less costly and more effective treatment, recovery, containment, and stabilization techniques are needed for mercury-contaminated media – debris from demolition, soil and sediment, and water. *In-situ* treatment approaches that immobilize mercury in contaminated sediments represent an opportunity for considerable savings in comparison to excavation/treatment/disposal methods.
- **Hot Spot Stabilization/Containment/Removal –** Considerable cost savings may be gained with the application of reactive caps/barriers to line the creek banks/beds as an alternative to excavation/treatment/disposal methods. Additionally, techniques that remove or isolate mercury surface contamination in concrete or soils would also greatly reduce volumes and/or simplify handling of debris requiring treatment.
- **Predictive Modeling and Monitoring** – Development of a systems-based understanding of the impact of D&D activities on subsurface flow paths and mercury release is ongoing, and can help understand and predict the long-term effectiveness of remedial alternatives on mercury flux reduction. This knowledge provides information needed to better design remediation strategies and long-term stewardship methods, as well as define achievable alternative endstates.

Some of the above activities have been structured into tasks to be completed over the next several years, and are integrated into this Mercury Strategy Plan as *Technology Development and Planning* activities, shown in the strategic schedule, Figure 10. Proposed studies aimed at addressing water and fish mercury levels (Section 4.3.2.2) to be performed are also included in the figure. The benefit of activities being performed as part of the Mercury AFRI can result in cost savings by reducing the amount of mercury-contaminated material requiring treatment and disposal. For example, investments in the characterization of mercury sources near and around facilities—specifically the form, chemical speciation, and range of concentrations—will enable a refined cost estimate for cleanup and allow for more surgical treatment in place as an alternative to the baseline technology, excavation. Furthermore, technology development activities will also:

- Reduce the overall project schedule by increasing the technical maturity of unproven approaches and technologies.
- Reduce the uncertainty associated with implementation of these approaches and technologies.
- Increase the likelihood of success for alternative approaches and technologies that can revolutionize and reduce cost during the cleanup project execution phase.

3.6 REGULATORY STRATEGY

The process of addressing cleanup under CERCLA involves prescriptive documentation/ regulatory approval procedures as outlined and maintained/statused within the FFA. Planning and sequencing of Y-12 OREM projects for the CD-1 baseline was completed based on a regulatory strategy that is unchanged in this strategy (DOE 2008b). Consideration of time and resources required for preparation of regulatory documents (CERCLA and National Historic Preservation Act documentation, permits and permit modifications, public comment periods, and regulatory review and approval) was part of CD-1 conceptual design and planning, and is consistent with this strategy plan and baseline information presented herein. Figure 13 is a schematic of the steps undertaken in the CERCLA remediation process, where each bullet or step approximately applies to a study/evaluation that is performed, documented, and approved by all parties. For most of the actions addressed in this strategy, the process is in the middle stage, Set Goals and Develop Solution, where detailed information regarding implementation planning occurs (e.g., design, design reports, design characterization SAP/Quality Assurance Program Plans [QAPPs], and WHP for EMWMF waste).

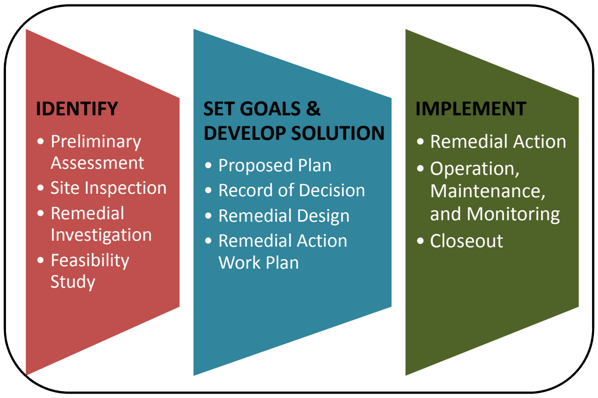

Figure 13. CERCLA Process

Table 7 summarizes the CERLCA documents required for project activities currently envisioned. Activities involving approaches that deviate significantly from those envisioned (e.g., in situ treatment of soils) may require further/different documentation and approvals from those specified in the table. The strategic schedule (Figure 10) appropriately schedules the CERCLA and DOE documents expected to be required prior to the execution of the specified projects.

3.7 RISKS AND OPPORTUNITIES

Specific risks associated with mercury remediation at Y-12 include:

- **Mercury in fish continues to be elevated –** Mercury concentrations in fish continue to be elevated and do not respond to actions to reduce creek concentrations and loading. The relationship between effluent concentrations and mercury in fish is non-linear.
- **Final surface water and groundwater decisions require reassessment of soil/sediment remediation levels** – This risk is low, but has significant consequences**.**
- **Mercury leach testing protocol –** TCLP protocol is being examined by EPA and may be modified. This may affect applicability of past characterization data in meeting LDRs, could result in increased volumes of waste requiring disposal, and may affect implementation of treatment options.
- **Funding availability –** Funding availability is driven by economic mechanisms that can negatively affect the schedule for remediation of Y-12.

Table 7. Examples of Required CERCLA, DOE Documentation in Support of Mercury Remediation Projects

Activity/Project	Required CERCLA Documentation and Approvals[a,b]	Required DOE Documentation and Approvals[b]
Legacy Material	• DQOs • RAWP* • WHP*/SAP/QAPP • PCCR*	• See footnote c
Building Characterization	• DQOs • WHP*/SAP/QAPP (for characterization waste)	• See footnote c
Building Pre-Demolition	• WHP*/SAP/QAPP (single plan for pre-demolition and demolition waste) • PCCR*	• See footnote c
Building Demolition	• WHP*/SAP/QAPP (single plan for pre-demolition and demolition waste) • RmAWP[d] and addendum* • PCCR*	• CD-2 Approve Performance Baseline • CD-3 Approve Start of Execution • CD-4 Project Closeout
All Building Complexes Demolition	• Removal Action Report*	• NA
Soils/Subsurface Characterization	• RAWP[e] and attachment* • DQOs • WHP*/SAP/QAPP (one for whole EU remediation)	• See footnote c
Soils/Subsurface Remediation	• RAWP[e],and attachment* • DQOs • WHP*/SAP/QAPP • TM/PCCR*	• CD-2 Approve Performance Baseline • CD-3 Approve Start of Execution • CD-4 Project Closeout
Sediment Characterization	• RAWP[e] and attachment* • DQOs • WHP*/SAP/QAPP • Nature and Extent Characterization	• See footnote c
Sediment Remediation	• RAWP* • DQOs • WHP*/SAP/QAPP • TM/PCCR*	• CD-2 Approve Performance Baseline • CD-3 Approve Start of Execution • CD-4 Project Closeout
All Soil/Sediment/ Subsurface Remediation	• Remedial Action Report*	• NA

[a] The documents/approvals listed here are those required after decision documents have been approved (see Section 2.3). In some cases, these documents may be addenda or appendices to existing documents. Some of these documents may be combined, for example, the WHP for pre-demolition and demolition waste may be able to be submitted as a single plan, and for multiple facilities.

[b] This list is not meant to be exhaustive. Various documents are required, for example the facility safety basis documents must be up-to-date and modified to include all projected activities to be completed under the given work scope. As another example, the RmAWP for building demolition states that other project-specific plans, such as verification plans, monitoring plans, and water management plans may be required.

[c] These activities are typically completed outside of the Critical Decision process. However, much of the documentation required is similar (e.g., Work Plans; Safety Basis; Environmental, Safety, and Health Plan; etc.)

[d] The RmAWP for Y-12 building demolition is an existing document (EDI 2010c). Project-specific plans will be developed (e.g., Verification Plans, Monitoring Plans, Water Management Plans). Addendums to the RmAWP will address project-specific information and requirements.

[e] The RAWP for UEFPC soils is an existing, approved document (EDI 2010a).

*These documents are primary FFA documents and require regulatory approvals.

The relationship between water and fish concentrations is clearly non-linear and not well understood. During source, removal efforts the mercury water concentrations will likely fluctuate, and completion of source removal is expected to result in a final picture of the mercury conceptual model that is significantly different from that of today. Although efforts will be directed at reducing fish tissue mercury concentrations throughout this strategy with parallel monitoring/assessment of those concentrations, it is conceivable that a final evaluation of effort needed to influence fish tissue mercury concentrations will not be possible until after source removal is completed. The adaptive management approach put forth in this strategy is to respond to those fluctuations by revising, as necessary and as allowed within constraints (e.g., budgets, timing), approaches to best address those as yet unforeseen ecological responses to cleanup actions. In the interim, reduction of mercury flux will be addressed through construction and operation of the OF 200 MTF, evaluation of flow diversion, and flow augmentation modification. Recent ARRA-funded activities, installation of mercury traps and secondary pathways modifications, have and will continue to result in mercury reductions in pathways.

Mercury remediation projects have risk management plans and associated contingencies. The risks identified above: off-site release of mercury and a expectation to further decrease mercury levels in surface water, TCLP protocol modifications, and funding availability, as well as other risks not addressed here, are captured and managed within the baseline. A comprehensive risk management process is used to ensure that project activities incorporate appropriate, efficient, and cost-effective methods to identify, manage, and mitigate the impact of project-related risks. Project contingencies are calculated utilizing Monte Carlo methodology; simulation runs are conducted to provide technical and programmatic risk cost and schedule impacts. Contingency is thus calculated at 50% and 80% confidence levels, and incorporated in project baseline projections. Opportunities associated with mercury remediation at Y-12, currently being implemented or to be implemented in the future, include the following:

- **Targeted Hot Spot Segregation and Remediation of Mercury Contamination –** As a form of volume reduction, targeted, localized determination of the extent of mercury-contaminated areas in buildings and identification of soil "hot spots" (identified through characterization efforts) will allow for reduced treatment costs. For example, Alpha-5 characterization shows localized areas of the building that have much higher mercury concentrations. These areas may be surgically demolished and separated from the bulk of the building debris to reduce treatment costs. This approach will be documented and approved through work plans, WHPs, or other appropriate documents.
- **Consolidation of Required Documentation –** The existing RAWP for UEFPC soils (EDI 2010a) has been written to encompass all EUs that will require remediation and includes common information to all areas, with the idea that appendices may be added to address the individual areas as the work becomes more defined, rather than developing multiple, repetitive RAWPs. These appendices will address the specific scope and schedule response action planning and completion reporting. Consolidation of other CERCLA documentation in a likewise manner, where possible, will be pursued, as well as separate consolidation of DOE-required documentation in a similar manner, as applicable (e.g., as was completed for a single CD-1, which captured multiple projects in the IFDP).
- **Gap Analysis of Building Characterization** – A completed assessment of the mercury-use facility complexes considers existing structural characterization and historical documentation to identify outstanding data gaps. Results of the analysis will help target and minimize needed future building characterization.
- **Optimization of OF 200 MTF Design** – Continue to refine conceptual design of the treatment system by gaining an understanding of the storm flow mercury concentrations and further investigation of contributors to the base flow (possible diversion/interception modifications).

4. PROJECT SUMMARY AND TIME-PHASED PLAN

The current and future OREM work scope discussed in this strategy has involved only those projects associated with mercury-contamination in UEFPC. However, Y-12 cleanup scope includes many more projects than have been presented thus far, and a discussion of the time-phased execution of Y-12 projects cannot be isolated from the rest of the OREM baseline and ORR priorities. A total of 41 projects have been defined to complete the cleanup of Y-12, of which 12 are related to the mercury-cleanup. The prioritization and sequencing of all Y-12 cleanup projects are discussed further in sections that follow.

4.1 Y-12 BASELINE PROJECTS

Forty-one projects are defined in the OREM baseline to accomplish the cleanup at Y-12. Figure 14 lists 38 of those projects, arranged by the overarching CERCLA decision documents. The remaining three projects not shown in the figure include ongoing and future S&M/Environmental Monitoring and Reservation Management Projects. The mercury remediation projects, all in the UEFPC watershed area, are given as red text and italicized in the figure. They include the four mercury-use facility complexes D&D; four subsurface, soil, and sediment remediation projects; two projects to design, construct, and operate the OF 200 MTF; and two projects to develop UEFPC RODs.

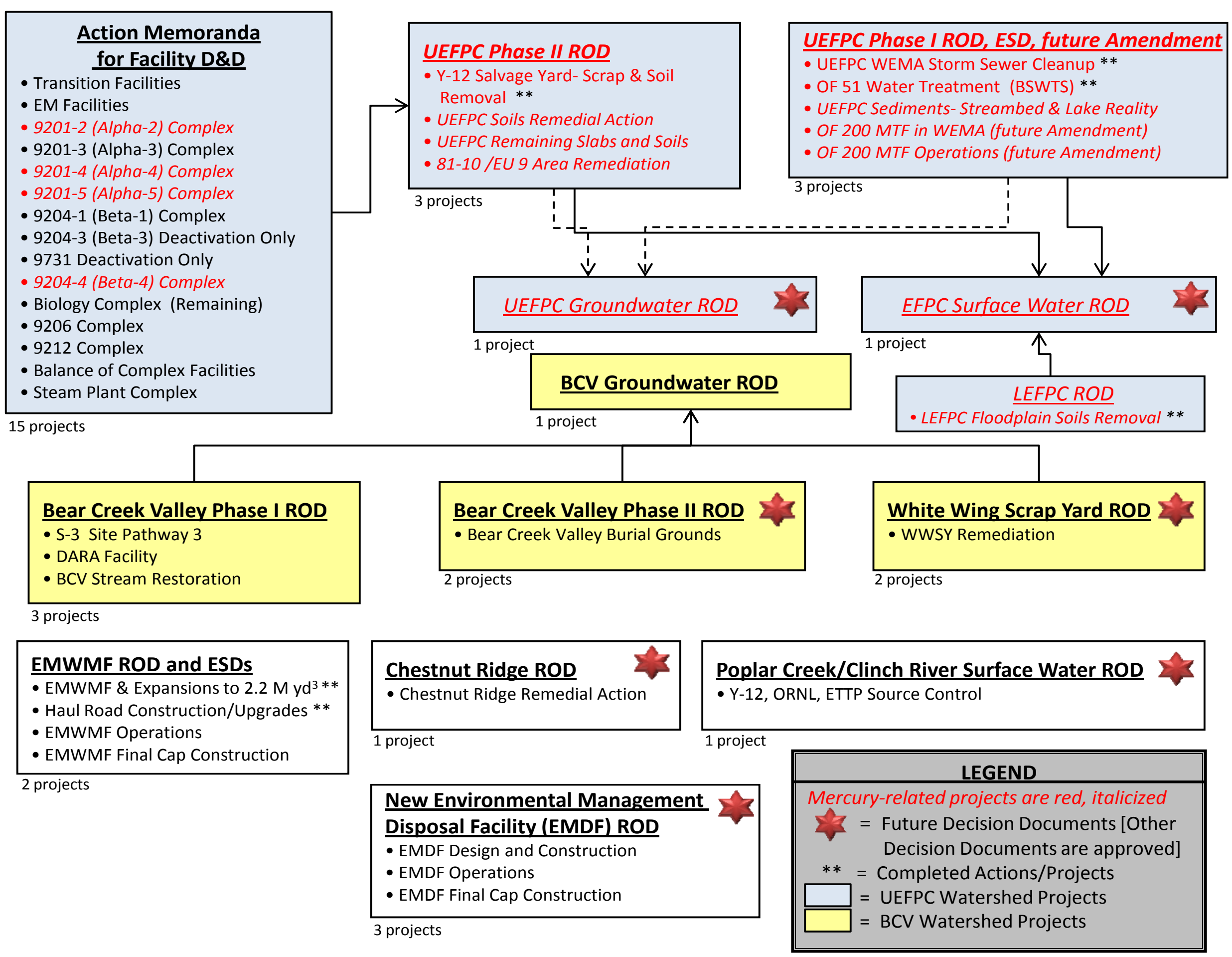

Figure 14. Project Summary for Y-12, Grouped by CERCLA Decision Document

A detailed list of the Y-12 projects is given in Attachment B, along with a list of all facilities in the 15 D&D projects.

Once defined, the site's projects are prioritized. Following prioritization, Y-12 projects are integrated into the overall OREM program and project prioritization (which includes ETTP and ORNL projects). Enforceable milestones are established based on consensus priorities, and aligned to the overall pace of cleanup and projected funding. Annual funding levels, both projected and allocated, affect the time-phased sequencing of the OREM program projects and thus the OREM baseline.

4.2 PROJECT PRIORITIZATION

The Oak Ridge cleanup strategy employs a risk-based approach that focuses first on those contaminant sources that are the greatest contributors to risk. To further refine the overall cleanup strategy, a prioritization system has been developed to help guide decisions where investments should be made. DOE OREM Program risk-based prioritized goals are to:

- Mitigate immediate off-site risks.
- Reduce migration of contaminants off-site.
- Control ongoing sources of on-site contamination.
- Demolish excess facilities.
- Address remaining media (soil, surface water, and groundwater).

Other factors affecting prioritization include stakeholder interests, regulatory commitments, funding availability, and mission support. The OREM Program Plan discusses the prioritization of Reservation cleanup (DOE 2013e). Based on these goals, Y-12 projects have been prioritized with mercury remediation being the site's highest priority. Other prioritization considerations include construction logic (for example, building D&D allows access to underlying contaminated environmental media), building utility relationships, prevention of recontamination, opportunities for reduction of S&M costs, and release of strategic real estate to support site missions. The prioritization for the mercury remediation projects is:

- **OF 200 MTF Construction** – to provide immediate reduction of mercury leaving site and to be in place and operational to provide mercury removal capabilities during demolition activities.
- **Beta-4 Complex Demolition –** the first complex accessible from the west and has the most available surrounding area that can be used for staging/laydown; therefore, it is logical to begin demolition at this facility. In addition, a west to east approach has been adopted since it is the direction of groundwater flow, and is addressed in an ESD to the Phase I IROD (EDI 2011); working west to east will minimize the possibility of re-contaminating cleaned areas.
- **Soils Cleanup** – is being completed by EU where possible, and based on the west to east approach. Western EU 11 scrap yard soils were remediated by ARRA in FY 2011-2012; Beta-4 is contained in EU 11 and is a logical next cleanup target in that EU, and from an EU by EU perspective. Soil remediation for each mercury-use facility will follow demolition of that facility.
- **Alpha-5 Complex Demolition** – the building has been characterized and all legacy material has been removed; facility is beginning to deteriorate; delays in gaining entrance for deactivation activities may add costs needed for reinforcement of structure in the future and increase S&M costs. Soil remediation is sequenced to immediately follow after the complex demolition.
- **Alpha-4 Complex Demolition** – the building is to the east of Alpha-5 and is, therefore, sequenced to follow Alpha-5 demolition. Soil remediation is sequenced to immediately follow after the complex demolition.
- **81-10 Area Remediation** – soil (EU 9) is prioritized following building demolition starts. However, characterization has been completed and, while it is currently sequenced to be

remediated beginning in FY 2023, it may be possible to pull the project forward if funding becomes available.

- **Alpha-2 Complex Demolition** – building demolition is prioritized lower and sequenced later because the building and surrounding area is served by the BSWTS for mercury treatment of shallow groundwater inleakage to the basement and adjacent Outfall 51, Big Spring. Additionally, the building is located in the eastern portion of the site, so from a west to east approach it is prioritized lower as well.

Soil remediation (in relation to building demolition) is assumed to occur following after each individual (large) building demolition as opposed to completing multiple complex demolitions followed by large or multiple area soil remediations. This is considered to be a logical sequence for the scope execution for several reasons: (1) once a building has been demolished, the slab and/or subsurface (hole in the ground/basement/wind tunnels) may create an issue with contaminant movement and/or treatment of inleakage, thus minimizing the period of "vulnerability" would be desirable and (2) if the approach is to fill in the subsurface structure with flowable fill in order to avoid the previously mentioned issue, more waste may be generated during remediation and increase cost.

4.3 BASELINE SEQUENCE

All OREM projects (ETTP, ORNL, and Y-12) are sequenced in time based on a given annual funding constraint for the remaining baseline as well as logic ties within each site. This sequencing results in the schedule for Y-12 cleanup as seen in Figure 15. Appendix A contains a listing of projects that are included in each summary level presented in the figure. In developing the baseline, the cost of each project is estimated, Monte Carlo risk analyses are completed to define contingencies, and cost ranges developed and escalated as necessary. Mercury-related projects account for 25% of forecasted cost (including operation of the OF 200 MTF), all other D&D/remediation accounts for 25%, and the remaining 50% of the forecasted cost covers S&M, environmental monitoring, security, and operations, as well as all disposal cell planning, construction, operation, and closure. Funding needed to complete the Y-12 cleanup is estimated in the range of $7.5 to $8.4 Billion, and is expected to take 34 more years to complete at the level of funding currently projected for that period.

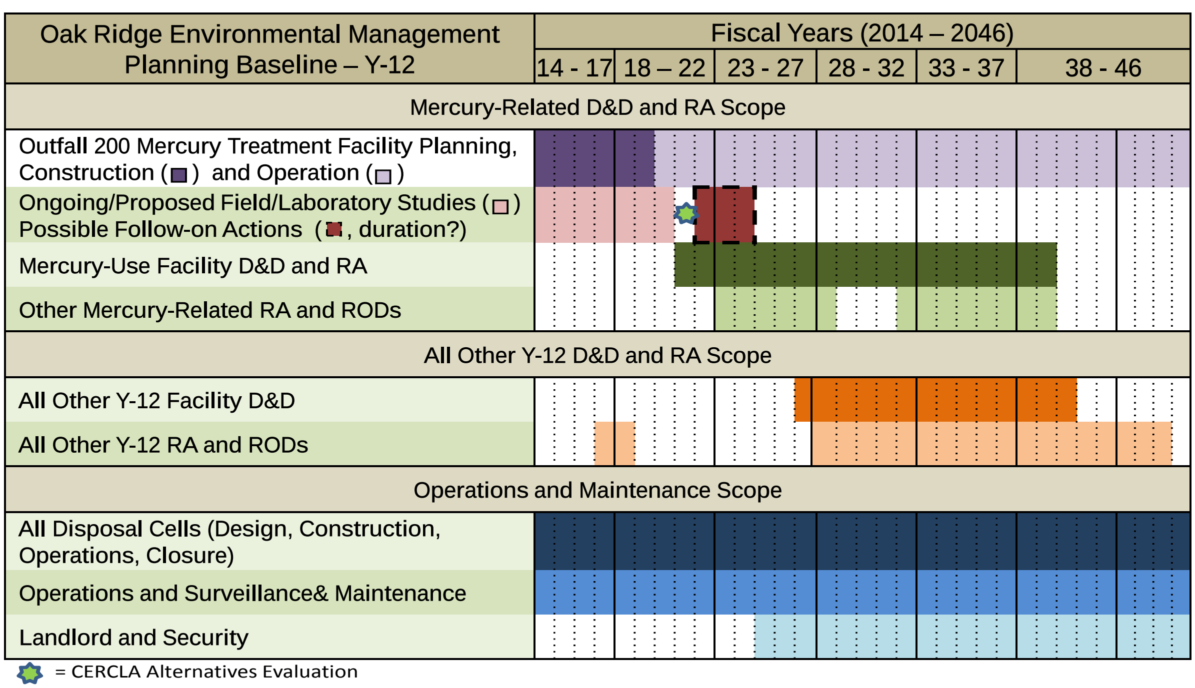

Figure 15. Y-12 EM Cleanup Project Summary Schedule

5. CONCLUSIONS

Cleanup of mercury contamination and sources at Y-12 presents a complex, multi-faceted problem that requires an equally multi-layered remediation approach. Remediation actions to date have had some opposing reactions (expected to be short-term only) where surface water mercury concentrations are concerned (e.g., WEMA storm sewer cleanout increased mercury flux), and future demolition activities are expected to generate runoff requiring treatment for mercury. Recent ARRA-funded actions that have advanced mercury remediation efforts at the site include:

- Projects such as the cleanout of mercury-contaminated sediment from the WEMA storm sewer system and the secondary pathways work to decrease infiltration of surface water through mercury-contaminated soils appear to have resulted in a significant decrease in mercury flux measured at Outfall 200 when consideration of the significant current wet/high rainfall conditions is taken into account.
- Three recent demonstrations of SPSS for the treatment of mercury-contaminated Y-12 soils were successfully completed. A follow-on study summarizes the regulatory path and approvals, treatment methods and facilities, disposal locations, and costs associated with management of mercury-contaminated soil.
- Legacy material has been removed from Alpha-5 and portions of Beta-4 in anticipation of future demolition.
- Characterization of the Alpha-5 building has been completed and will serve as the basis of a WHP for the building debris disposition.
- Re-routing building and terrain runoff (Mercury Secondary Pathways Project) and installing mercury traps in WEMA pipelines (Free Mercury Removal) are small-scale methods to reduce mercury input to UEFPC with potentially large paybacks.

Mercury has been identified as the largest environmental risk on the ORR stemming from ongoing releases of mercury in UEFPC to off-site, public waters and due to a lack of response in fish mercury concentrations to overall reductions of mercury in UEFPC from pre-1980 highs. This strategy responds to that risk with the following near-term elements:

- Flow augmentation will be modified/relocated or eliminated and is expected to result in a reduction of mercury flux at Station 17.
- Construction of the OF 200 MTF to reduce mercury loading in UEFPC will be completed, thereby reducing the amount/flux of mercury leaving the site at Station 17, as well as providing necessary treatment for future demolition/remediation-generated contact storm water and decontamination water. Optimization of the facility design in terms of treatment method, secondary waste generation, through-put versus cost, and mercury removal efficiency will be considered, as will be methods to reduce the volume of baseflow and storm water sewer contributions going to Outfall 200, to ultimately reduce the volume of water requiring treatment at the OF 200 MTF.
- Several studies with goals of reducing fish mercury concentrations, mercury flux, and surface water mercury concentrations are proposed over the next several years to help determine actions that might be needed after the OF 200 MTF becomes operational. A tri-party decision point to be evaluated in a CERCLA Alternatives Evaluation in the FY 2021 time frame will be the basis for agreement on any additional actions to be implemented in UEFPC or LEFPC, if necessary, with input from the OF 200 MTF operation evaluation. Implementation of these actions may result in delays of source removal/remediation due to funding limitations.
- Large-scale, future mercury source removals (building demolitions followed by soil remediation) have been planned through a project-based approach. The approach involves many planning and

pre-demolition activities prior to demolition and remediation. Key to the success of these large-scale demolition and remediation projects is a well-defined path for managing the expected waste debris and soil. A significant step toward identifying the soil management path has been addressed through the soils feasibility study (UCOR 2012). A similar debris study may be desirable, based on the current plan to macroencapsulate mercury-contaminated debris at the EMWMF. Working with regulators, the path forward on managing the expected mercury-contaminated soils and debris will be defined and approved prior to the actual execution of these projects. Advance planning will allow efficiencies and cost-benefit analyses to be more successfully considered and implemented prior to, and in parallel, with the work.

- Building demolition and soil remediation have been sequenced in the OREM baseline to proceed west to east, to allow for ease of access in completing demolition and to reduce or eliminate issues of recontamination associated with groundwater flow that exhibits a west to east flow. Remediation of soil will follow directly after demolition for each facility.

The ongoing and future mercury remediation at Y-12 is an extremely large and complex problem from all perspectives: chemical, geological, ecological, physical, regulatory, and financial. Efforts are being made daily by DOE contractors, regulators, and DOE officials to define, develop, and implement solutions to the issues. This strategic plan has been written as a source to guide future mercury remediation activities and support processes. Changes to schedules will likely occur over the extensive time frame encompassed by this plan. Hopefully many advancements and achievements in mercury remediation will be forthcoming, but some unexpected setbacks will undoubtedly be encountered. This plan will be updated through tri-party agreement, as necessary, to remain effective in organizing and focusing those efforts to define the work, reduce costs and increase efficiencies where possible, and to ultimately achieve the goal of cleaning up mercury from the Y-12 site and EFPC.

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ATTACHMENT A:
ACTION PLANS EXCERPTED FROM THE 2013 RER

(UCOR 2013)

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ACTION PLAN 1
East Fork Poplar Creek Streambed and Bank Sediments

FYR ISSUE: OF-2
CERCLIS OU: #28

ISSUE: 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 ROD did not fully consider the entire hydrologic system and did not explicitly address creek bank or creek bed sediments.

BACKGROUND: The role of in-stream and floodplain mercury sources on mercury flux, speciation, and bioavailability in the East Fork Poplar Creek 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 DOE's current and near-future remediation activities to address mercury contamination is in the "upstream areas" near the Y-12 Complex, 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 beneath the floodplain as sources of mercury and methylmercury to the 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 FYR, and progress reported annually in the Remediation Effectiveness Report.

The focus of proposed investigations and schedule is as follows:

FY 2013: Investigations will focus on the leachability, methylation, and bioaccumulation characteristics of four mercury sources (floodplain soil, sediment, bank soil, and facility suspended sediment) to LEFPC. An initial evaluation of shallow groundwater beneath mercury contaminated soil areas of the LEFPC floodplain will be conducted.

FY2014: 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/GIS data/land cover data, and direct measurement. Results will be presented in the RER.

FY2015: 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 2012-2013 studies

In the first four months of FY 2013 a number of team meetings were held to develop a strategy for field and laboratory studies later in the year. One of the priority studies was determined to be an assessment of riparian and sediment characteristics in EFPC. Understanding stream bank erosion on the East Fork Poplar Creek was deemed to be an important need if site specific mercury data was to be modeled at a watershed scale. Dr. Paul Ayers, University of Tennessee, was subcontracted to develop stream bank erosion condition maps on 14 miles of the lower East Fork Poplar Creek (EFK 23 to confluence with Poplar Creek) using global positioning system (GPS)-based above water video mapping and sensing techniques. The advantage of video mapping every foot of stream and bank is that 1) the total stream bank erosion can be determined, and 2) the locations of high erosion and stream bank rescission can be identified and managed to reduce sediment loads to the creek. The GPS-based kayak-mounted above water video mapping and electronic sensing evaluation is planned for February 2013, when base flows are relatively low and prior to leaf out.

The project team also did field surveys in winter 2012-2013 to evaluate potential field sites to evaluate shallow subsurface flow into EFPC. In addition, early in FY 2013 an ORNL-developed spreadsheet mercury transport model that included recent study data in EFPC was mined for use in a more quantitative systems-based model that will be developed using STELLA software.

Laboratory experiments were undertaken in late FY 2012 using upper East Fork Poplar Creek soils and sediments to evaluate mercury source characteristics. These studies helped develop suitable protocols for further studies planned in FY 2013, focused on LEFPC soil and sediment media but also to include suspended sediment source evaluation. Experimental studies in FY 2012 examined 1) the release of mercury from three different particulate sources in East Fork Poplar Creek (floodplain soils, stream bank soils, and streambed sediments) into water over time under different conditions, 2) the bioavailability of the sediment-leached mercury to algae at the base of the aquatic food chain leading to fish, and 3) the potential of each of the sediment compartments to methylate mercury. Preliminary results from these laboratory studies follow.

Experiment 1: Mercury leaching from different sediment compartments

Floodplain, streambank, and streambed sediments were collected from East Fork kilometer 23.4 and were sieved to remove gravel and coarse sediment and debris. The fine particulate material was incubated with clean creek water (collected from First Creek on the Oak Ridge Reservation) at a ratio of 9 parts water to 1 part sediment for approximately three weeks. At regular intervals, samples were taken for dissolved mercury to examine mercury leaching from particles over time in each of the compartments. In these experiments, the streambank soils had the highest mercury content, and released the most mercury over time. Streambed sediments and floodplain soils released approximately the same amount of mercury from particulates, but the dynamics of release were very different. While mercury was released rapidly from streambed sediments, release was much more gradual and constant from the floodplain soils. This suggests that the speciation of mercury in the different compartments is quite different and warrants further attention.

Experiment 2: Mercury bioavailability from different sediment compartments

Leachate from each of the sediment compartments was filtered and analyzed for total and methylmercury at the end of leaching experiment (Experiment 1, above). To the leachate, WCL-1 nutrients (Guillard, 1975) were added and the green algae *Chlamydomonas reinhardtii* was added at an initial cell density of 3000 cells/ml in the culture media. Cell density was monitored by fluorescence (chlorphyll a) as well as microscopy, and mercury was measured in cells after 1 hour and after 4 days of incubation. Figure 1 shows that mercury uptake was greatest in cells exposed to the streambank soil leachate, and was below detection limit in the floodplain soil leachate. The bioaccumulation of mercury in the leachate experiments was more closely related to methylmercury than total mercury concentration.

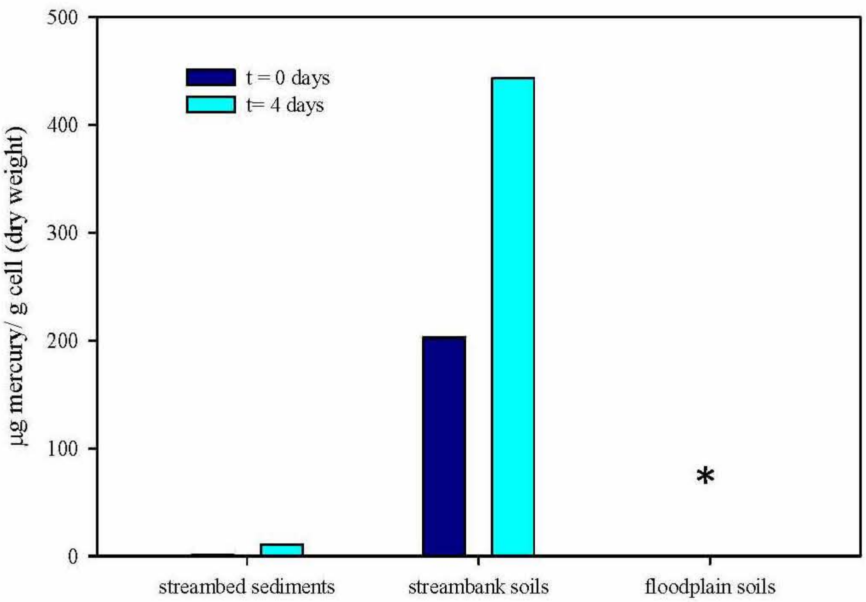

Figure 1. Mercury uptake in green algae C. reinhadtii cells when exposed to leachate from different sediment compartments. * = not detected

Experiment 3: Mercury methylation in different sediment compartments

Sediments from the floodplain, streambed, and streambank were incubated with clean creek water (at a ratio of 9 parts water to 1 part sediment) in a glove bag under anoxic conditions. Methylmercury was measured in the slurry samples initially and after one week of incubation. Treatments were compared to control sediments collected from First Creek on the Oak Ridge Reservation. Figure 2 shows that methylmercury concentrations were initially similar in the floodplain soils and streambed sediments. However, upon incubation, more methylmercury was produced in the streambed soil incubation, while it appears that net demethylation occurred in the floodplain soil incubation. The streambank treatment had the highest methylmercury concentrations, both initially and at the end of the experiment, with a net increase of >150% methylmercury content after one week of incubation.

Results from the three experiments described above suggest that while the total mercury concentration in sediment fractions is important, mercury speciation and potential for methylation is also important in driving mercury bioaccumulation. Future work will examine sites further downstream to see if these relationships hold throughout the watershed. These controlled experiments may help explain the unexpected mercury bioaccumulation trends in LEFPC. Importantly, the findings may help elucidate the role of water-borne mercury relative to in-stream sediment sources in controlling mercury methylation, and thereby help guide future remedial decision-making.

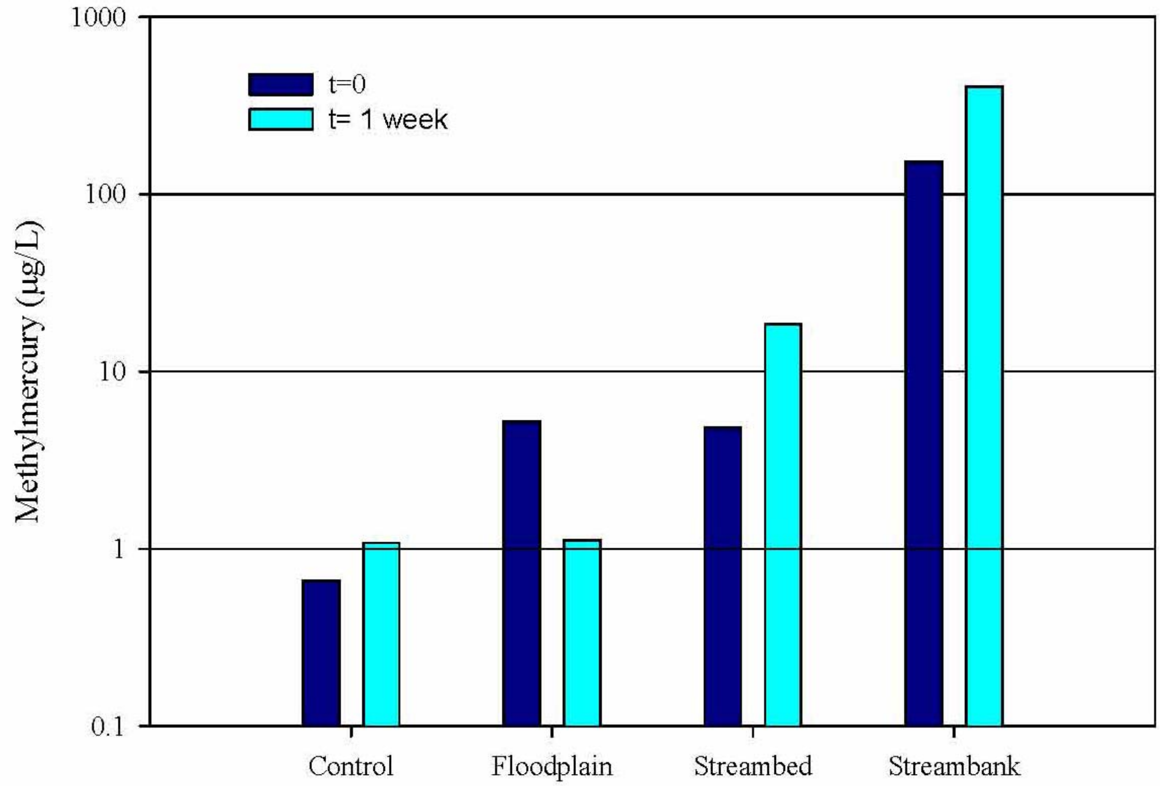

Figure 2. Methylmercury concentrations in sediments incubated under anoxic conditions for one week. Note the log scale on the y-axis.

ACTION PLAN 2
MERCURY BIOACCUMULATION IN LEFPC

FYR ISSUE: OF-3
CERCLIS OU: #10

ISSUE: New mercury bioaccumulation studies show mercury uptake in spiders along Lower East Fork Poplar Creek (EFPC).

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)/Feasibility Study (FS), Proposed Plan (PP)/Record of Decision (ROD), and 2006 Five-Year Review (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.

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 methyl mercury uptake in spiders near the South River in Virginia was completed in early fiscal year (FY) 2013. Based on this information, it had been planned to establish a protectiveness determination in Spring 2013.

PLAN/SCHEDULE: The U.S. Department of Energy (DOE) performed the requested literature reviews and data analysis. The scope of the literature review included:

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 2013 Remediation Effectiveness Report. 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 plans to complete a Data Quality Objectives workshop, an LEFPC Sampling and Analysis Plan, and subsequently perform the monitoring and evaluation that would be used to determine an LEFPC protectiveness statement.

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ATTACHMENT B:
Y-12 PROJECT INFORMATION

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Y-12 OREM Baseline Projects

(Summary Level)	**Mercury-Related D&D and Remediation Scope**
(Summary Level)	Outfall 200 Mercury Treatment Facility, Design, Construction, Operation
• (Project level) – note, ongoing projects are **BOLDED**	• Outfall 200 Water Treatment Facility
	• Outfall 200 Water Treatment Facility Operations
	Mercury-Use Facility D&D and Associated Soils
	• Alpha-2 Complex
	• Beta-4 Complex
	• Alpha-4 Complex
	• Alpha-5 Complex
	Other Mercury-Related Soil/Sediment Remediation and RODs
	• UEFPC Soils Remedial Action
	• UEFPC Remaining Slabs and Soils
	• UEFPC Soils 81-10 Area
	• UEFPC Sediments - Streambed and Lake Reality
	• UEFPC Groundwater Record of Decision
	• EFPC Surface Water Record of Decision
	All Other Y-12 D&D and Remediation Scope
	• Alpha-3 Complex
	• Beta-1 Complex
	• Beta-3 Prep for Historical Preservation
	• Remaining Biology Complex
	• 9206 Complex
	• 9212 Complex
	• Steam Plant Complex
	• Balance of Facilities Complex
	• Transition Facilities
	• Y-12 EM Facilities
	• 9731 Prep for Historical Preservation
	• BCV Burial Grounds Record of Decision
	• BCV S-3 Ponds Pathway 3
	• BCV DARA Facility
	• BCV Stream Restoration
	• BCV Burial Grounds Remedial Action
	• BCV White Wing Scrap Yard Record of Decision
	• BCV White Wing Scrap Yard Remedial Action
	• BCV Groundwater Record of Decision
	• Chestnut Ridge Record of Decision and Remedial Action
	• Clinch River/Poplar Creek Surface Water Record of Decision
	Y-12 Operations Scope
	S&M/Environmental Monitoring and Reservation Management
	• **Y-12 S&M/Environmental Monitoring**
	• Y-12 S&M/Environmental Monitoring New
	• Reservation Management
	Disposal Cells (Planning, Construction, Operations, and Closure)
	• **EMWMF and ORR Landfills Operations**
	• EMWMF Final Cap Construction
	• EMDF Design and Construction
	• EMDF Operations
	• EMDF Final Cap Construction

Demolition Projects, Facility Program Owners, and Gross Square Footage

(Mercury-Use Complexes are Highlighted)

D&D Project	No. of Facilities to be Demolished Total	Demolition Gross sq ft	Deactivation Only Gross sq ft	Program Owner	No. of Facilities by Program	Demolition Gross sq ft by Program
Alpha-2 Complex	4	332,595		NNSA	2	7,667
				SC	2	324,928
Alpha-3 Complex	3	196,870		NNSA	3	196,870
Alpha-4 Complex	4	513,374		EM	1	510,218
				NNSA	3	3,156
Alpha-5 Complex	15	662,541		NNSA	15	657,575
Beta-1 Complex	3	213,162		NNSA	1	N/A
				SC	2	213,162
9731 Prep for Historical Preservation (sq ft and facility count not included in totals)	0	N/A	37,159	NNSA	1	0
Beta-3 Prep for Historical Preservation (sq ft and facility count not included in totals)	0	small	0	NNSA	1	small
		N/A	255,656	NE	1	0
Beta-4 Complex	10	347,132		NNSA	10	347,132
Remaining Biology Complex	8	346,278		SC	8	346,278
9206 Complex	5	75,650		NNSA	5	75,650
9212 Complex	26	548,709		NNSA	26	548,709
Balance of Facilities	6	2,097		EM	3	701
				NNSA	2	716
				SC	1	680
Steam Plant Complex	6	68,951		NNSA	6	68,951
Transition Facilities	2	37,308		EM	2	37,308
Y-12 EM Facilities	7	54,313		EM	7	54,313
TOTALS	**99**	**3,398,980**	**292,815**	**EM**	**13**	**602,540 sq ft**
				NNSA	**73 ***	**1,911,392 sq ft**
				SC	**13**	**885,048 sq ft**
				NE	**1 Building, Deactivation Only**	

EM=Office of Environmental Management; N/A = not applicable; NE=Office of Nuclear Energy; NNSA=National Nuclear Security Administration; SC=Office of Science; sq ft=square feet.
* In addition to the 73 buildings, NNSA owns two facilities that will be deactivated only.

D1 MERCURY STRATEGIC PLAN COMMENT AND RESPONSE SUMMARY

Comments by: U.S. EPA Region 4
Comments Received: June 7, 2013
Title of Document: Strategic Plan for Mercury Remediation at the Y-12 National Security Complex Oak Ridge, Tennessee
Revision No: D1
Document No: DOE/OR/01-2605&D1
Date: March 2013

No.	Reference	Comment	Response
GENERAL COMMENTS			
(1)	**General**	As requested in EPA correspondence on April 25, 2013 and May 7,2013, the Outfall 200 CERCLA response action must include milestones for FFA Primary Documents in Appendix E and J that will document the basis for selecting and implementing this CERCLA response action. The documentation currently under development (Strategy and Conceptual Design) are limited to secondary supporting documentation and cannot replace documentation required under the FFA. Modify Appendix E/J to include the following milestones. Dates included below are suggested for discussion purposes in support of collaborative efforts among the FF A Parties to establish final dates prior to inclusion in a modified Appendix E/J: a. D1 Feasibility Study Addendum (9/30/13) b. D1 Proposed Plan (3/30/14) c. D1 Interim Record of Decision Amendment (12/30/14) d. D1 Remedial Action Work Plan (3/30/17) e. D1 Remedial Action Report (3/30/20)	Milestones have been added to Appendix E/J regarding the Outfall 200 Mercury Treatment Facility (OF 200 MTF) and have been incorporated in the document as appropriate: D1 Focused Feasibility Study/Proposed Plan, (9/30/14) D1 UEFPC Phase I IROD Amendment, (9/30/15) D1 Remedial Design Report, (9/30/16) D1 Remedial Action Work Plan, (9/30/17)

No.	Reference	Comment	Response
(2)	**General**	The Phase I & II RODs document a waiver for final cleanup of surface water (AWQC for mercury of 0.051 ug/L or 51 ppt). The Outfall (OF) 200 treatment plant design discharge standard should not default to the interim goal of 200 ppt that was developed for the Station 17 in stream standard. Ten years of interim actions based on the (200 ppt) goal have not demonstrated a significant positive impact on ecological receptors or the ability to meet the interim goal itself. Currently, the Phase I IROD has been identified as *"Not Protective"* under the most recent Five Year Review. DOE should construct the OF 200 treatment plant to meet the final in-stream standard at its point of effluent discharge, as measured during routine treatment plant operations. Since the OF 200 plant will not capture all sources, designing its operation so that the effluent discharge meets the final standard may increase the potential that the interim goal at Station 17 will finally be achieved and be responsive to ameliorating the Five Year Review *"Not Protective"* determination.	A phased approach is proposed whereby the OF200 MTF is being designed so that if needed, additional polishing unit operations can be evaluated against other broader actions to aid in further reducing mercury in the effluent, once the effects of other actions (e.g., capability of precipitation operation to reach the 51 ppt effluent concentration [as indicated is a possibility through bench-scale tests conducted to date], flow augmentation, diversion of process/watershed inputs to WEMA storm system, and discharge of the effluent approximately 1200 ft downstream of contaminated reaches of UEFPC) can be evaluated in terms of resultant flux/in-stream mercury concentration at Station 17. Also, see comment response #36 for more information.
(3)	**General**	The Strategic Plan indicates the observed decreases in mercury loading to the UEFPC from Station 17 in recent decades have not resulted in corresponding decreases to mercury levels in fish tissue. The Strategic Plan does not elaborate further on the relationship between water and fish tissue mercury concentrations except to acknowledge that the relationship is non-linear and not well understood. In order to further justify the remediation strategy proposed in the Strategic Plan, additional details about this relationship should be provided. *Revise the Strategic Plan to include a basic summary of any information that is well understood about the relationship between mercury concentrations in water and fish tissue including relevant biogeochemical processes. The discussion should also highlight what aspects of the relationship are not yet well understood and indicate how the uncertainties related to this lack of understanding were handled during the development of the plan.*	Strategy has been revised to include discussion of relationships between mercury species/forms and fish mercury concentrations that are known as well as those that are unknown. Pertinent to this comment, Matthews et al (2013) have recently published *(Science of the Total Environment*, 443:836-843) a detailed summary of the history of efforts to reduce mercury concentrations at Station 17 and the responses in fish tissue concentrations that followed these efforts. These authors also examined the relationship between water and fish concentration in White Oak Creek as it has evolved during similar efforts to reduce mercury concentrations in water at the ORNL facility. Both the Mathews et al paper, and another recent ORNL publication (Southworth et al 2013), also mention that fish tissue concentrations in lower EFPC are not being entirely controlled by waterborne mercury from the plant site. They note that more than 80% of the mercury loading from the EFPC watershed is derived from floodplain soils and downstream creek sediments due to stormflow erosion of bed sediments and bank soils.

No.	Reference	Comment	Response
(4)	**General**	The document does not provide the information necessary to adequately understand how free phase Hg, a Principal Threat Waste (PTW), relates to the ongoing degradation found in the Upper East Fork Poplar Creek (UEFPC). It is understood that this source material may, in some specific conditions, not be currently impacting surface water. However, discernable zones of free phase Hg in soils and the building infrastructure is a PTW even if this PTW source material is currently not shown to be very mobile. The presence of Hg PTW and the strategy to mitigate this source and address the CERCLA statutory reference of treatment of principal threats must be included the strategy. Therefore, discussion and planning for free phase mercury found in subsurface soils (and not only in storm sewer pathways or other currently mobile pathways) must be part of remediation planning at Y -12 and should be presented in this strategy document.	Within the Phase I IROD, mercury-contaminated media that contributes to surface water contamination has been defined as PTW, and likewise is addressed as PTW in the Strategic Plan (see Section 2.2.1.1): (1) WEMA vicinity soils and storm sewer sediments, (2) sediments in UEFPC and Lake Reality, and (3) soils in the vicinity of Building 9201-2 that contribute to shallow groundwater contamination and in turn to surface water contamination. The Phase II IROD addresses soils that are accessible, and currently inaccessible (under buildings), with a remedy (excavation) to remediate these soils to levels determined to be protective through modeling as described in the Phase II IROD. Additional information added to the plan in Section 2.2.1.1 states that future RODs for groundwater and surface water remediation have not yet been proposed. Soil remediation levels will be reassessed at the time of development of these future RODs if needed in order to meet final goals. These statements address soil mercury contamination that is not currently shown to be mobile, and is therefore not addressed through the Phase I and II RODs, and which may be addressed in future RODs if final goals for groundwater and surface water are not able to be met, presumably because of continued contamination contribution by these soils. However, at this time, without having completed interim remedial actions for soil/sediment that is known to be mobile, it is currently not feasible to determine if contamination that is considered non-mobile through modeling is contributing/or will contribute to groundwater/ surface water contamination. The discussion and planning for those “remaining” mercury sources is therefore addressed in the plan through deferral to future decisions and possible future actions.

No.	Reference	Comment	Response
(5)	**General**	Table 4 identifies many issues in the form of questions that must be refined/resolved during the course of implementing this strategy. Listing these key uncertainties in Section 1 may highlight attention and management of these matters. A summary discussion of the evolving nature of this strategy and potential updates in the future should be included.	Figure 1 in Section 1 is a graphic capturing these key issues at a high level. A paragraph describing the evolving nature of the strategy and potential future updates has been included in both the introduction and conclusion sections.
SPECIFIC COMMENTS			
(1)	**Executive Summary, p.ES-1**	The term "contact water" is included in the last paragraph. Explain the term.	Revised as suggested.
(2)	**Executive Summary, p.ES-2**	How is targeted legacy material disposition related to the ongoing uncontrolled mercury flux issue?	In this case, the statement regarding "targeted legacy material disposition" was made in reference to the removal and disposition of legacy tanks containing mercury-contaminated material. The statement is made in support of the lead-in phrase "Other near-term efforts supporting the mercury cleanup include….", it was not made related to the mercury flux issue. A new paragraph was added to alleviate the confusion.
(3)	**Executive Summary, p.ES-2**	Revise (c) to state: development of required planning documents which effectively document the phased scope and schedule for the planned deployment of CERLCA operable unit response actions. This may include some generic documentation for multiple areas if such documents develop information that is common to all operable unit phases. However generic documentation will not take the place of an operable unit's specific scope and schedule response action planning and completion reporting.	The term "as appropriate" was added to the text in the Executive Summary to capture the fact that there are definitely limitations to the ability to generate generic documentation. However, the explanation requested in the comment is too detailed for the Executive Summary, but was added to the text under the second bullet in Section 3.7 of the D2 document that presents the opportunity of "combined or generic" documentation. Also, see EPA specific question 58 response.
(4)	**Executive Summary, p.ES-2**	At the end of the first sentence of the final paragraph, revise to state: "and monitor the scope of CERCLA response actions at Y-12."	Revised as suggested.

No.	Reference	Comment	Response
(5)	**Introduction, p.1, First bullet**	Replace "as low as reasonably achievable" with "to protect human health and the environment."	Revised as suggested.
(6)	**Introduction, p.1**	The statement "While comforting to know that human health has not been affected to date ... " appears to be more definitive than the ATSDR statement in the first sentence. The first sentence states no adverse health effects '" "due to most..." This applies to most past and current exposure but does not apparently apply to all exposures. Furthermore, the matter of mercury flux effect on the environment, the acknowledged greatest adverse mercury release exposure effect, appears to be understated relevant to human exposure and an ecological exposure summary seems appropriate at this up front location in the document.	The statement by ATSDR was qualified with the words "most past" because they could not unequivocally state that "*no* past exposure pathways" have resulted in adverse human health effects. But the study did determine that no adverse health effects had been found from those past exposures that were able to be analyzed, which was quite extensive but not all encompassing. Much more information has been added to the document regarding ecological exposure (see responses to General Comment 3and Specific Comment 19) to mercury. Additionally, a sentence has been added to the paragraph addressing fish tissue mercury concentrations as an introduction to more material added to the rest of the document regarding the fish/human health link.
(7)	**Section 2.1, p.3**	The first sentence should acknowledge downstream impacts beyond EFPC, down to and including the CERCLA Operable Unit Lower Watts Bar Reservoir.	Revised as suggested.
(8)	**Section 2.1, p.3**	Include "ecological receptors" to the end of the second sentence.	Revised as suggested.

No.	Reference	Comment	Response
(9)	**Section 2.2, p.5**	The middle of the paragraph refers to adding IFDP scope to the baseline in discrete projects. Include a statement that this IFDP scope has been added to the scope and schedule of FFA cleanup projects in FFA Appendices C, E and J. Include a statement that the NCP framework for cleanup and the FFA process and schedules, in particular phased response actions in Operable Units, will not be replaced by the DOE framework.	Revised in part, as requested regarding the FFA App. C, E, and F scope. Additionally, Sections 2.2 and 2.3 were reversed, so that the Regulatory Framework discussion precedes the DOE Framework discussion, as the Regulatory process defines the scope and comes first. A statement regarding not replacing the NCP/FFA framework with the DOE framework is not necessary; the wording was changed to alleviate any confusion by a reader (there was no intent meant to replace NCP/FFA framework with DOE requirements). The DOE framework discussed in this paragraph is the project introduction/ approval process, per DOE Order 413.3B. That process explains and introduces the scope of the projects to other DOE entities (for funding and planning purposes, etc.), but the definition of the scope is set through the CERCLA and FFA processes in conjunction with TDEC and EPA. To help cross-walk the FFA project framework to the DOE projects definition, a clarification was added to the first sentence, stating the project scopes are developed “based on tri-party agreed-on actions”.
(10)	**Section 2.3.1, p.6**	It is not clear why Bear Creek Valley would be included in a mercury strategy document for the Y -12 UEFPC mercury source problem.	Bear Creek Valley is introduced very briefly, to allow a complete picture of Y-12 cleanup scope to be developed. It is included so as not to leave gaps in scheduling, funding, etc. in the Y-12 “picture”. Additionally, TDEC has requested that future mercury cleanup actions that may be related through disposal of excavated UEFPC soils in the Bear Creek watershed be addressed. This language has been added to the document.
(11)	**Section 2.3.1, p.6**	The summary of the Phase I IROD states this decision led to an interim action to protect surface water. This ROD included those mercury Principal Threat Waste sources believed to be migrating and impacting surface water. This summary should describe this focused use of Principal Threat Wastes as an interim remedial goal in the Phase I IROD (i.e., migration threat only) and acknowledge that Principal Threat Wastes that are not mobile are also addressed explicitly in this strategy.	The summary of the Phase I and Phase II IRODs have been expanded to note specifically which contaminated areas/media are addressed by each ROD. Additionally, text has been added to the document (previously Section 2.3.1.1, now 2.2.1.1) in reference to statements from both Phase I and II RODs that future, additional soil remediation – based upon the results obtained from the Phase I/II interim actions and the requirement to meet future surface water goals – may occur. Also see General Comment #4 response.

No.	Reference	Comment	Response
(12)	**Section 2.3.1.1, p.6**	The final sentence of the first paragraph should describe this as an interim goal that used the interim ARAR waiver and to date, the goal has not been met.	The sentence has been revised to state the 200 ppt is an interim goal, based on an ARAR waiver. This section is limited to an introductory discussion of the regulatory framework – it does not include a discussion/mention of progress or current situations. A new table (Table 4) has been added to the document that addresses this interim goal, and in addition, it notes that this goal has not yet been met.
(13)	**Section 2.3.1.1, p.6**	The discussion of the Phase I IROD in this section is incomplete. Please include references cited both in the Phase I IROD (DOE 2002) and Phase II IROD (DOE 2006) that refer to the need to address free-phase Mercury (Hg) as a principal threat waste (PTW) as required by the Phase I IROD. The discussion of the Phase II IROD requirements should cite that part of the second ROD that clarifies, "Hg PTW (has) been addressed in the Phase I IROD".	Section 2.3.1.1 (now Section 2.2.1.1) has been revised to include the information presented in the Phase I and Phase II IRODs regarding the contamination areas addressed by each IROD. It is noted that PTW identified in the Phase I IROD as WEMA soils that contribute to surface water contamination was to be addressed through capping of portions of the WEMA area and installation of horizontal wells. These actions were removed from the ROD, by agreement of the FFA parties, through an Explanation of Significant Difference. With that decision, remediation of those soils, considered as PTW, falls under the Phase II IROD. (See revised Section 2.2.1.1 for the discussion).
(14)	**Section 2.3.1.1, p.8**	The first sentence on this page should be revised to state: " ... from exposure to hazardous substances in the uppermost two feet of soils and ... "	Revised as suggested.
(15)	**Section 2.3.1.1, p.6-8**	This Section does not provide a clear explanation of the relationship and applicability of the Phase I Record of Decision (ROD) and the Phase II IROD. It is unclear what, if any, discrepancies exist between the Remedial Action Objectives (RAOs) and Remedial Goals (RGs) presented in each ROD. Also, it is unclear if there are any situations in which both RODs could be considered applicable to the same remedial action. *Revise the Strategic Plan to include additional information about the scope, applicability, and RAOs/RG presented in each ROD. Be sure to address how discrepancies between these documents will be handled in situations where they are both considered applicable.*	Text has been added to Section 2.3.1.1 (now Sec. 2.2.1.1) to define the scopes of the two IRODs and differentiate their “coverage”. An interim goal/endstate table has been added to the document and addresses this question, as it gives objectives and goals for the various media addressed by the IRODs; this table is included in Section 3.3. Also, see comment # 13 above for responses regarding any “overlap/discrepancy” of the documents, which is the “passage” of WEMA soils remediation from the Phase I to Phase II IROD. At this time, there do not appear to be situations where both IRODs are considered applicable (e.g., overlap).
(16)	**Section 2.3.1.3, p.8**	It would be informative to stakeholders to include a statement describing when these final actions are scheduled based on current planning assumptions.	Revised as suggested.

No.	Reference	Comment	Response
(17)	**Section 2.4, p.9**	This discussion states that costs for working within PIDAS are not included for Beta-4 and Alpha-5. Discuss whether NNSA is funded, or is seeking funding, to develop plans to alter the PIDAS configuration on a schedule that is ahead of the start of CERCLA response actions at these structures.	Revised as suggested.
(18)	**Section 2.4, p.9**	In the complete first sentence, replace "remediation" with "response actions."	Revised as suggested.
(19)	**Section 2.6**	Current Y -12 Conceptual Model, indicates data collected during 2012 showed a significant decrease in the Outfall 200 average mercury flux from 31 grams per day (g/day) in 2011 to 7 g/day. Conversely, the Station 17 average mercury flux decreased by only 3 g/day, from 33 to 30 g/day. The conceptual site model for mercury sources at Y-12 attributes approximately 70-80 percent of the flux observed at Station 17 to Outfall 200. Based on the above information, there appears to be a significant residence time required for the mercury contamination discharged from Outfall 200 to reach Station 17. A specific explanation of the fate and transport of mercury contamination after it is discharged from Outfall 200 but before it reaches Station 17 should be provided to further support the proposed remediation strategy. *Revise the Strategic Plan to include an explanation of the estimated time required for mercury contamination discharged from Outfall 200 to reach Station* 17. *Include a discussion of the processes by which mercury in this section of UEFPC is transported. Also, clarify which of the near-term remediation strategies discussed in the Strategic Plan will directly target mercury in this part of UEFPC.* For example, it is unclear if any of the traps recently installed for the removal of free mercury are located between Outfall 200 and Station 17. *Revise the Strategic Plan accordingly.*	The plan has been revised to include a discussion of the behavior of mercury in UEPFC (between Outfall 200 [OF200] and Station 17) after it is discharged at OF200. That discussion highlights the fact that mass balance for this reach is dynamic and controlled by timing and duration of dry weather and storm flows. The reach effectively stores significant amounts of the mercury discharged during dry weather flow in bed sediments and then releases portions of it during storm flow. The reach provides trapping of particle-associated mercury (including free phase mercury) between storm events as well as opportunities for solution phase (dissolved) mercury to partition to bed sediments and suspended particles. In addition some solution phase mercury is lost from the creek due to reduction of ionic mercury to the volatile elemental form and evasion from creek water. These processes make calculation of short-term mass balances, which do not include storage and evasion terms, meaningless. The relevance of this behavior to remediation strategies is that it makes effectiveness of any applied remedy more difficult to assess. Nonetheless, work by ORNL and Y-12 continues to improve the understanding of the residence time of mercury in UEFPFC under various discharge scenarios. Near-term strategies do not explicitly target mercury in the reach, but through the planned flow augmentation modification and the discharge of future OF200 MTF effluent 1200 ft downstream of this reach, some relief in terms of by-passing this area of the stream will be realized. Near-term strategies do explicitly address capture of free phase mercury in pipes at and upstream of OF200.
(20)	**Table 3, p.11**	Consider adding a column to list DOE Document numbers related to the actions taken. This would improve this strategic plan as a resource of links to past efforts.	Revised as suggested.
(21)	**Section 3, p.15**	Refer to planning documentation in RmAWPs and RAWPs in addition to the WHP.	Revised as suggested.

No.	Reference	Comment	Response
(22)	**Section 3, p.15**	Include a brief summary of the current planned timeline for the overall set of mercury cleanup projects in the FFA.	Revised as suggested.
(23)	**Figure 7, p.16;** **Section 3.3.3, p.20,** **Table 4, p.23**	The figure, section and table refer to a Treatability Study for Soils at Y-12 (listed in References, as well). Has this document been shared with the regulators? And if not, will there be future opportunity to review?	As of this response writing, the document has been shared with regulators (transmitted in June of 2013).
(24)	**Figure 7**	"Free Mercury Removal" is not clear. Explain and include CERCLA PTW.	Free Hg Removal is a small project. The introduction to the figure (Section 3.1) states that discussions of the actions are given in subsequent sections. See Section 3.4.1, Table 5 for a summary of the Free Mercury Removal project.
(25)	**Section 3.1, p.16**	Describe why the 9201-5 sump is not used.	Revised as suggested. Also see Table 3 which contains reference to the Non-Significant Change to the Phase I IROD documenting this cessation of sump treatment.
(26)	**Section 3.1, p.17**	The second paragraph should refer to Subtitle C and D Landfills; not Schedule.	Revised as suggested.
(27)	**Section 3.1, p.17**	The final sentence of the second paragraph states "this work has been initiated. It would help if "this work" was clear and specific project documentation for "this work" was referenced. Additionally, the next paragraph should cite specific project documentation for "These and other technology development initiatives are ongoing ... "	Limited revisions made. Also see comment/response # 32. A statement was added referring the reader to Section 3.5 Technology Development, for a full discussion of TD initiatives. It would be repetitive to go into any detail in this section.
(28)	**Figure 8**	Excellent strategic schedule. RAWP and RAR documents needed for OF 200. Explain why "Free Mercury Removal" is an operational activity and not a CERCLA response action. The figure should represent PTW elemental mercury.	Figure modified to include RAWP and RAR for OF 200 facility. See comment/response #33. The “Free Mercury Removal” is a CERCLA action (see Table 6, which gives an explanation of this action). It is noted in the Figure as having an “operation” because the traps will be checked periodically for elemental mercury needing to be removed. An element has been added to the figure to account for possible additional actions that may be required in the future to address attaining future surface water and groundwater goals.

No.	Reference	Comment	Response
(29)	**Section 3.3**	There is an incorrect statement that groundwater and surface water end states are not determined. It appears this section is missing a description of which end states have been determined (e.g., building demolition and land use). Land use expectations do not determine groundwater and surface water resource classifications. Clarify that these end state resources have been determined by the State and that the timing and ability of achieving these resource based end states have not been determined.	The statement has been revised as follows: "Land use expectations do not, however, determine groundwater and surface water resource classifications and therefore final goals. Final decisions for groundwater and surface water, which could potentially include reclassification of surface water or groundwater resources, have yet to be determined and will be addressed in future RODs."
(30)	**Section 3.3.1, p.18**	The final sentence of the second paragraph needs to state that the waste is not RCRA Hazardous. Meeting LDR does not necessarily mean the solid waste is no longer hazardous.	Revised as suggested.
(31)	**Section 3.3.2, p.18**	Include the CERCLA bias against off-site land disposal of untreated waste (NCP 300.430(f)(ii)(E)) and Off-Site Rule (300.440).	Revised as suggested.
(32)	**Section 3.3.3, p.18**	The completed study for soils treatment is cited. Include a summary of the study conclusions.	A new section was added (Section 3.4.4.1) to address the study. The summary is very high level. Interested readers are referred to the study for further information.
(33)	**Figure 8, p.19**	This schedule should include the CERCLA milestone deliverables associated with the OF 200 MTF. Namely, the FS Addendum, Proposed Plan, IROD Amendment, and Remedial Action Work Plan.	The schedule has been revised to indicate all these documents; milestones dates that are set, are given in Table 6.
(34)	**Section 3.3.3**	In the LDR discussion there needs to be a brief discussion on the possibility of underlying hazardous waste constituents in the waste at the point of generation. If any waste has other hazardous waste constituent (underlying hazardous waste constituents) at concentrations above the respective universal treatment standards, the generator would have to address those constituents as well.	A discussion was given, although brief. It was revised somewhat to be more definitive. See the last sentence in the first paragraph under Section 3.3.3.

No.	Reference	Comment	Response
(35)	**Section 3.3.5, p.22**	Summarize the CERCLA response action assessment/ evaluation/decision processes here and identify operable unit phases and documentation of response actions planned. Specific documentation for response action phases implemented as operable units must include response action work plans that describe the planned work and documentation (e.g., Design, Design Reports, design characterization *SAP/QAPPs*, WHP for EMWMF waste, PCCR), as necessary based on the scope, complexity and phase of the operable unit response action. This comment should be addressed together with Specific Comments 37, 39, 44, 46, 48, 50, 57, and 58 below.	Reference is added in Section 3.3.4 (was 3.3.5) to the CERCLA process and the reader is pointed to Section 3.6 (Regulatory Strategy), which is dedicated to that process. Section 3.6 was expanded to address this process in more detail as requested in this comment.
(36)	**Section 3.4.2, p.22**	The OF 200 treatment plant design discharge standard should not default to the interim goal that was developed for the Station 17 in stream standard. The BSWTP was designed earlier in the cleanup and its design/operation also recognized that its effluent was expected to be well below the Station 17 in stream standard. Although this lower standard was not set for the effluent of BSWTP, it is now appropriate for the OF 200 plant to be designed to the support the final Station 17 in stream standard. The goal of this plant is to reduce flux. OF 200 should not be designed to allow the maximum possible flux based on an interim goal for an in stream standard at Station 17. Over ten years of interim actions based on this goal have not demonstrated a significant positive impact on ecological receptors or the ability to meet the interim goal itself. Currently, the Phase I IROD has been identified as Not Protective under the most recent Five Year Review. DOE should construct the OF 200 treatment plant to meet the final in stream standard at its point of effluent discharge, as measured during routine treatment plant operations. Since the OF 200 plant will not capture all sources, designing its operation so that the effluent discharge meets the final standard may increase the potential that the interim goal at Station 17 will finally be achieved and be responsive to ameliorating the Five Year Review "Not Protective Determination."	Agree that the in-stream criteria for UEFPC will be 51 ppt. A phased approach to meeting this criteria as well as the goal of reducing fish mercury levels is proposed, and an evaluation of possible further actions such as the addition of a polishing step for the OF 200 MTF is part of that phased approach through use of a CERCLA Alternatives Analysis. Bench-scale testing of the current conceptual design that employs the use of chemical precipitation only to reduce mercury has been shown to reduce the mercury to at or below 51 ppt. It is proposed that the facility be built to the current conceptual design specifications (e.g., no carbon polishing) in order to test the full-scale system for its ability to reach the AWQC for mercury of 51 ppt without the costly carbon columns polishing step. The conceptual design does accommodate the addition of carbon columns to provide the additional mercury removal, if needed, after the facility has become operational. Also, see general comment response #2 for additional information.
(37)	**Section 3.4.2, p.22**	CERCLA documentation is missing from the final paragraph. It may be important to define the DOE project terminology but CERCLA documentation must be planned.	Revised as suggested.

No.	Reference	Comment	Response
(38)	**Section 3.4.2**	The section accurately states what this Hg strategy objective is with respect to DOE's view of how it central remedial action (OF 200 MTF) will achieve remedial goals. However, this section does not refer to remedial action objectives that will need to be brought forward as stipulated in the existing Phase I and Phase II IRODs or further developed and included in the pending I ROD Amendment (as relates to surface water cleanup). It is recognized this document is not the place for this detailed information, but this section should point toward or provide a placeholder for consideration of additional remedial goals that may need to be developed before design completion.	A statement was added in first paragraph of Section 3.4.2 noting that RAOs for the OF200 MTF will be included in the Phase I IROD amendment.
(39)	**Table 4&5, p.23-24**	The tables provide a well thought out strategy for the many contingencies or critical path elements that will be required as this project becomes reality. The tables do not provide enough notation that many of the documents and studies will require regulatory approval. EPA recommends a 'regulatory critical path' column be added to Table 4 (similar to Table 5); or, at a minimum, an asterisk footnote added to strategies and activities where regulatory interface will be required or may be anticipated.	A global footnote has been added to Table 4 to document the needed regulatory interactions. Table 5 documents have also been footnoted as requiring regulatory approvals.
(40)	**Table 4, D&D Waste**	Processing all facilities consecutively must be balanced with funding available for early action on environmental media.	Understand and agree. The early action on environmental media is captured by the proposed OF200 MTF. As explained in the document, (see Section 3) additional early actions that are currently not “foreseen” but may be required to see responses in fish or to meet lower mercury in water concentrations, would thus push out and/or extend facility demolition.
(41)	**Table 4, Building Slab**	The end state must address the need to access PTW mercury in the subsurface structure and surrounding soils.	Wording was added to address the need to access subsurface and surrounding Hg-contaminated soils for characterization and remediation.
(42)	**Table 4, water**	The interim surface water goal of 200 ppt at Station 17 is not an end state. The surface and groundwater end states should be tied to the State's use classification.	Revised as suggested.

No.	Reference	Comment	Response
(43)	**Table 5, p.24**	The last sentence of the "Mercury-Contaminated Soils Treatability Study" text provided in the Activity column of Table 5 states, "one additional technology which did not receive a soil sample for demonstration was recommended for further evaluation". No additional information is provided about this technology. *Revise the Strategic Plan to provide more information about the referenced technology.*	The technology is a stabilization technology, which has been demonstrated for mercury in other soils (Y12 soils in particular, but at different starting concentrations than the 3 vendors that are compared in the study). Section 3.4.3 has been added to the document to summarize the soils treatability study; however, it is very high level. The reader is pointed to the study for further information.
(44)	**Table 5, p.24**	The first activity description, last sentence should include the Regulatory/DOE submittals with approximate schedule. The information should be repeated or referred to in the Regulatory/DOE submittal column.	Table 5 (now table 6) has been revised to include the schedules for future document submittals (as known) in the submittal column. References to completed documents have been included as well.
(45)	**Table 5, p.24**	The Mercury Contaminated Soils Treatability Study notation does not show a published date. It is assumed the Regulatory/DOE submittal Report has not been submitted. This is a concern since the activity column informs that 'the treatability studies were successful. .. ". Please clarify either in a response or in an appropriate section (3.4.2?), DOE's intent to provide this document to the regulators.	As of the writing of this response, the document has been provided to the regulators (transmitted June of 2013). Reference has been added to the table (now Table 6).
(46)	**Section 3.4.3.1-3.4.4, p.25-26**	The text in these sections should clarify that such activities as start of construction, scoping activities; or submittals of treatability, feasibility studies, and WHPs will require regulatory interface and/or approval.	Additional text referring to CERCLA documents and approvals required were incorporated in various sections.
(47)	**Section 3.4.3.1, p.25**	How does DOE assure that LM is finite and operations are not continuing to expand the universe of LM?	DOE has specific requirements regarding the turnover of facilities from an active owner (e.g., NNSA) to OREM. Those specific requirements (under DOE O 430.1B, Chg 2, *Real Property Asset Management*) guide the acceptance/non-acceptance of facilities with legacy materials. OREM controls LM receipt through application of this Order during transition of facilities. OREM has an existing LM inventory in its inactive facilities. Ongoing operations do not contribute to legacy inventories.

No.	Reference	Comment	Response
(48)	**Section 3.4.3.1, p.25**	This section describes FFA WHP documents to plan work for waste going to the CERCLA Landfill. Describe the FFA planning documents for all response action phases and how this document is used to develop the plans/reports for incremental phases. Include a description of how CERCLA derived waste disposition that is not sent to the CERCLA Landfill is not a part of the planned response action and documented in other plans since a WHP will not be developed.	Section 3.6 discusses documentation for all response action phases, and gives a brief look (Table 7) at the plans/reports expected for the various phases for actions discussed in the strategy. This table is not meant to be all inclusive, but rather, to give a general overview. The waste generated by a response action that does not go to EMWMF is not covered in a WHP, but rather, a Waste Management Plan would address that waste, as mentioned in Section 3.4.3.1. This document is a strategy document and not a workplan.
(49)	**Section 3.4.3.1, p.25**	Define the "gap analysis" and how/when it will be reported.	The Gap Analysis is a document that examines existing characterization data on mercury contamination in Alpha-4, Alpha-5, and Beta-4 at Y-12 and considers the future characterization needs in order to identify missing data or data that need not be repeated, thus focusing future efforts where needed. This document will be utilized during the DQO sessions for these buildings.
(50)	**Section 3.4.3.1, p.25**	CERCLA documentation is missing from the final paragraph. It may be important to define the DOE project terminology but CERCLA documentation must be planned.	Text added; see response to comment # 46 and #48**.**
(51)	**Section 3.4.4, p. 27**	The final sentence of the first paragraph states that work on soils is sequenced after building demolition. The strategic plan should also describe the timing of the subsequent sequencing of soil work. The plan must show balanced approach to sequencing soil work so that all soil cleanup is not deferred until after all building demolition. The current Dynamic Planning Model shows this balanced approach. Describe this balanced approach more thoroughly in the plan.	Related to Comment #63. Added the term “immediately” before the words “follow demolition” as suggested in #63.

No.	Reference	Comment	Response
(52)	**Section 3.4.4-3.5, p.26-27**	The mercury assessment technology development study in 2013 sounds very interesting and could be a critical tool to refining the conceptual model for residual mercury source identification in the earlier stages of overall strategic planning. However, the study appears to not be as fully integrated into CERCLA planning as it might be if the three parties were to collaborate more on its potential application. This strategic plan should look into specific opportunities to apply this assessment technology. Ideally, the plan could be deployed at a scale that supports technology development needs and at the same time provides results that would support CERCLCA mercury soil source assessment needs and be included in CERCLA documentation. Although this integration appears to be the purpose of the ARTD Program within EM and this strategic plan, specific efforts to integrate technology development and CERCLA assessment needs appear to be substantially internal to DOE EM. This strategic plan is an opportunity to collaborate with EPA/TDEC on this tool and leverage the technology development resource to meet CERCLA assessment objectives. At most, this plan refers to those objectives without any specifics for an applied outcome and the reporting of the results in the context of CERCLA documentation. This comment emphasizes assessment in this context due to this being an earlier objective in the overall sequence of cleanup. Similar efforts should be considered to apply technology development for CERCLA purposes (e.g., treatability studies) and reporting. DOE should consider formally submitting applied technology development reports as FFA secondary documents.	By “mercury assessment technology development study” the assumption for this response is that the mercury vapor soils characterization work is being addressed in this comment. Efforts are ongoing to integrate the work and results of technology development activities into cleanup activities. For example, a technology development plan will be completed, and will serve to help the integration of technology development efforts into the CERCLA processes external to DOE, and invite input from EPA and TDEC. DOE will provide Applied Technology Development reports to TDEC and EPA.

No.	Reference	Comment	Response
(53)	**Section 3.4.4, p.27 (top)**	The Treatability Study Report cited on the previous page has not been reviewed by EPA or TDEC. See previous comments. The discussion that follows on page 27 is incorrect and must be revised or omitted. The 'current default treatment' as cited here for the mercury contaminated soils is governed or stipulated *only by* the Phase II IROD. The Phase II IROD selected remedy does not satisfy the intent to address free phase mercury or Principal Threat Waste (PTW). The Phase II IROD (DOE 2006), in Section 1.4, page 1-6, states its limited scope with respect to soils remediation: "The ROD for Phase I interim source control action in the UEFPC Characterization Area (DOE 2002a) constitutes the initial phase and addressed interim actions for *remediation of principal threat waste*, mercury-contaminated soils, sediments, and point groundwater discharges that contribute contamination to surface water." [Italicized underscore added for emphasis]. Please revise this section accordingly.	The Treatability Study Report has, since these comments were received, been provided to regulators. The Phase II IROD addresses soils that are accessible, but also those soils that are inaccessible because as it states "This remedy includes *all Y-12 soils* as, over time, currently inaccessible soil will become accessible and will be addressed." [Italicized underscore added for emphasis] As discussed in previous comment responses (see General 4, Specific 13,15) PTW that includes WEMA soils, are covered by the Phase II IROD. Additionally, as discussed under General Comment 4 response, both IRODs leave open the possibility to revisit soil remediation if surface and groundwater future ROD goals require it. No limitations on contamination are made within these IROD statements, and therefore PTW is included in this future action. More information has been added to the Strategy Plan to discuss the intent to further investigate in situ treatment, which may be more applicable to mercury-contaminated soils that are difficult to access and/or contain non-mobile mercury contamination.

No.	Reference	Comment	Response
(54)	**Section 3.5-3.6**	The final paragraph of Section 3.5 includes a statement that *"investments in the characterization of mercury sources near and around facilities ... ... will enable refined cost estimates for cleanup and allow for more surgical treatment in place as an alternative to the baseline technology, excavation."* This statement appears to be a fundamental CERCLA RI objective that was not met by the watershed RI due to its overall assessment scale. Earlier in this strategic plan (Section 3.4.4), it states *" ... depth and areal extent of mercury contamination under and around buildings (basements) remains largely unknown. .. "* The bullets defining the outcome of technology development (i.e., p. 28 prior to Section 3.6) are typical NCP objectives for the RI/FS process. Together, these statements reveal significant shortcomings in the watershed scale *RI/FS* implemented in the 1990s. It is noted that FFA Appendix E and J include no RI starts to address these significant data gaps highlighted in the statement above. This strategic plan needs to include CERCLA assessment activities and documentation that will support CERCLA response action evaluations, decisions and remedy implementation. The strategy misses the mark on this matter and seems to emphasize Technology Development to meet CERCLA data assessment needs not met by the RI. Furthermore, WHPs appear to be the only CERLCA documents planned and all other CD-3 documents are expected to meet CERCLA documentation objectives. Much work is needed here on the CERCLA strategic plan.	The uncertainties pointed out in the strategic plan regarding characterization are with respect to volumes of waste (resulting from remedial actions) that will require management through treatment/disposal. The RI/FS process completed on the UEFPC area sufficiently bounded the expected contaminants and their concentrations, and therefore was able to address the risks posed, but without extensive characterization, the areal extent (surface area) and depth of the contamination and exact locations requiring remediation were not able to be defined. This "data gap" does not change or otherwise modify the selected remedies, nor does it change the results of the CERCLA evaluation under which the possible remedies were analyzed and compared, since they were analyzed/compared on the same volume basis. The results and selected remedies would remain the same even if volumes were modified. However, the estimated costs would change. Additionally, if situations change drastically for some, at this time unforeseen reason, changes to those decision documents can be made through the Explanation of Significant Difference process or an addendum to the decision documents, which would require tri-party concurrence and approval. The CERCLA process for data quality objectives, sampling and analysis plans/quality assurance program plans, and waste handling plans for both characterization of buildings and soils allows for refining characterization, volumes of waste expected, and plans for treatment and disposal. For the planned building demolitions, a Removal Action Work Plan (DOE/OR/01-2479&D1) has been approved. For soil/sediment remediation in UEFPC watershed, a Remedial Action Work Plan (DOE/OR/01-2423&D2) has been approved with the understanding that attachments will be added as each soil area remedial action is undertaken. Some clarification regarding CERCLA documents required has been added to Table 6 (now Table 7) to address the latter portion of this comment; in addition, see the response to comment numbers 46, 48, 50, and 58.
(55)	**Table 6**	This table may be appropriate to deploy excavation actions based on the old RI but would be inconsistent with Section 3.5.	Wording was revised in first paragraph of Section 3.6 (that discusses Table 6…revised to Table 7) to acknowledge this.

No.	Reference	Comment	Response
(56)	**Section 3.7, p.30**	The paragraph beginning with "Mercury remediation projects ... " refers to the following that are not at all clearly demonstrated: - Risk Management Plans - Contingencies - Risks managed (including funding availability) are managed in the baseline. Expound on how these plans/contingencies and risks are documented and managed.	Text has been added to address the risk management methodology used, which includes Monte Carlo analysis for calculation of cost and schedule contingencies based on identified risks. Contingencies at 50 and 80% confidence levels are then accounted for in estimated project costs and schedules.
(57)	**Section 3.7, p.30**	Describe how the CERCLA assessment, decision and remedy implementation process will be documented to support the deployment of the opportunity in the first bullet. EPA does not support use of removal actions for these activities due in part to DOE's recent efforts to minimize EPA oversight of CERCLA removal actions at ORR, and the fact that early and interim remedial actions can be deployed in a timely manner.	At this time, there are no planned removal actions in this document. The word “removal” in this usage was not meant to refer to a “Removal” action per CERCLA. Wording has been modified to clarify this, as it refers to areas of localized contamination (e.g., in a building wall or roof) that can be separated from non-contaminated areas and managed separately to reduce costs. This is a form of volume reduction.
(58)	**Section 3.7, p.30**	The opportunity as described in the second bullet is not clear. First, it appears that Section 3.5 actions are evaluating the use of the existing soils/sediment RAWP as it pertains to mercury in and around the buildings. The scope of this RAWP is limited to the uppermost 2 feet and currently does not address a low mobility PTW at depth greater than 2 feet. It is not clear how this supports further CERCLA documentation consolidation. DOE may choose to utilize FFA documentation to meet its internal needs. EPA does not support the use of internal DOE documents to meet the needs of CERCLA documentation.	This appears to be a misunderstanding…this opportunity was not meant to combine CERCLA documentation with DOE documentation, but rather to consolidate CERCLA with CERCLA documentation where possible as is being accomplished under the EU RAWP. Also, consolidation of DOE documentation with DOE documentation where possible…but not to intermingle the two. Wording was revised to more clearly convey the idea.
(59)	**Section 3.7, p.30**	(Risks and opportunities) The bullet on "Targeted hot spot removal" should include Principal Threat Waste as part of the criteria used to remove mercury "hot spots".	The use of the term Principal Threat Waste does not appear to fit in this bullet. The bullet has been revised (see response to Comment 57).

No.	Reference	Comment	Response
(60)	**Figure 10, p.31**	See previous comment #9: Please revise the CERCLA Decision Document box, **UEFPC Phase II IROD,** to indicate soils remediation applies to the first (1^{st}) two feet of soil (for worker protection). Please revise the CERCLA Decision Document box, **UEFPC Phase I IROD and ESD,** to include a bullet entitled, "Mercury Principal Threat Waste" or "Hg PTW".	The information requested to be added to the figure loosely defines the scope of the two RODs, and has been added and more succinctly addressed in many other places throughout the revised D2 document, so that the intent of this comment is covered adequately by the time this figure is introduced. The purpose of this Figure is to summarize the OREM baseline projects that originate from each ROD. Details such as 1^{st} two feet of soil (Phase II IROD scope) and PTW (Phase I IROD scope) would not be appropriate for this figure.
(61)	**Section 4.1, p.32**	Add the following sentence prior to the final sentence of this section and revise the final sentence as follows: "Enforceable milestones are established based on consensus priorities with efforts to align milestones with the overall pace of cleanup and projected funding. Annual funding levels, both realized through allocations and projected will affect the DOE OREM Program baseline."	Revised to "Enforceable milestones are established based on consensus priorities, and aligned to the overall pace of cleanup and projected funding. Annual funding levels, both projected and allocated, affect the time-phased sequencing of the OREM program projects and thus the OREM baseline."
(62)	**Section 4.2**	Please add a bullet adjacent to the third bullet that incorporates the Phase I IROD stipulation that free phase mercury will be addressed as "Principal Threat Waste" and is to be addressed in a subsequent (pending?) IROD Amendment and is not 'defaulted' to the Phase II IROD stipulation for soils.	There are no plans, at this time, to submit a subsequent Interim ROD to address free phase mercury. The Phase I IROD addresses PTW, and the Phase II IROD addresses those soils not addressed under the Phase I IROD. Both RODs leave open future actions to address remediation those soils found to impede the attainment of final groundwater and surface water goals that will be stipulated in future, final RODs.
(63)	**Section 4.2, p.32**	Consistent with page 33, in the third prioritization bullet, include "immediately" prior to "follow" in the final sentence. The final sentence of the fourth prioritization bullet is not consistent with the preceding bullet. Use the same sentence in the preceding bullet as modified. Use this same sentence for the fifth bullet.	Revised as suggested.
(64)	**Section 5, p.35**	Given the long term nature of this strategic plan, the conclusions should emphasize the use and update of this plan as necessary for the thirty-plus year duration of the program.	Reference to the "living" status of this strategic plan has been added to the last paragraph of Section 5.

D1 MERCURY STRATEGIC PLAN COMMENT AND RESPONSE SUMMARY

Comments by: TDEC
Comments Received: August 26, 2013
Title of Document: Strategic Plan for Mercury Remediation at the Y-12 National Security Complex Oak Ridge, Tennessee
Revision No: D1
Document No: DOE/OR/01-2605&D1
Date: March 2013

No.	Reference	Comment	Response
GENERAL COMMENTS			
(1)		TDEC agrees with conclusions from the Mercury Workshop and the OF 200 conference call that the Strategic Plan for Mercury Remediation at the Y-12 National Security Complex Oak Ridge, Tennessee (Mercury Strategy) needs to be a comprehensive strategy to address mercury at and originating from the Y-12 National Security Complex. This comprehensive approach would include Y-12, downstream of Y-12, and Bear Creek. At the Mercury Workshop we were also pleased that DOE embraces an adaptive management approach to addressing mercury pollution with the goal of reducing mercury concentrations in fish and look forward to the adaptive management approach being included in Mercury Strategy. The adaptive management approach prior to the final Records of Decision for East Fork Poplar Creek will allow identifying actions that may help reduce concentrations of mercury in fish, implementing selected actions, and evaluating results. For example, we were encouraged with discussion that the OF 200 treatment plant discharge would be located approximately 1,200 feet downstream to bypass some of the most mercury contaminated sediment and there was discussion of ways to prevent additional mercury mobilization from these sediments under an adaptive approach. We also recognize that when utilizing an adaptive management approach conditions may change through time leading to a need to update the Mercury Strategy when agreed by DOE, EPA, and TDEC. We also recognize and support recent and/or ongoing studies of Lower East Fork Poplar Creek through the City of Oak Ridge and Upper East Fork Poplar Creek through Y-12 to better understand these areas and suggest the Mercury Strategy include an ongoing emphasis to better understand the system so we can jointly make better decisions related to mercury pollution and cleanup.	Agree. Modifications have been made to the plan, to include Workshop conclusions as discussed in this comment. Those modifications include: • An emphasis on the adaptive management approach, evaluations of studies/actions and discussion of additional interim actions as necessary to work toward a goal of reduced fish tissue mercury concentrations and surface water mercury concentrations. • The Mercury Strategy Plan will be updated as necessary to continue to serve as a guidance document for actions to reduce and remediate mercury contamination. • The plan is a more comprehensive strategy that includes Lower East Fork Poplar Creek and Bear Creek. • More detail has been added discussing mercury-fish relationships and addressing knowledge to be gained through further studies of these relationships and the impacts on the environment.

No.	Reference	Comment	Response
(2)		During a teleconference on August 23, DOE requested TDEC clarify its support for the OF 200 treatment plant. TDEC supports establishing adequate treatment of water collected in the storm sewer that drains the West End Mercury Area at OF 200. That being said, TDEC still has concerns whether the proposed treatment plant is adequate. TDEC is evaluating this proposed treatment plant from two different perspectives. The first perspective is the effect of the proposed treatment on existing water quality and compliance with the Tennessee Water Quality Control Act and regulations promulgated thereunder. The second perspective is whether the proposed treatment plant (1) will serve as a backstop to prevent flushing mercury downstream during decommissioning and demolition (D&D) of mercury-contaminated facilities and related cleanup and (2) has sufficient treatment capacity to maintain ongoing treatment demands and to meter in collected mercury polluted storm water during D&D and cleanup activities. This is further specified below:	The facility conceptual design has been modified to a design capacity of 3,000 gpm, which will accommodate a significant storm flow treatment (base flow is currently ~ 1,500 gpm) as well as increased capacity needed during D&D activities. In addition, diversion of clean storm flow and process flow will be evaluated and implemented as feasible.
(2a)		TDEC still has questions as to the justification for the selected technology. Discussion during the August 23rd teleconference helped. However, there are still concerns and TDEC recommends that DOE establish a flow proportional pilot project that mimics storm flows and evaluates both wet and dry seasons (e.g. plan for 12 months) to validate the selected design.	A white paper has been written and was provided to TDEC in regard to a proportional pilot project. While this white paper addressed a pilot project in terms of filtration investigations, it also applies to a pilot plant project for evaluating storm flows. The estimated cost of a pilot plant study is not justified in this case.
(2b)		The proposed approach is only a portion of the recommended design and our impression is that what was included and left out was more a function of funding and not technically driven. For example, discussion at the Mercury Workshop on storm water tanks focused on cost instead of whether storm water tanks are needed or not. There was a discussion as to limitations to redirecting clean storm water due to constraints at Y-12. The discussion should include why items were included or removed and which items would need upgrading if the plant were scaled up to treat larger flows or if additional treatment is needed to consistently achieve needed effluent concentrations.	The facility conceptual design has been modified to increase the design capacity to 3000 gpm, which will accommodate a significant storm flow treatment (base flow is currently ~ 1500 gpm) as well as increased capacity needed during D&D activities. In addition, diversion of clean storm flow will be evaluated and implemented as feasible. The strategic plan now emphasizes a phased and adaptive approach to meeting in-stream regulatory criteria, including possible modifications to the treatment facility and proposes multiple studies to evaluate the reduction of mercury in fish and surface waters.
(2c)		The OF 200 treatment plant is proposed to be scaleable both related to flow and concentration. With the proposed design estimated to treat 55% of water volume and remove 52% of the mercury load from a heavy rainfall year (e.g. 2003) it does not appear adequate for either a backstop during D&D and cleanup or to meter in stormwater collected by enhanced best management practices during D&D and cleanup. The strategy needs a comprehensive plan of well-defined phases as to when and how decisions will be made to scale the treatment plant to either treat larger flow or to add polishing to reduce effluent concentrations.	The facility conceptual design has been modified to increase the design capacity to 3000 gpm, which will accommodate a significant storm flow treatment (base flow is currently ~ 1500 gpm) as well as increased capacity needed during D&D activities. In addition, diversion of clean storm flow will be evaluated and implemented as feasible. The strategic plan now emphasizes a phased and adaptive approach to meeting in-stream regulatory criteria, including possible modifications to the treatment facility and proposes multiple studies to evaluate the reduction of mercury in fish and surface waters.

No.	Reference	Comment	Response
(2d)		The treatment plant should be based on a flow basis that includes a portion of the storm water and a DOE take away from the August 23rd conference call was to reevaluate the treatment plant to treat a portion of the storm water. At the Mercury Workshop data indicating a first flush that would capture a significant portion of the dissolved and suspended load was discussed and under an adaptive management approach, we suggest evaluating capturing and treating this first flush and then evaluating results. Then if additional capacity is needed to provide the backstop during D&D and cleanup modifications could be made during pre-D&D activities.	The facility conceptual design has been modified to increase the design capacity to 3,000 gpm, which will accommodate a significant storm flow treatment (base flow is currently ~ 1,500 gpm) as well as increased capacity needed during D&D activities. In addition, diversion of clean storm flow and process flows will be evaluated and implemented as feasible. References to storage of contact water during demolition have been made in the document.
(3)		The goal of the strategy for mercury remediation should be that East Fork Poplar Creek meet the water quality standard for mercury at Station 17, which is 51 parts per trillion (ppt) to comply with State law and rules. It is the State's expectation that the *Record of Decision for Phase I Interim Source Control Actions for the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* be updated to reflect this new goal. This goal is applicable to the proposed treatment facility at Outfall 200 and to other remediation activities at Y -12. We recognize that a phased, staged, or adaptive management approach may be necessary to meet the goal at Station 17. However, at both the Mercury Workshop and during the OF 200 teleconference TDEC specified that the Strategic Plan for Mercury Remediation at the Y -12 National Security Complex Oak Ridge. Tennessee (Mercury Strategy) should include a more comprehensive plan that specifies steps for the goal to ultimately be met.	The Strategic Plan has been revised to state the ultimate goal for mercury concentration in UEFPC at Station 17 is 51 ppt, the recreational use AWQC. A phased approach is proposed to reach that goal, through actions (e.g., OF 200 MTF construction and operational assessment, proposed studies) that will be evaluated individually for their effectiveness in meeting the goal and the goal of reduced fish mercury concentrations. Additional interim measures will be decided by the FFA parties as necessary in striving to reach the 51 ppt goal in-stream at Station 17 through the addition of a proposed CERCLA Alternatives Analysis.
(4)		In addition to onsite remediation issues within the Y -12 plant, the strategy should address mercury contamination in Lower East Fork Poplar Creek. Efforts to eliminate mercury loading from headwaters should be correlated to actions proposed for the entire watershed. Emphasis should remain on defining sources of mercury load and factors affecting bioaccumulation, to include further field and laboratory studies culminating in a quantitative watershed model. The ultimate goal of the strategy should be the reduction of mercury in fish tissue in Lower East Fork Poplar Creek to levels below 0.3 mg/kg.	The Strategy Plan has been revised to include LEFPC, both from a historical perspective, ongoing research perspective regarding mercury in the environment, and a future remediation perspective. Ongoing field studies looking at mercury loading to the creek are discussed, as are those ongoing studies concerning bioaccumulation. Proposed studies to further examine these phenomena are outlined. The ultimate goal of the strategy, a reduction of mercury in fish tissue to levels at or below 0.3 mg/kg has been added to the strategy.

No.	Reference	Comment	Response
(5)		Given sampling results show elevated levels of mercury in fish tissue from Bear Creek; the strategy should be expanded to address mercury in Bear Creek Valley in regard to both the existing landfill and future cells.	All mercury-contaminated waste planned for disposal in CERCLA facilities in Bear Creek Valley will comply with Applicable or Relevant and Appropriate Requirements (ARARs) specified in decision documents for the CERCLA disposal facilities and disposal practices will meet Remedial Action Objectives (RAOs) of those decision documents. In general, those ARARs and RAOs approach protection of human health and the environment from multiple perspectives: (1) design of the landfill (e.g., liner and caps) along with assessment of the design (including defining waste acceptance criteria) to achieve protectiveness assurance, (2) treatment of the waste to assure containment within the landfill, most notably the Land Disposal Restrictions (LDRs), (3) protection of human health and the environment through release restrictions, e.g., managed through treatment of leachate as necessary to meet discharge limits, and defining waste acceptance criteria (4) containment assurances through proper closure as well as post-closure maintenance, and (5) institutional controls and monitoring during operation, closure and post-closure. These processes help assure the containment of the waste, and interception of exposure pathways. Ongoing monitoring (e.g., groundwater monitoring) to indicate any unexpected deviations early-on provides assurance that issues that may develop are dealt with in a timely manner.
(6)		As part of the general strategy, the Outfall 200 project must be designed to treat storm water, not just base flow to accomplish the stated goal in the Strategic Plan of removing mercury from contact water generated during future demolition activities. It is understood that stormwater will vary depending on the event, but the plan should address - even in a phased approach - capture and treatment of quantities of stormwater in light of the collected data showing the high levels of mercury flux during storm events. It would also address the mercury in storm flows under current conditions, which data collected have shown contain significant concentrations of mercury.	The facility conceptual design has been modified to increase the design capacity to 3,000 gpm, which will accommodate a significant storm flow treatment (base flow is currently ~ 1,500 gpm) as well as increased capacity needed during D&D activities. In addition, diversion of clean storm flow will be evaluated and implemented as feasible. The strategic plan now emphasizes a phased and adaptive approach to meeting in-stream regulatory criteria, including possible modifications to the treatment facility and proposes multiple studies to evaluate the reduction of mercury in fish and surface waters.
(7)		The general strategy should also include a more detailed discussion of stormwater management and the role this will play in reducing mercury discharges to the environment.	Diversion of clean storm flow will be evaluated and implemented as feasible, to reduce the role storm flow has in increasing mercury flux in UEFPC. This information has been added throughout the Strategic Plan.

No.	Reference	Comment	Response
(8)		The strategy should include an adaptive management approach to address the potential for interim actions at Y -12 and elsewhere prior to Final Records of Decision that might yield decreased concentrations of mercury in fish tissue.	See revised Section 3.4.2 that introduces the adaptive management approach for UEFPC Hg loading reductions, and additional Section 3.4.2.2 that addresses further interim actions aimed at reducing Hg in fish.
(9)		Because buildings to be demolished have standing groundwater in their basements, the strategy should include the capture and treatment/disposal of these concentrated sources of mercury, including free-phase mercury and/or groundwater encountered in excavations and stormwater captured during demolition. TDEC agrees with EPA's comment that these pollutants should be handled as Principal Threat Wastes.	The strategy addresses the capture and treatment of waste water contaminated with mercury during demolition (see Section 3.4.3.3) and remediation (see Section 3.4.4). It will be sampled and treated if required. Typically, contaminated groundwater and surface water, per EPA guidance (EPA Superfund Publication 9380.3-06FS, 1991 *A Guide to Principal Threat and Low Level Threat Wastes*) are not considered PTW, since they are not the source of contamination. Any free phase mercury on the floor of the basement will be treated and disposed.
(10)		The document should present the CERCLA strategy and milestone schedule to achieve the objective for the Outfall 200 project. A focused feasibility study/proposed plan and accompanying interim record of decision should be submitted for regulatory review, comment and approval, prior to design of the treatment facility.	This information has been added to the document (see Section 3.4.2 and Table 5).

No.	Reference	Comment	Response
(11)		The Mercury Strategy references that an enormous quantity of waste debris and soil will be generated with the demolition and disposition of approximately 1.8 million square feet of facilities contaminated with radio isotopes and mercury and accompanying soils. A potentially large portion of this debris and soils will be subject to land disposal restrictions for mercury. This strategy assumes the majority of the low-level waste (LLW) and mixed (LLW and hazardous) waste resulting from future demolition and remediation activities will be placed at the on-site CERCLA facility, the Environmental Management Waste Management Facility (EMWMF), or a successor onsite CERCLA landfill (EMDF) jointly referred to as EMWMF in the strategy. Non-hazardous, nonradioactive waste generated during future demolition and remediation activities are slated to be disposed of at ORR Industrial Landfills (ORR Landfills), which the strategy assumes to have sufficient capacity throughout the Y -12 cleanup efforts. At this time, mercury treatment of debris is regulatory limited to either micro or macroencapsulation. The strategy referenced a pursuit of alternative mercury treatment technologies and subsequent land disposal restrictions for mercury contaminated matrices. This would take demonstration and approval by EPA RCRA. The strategy references land disposal restriction concentrations of mercury at either TCLP < 0.2 mg/L or TCLP <0.025 mg/L depending on the type of treatment. (Please see Mercury Strategy Table 2 and Figure 9). Recreation use water quality criteria for mercury is 51 ppt. Fish in Bear Creek downstream of EMWMF already contain mercury at concentrations above the fish advisory level. This problem achieving recreational use criteria is without West End Mercury Area waste being disposed at the EMWMF facilities. The Mercury Strategy should recognize that waste disposal has to be performed in a manner that will not cause additional degradation of Bear Creek.	See response to Comment 5 above. In response to the comment, “The strategy referenced a pursuit of alternative mercury treatment technologies and subsequent land disposal restrictions for mercury contaminated matrices. This would take demonstration and approval by EPA RCRA.” The strategy addresses the requirement that pursuit of alternative mercury treatment technologies will follow the regulatory approval process as required in the regulations. In response to the comments regarding the mercury recreational AWQC limit, it is recognized in the strategic plan that this 51 ppt limit must be met by any discharge from the landfill(s) during the mercury-contaminated waste disposal. Those mercury-contaminated wastes will be generated during source remediation projects (building demolition and soil remediation),, and will be disposed of in Bear Creek Valley facilities beginning no earlier than 2023. It is planned that all leachate and contact water generated by the Bear Creek landfill(s) will be treated, if necessary, to meet all discharge requirements specified in the ARARs, including the 51 ppt mercury AWQC limit in this corresponding timeframe.
SPECIFIC COMMENTS			
(1)	**Section 1**	Revise the "Key factors and goals" which guided the development of this strategy to include complying with TN water quality standards.	Revised second bullet under *1. INTRODUCTION* to include TN water quality standards as an example of meeting the regulatory requirements.
(2)	**Section 2.3**	It is recognized that the cleanup goal from the Phase I ROD is 200 ppt at Station17, but the ultimate goal will be set at 51 ppt to match TN's published WQC.	Wording was revised in Section 2.3.1.1 (now 2.2.1.1) to recognize 200 ppt as an interim goal, and the final goal as 51 ppt (in Section 2.3.1.3 now Section 2.2.1.3).

No.	Reference	Comment	Response
(3)	**Section 2.3.3**	Agree that wording accurately describes the NPDES appeal, but it still should be stated that blending a legacy pollutant with process/cooling waters must be permitted.	DOE agrees that an NPDES permit is required for outfalls discharging into waters of the state of Tennessee at the Y-12 National Security Facility, and appealed the imposition of CERCLA remedial actions in the permit that would otherwise have been executed consistent with the Federal Facilities Agreement. Legacy pollutant versus process/cooling waters seems an unnecessary distinction considering the current discussions surrounding possible settlement.
(4)	**Section 3**	"This facility [MTF] will provide effective relief regarding mercury loading" - It has yet to be determined if this facility will be able to achieve the goals stated here.	Agreed, "effective relief regarding" was modified to "a reduction of".
(5)	**Section 3.1**	"Water Management" Water management must include 1) diversion of clean stormwater around remediation projects to the max, 2) dealing with contaminated stormwater from rainfall onto structures/areas during remediation, and 3) handling contaminated groundwater encountered during removal actions.	Added a discussion of diversion of storm water during D&D/RA to "Water management". "Capture and Treat" was modified to include management of contaminated storm water/ground water during D&D/RA.
(6)	**Section 3.1**	"Capture and Treat" - Disagree with label as an "interim action", implying a short-term nature. It is a certainty that the OF 200 MTF must be operated and maintained long-term (and expanded to capture storm event loadings). DOE must be "capture-and-treat" concentrated pollutants in water nearest the source removal actions, i.e., stormwater and contaminated groundwater. The installation of manhole traps should be expanded to multiple other locations prior to startup of demolition.	The word "interim" was removed; however, it referred to that fact that capture and treat generally does not remediate a source – it remediates a "symptom" but does not "cure" the problem. In that respect, it can be a very long-term process especially if sources are not dealt with. The use of manhole traps and their success is still being evaluated. At this time, it has not been determined that additional manhole traps will be beneficial; however, it is noted that the commenter refers to manholes "prior to startup of demolition", and therefore, with demolition in mind, would manhole traps become more efficient is a question that bears consideration.
(7)	**Section 3.3**	An omitted endstate is that WQ will comply with TN WQC.	A table to more comprehensively address endstates as well as interim endstates has been added to the document.
(8)	**Section 3.4.2 Outfall 200 MTF**	"based on a design criteria of...obtaining a mercury concentration in the effluent of at most 200ppt". The goal of the strategy for mercury remediation should be that East Fork Poplar Creek meet the water quality standard for mercury at Station 17, which is 51 parts per trillion (ppt) to comply with State law and rules.	Agree. Wording has been changed throughout the document to acknowledge the ultimate 51 ppt AWQC goal at Station 17, and that a phased approach is proposed to achieve that goal.

No.	Reference	Comment	Response
(9)	**Section 3.4.3.3 Building Demolition**	"Building demolition includes activities such as:" - this ignores the fact that contaminated stormwater will be generated during demolition [similar challenges arose at ETTP and Bldg. K-33 with Hex Chrome issues]. These are huge impervious structures generating tremendous amounts of contaminated stormwater exposed to mercury. DOE' s strategy must recognize that controls for "capture-and-treat" contaminated stormwater are necessary for these demolition activities.	Agreed. Two bullets have been added to this section to address this oversight.
(10)	**Section 3.5**	TDEC's position is that free-phase mercury found in creek sediments should be considered Principal Threat Waste exactly the same as free-phase mercury found in utility trenches or beneath WEMA buildings.	Agreed, creek sediments are defined as PTW in the Phase I ROD. Not sure why section 3.5 is referenced…added term "sediment" in bullet.
(11)	**Section 3.6 Regulatory Strategy**	"Planning and sequencing of ... projects was completed based on a regulatory strategy that is unchanged in this strategy (DOE 2008b)" - The goal of the strategy for mercury remediation should be that East Fork Poplar Creek meet the water quality standard for mercury at Station 17, which is 51 parts per trillion (ppt) to comply with State law and rules.	Agree. Wording has been changed throughout the document to acknowledge the ultimate 51 ppt AWQC goal at Station 17, and that a phased approach is proposed to achieve that goal.
(12)	**Section 3.7 Risks and Opportunities**	"a final evaluation of efforts that may be needed to influence fish tissue mercury concentrations cannot be made until after source removal is complete." - Disagree, evaluation of fish tissue levels can be an ongoing process to monitor effectiveness of current and future practices and possibly influence future methodologies of remediation.	Agree, wording has been changed to: *During source removal efforts the mercury water concentrations will likely fluctuate, and completion of source removal is expected to result in a final picture of the mercury conceptual model that is significantly different from that of today. Although efforts will be directed at reducing fish tissue mercury concentrations throughout this strategy with parallel monitoring/assessment of those concentrations, it is conceivable that a final evaluation of effort needed to influence fish tissue mercury concentrations will not be possible until after source removal is completed. The adaptive management approach put forth in this strategy is to respond to those fluctuations by revising, as necessary and as allowed within constraints (e.g., budgets, timing), approaches to best address those as yet unforeseen ecological responses to cleanup actions.*

<table>
<tr><th>No.</th><th>Reference</th><th>Comment</th><th>Response</th></tr>
<tr><td>(13)</td><td>Section 5 Conclusions</td><td>"... actions that have advanced remediation efforts" says WEMA storm cleanout " has resulted in a significant decrease" - Factually Not True - DOE reported at the Feb project team meeting that FY 2013 OF 200 loadings have returned "to levels observed prior to pre-storm drain c1eanout project" - 6.8 grams/day, as compared to 6.2 g/d in 2011. Point is, a huge pollution problem remains - and is worsened between OF 200 and Station 17 by sediment contribution.</td><td>This statement took into consideration that the “pre-WEMA storm cleanout” numbers correspond to significant dry/drought conditions, so to return to those levels during a significant rainy/wet season, as is currently being experienced, implies a significant decrease. Wording to explain that effect has been added to the statement.

Agree that a pollution problem remains, and between OF 200 and Station 17 a good deal of sediment-contributed Hg adds to the problem. However, this statement regarding WEMA cleanout is in reference to measurements taken at OF 200. The inferred result of WEMA cleanout is that less sediment-loaded Hg is being added by WEMA via OF 200 in the region between OF 200 and Station 17.

<table>
<tr><th>Hg Flux at OF 200A6</th><th>Rainfall (in/yr)</th><th>Kg/Yr</th><th>g/d, median</th><th>median g/d</th></tr>
<tr><td>2007</td><td>37</td><td>2.00</td><td>5.48</td><td>5.50</td></tr>
<tr><td>2008</td><td>49</td><td>3.70</td><td>10.14</td><td>6.80</td></tr>
<tr><td>2009</td><td>63</td><td>6.00</td><td>16.44</td><td>7.30</td></tr>
<tr><td>2010</td><td>56</td><td>9.30</td><td>25.48</td><td>6.90</td></tr>
<tr><td>2011</td><td>60</td><td>11.30</td><td>30.96</td><td>13.80</td></tr>
<tr><td>2012</td><td>62</td><td>2.60</td><td>7.12</td><td>5.40</td></tr>
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