Report to the Senior Advisor Office of Environmental Management United States Department of Energy

Focused Review of the Research & Development Roadmap for Hanford Tank Waste Mission Acceleration

Prepared by the Environmental Management Advisory Board

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Acknowledgment

This report to the Senior Advisor, Office of Environmental Management, was prepared by a subcommittee of members of the U.S. Department of Energy Environmental Management Advisory Board (EMAB).

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Introduction and Charge

The Office of Environmental Management (EM) is using an adaptive management framework to inform decision-making, address emerging priorities, and achieve effective mission results. The term "adaptive management" is used to address potential options for adjusting implementation of a proposed action after a decision document has been signed. The process allows flexibility in response to changing conditions, within agreed upon parameters, and facilitates communication with stakeholders regarding adaptations to implementing the proposed action. This approach is particularly useful at sites where remediation is difficult and complex, the remediation potential is uncertain, and the remediation may require a long time.¹

As an example, the U.S. Department of Energy's (DOE) Office of Legacy Management has developed an Adaptive Management Plan (AMP) at the Rocky Flats Site in Colorado. The AMP includes a monitoring and data evaluation program to assist in deciding when to implement final steps of the agency's action to return surface water flow to approximate conditions that existed before retention ponds were constructed.²

Consistent with this approach, the EM Program Plan, which outlines a framework for charting EM's path forward to complete the cleanup mission, will be used to guide efforts over the next two decades. To support this approach, it is imperative to gain and maintain alignment among EM, states, local governments, tribes, and other stakeholders for decisions to facilitate mission progress.

While EM's priority focus areas include cleaning up tank waste and remediating contaminated soil and groundwater, there is also a need to use research and development (R&D) efforts in an adaptive manner to identify opportunities for technology innovation and pursue Technology Development (TD), and to integrate and share advanced technologies across the complex. In doing such, EM has embarked on development of an integrated strategy and framework for TD and R&D efforts across the EM complex.

Recently, Congress tasked the Army Corps of Engineers to review EM's R&D activities with a focus on the Hanford, Savannah River, Oak Ridge, Idaho, and Los Alamos sites, to make recommendations on annual funding levels for EM's TD Program. Recognizing that the Hanford tank waste remains as the largest portion of EM's environmental liability, EM chartered the

¹ Interstate Technology & Regulatory Council (ITRC) 2017. *Remediation Management of Complex Sites.* RMCS-1. Washington, D.C.: Interstate Technology & Regulatory Council, Remediation Management of Complex Sites Team. http://rmcs-1.itrcweb.org.

² U.S. Department of Energy, Office of Legacy Management. *Surface Water Configuration Adaptive Management Plan for the Rocky Flats Site, Colorado*, LMS/RFS/S07698 Rev. 5, December 2021.

DOE National Laboratories, through the Network of National Laboratories for Environmental Management and Stewardship (NNLEMS), to develop a R&D roadmap to guide EM's TD investment for breakthrough technologies that could help accelerate the Hanford tank waste mission. In the R&D roadmap, NNLEMS identified ideas for projects that could be explored and used for near-term benefits for the cleanup program. The roadmap also recommended prioritized research areas and a full R&D portfolio to develop breakthrough technologies over time.

Congress appropriated \$851 million for the control point "Rad Liquid Tank Waste Stabilization and Disposition" in the FY23 Appropriations Act. DOE plans to use \$50M of that appropriation for the implementation of the Roadmap.

EM is in the process of evaluating the NNLEMS recommendations to develop, in collaboration with the Office of Science and the Advanced Research Projects Agency-Energy, a comprehensive R&D portfolio for Hanford tank waste while interacting with the broad research community through a number of initiatives, including a competitive TD process.

In March 2023, EM requested that the Environmental Management Advisory Board (EMAB) assess the NNLEMS' focus areas as proposed in the Roadmap and provide input to reinforce and assist EM's development of the R&D portfolio for Hanford tank waste. These results will be key in informing near term and future tank waste decision-making in a cost-effective manner, while interacting with a broad range of government and industry experts for developing and applying innovative solutions. This approach supports an adaptive and flexible approach for adjusting direction as necessary to improve organizational capacity in gaining and maintaining sustainable progress.

The DOE is on an accelerated schedule to make project awards within this fiscal year using a competitive process for most of the appropriated funds. Therefore, EMAB's feedback needs to be timely so that information can be incorporated upfront into the Funding Opportunity Announcement. The R&D Roadmap authors appear to have assembled an appropriate group of experts from many related disciplines with experience applicable to the handling, treatment, and disposal of the types of radioactive and hazardous wastes associated with the Hanford tank wastes. Of necessity, the product of their work relies heavily on their informed judgements.

In reviewing the R&D Roadmap document, however, EMAB had neither the time nor the scope of expertise to evaluate these individual and collective judgements. Rather, members have considered the overall logic of the process, the extent to which appropriate factors have been considered, and how well the findings and recommendations flow from the information presented in the report. Thus, to meet DOE's goals of incorporating EMAB's comments into the funding opportunity, a subcommittee of EMAB members agreed to participate in a *focused review* of the R&D Roadmap that is limited to the following three Charge Questions.

- 1. Generally, what does the EMAB think of the R&D Roadmap, does the roadmap represent a sound approach for acceleration of the tank waste mission?
- 2. Generally, do you agree with the priorities represented in Table 4? Which priorities deserve the most attention? Does the EMAB have other suggestions on priorities that do not appear to have been considered?
- 3. Are there any metrics the EMAB would recommend measuring the success of the R&D program to implement the Roadmap?

The following report contains the EMAB's perspectives, issues and recommendations for DOE EM's consideration as the agency generates funding opportunities for R&D that can lead to technological innovation across the DOE EM complex.

EM Charge: Hanford Tank Waste R&D Roadmap Charge Question #1

Generally, what does the EMAB think of the R&D Roadmap, does the roadmap represent a sound approach for acceleration of the tank waste mission?

Overall, the EMAB is supportive of the *R&D Roadmap for Hanford Tank Waste Mission Acceleration* (hereafter R&D Roadmap). The R&D Roadmap indeed represents a sound approach for risk reduction and acceleration of the Hanford tank waste mission. The R&D Roadmap is comprehensive in scope and has pursued a systematic process for identifying potential areas of R&D, organizing information, and ranking projects in relation to criteria that reflect the important values that need to be considered in the difficult process of organizing a program that will provide the best value within the resources likely to be available.

EMAB is aware of multiple past efforts by EM to establish a viable and lasting R&D program to support the cleanup mission. The EMAB even had some direct involvement in supporting this with a recommendation report for tank waste in 2014 that took almost two years to develop. Each of these R&D efforts had some limited success, even occasionally success at a specific site. However, the focus on R&D always waned when other priorities garnered more attention and funding became tight. The cyclic rise and fall of R&D emphasis was less of an issue for soil and water remediation and demolition projects, which typically span a decade or so. In contrast the Hanford tank waste mission, which has already spanned four decades, will require multiple decades more, even multiple generations, before completion. An R&D program which ebbs and flows is very detrimental to such a complex and extended mission, and thus the R&D Roadmap provides the blueprint for a comprehensive, rational, and visionary R&D program to ensure successful completion of the Hanford tank waste mission as efficiently and effectively as possible.

There are multiple aspects of the latest R&D Roadmap which positively distinguish it from previous efforts.

- 1) First, the R&D Roadmap demonstrates EM's commitment to complete the Hanford tank waste mission completely and in an integrated manner that focuses on improvements in safety, schedule, effectiveness, and efficiency. EM has taken the bold choice to advocate for technical advancement so that tank remediation does not just plod along with no clear path for some of the more intractable processing problems. This commitment is demonstrated by the attention given to aligning the R&D Roadmap project timelines with the anticipated timing of key policy decisions (e.g., Critical DOE Mission Level Decisions) that will be needed to advance the cleanup effort.
- 2) The R&D Roadmap is comprehensive. It does not avoid research alternatives that may face regulatory or stakeholder opposition or require extended development timelines. It combines, analyzes, and prioritizes all the technically viable research alternatives to support informed decision-making in a systematic fashion. The result provides a balanced research portfolio that incorporates both incremental and transformative improvements.
- 3) The R&D Roadmap is improvement and results focused. Improvements in schedule acceleration, cost, risk reduction, and safety are evident in the criteria used to organize and prioritize the R&D Roadmap research areas. Metrics developed to measure R&D Roadmap progress will continue to maintain the outcome focus. The R&D Roadmap also includes a well-developed framework for contracting which increases confidence in EM's ability to implement the elements of the plan.
- 4) The R&D Roadmap is flexible and responsive. Technology development activities are rarely linear in their progress nor predictable in their outcome. R&D which pushes the boundaries of knowledge will have failures, and the Hanford tank waste mission is clearly in that realm. The R&D Roadmap is structured to acknowledge this fundamental truth about R&D by utilizing an adaptive framework, recognizing the need to revisit priorities and opportunities on a regular basis and to account for progress to date, new challenges, and the innovative technologies and tools that may become available outside of this initial R&D Roadmap.
- 5) The R&D Roadmap is logical and factual. Information involving tank waste processing and disposal has been gathered from the past operations at Hanford, and other DOE and international sites. The R&D Roadmap starts first with this expansive listing of technologies and approaches, then using a systematic approach narrows the initial broad array of potential projects to a final set of project recommendations. Use of the fourteen evaluation criteria provide consistent and comparable information on these criteria for the potential projects.

- 6) The R&D Roadmap is inclusive of laboratory expertise. The DOE laboratory and university network includes the best knowledge in the world to address Hanford tank waste challenges. Some past R&D efforts have focused on a particular laboratory or reflected bias toward a particular laboratory's expertise. This R&D Roadmap reflects broad inclusion of laboratory and university input, focusing on technical advancement in research areas rather than promotion of a specific technical approach. In this manner the R&D Roadmap is broadly inclusive of laboratory talent, and thus also provides a means to demonstrate tangible return on the investment made in national laboratories.
- 7) The R&D Roadmap is organized in an understandable manner. The technical challenges for the Hanford tank waste mission are daunting in their complexity and often conflicting internal process relationships. This characteristic of the mission is especially difficult for EM decision-makers trying to maintain long-term mission focus in a political environment that desires short-term results and success. Use of the train station analogy to organize the R&D Roadmap research areas at a macro level effectively demonstrates the bigger picture with those difficult tradeoffs, but also the critical nature of those decision points. The structure also demonstrates the mission completion focus and promotes measurement of progress as the mission advances along the tracks.

EM Charge: Hanford Tank Waste R&D Roadmap Charge Question #2

Generally, do you agree with the priorities represented in Table 4? Which priorities deserve the most attention? Does the EMAB have other suggestions on priorities that do not appear to have been considered?

Table 4, *Prioritized List of Investment Portfolio,* is well done. It is comprehensive and provides the key comparison metrics used by the authors so that a reviewer can draw their own conclusions and opinions. It is viewed as positive that the list includes multiple cost aspects such as total cost, return on investment, and estimated savings. Some previous EM planning products have focused on only one or two of these elements. Table 4 gives a much more complete picture of the cost considerations, and including the current technical maturity and type of technological impact expected are also helpful. The Hanford tank problems are so complex and with so many 'targets' for improvement or research, it is important to understand more clearly the target each R&D effort is pursuing.

One possible criticism of Table 4 could be that it is complex and not easy to understand in a quick first read. However, EMAB members recognize that the Hanford tank waste problem is extraordinarily complex, and its solutions will span many more decades. A well-thought-out and extensive plan to address the R&D needs of such a challenge *should* be complex and

require an interested reader to invest time to achieve fundamental understanding of the mission.

One reviewer noted that the criteria and explanations for how Table 4 was developed seem reasonable, though the term "transformational" as defined on Page 27 is defined as "not implementable within Hanford program or long term to realize." This seems inconsistent with how the term is used within the table. Many of the areas described as transformational and these areas have the potential to significantly change some aspects of the cleanup program. Should reviewers assume they are potentially implementable, or they would not be on the list? A small, related question concerns project PS-3, which has Long-range listed as the Technology type, whereas all the others are listed as incremental, transformational, or risk mitigation. Is that a separate type of classification?

Clarification was provided by an author, that the intent of "not implementable within Hanford program" means that something in regulatory or programmatic (DSA, procedural) space would need to be changed in order to implement the technology. Regarding PS-3, that project is currently at the basic science level from an understanding so the authors considered the project would take a long-time before it could be implemented. Thus, it would fall under transformational definition.

Although EMAB had limited time available for review, members encourage comparison and consideration of priorities as described in two recent National Academy of Science reports on treatment approaches of supplemental low-activity tank waste (SLAW) at Hanford. Congress directed DOE in Section 3125 of the Fiscal Year 2021 National Defense Authorization Act to enter in into an arrangement with a Federally Funded Research and Development Center (FFRDC) to "conduct a follow-on analysis to the analysis required by section 3134 of the National Defense Authorization Act for Fiscal Year 2017" (NDAA 2017) and develop an analytic framework that would help decision-makers decide among the SLAW treatment technologies, waste forms, and disposal locations. In addition, Section 3125 of NDAA 2021 requires the FFRDC team to perform additional analysis on grout treatment options building on the analysis in the FFRDC report for Section 3134 of NDAA 2017. The National Academies was directed to form an ad hoc committee of experts to provide a concurrent review of the FFRDC team's continuing draft and final analytic frameworks. DOE appointed Savannah River National Laboratory (SRNL) as the FFRDC to lead this study, and then SRNL assembled a team of experts from SRNL, other DOE national laboratories, and outside the laboratories' network to perform the analysis. The National Academies appointed its committee to conduct the overlapping

review. The reports are intended to assist decision-makers in reaching a decision on the treatment and disposal of the SLAW.^{3 4}

Adding to these general observations, the following comments and recommendations are offered regarding Table 4:

- 1) Implementation of grouting and offsite disposal of Hanford's supplemental LAW should be a high priority.
- 2) Maximize efforts to remove low level waste from high level waste to increase efficiency and reduce cost.
- Continue to seek out-of-the-box disruptive technologies to advance clean up. Where possible, spent fuel recycling should be considered to support other energy and national security missions.
- 4) Around the time that the B-102 leak was announced, there were some that suggested that DOE should look at <u>the combination of tank-side pretreatment and</u> <u>grouting (for offsite disposal)</u> to quickly respond to emergent leaking tanks. EMAB reviewers note that R&D around that concept could be worthwhile.
- 5) Reviewers appreciate that the "Risk-based waste retrieval sequencing" explains that DOE would "work with the regulators and stakeholders" to prioritize sequencing and closures to address the highest risk to the environment. These risk-based decisions that include stakeholder engagement should remain in the "High" priority category, if not in the "Top" priority category. It will be critical that DOE have meaningful stakeholder agreement, engagement and discussion that includes evaluation of risks and ROI information.

³ National Academies of Sciences, Engineering, and Medicine. 2022. *Review of the Continued Analysis of the Supplemental Treatment Approaches of Low-Activity Waste at the Hanford Nuclear Reservation: Review #1*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26423.

⁴ National Academies of Sciences, Engineering, and Medicine. 2022. *Review of the Continued Analysis of Supplemental Treatment Approaches of Low-Activity Waste at the Hanford Nuclear Reservation: Review* #2. Washington, DC: The National Academies Press. https://doi.org/10.17226/26632.

- 6) WRT&C: Consider raising TC-3 up to the first High priority (second item in the table). The reason is because of the huge importance of working with regulators and stakeholders, which is the focus of this research area. Also, the cost is lower than WR&T-3b & 10a and WR&T-7b above it, so it should be possible to slip it in. Also, the regulator and stakeholder have potential carryover for work on other research areas.
- 7) WI&D: Consider moving DL-3 ahead of IM-4 in the table. They are both Top priorities with similar schedule acceleration and ROI. However, it appears that DL-3 might have the added benefit of greater utility for ongoing Hanford Tank Waste management, and disposal efficiency throughout the EM network.
- 8) SWT: Consider making SW-1 a Top rather than High priority. The reason is that it appears SW-1 could have considerable synergy with IM-13, and thus provide a multiplier effect between these research areas.
- 9) ME: Consider making Hanford-1 a Top rather than High priority. The reason is that it provides significant synergy with the overall R&D Roadmap at a fairly low cost and with relatively quick results. It also has the potential to assist EM dialogue with regulators, stakeholders, and Congress about the R&D Roadmap as it proceeds.

EM Charge: Hanford Tank Waste R&D Roadmap Charge Question #3

Are there any metrics the EMAB would recommend to measure the success of the R&D program to implement the Roadmap?

Measuring the success of any R&D initiative can be challenging, and particularly so with the prioritized list of multi-year research areas described in Table 4. However, the document presents several "key considerations" that could serve as reasonable metrics as projects are selected, funded, and tracked. These include:

- 1) Technologies that deliver timely risk reduction for the surrounding Hanford communities, site workers, the nation, and the environment
- 2) Technologies that reduce the need for cross-site transfers to the Waste Treatment and Immobilization Plant (WTP) facilities.
- 3) Technologies that support improvements to the baseline without additional escalation of cost and schedule.

The technology development metrics already in use should include all elements of the R&D process as research areas are progressed through to demonstration and implementation. One of the most important metrics or set of metrics necessary are those which will provide Congress with the information they need to continue dedicated and consistent funding for the R&D Roadmap. Consistent R&D funding has been a challenge for the EM program since its formation.

The R&D Roadmap is created with the implied understanding that consistent funding will be necessary for decades as the tank waste processing continues. Metrics that speak to Congress and convince them to maintain the R&D funding are vitally necessary. Certainly, cost savings, schedule acceleration, time to element, and risk reduction are common areas of interest for Congress and all stakeholders. EMAB members recommend that EM engage directly to ask the Congressional committees for their input on metrics that would be the most meaningful to them. There may be some new and unexpected metrics, specifically tailored for the key Congressional committees, which would be helpful for the long-term vitality of the R&D program.

Metrics based on intangible elements are always hard to develop but will be important to the success of the R&D Roadmap. Metrics for Regulator acceptance and Stakeholder acceptance will be important because so many of the research areas in the R&D Roadmap challenge established norms and understandings, even regulatory agreements, for the Hanford tank waste.

Measuring Regulator and Stakeholder acceptance in an absolute sense is difficult if not impossible, however metrics which provide relative degrees of acceptance between research areas would be particularly useful to EM. The relative acceptability would inform both the close decisions for funding at the annual funding cutoff point and inform EM regarding the additional resources that may be necessary to advance a particular research area with regulators and stakeholders. There are many different survey methods to measure opinions or attitudes of large and diverse populations, which would characterize the Hanford Tank Waste stakeholders. EMAB recommends EM consider use of consulting organizations specifically focused on gathering public opinion of complex issues.

Regulator and Stakeholder acceptance has the potential to impact Congress, and to act either as a multiplier in support of or against a particular research area. Also, the very act of measuring regulator and stakeholder acceptance demonstrates to these groups that they are important to EM in the implementation of the R&D Roadmap. For these reasons, focus on the development of key metrics for the R&D Roadmap aside from the technical and timeline metrics noted in the tables is warranted. The Office of EM should review the adaptive management plan for Rocky Flats and consider similarly maintaining a record of meetings with local governments and other community stakeholders. These records would identify how often and how early stakeholders were engaged throughout the Roadmap. The R&D Roadmap identified five "quick win" ideas that could help advance the near-term Hanford mission should funding become immediately available. If one or more of these technology development projects were successfully implemented within a reasonable timeframe, the "quick win" could serve as a high-level metric that the overall R&D Roadmap is an effective framework for achieving mission results.

Additional Comments and Recommendations

While EMAB has an overall favorable perspective for the R&D Roadmap, such a complex undertaking invariably provides opportunity for omissions or constructive advice. EMAB offers the following comments and suggestions for consideration to further improve the R&D Roadmap.

- 1) EMAB recommends the development of an implementation timetable for the R&D Roadmap.
- 2) The R&D Roadmap recognizes that the Hanford tank waste mission is not only technical, but political, budgetary, and regulatory in nature, as illustrated in the statement: *"Alternate technical approaches may be beneficial without increasing the technical risk but may require significant regulatory negotiations stakeholder engagement and regulatory document changes in order for the technology to be implemented."* A recurrent theme among reviewers is the need for ongoing community and stakeholder engagement that shares information, particularly about levels of risk and regulatory requirements. Such engagement should remain a high priority throughout the R&D Roadmap process. Stakeholders, broadly defined, include Congress, state and local governments, Tribal members, regulators, workers, unions, special-interest groups, and citizens, which have demonstrated over the last several decades their ability to directly impact the Hanford tank waste mission.
- 3) Several useful means of communication include public forums that the community can attend, in addition to regular meetings with local officials in the community and at DOE headquarters. Communicating challenges to local government officials is essential, as it allows local government officials to be transparent with constituents. EMAB views as critical that stakeholders be involved in such decisions rather than a "decide-and-inform" framework. If stakeholders are included in the decision-making process, it is more likely that they will accept the outcome because they had a chance to shape that outcome.
- 4) If alternate approaches are pursued, local governments should be included in ongoing discussions to build trust and build community buy-in. This type of engagement as early as possible will be key to ensuring smooth implementation. *"Communicate successes and challenges across the Hanford Site Clean-Up program with a focus on building consensus with internal and key external stakeholders and regulators."* The potential of

new missions that could leverage and lessen or reuse waste for other applications should also be considered as a pathway to accelerate clean up and support other energy needs.

- 5) The R&D Roadmap demonstrates the vital importance of research to accelerate the Hanford tank waste mission in a more effective manner. EM should make this connection between mission success and R&D progress even more explicit so that the R&D Roadmap becomes an inherent and expected part of the Hanford tank waste funding request each year. It is important that R&D investments are followed through and supported with reinvestment if the technological measures are deemed critical to ensure success. Regulators, stakeholders, and Congress must come to understand that Hanford success is dependent on continued and predictable support for the R&D Roadmap research areas.
- 6) The R&D Roadmap has taken great strides to organize the tank waste technical challenges in an understandable manner. Yet the technical issues are still extremely complex, usually interrelated, and impossible to reduce to simple three bullet slides or soundbites. EMAB suggests that EM continue the steps taken with the railroad station analogy and explore further analogies and techniques to make the tank waste technical issues more readily understood by the broad range of stakeholders. EMAB believes investment in these communication enhancements will more than pay their way with better and faster understanding of the issues and decisions.
- 7) There is an acknowledgement in the executive summary that the reinterpretation of the high-level waste definition has not been able to be implemented at Hanford. While the technical solutions proposed in the Roadmap assume that the HLW interpretation is not implemented, discussions surrounding the HLW interpretation could influence several of the priority areas for the R&D Roadmap. As the Energy Communities Alliance notes, "...there are several advantages to using the HLW interpretation at Hanford that can decrease costs and accelerate cleanup schedules. First, it requires no change in law. Second, Section 3116 and WIR are not fully risk-based because they unnecessarily require radioactive radionuclides to be removed. Additional treatment of waste that already meets existing legal, regulatory, and technical requirements for safe transportation and disposal offsite or onsite is unnecessarily expensive and inefficient, with no added benefit to safety or human health." It may make sense to do a more detailed analysis on the opportunities/process associated with implementing the HLW interpretation, especially at Hanford.

Conclusion

The DOE's Environmental Management program has made significant progress over the past several decades in cleaning up legacy waste and closing many of its formerly utilized sites. Some of the most vexing challenges that remain, such as the Hanford tank treatment mission, can benefit from investments in research and development as described in the R&D Roadmap. Such taxpayer-funded investments have the potential to shorten the long-time horizon associated with the current treatment schedule, estimated at more than half a century.

Based upon EMAB's focused review of the R&D Roadmap for Hanford, several factors emerge as pivotal to successful acceleration of the tank mission. First, the agency should continue to monitor, analyze, and leverage work performed at the Savannah River and Idaho sites for technologies and processes that could be applicable to the Hanford tank mission. The R&D roadmap acknowledges the need for continuous monitoring and feedback so that roadmaps can be updated regularly as technologies are deployed and flowsheet changes implemented.

Second, the EM's R&D Roadmap should complement and integrate the congressional directive to develop an analytic decision making framework regarding supplemental low activity waste. A hybrid public meeting is scheduled in Richland, WA on June 6, 2023 to discuss the National Academies of Science's committee's final review of the Federally Funded Research and Development Center (FFRDC) report on supplemental waste treatment alternatives, including vitrification, fluidized bed steam reforming, and grouting. ⁵The Savannah River National Laboratory was appointed by DOE as the FFRDC to lead this study. Results from this report, as well as stakeholder comment, could inform and influence the prioritization of projects as described in Table 4 of the R&D Roadmap, and define and refine metrics that can shape program direction. Acknowledgement of this parallel effort should be included in the EM funding opportunity for FY24 and integration should be considered as a scoring element for responses.

Third, the Office of EM's adaptive management framework can provide ongoing opportunities for stakeholders to engage in risk-reduction decisions regarding tank treatment R&D prioritization. This iterative process is vital for affected local governments, regulators, tribal representatives, and the public to convey their views and engage DOE as the agency pursues a sustainable and effective R&D Roadmap.

Finally, the R&D Roadmap should be viewed as a model for how the Office of EM can address other cleanup challenges in their remaining portfolio, with metrics that can be replicated. Given the significant proportion of the annual EM budget devoted to Hanford cleanup, demonstrated success in using the R&D framework at Hanford to realize an estimated \$150B in long-term cost savings will facilitate broader political and public support needed for additional EM Technology Development at Hanford and across the DOE complex. Sustained

⁵ https://www.nationalacademies.org/event/06-06-2023/review-of-the-continued-analysis-of-supplemental-treatment-of-low-activity-waste-at-the-hanford-nuclear-reservation-public-meeting-june-6-2023

funding will also generate the scientific inquiry necessary for mission success. EMAB members are pleased to offer an ongoing and more in-depth review of the R&D Roadmap.