U.S. Government Accountability Office

Oak Ridge Mercury Cleanup: Opportunities Exist to Enhance Risk Management and Technology Development

GAO-24-107096
Q&A Report to Congressional Committees
September 12, 2024

Why This Matters

The U.S. Department of Energy (DOE) estimates that from 1950 through 1982 over 700,000 pounds of mercury was released to the surrounding environment during nuclear weapons production at the Y-12 National Security Complex (Y-12), one of three sites at the Oak Ridge Reservation in Tennessee. In addition to contaminating soil and surface water, these releases also contaminated structures on the site. An additional 1.3 million pounds of mercury are unaccounted for at Y-12 and may also have been lost to the environment. DOE's Oak Ridge Office of Environmental Management (OREM) and the U.S. Environmental Protection Agency (EPA) identified mercury contamination at Y-12 as the greatest environmental risk at Oak Ridge due to offsite migration of mercury in streams and continued high levels of mercury in local fish populations.

OREM oversees mercury cleanup at Oak Ridge, which includes remediating mercury contamination sources that impact the surface waters of Upper East Fork Poplar Creek and deactivating and decommissioning (D&D) four large mercury-contaminated buildings at Y-12, which are adjacent to active National Nuclear Security Administration (NNSA) missions. The current mission of Y-12 includes NNSA assignments in stockpile stewardship and nuclear nonproliferation as well as special production support to other programs. NNSA's plans to use the remediated land and expand the national security mission depend on the completion of mercury cleanup at Y-12. According to DOE's 2017 Strategic Plan for Mercury Remediation at Oak Ridge, OREM has been conducting mercury cleanup activities since the mid-1980s, including cleaning and relining storm sewers, and removing contaminated sediment and piping.

Senate Report 118-58 includes a provision for GAO to assess OREM's efforts to clean up mercury contamination at Oak Ridge. We are providing information on the scope, cost, and schedule of planned mercury cleanup at Y-12; the regulatory framework guiding mercury cleanup; risks associated with mercury cleanup; and OREM's mercury cleanup technology development efforts.

Key Takeaways

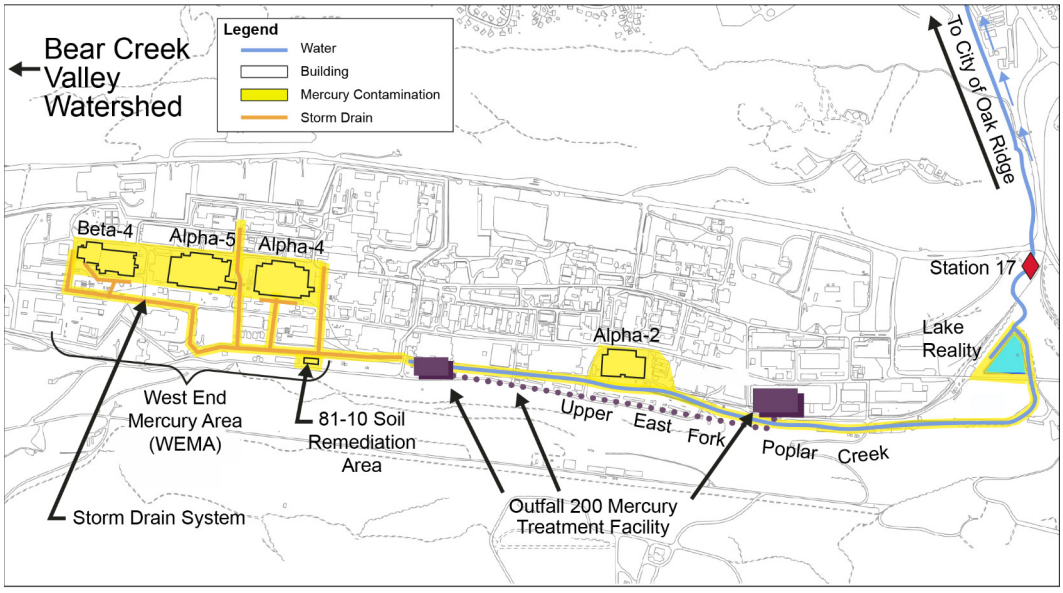
- OREM estimated in 2023 that the remaining cleanup will cost at least $3.2 billion and continue through 2043, with some of the most challenging work yet to be conducted.
- OREM manages mercury cleanup risks by project, which does not comprehensively reflect the potential impact of similar risks that OREM has identified across multiple projects and omits key interdependent risks. We recommend that OREM elevate risk management to a programmatic level from a project level for mercury cleanup to enhance the understanding of comprehensive risk impacts and interdependencies.

- OREM does not track risk mitigation actions from inclusion in the baseline through implementation, as suggested by DOE's risk management guidance. We recommend that OREM document the mitigation strategies it has identified and develop a mechanism to track them.
- OREM routinely discusses outcomes of the mercury technology development program at the project level, but the office has not assessed the program for progress toward the intended goals of reducing the cost, risk, and schedule of mercury cleanup, while improving worker safety. We recommend that OREM assess the mercury technology development program's progress in meeting these intended goals.

What is the remaining scope of OREM's planned mercury cleanup at Y-12?

The remaining mercury cleanup scope (projects and activities related to mercury cleanup) at Y-12 includes three capital asset projects, D&D of four mercury-contaminated buildings, and soil and water remediation activities (see fig. 1).

Figure 1: Map of the Oak Ridge Reservation's Y-12 National Security Complex and Key Mercury Cleanup Areas



Source: GAO analysis of U.S. Department of Energy (DOE) Office of Environmental Management – Oak Ridge map. | GAO-24-107096

The three capital asset projects include the following:

- **Construction of a mercury treatment facility.** OREM is constructing a mercury treatment facility that can capture, store, and treat stormwater to remove mercury before discharging the treated water to nearby Upper East Fork Poplar Creek.
- **Relocation of a high-security area fence.** NNSA is leading a project to relocate the high-security fence at Y-12 around two of the mercury-contaminated buildings (Alpha-5 and Beta-4) in the West End Mercury Area. According to OREM, the fence relocation will allow OREM and its contractors easier access to the buildings for demolition. OREM officials said avoiding costs associated with working within a secured area could reduce cleanup labor costs by more than 40 percent. As of February 2024, NNSA estimated that the fence relocation project was expected to be completed in April 2028 at a cost of $265 million. However, OREM officials said, according to NNSA's revised schedule, they expect to have access to and begin cleanup work on the mercury-contaminated buildings by October 2025, before NNSA's expected completion date for the full project.

- **Construction of a new waste disposal facility.** Under a record of decision approved in September 2022, OREM is constructing a new waste disposal facility with a capacity of up to 2.2 million cubic yards.[1] This new facility, which is sited near Y-12 in the Bear Creek Valley watershed, is needed to provide onsite waste disposal capacity for OREM's mission needs, including planned D&D of the mercury-contaminated buildings at Y-12. OREM's cleanup strategy assumes most of the waste resulting from mercury-contaminated building demolition and soil remediation activities will be disposed of onsite at the new facility, as the existing disposal facility is approaching capacity. OREM expects the new facility to begin receiving waste from Y-12 cleanup projects in 2029.

The D&D of the mercury-contaminated buildings (see fig. 2) is dependent on the completion of the mercury treatment facility and the relocation of the high-security area fence. OREM's strategy for mercury cleanup at Y-12 is to first address the Alpha-2 building, located outside the high security area, and then address the remaining three buildings after the high-security fence is relocated to provide easier access and the mercury treatment facility is completed. Safe demolition of these large mercury-contaminated facilities presents a significant challenge. Together the four buildings and associated structures comprise over 1.8 million square feet. In addition, the mercury contamination at these buildings can be found in liquid and vapor forms and in porous solid materials—making it challenging to detect, contain, and remove.[2]

Figure 2: Mercury-Contaminated Buildings at the Oak Ridge Reservation's Y-12 National Security Complex

Source: U.S. Department of Energy (DOE) Office of Environmental Management – Oak Ridge. | GAO-24-107096

After the buildings are removed, OREM plans to undertake soil, surface water, and groundwater remediation in two phases. The first phase includes interim actions to address highly toxic or highly mobile sources of mercury-contaminated soils, sediments, and certain groundwater discharges that contribute to surface water contamination, including the soils and storm sewer sediments in the West End Mercury Area and sediment in exposed portions of the Upper East Fork Poplar Creek stream channel. The second phase includes remediation of the balance of contaminated soil, scrap, subsurface structures (including slabs of previously demolished buildings and currently inaccessible soils under buildings), and buried materials at Y-12. Current planning assumptions include disposal at an onsite facility.

What regulatory framework guides OREM's mercury cleanup at Oak Ridge?

OREM conducts cleanup work at Oak Ridge under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), also known as Superfund, through a Federal Facility Agreement.[3] This tri-party agreement was signed in 1991 by DOE and its regulatory agencies—EPA and the Tennessee Department of Environment and Conservation (TDEC). The three parties decide on cleanup actions using the process outlined in the agreement and finalized in CERCLA records of decision.

Records of decision document the scope of cleanup work and identify the relevant state and federal cleanup standards. There are numerous records of decision guiding various aspects of mercury cleanup. For example, the record of decision for Upper East Fork Poplar Creek outlines how the surface water, soils, and sediments within that watershed must be cleaned and specifies that the final cleanup standard for surface water is 51 nanograms per liter (ng/L) of mercury, in accordance with Tennessee regulations.[4] In 2016, the three parties agreed on an amendment to this record of decision to include the construction of the mercury

treatment facility. The record of decision would allow an interim goal of 200 ng/L of mercury for the surface waters of Upper East Fork Poplar Creek. This interim decision provides some flexibility for OREM to evaluate the effectiveness of the mercury treatment facility. After the facility has operated for 2 years, the parties intend to evaluate the facility's performance against the final goal of 51 ng/L of mercury to determine if additional cleanup actions are required.

The record of decision for the new waste disposal facility also affects mercury cleanup at Oak Ridge. In the 2022 decision, the three parties agreed that if methylmercury levels in the fish tissue in Bear Creek exceed 0.3 milligrams per kilogram (mg/kg) of fish, Tennessee's antidegradation rule applies, which would prohibit discharges that load additional mercury and other contaminants into Bear Creek. Since methylmercury levels of the fish in Bear Creek currently exceed 0.3 mg/kg, OREM must implement selected actions to reduce sources of methylmercury prior to discharging wastewater from the waste disposal facility. Wastewater discharge from the waste disposal facility must be treated to meet the effluent limit of 51 ng/L of mercury.

Reaching agreement over cleanup actions and documenting them in records of decision can require years of research and negotiation. The Federal Facility Agreement outlines a process for DOE, EPA, and TDEC to annually negotiate and document milestones for mercury cleanup that work toward cleanup progress. Enforceable milestones correspond to the cleanup work that OREM must complete within the next 3 fiscal years.[5] Types of milestones include reports describing completed phases of cleanup such as site evaluations or construction completion. For example, one milestone requires OREM to complete a remedial site evaluation by September 2024 for Bear Creek Valley—the location of the future waste disposal facility—to identify sources of mercury that may be contributing to mercury contamination of the fish in Bear Creek.[6]

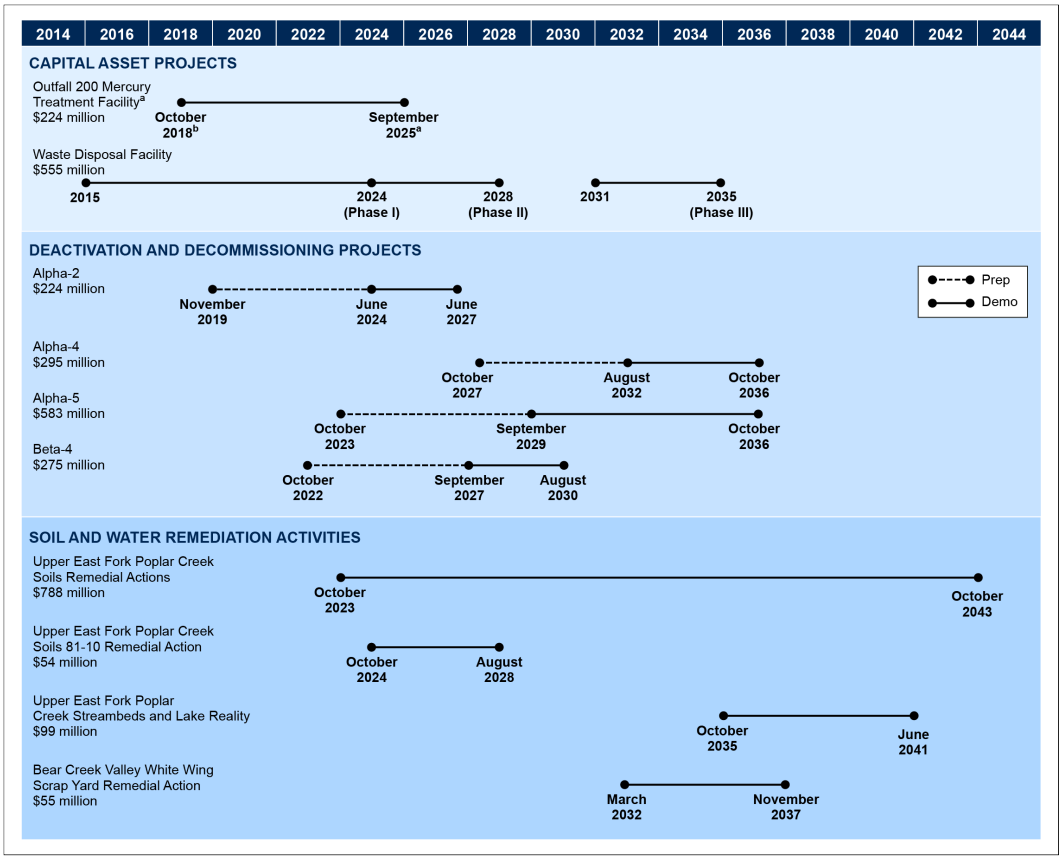
EPA and TDEC have asked that DOE update the agreement with additional milestones including developing waste handling plans for some of the mercury-contaminated buildings. TDEC officials said that these plans will help the three agencies reach agreement on the waste acceptance criteria for the new disposal facility. Waste acceptance criteria are a key determinant of what types of waste (including how much mercury-contaminated waste) can be placed in a disposal facility. In March 2024, OREM submitted updated milestones to TDEC and EPA for consideration. As of June 2024, OREM, TDEC, and EPA were negotiating to resolve regulator comments and finalize these milestones.

However, numerous decisions regarding mercury cleanup have yet to be made. For example, once the four contaminated buildings are removed, additional site investigations will be needed to establish final cleanup standards for basements, other belowground structures, and contaminated soils. The three parties stated they will continue to develop milestones and work toward these decisions as the D&D of the mercury-contaminated buildings at Y-12 progresses.

What are OREM's estimated costs and schedule for mercury cleanup?

OREM has estimated mercury cleanup projects and activities at Y-12 to cost at least $3.2 billion and to be completed in 2043.[7] These estimates were developed in OREM's Federal Site Lifecycle Estimates. Officials from DOE's Office of Environmental Management said they approved the estimates in December 2023 (see fig. 3). According to OREM officials, since these estimates were approved, various changes have occurred that will require updates to these estimates. For example, OREM determined in 2023 that the Outfall 200 Mercury Treatment Facility will exceed the original cost and schedule estimates, resulting in at least $100 million in additional costs and a year of additional schedule. The project is currently undergoing a cost and schedule baseline change, which will need to be incorporated into the Federal Site Lifecycle Estimate after it is approved.

Figure 3: Estimated Costs and Schedules for Key Mercury Cleanup Projects and Activities at the Oak Ridge Reservation's Y-12 National Security Complex, as of 2023



Source: GAO analysis of U.S. Department of Energy (DOE) data. | GAO-24-107096

Note: DOE's estimated costs for non-capital asset projects in escalated fiscal year 2019 dollars, including contingency at the 80-percent confidence level.

[a]Oak Ridge's Office of Environmental Management is currently re-baselining this project to determine the cost and schedule changes needed to complete the remaining scope of the project.

[b]This date represents the approval of the performance baseline and the start of construction.

What guidance governs OREM's risk management related to mercury cleanup?

OREM has a risk management procedure based on DOE's Risk Management Guide that defines the process for ensuring that it incorporates consistent methods to identify, manage, and mitigate the impact of project-related risks and opportunities.[8] According to the procedure, it serves as OREM's risk management plan and addresses the key steps in the risk management process: (1) risk planning; (2) risk assessment, which includes identifying and evaluating the risk; (3) risk handling—accepting, mitigating, avoiding, or transferring the risk; and (4) risk monitoring. A companion to the risk management plan is a risk register for each project, or central repository of risks, that is a day-to-day guide for the project team.

DOE's Environmental Management Program Management Protocol also provides guidance on risk management both for capital asset projects and for operations activities.[9] The Protocol states that the risk register and accompanying risk description sheets are where risks should be identified and defined. Further, risks should be analyzed and classified as high, medium, or low depending on their likelihood of occurring and the magnitude of their potential consequences. The Protocol also states that mitigation strategies are developed and documented for each risk and are incorporated in the baseline.

The Protocol states that sites have a programmatic risk manager in charge of managing risks related to the Federal Site Baseline. The Protocol does not

require risk management to occur at a program level rather than individual project or activity level. However, additional EM guidance on programmatic risk management states that risk management for the Federal Site Lifecycle Estimate shall be integrated and conducted at a sufficiently high level for the comprehensive understanding of risk impacts, interdependencies, and requirements across the entire site's program and mission.[10]

What risks has OREM identified for mercury cleanup, and how is OREM managing them?

OREM has identified about 250 risks across eight projects and activities related to mercury cleanup.[11] The identified risks have a total potential cost impact ranging from nearly $180 million (best case) to $1.2 billion (worst case).

As we reported in 2024, OREM manages risk primarily through individual projects, rather than at the program or site level.[12] OREM's management of risks in individual project risk registers prevents a comprehensive understanding of risk impacts related to the overall mercury cleanup program. In particular, the approach obfuscates the potential impact of similar risks that OREM has identified across multiple mercury cleanup projects.

For example, 10 of the 15 risks with the greatest likelihood of occurrence and potential consequence across the mercury-related projects and activities are related to waste disposal. These risks include unexpected waste volumes from several projects and disposal of waste that does not meet waste acceptance criteria. Individually, the worst-case cost impact for each of the 10 waste disposal risks ranges from about $1 million to $56 million. However, collectively, these risks have the potential to cost nearly $190 million. As DOE's Risk Management Guide states, looking for risks with common causes could present opportunities for risk mitigation strategies, as well as commonalities in monitoring triggers.

In addition, according to our review of OREM's risk registers for mercury cleanup projects and activities, OREM has not included key interdependent risks in its registers. Interdependencies refer to projects that depend on other projects to deliver some enabling capabilities that are essential to their successful implementation. For example, OREM is depending on NNSA's high-security fence relocation project and the construction of the mercury treatment facility to enable two D&D projects. Because the fence relocation and mercury treatment facility construction projects are behind schedule, the D&D work could be delayed, and cost more than originally estimated.

However, OREM did not include risks associated with these potential delays and cost increases in its risk registers for the D&D projects. OREM officials said these risks were not included because the delays in those projects had not yet occurred. The officials said those risks would be represented in updated risk registers, which are expected to accompany a revised baseline in the fall of 2025.

Finally, it is not clear whether OREM is selecting meaningful risk handling strategies. For all 250 risks identified across the eight mercury-related projects and activities, OREM selected "accept" as the documented risk handling strategy. OREM officials said they chose "accept" because, in creating the baseline, they planned the mitigation actions that they intend to take to address or reduce risks and, in accordance with DOE's Risk Management Guide, included those costs in the baseline cost estimates. For example, to address the risk of inadequate contractor performance, OREM officials said they built in costs for coordination meetings. In addition, to mitigate the risk of insufficient federal resources risks, they said they included support contract awards in the baseline.

However, OREM has not documented those planned mitigation actions in the risk registers or individual risk sheets, making it difficult to monitor and track the actions to ensure that they are being implemented. As mentioned above, EM's

Program Management Protocol states that mitigation strategies should be documented on the risk description sheets. DOE's Risk Management Guide also suggests that the strategies should be developed as a step-wise plan that can be included in the project baseline. It further suggests that the mitigation plans should be analyzed to ensure they are feasible and that resources are available. Clearly documenting these mitigation strategies and developing a tracking mechanism could provide OREM with greater assurance that they will be implemented as intended.

What actions has OREM taken to develop technologies to support mercury cleanup?

OREM established a mercury technology development program, which aims to identify technologies that reduce the cost, risk, and schedule of mercury cleanup, while improving worker safety. Since 2018, OREM has received at least $3 million annually in funding for mercury technology development activities.[13] The program contains two facets:

- **Technology development.** Research at Oak Ridge National Laboratory aims to enhance a fundamental understanding of the environmental behavior (physical and chemical) of mercury and apply that knowledge to identify methods for long-term remediation. Technology development refers to fundamental scientific research and research of nascent technologies that could be developed for mercury remediation.[14]
- **Technology demonstrations.** Overseen by OREM, technology demonstrations use pilot programs to test how existing technology could be used for mercury cleanup at Oak Ridge.[15]

OREM is responsible for integrating mercury technology development activities. This includes, for example, ensuring that the fundamental science conducted at the Oak Ridge National Laboratory contributes to knowledge that will facilitate aspects of the cleanup, including building D&D, soil remediation, or water quality improvements.

In 2019, OREM had its contractor identify key technological needs to improve safety and reduce costs for the D&D of mercury-contaminated buildings using guidance from OREM's 2017 mercury technology development plan. OREM currently has ongoing technology demonstration projects that support two of five identified technological needs:

- **Mitigate mercury vaporization.** The four mercury-contaminated buildings slated for D&D are expected to have high concentrations of mercury vapor that would reduce the amount of time workers could safely conduct D&D. By testing methods for reducing mercury vapors in building structures, OREM plans to improve worker safety and potentially reduce the time needed for building demolition.
- **Immobilize mercury in waste.** Some of the waste from building demolition could have mercury contamination that could pool as elemental mercury if packaged in waste containers. This elemental mercury would pose a disposal risk for OREM because, according to officials, there is no available disposal site for mercury-contaminated waste that is characteristically hazardous in the United States.[16] OREM seeks to identify a chemical compound to reduce the amount of elemental mercury that pools within the container. Officials said that this technology could increase the amount of potentially mercury-contaminated waste OREM can package in waste containers and dispose of in on-site landfills.

OREM has completed initial technology demonstrations for these two technology needs, and they will use the results to scale up the technologies and apply them to mercury cleanup.

OREM has not yet initiated technology demonstrations for the other three technical needs identified by their contractor, which include the following:

- **Measure and detect mercury.** Because mercury may exist in a liquid or vapor form within pipes and other building components, or pool in porous building materials like cinder blocks, it is challenging to accurately measure the amount of mercury contamination in buildings, building debris, and D&D waste. Identifying technology to more accurately detect and measure mercury would improve D&D plans, worker safety, and compliance with waste acceptance criteria. OREM officials said they were unable to identify a technology to measure and detect mercury to pursue with a technology demonstration at this time.
- **Prevent mercury from leaching in landfills.** Identifying a cost-effective technology to line the bottom of landfills would prevent mercury in contaminated waste from leaching into the groundwater. OREM officials told us they have not initiated a technology demonstration for a landfill liner because the technology demonstration for immobilizing mercury in waste may have a secondary benefit of preventing mercury from leaching into groundwater.
- **Remove mercury mechanically.** Identifying a method, such as using robotics, to remove mercury-contaminated building debris would improve worker safety by reducing workers' direct exposure to mercury contamination. In 2019, OREM allocated funding to test three mechanical methods for removing mercury-contaminated debris on a previous demolition project. However, OREM officials said the methods were slow and inefficient. As a result, OREM decided to focus on the vapor mitigation technology demonstration, which would have a similar outcome of reducing worker exposure to mercury vapors.

To what extent does OREM ensure its technology development efforts support its mercury cleanup goals?

OREM officials said that they have not conducted assessments of OREM's technology development efforts to ensure these efforts are supporting cleanup goals. OREM tracks some progress of the technology development program by identifying challenges and accomplishments of specific technology demonstrations and discusses these outcomes during monthly project-level meetings. However, these performance metrics only measure progress toward meeting technology needs for near-term mercury cleanup projects. Moreover, since identifying goals in the 2017 mercury technology development plan, OREM has not comprehensively assessed the mercury technology development program. OREM officials said they are in the process of updating the 2017 plan, but they did not provide details or documentation of this effort.

DOE's program management policy includes evidence-based decision-making as a guiding principle of effective program management. That is, program performance should be compared with metrics identified during planning phases to confirm the effectiveness, efficiency, and relevance of the DOE program.[17] Such assessments of all mercury technology development efforts could be helpful to ensure that decisions about future spending on technologies in support of overall mercury cleanup goals are based on evidence gathered to date. Without such assessments, OREM cannot ensure that the technology development program is achieving its articulated goals of identifying technologies that reduce the cost, risk, and schedule of cleanup while improving worker safety.

Conclusions

Mercury contamination poses the largest environmental risk at Oak Ridge, as mercury continues to migrate into streams, soils, and local fish populations. OREM has taken actions to reduce sources of onsite contamination as well as to prevent mercury from migrating into areas surrounding Oak Ridge. Nevertheless, OREM has identified numerous risks that could affect cleanup progress and is working to develop new mercury technologies to assist the cleanup process.

The office currently manages risks that could occur during cleanup work at a project level through individual risk registers. If OREM elevated risk management for mercury cleanup risks to a programmatic level, the office would be better equipped to understand how each risk impacts cleanup work across individual projects. Further, OREM does not track risk mitigation actions from inclusion in the baseline through implementation, as stated in DOE's risk management guidance. Tracking risk mitigation actions could help ensure that the actions are being implemented, which in turn could result in reductions in overall cleanup costs and environmental contamination risks.

In addition, while OREM routinely discusses outcomes of the mercury technology development program at the project level, the office has not assessed the program for progress toward its intended goals of reducing the cost, risk, and schedule of mercury cleanup, as well as of improving worker safety. By assessing the program's outcomes, OREM could employ evidence-based decision-making to ensure that these technologies deliver on their potential to improve the cleanup process.

Recommendations for Executive Action

We are making three recommendations to DOE. Specifically:

The Senior Advisor for the Office of Environmental Management should ensure that OREM elevates risk management to a programmatic level from a project level for mercury cleanup to enhance the understanding of comprehensive risk impacts and interdependencies. (Recommendation 1)

The Senior Advisor for the Office of Environmental Management should ensure that OREM documents the risk mitigation strategies it has identified and develops a mechanism to track their implementation. (Recommendation 2)

The Senior Advisor for the Office of Environmental Management should ensure that OREM assesses the mercury technology development program's progress in meeting the intended goals of reducing the cost, risk, and schedule of mercury cleanup, while improving worker safety. (Recommendation 3)

Agency Comments

We provided a draft of this report to DOE for review and comment. In its comments, reproduced in appendix I, DOE concurred with our recommendations. DOE provided technical comments, which we incorporated as appropriate.

Appendix I: Comments from the Department of Energy

Department of Energy
Washington, DC 20585
August 20, 2024

Mr. Nathan Anderson
Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Mr. Anderson:

The Department of Energy (DOE) Office of Environmental Management (EM) appreciates the opportunity to comment on the U.S. Government Accountability Office (GAO) draft report, *OAK RIDGE MERCURY CLEANUP: Opportunities Exist to Enhance Risk Management and Technology Development* (GAO-24-107096).

DOE's Oak Ridge Reservation occupies more than 32,000 acres in East Tennessee. Three sites lie within its borders: the Y-12 National Security Complex, Oak Ridge National Laboratory, and the East Tennessee Technology Park. DOE's Oak Ridge Office of Environmental Management (OREM) has cleanup responsibilities at all three areas. To date, OREM's actions are removing risks, enhancing safety, availing land for re-development and clean energy, and enabling key science and energy research, as well as national security missions.

Mercury cleanup at Oak Ridge will continue to be one of the Department's highest priorities, and the construction of the Outfall 200 Mercury Treatment Facility and ongoing research and development are positioning DOE for future success. DOE has developed a comprehensive Mercury Technology Development Plan that serves as a roadmap to complete the mercury cleanup at the site. This plan includes supporting research at ORNL's Aquatic Ecology Laboratory, where researchers are expanding our understanding of mercury in the environment, advancing technology development, and identifying solutions for demolition and remediation at Oak Ridge.

EM concurs with GAO's recommendations. GAO's report and recommendations will enable OREM to strengthen its planned mercury cleanup strategy at Oak Ridge. EM's responses to the recommendations are provided in the enclosure. Technical comments on the draft report have been provided separately.

If you have any questions, please contact me or Mr. Gregory Sosson, Associate Principal Deputy Assistant Secretary for Field Operations, at (202) 586-4505.

Sincerely,

Candice Trummell Robertson
Senior Advisor for Environmental Management

Enclosure

Enclosure

Management Response to Recommendations
GAO-24-106716 Draft Report, *OAK RIDGE MERCURY CLEANUP: Opportunities Exist to Enhance Risk Management and Technology Development*

Recommendation 1: The Senior Advisor for the Office of Environmental Management should ensure that OREM elevates risk management to a programmatic level from a project level for mercury cleanup to enhance its understanding of comprehensive risk impacts and interdependencies.

Management Response: Concur.

EM will ensure that the Oak Ridge Office of Environmental Management (OREM) documents risks for each of the specific cleanup sites/portfolios (Y-12, Oak Ridge National Laboratory (ORNL) and East Tennessee Technology Park), and then at the Oak Ridge site level to enhance understanding of comprehensive risk impacts and interdependencies across the site. Portfolio level risks will be owned by the Portfolio Federal Project Director(s) and will be discussed, along with mitigation strategies, with the Site Manager during quarterly reviews of each portfolio. Oak Ridge site level risks will be owned by the Chief Engineer(s) and will be discussed, along with mitigation strategies, with the Site Manager on an annual basis.

Estimated Completion Date: September 30, 2026.

Recommendation 2: The Senior Advisor for the Office of Environmental Management should ensure that OREM documents the mitigation strategies it has identified and develops a mechanism to track their implementation.

Management Response: Concur.

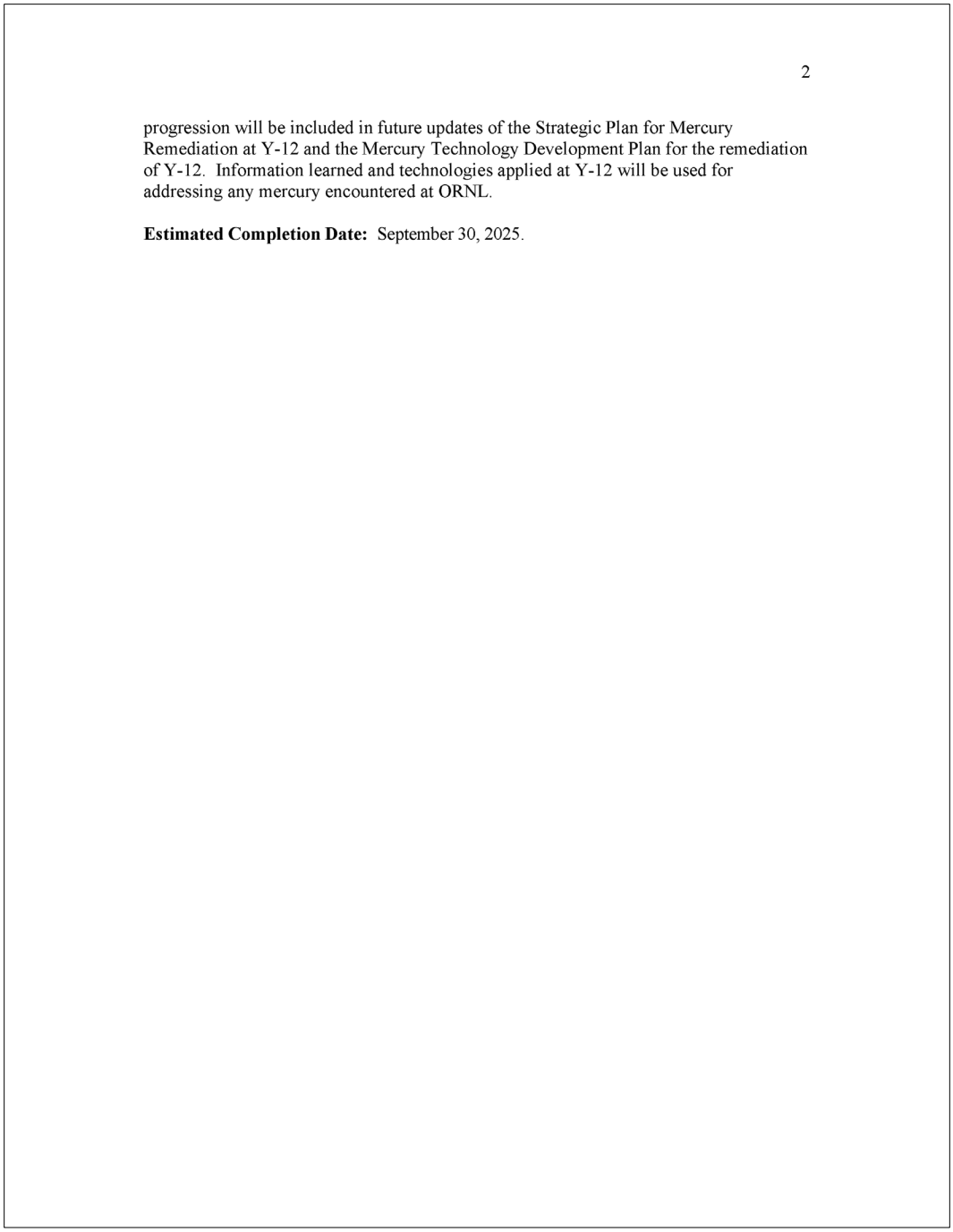
EM will ensure that OREM documents the mitigation strategies of the risks at the portfolio and OREM site level (as discussed in recommendation #1). Furthermore, OREM will document the mitigation strategies identified for risks at the project level and track progress against them.

Estimated Completion Date: September 30, 2026.

Recommendation 3: The Senior Advisor for the Office of Environmental Management should ensure that OREM assesses the mercury technology development program's progress in meeting its intended goals of reducing the cost, risk, and schedule of mercury cleanup, while increasing worker safety.

Management Response: Concur.

EM will ensure that OREM performs an assessment of the progression of technology development activities toward intended mercury technology development goals. The



2

progression will be included in future updates of the Strategic Plan for Mercury Remediation at Y-12 and the Mercury Technology Development Plan for the remediation of Y-12. Information learned and technologies applied at Y-12 will be used for addressing any mercury encountered at ORNL.

Estimated Completion Date: September 30, 2025.

How GAO Did This Study

We assessed documents and data related to the scope, cost, and schedule of OREM's plans for mercury cleanup. Specifically, we reviewed cleanup standards and milestones in interagency agreements and subsequent amendments, as well as other EPA, TDEC, and agency documents. We examined OREM's cost and schedule estimates in the 2023 federal site lifecycle baseline. We determined this information to be reliable for our purposes of reporting OREM's most recently approved estimates of expected future costs. We made this determination by (1) reviewing available documentation related to the estimates and (2) interviewing knowledgeable officials to better understand how the agency developed the estimates, including the underlying assumptions. We examined the risks OREM identified in risk registers for mercury cleanup projects and compared this information with OREM and DOE risk management guidance. Finally, we reviewed OREM documents describing goals, intended outcomes, and cost for mercury technology development activities supporting mercury cleanup.

We visited Oak Ridge to better understand the mercury cleanup program and projects at Y-12, including the construction of the mercury treatment facility and the mercury-contaminated buildings to be demolished. As part of our site visit, we interviewed OREM officials to obtain their views on the scope, cost, and schedule of mercury cleanup at Oak Ridge, as well as on risk and mercury technology development activities. In addition, we interviewed officials from EPA and TDEC to help us understand the regulatory framework and regulatory relationships impacting mercury cleanup.

We conducted this performance audit from October 2023 to September 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

List of Addressees

The Honorable Jack Reed
Chairman
The Honorable Roger Wicker
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Patty Murray
Chair
The Honorable John Kennedy
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
United States Senate

The Honorable Mike Rogers
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Chuck Fleischmann
Chair
The Honorable Marcy Kaptur
Ranking Member
Subcommittee on Energy and Water Development and Related Agencies
Committee on Appropriations
House of Representatives

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, and other interested parties. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

GAO Contact Information

For more information, contact: Nathan Anderson, Director, Natural Resources and Environment, AndersonN@gao.gov, (202) 512-3841.

Sarah Kaczmarek, Acting Managing Director, Public Affairs, KaczmarekS@gao.gov, (202) 512-4800.

A. Nicole Clowers, Managing Director, Congressional Relations, ClowersA@gao.gov, (202) 512-4400.

Staff Acknowledgments: Janice Poling (Assistant Director), Jamie Meuwissen (Analyst in Charge), Cindy Gilbert, Caitlin Scoville, Linda Tsang, and Cynthia Turner.

Endnotes

[1]U.S. Department of Energy, *Record of Decision for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal at the Environmental Management Disposal Facility, Oak Ridge, Tennessee* (2022) (DOE/OR/01-2794&D2/R2).

[2]The behavior of mercury in the environment is complex. It can be present in several forms (liquid, vapor, and gas), and various environmental factors affect how it migrates and in what form it exists. For example, where a subsurface mercury source is not initially elemental (the visible form that is most recognized), the elemental form can be generated through microbial-driven processes by certain bacteria. In addition, the relationship of mercury in fish tissue to mercury in water is complex and not well understood, despite many years of monitoring.

[3]Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Pub. L. No. 96-510, 94 Stat. 2767 (codified as amended at 42 U.S.C. §§ 9601-9675).

[4]Upper East Fork Poplar Creek is designated for recreation use, which includes the safe consumption of fish and shellfish. The final cleanup standard for Upper East Fork Poplar Creek surface water is based on the water quality criteria in Tennessee regulations for this use designation, which is 51 ng/L. This standard refers to the measurement of total mercury.

[5]In the past, OREM's failure to meet milestone deadlines resulted in OREM paying penalties to EPA and TDEC.

[6]U.S. Environmental Protection Agency, U.S. Department of Energy Oak Ridge Operations, Tennessee Department of Environment and Conservation, *Federal Facility Agreement for the Oak Ridge Reservation*, *Appendix E: FY 2024–2026 Federal Facility Agreement Milestones* (April 2024).

[7]These costs include CERCLA cleanup projects and the costs for two of the three capital asset projects (the mercury treatment facility and waste disposal facility). The costs do not include the estimated cost for the fence relocation that NNSA is managing.

[8]U.S. Department of Energy, *Oak Ridge Office of Environmental Management Procedure: Risk Management*, OREM-PC-IP-04, Revision 6, Admin. Change 1 (Washington, D.C.: May 21, 2021) and *Risk Management Guide,* DOE G 413.3-7A Change 2 (LtdChg) (Washington, D.C.: Nov. 22, 2021).

[9]U.S. Department of Energy, *Environmental Management Program Management Protocol* (Washington, D.C.: Nov. 6, 2020).

[10]U.S. Department of Energy, *Additional Guidance on Programmatic Risk Management for Federal Site Lifecycle Estimates* (Washington, D.C.: Aug. 17, 2023).

[11]OREM officials said a risk register for the Outfall 200 Mercury Treatment facility is not available because it is undergoing a baseline change.

[12]GAO, *Nuclear Waste Cleanup: Closer Alignment with Leading Practices Needed to Improve Department of Energy Program Management*, GAO-24-105975 (Washington, D.C.: June 4, 2024).

[13]For fiscal years 2020 and 2021, OREM's approved budget for the mercury technology development program was $5 million annually.

[14]Examples of mercury technology development projects at Oak Ridge National Laboratory include testing chemical absorbents for binding mercury in soil and mussel filtrations for removing mercury out of the water ecosystem.

[15]In case of insufficient funding, OREM plans to prioritize technology demonstrations that support building D&D and waste disposal over technology demonstrations that would support future soil remediation cleanup actions.

[16]Under the Resource Conservation and Recovery Act, as amended, a solid waste is a hazardous waste if it is specifically listed as a hazardous waste in EPA regulations or meets one or more of EPA's identified characteristics of a hazardous waste, such as toxicity. Wastes that are hazardous due to the toxicity characteristic are harmful when ingested or absorbed and present a concern as they may be able to leach from waste and pollute groundwater. Under EPA regulations, the toxicity of a waste is determined by using the agency's Toxicity Characteristic Leaching Procedure. A solid waste exhibits the characteristic of toxicity for mercury if, using this procedure, the extract from a representative sample of the waste contains a concentration of mercury equal to or greater than 0.2 milligrams per liter (mg/L).

[17]U.S. Department of Energy, *Program Management,* DOE P 410.3 (Washington, D.C.: Sept. 23, 2021).