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Summary of FY26 Engagement with IAEA on Environmental Remediation

November 2026

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Karen P. Smith

U.S. DEPARTMENT of ENERGY

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Pacific Northwest National Laboratory
Richland, Washington 99354

Summary

The Pacific Northwest National Laboratory has helped the International Atomic Energy Agency (IAEA) strengthen Member States' ability to safely and cost-effectively address radioactive contamination in the environment while advancing capabilities relevant to the cleanup mission of the U.S. Department of Energy's Office of Environmental Management (DOE-EM). PNNL's leadership in artificial intelligence-enabled remediation decision-support prototypes and the REMPOR information portal has laid the groundwork for broader access to proven technologies, site experience, and lessons learned that can inform remedy selection and reduce technical uncertainty. Training for 33 IAEA Member State participants, combined with leadership in ENVIRONET and international technical exchanges (through events like the Global Summit on Environmental Remediation and Waste Management Symposia), has built their practical expertise in site characterization, groundwater monitoring, and remediation planning. Together, these efforts have extended the value of DOE-EM's technical investments internationally and have created opportunities to bring global experience and emerging approaches back to the EM complex to support risk reduction and more effective cleanup decisions.

Acknowledgments

This important work was gratefully funded by the DOE Office of Environmental Management at the headquarters level through the Technology Operations Office (EM-3.21).

PNNL greatly appreciates the opportunity to collaborate with the IAEA, through our Practical Arrangement for cooperation in the areas of decommissioning, environmental remediation, and waste management. Specifically, Horst Monken-Fernandes and Sandra Faught are appreciated for coordinating and collaborating on the activities described in this report. Support from IAEA leadership, including Gloria Kwong, head of the Decommissioning and Environmental Remediation Section, and Olena Mykolaichuk, Director of the Division of Nuclear Fuel Cycle and Waste Technology, is also appreciated.

PNNL staff contributing to the development of the agentic/large language model prototype include Anurag Acharya, Tim Vega, Palak Mattoo, and Theresa Pham, with subject matter expert input from Xuehang Song and Christian Johnson. Inci Demirkanli was the principle investigator leading work on this prototype.

The team for the May 2025 Consultants Meeting is acknowledged for helping focus the initial ideas around artificial intelligence for environmental remediation on that IAEA ENVIRONET project: Inci Demirkanli (PNNL, Chair), Sameera Horawalavithana (PNNL), Christian Johnson (PNNL), Horst Monken-Fernandes (IAEA), Chantal Mommaert (IAEA), Edgar de Carvalho (IAEA), Duriem Calderin (IAEA), Akira Asahara (IAEA), Soraya Benalcazar (IAEA), Sushil Panghal (IAEA), Hany Abdel-Khalik (Purdue University) (IAEA), Dmitri Bugay (National Academy of Sciences of Ukraine), and Renee Roux (Lions Global).

Many thanks to the leadership and efforts from Karen P. Smith, who oversaw many of these interactions with IAEA until her retirement from PNNL at the end of March 2027. Karen had spent many years working with IAEA and ENVIRONET to further the goals of helping Member States build capacity, gain expertise, and have guidance to help with their environmental remediation activities.

Acronyms and Abbreviations

AI	artificial intelligence [1]
ALARA	as low as reasonably achievable
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLU-IN	Contaminated Site Clean-Up Information
CSM	conceptual site model
DL	deep learning
DOE	Department of Energy
DTL	decision tree learning
EPA	Environmental Protection Agency
EM	DOE Office of Environmental Management
ENVIRONET	IAEA Environmental Management and Remediation Network
ER	environmental remediation
ESD	Explanation of Significant Differences
FRTR	Federal Remediation Technologies Roundtable
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	fiscal year
IAEA	International Atomic Energy Agency
LLM	large language model
ML	machine learning
NLP	natural language processing
NORM	naturally occurring radioactive material
PDF	Portable Document Format
PNNL	Pacific Northwest National Laboratory
Q&A	question and answer
R&D	Research and Development
RAG	retrieval-augmented generation
RCRA	Resource Conservation and Recovery Act
RemPlex	PNNL Center for the Remediation of Complex Sites
REMPOR	REMediation PORtal
ROD	record of decision
TOO	DOE-EM Technology Operations Office
TRAC	Tracking Restoration and Closure
UK	United Kingdom
UKHSA	United Kingdom Health Security Agency
UMTRCA	Uranium Mill Tailings Radiation Control Act

[1] Note that Executive Order 14434 (September 29, 2026) directed United States federal agencies to call artificial intelligence "Super Intelligence" (or "SI"). Because of the international context of this report, the accepted international vocabulary standard for artificial intelligence found in ISO/IEC 22989 (*Information technology — Artificial intelligence — Artificial intelligence concepts and terminology*) is applied.

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1.0 Introduction

Pacific Northwest National Laboratory (PNNL) has collaborated with the International Atomic Energy Agency (IAEA) in specific technical areas of mutual benefit to the Department of Energy's Office of Environmental Management (DOE-EM) and IAEA related to environmental remediation (ER). A key part of IAEA's mission is to facilitate building the capacity of Member States in the form of technical expertise on the environmental remediation process. Having that expertise helps Member States safely and cost-effectively manage radioactive legacies, minimize radiation exposure, and restore contaminated land and water for public use.

This report provides a summary of fiscal year (FY) 2026 PNNL activities associated with IAEA engagement. This engagement showcased work at PNNL, DOE national laboratories, and across the DOE-EM complex, and has collaboratively supported international capacity building while concurrently furthering DOE's own ER decision support needs. The activities spanned two key ENVIRONET[2] projects, the ENVIRONET Steering Committee, a training workshop for IAEA Member State personnel, organization of Waste Management Symposia panels/sessions, and cooperative organization of the Global Summit on Environmental Remediation (RemPlex Summit). These activities are described in the following sections.

[2] https://nucleus.iaea.org/sites/connect/ENVIRONETpublic/Documents/Environet-Brochure.pdf

2.0 Advanced Computing to Support Environmental Remediation

One of the key ENVIRONET projects that PNNL led was on the "Use of Artificial Intelligence (AI) and Machine Learning (ML) in Environmental Remediation and Clean-up Projects." The project aimed to evaluate the use of AI/ML methods to support environmental remediation decision-making and, as appropriate, promote development of guidance and tools for use by its Member States' remediation experts and site managers. For IAEA Member States, the objective was to provide actionable guidance on AI-enabled remediation approaches while informing strategic decisions about future investments in these technologies. PNNL's contributions guided these efforts so that they are scientifically grounded, operationally relevant, and scalable across diverse remediation contexts. Through this work, PNNL is helping demonstrate the practical applicability of AI/ML methods while contributing to the development of an international framework for the responsible and effective use of these tools. Concurrently, this work helped inform efforts such as the DOE-EM AI Roadmap[3], which was developed to support more efficient cleanup across the DOE-EM complex, thereby reducing risk and improving environmental outcomes.

PNNL researcher Inci Demirkanli served as chair for a May 2025 consultancy meeting at IAEA in Vienna, Austria, where she, several other staff from PNNL (attending virtually), and participants from IAEA, several European countries, and other U.S. entities, discussed computational approaches that could benefit IAEA Member States. The consultancy meeting discussed the relevance, scope, and general approaches that could potentially support environmental data collection and interpretation, and ultimately ER decision making. The discussion considered approaches that included natural language processing (NLP), large language models (LLM), deep learning (DL), and autonomous (agentic) workflows. An important question was how these collective approaches might help practitioners with decision-making over the course of the environmental remediation process (i.e., starting from preliminary site evaluation through the post-remedial monitoring/stewardship phase). The expectation was that existing ER data and experience (i.e., from lessons learned and best practices) could be leveraged to facilitate providing answers to practitioner questions. Such approaches would enhance the ER decision-making process by supporting (not replacing) individual experts' evaluations for developing mitigation approaches to achieve risk reduction while maximizing benefits and remedy acceptability.

The path forward from the consultancy meeting was to explore potential methods/approaches and implementation feasibility for developing a tool that would be helpful to support remediation decisions. PNNL continued to take a lead role in this effort in FY26, which resulted in two prototypes: a LLM to support ER decision making in a broad manner and a decision tree learning (DTL) model for remedy recommendations, which are discussed in the sections below.

Both prototypes were described to EM HQ Technology Operations Office (TOO) staff in a June 30, 2026, online briefing provided by Christian Johnson. PNNL's Theresa Pham also gave an online briefing to TOO staff about the DTL model on October 28, 2025.

[3] A NNLEMS (Network of National Laboratories for Environmental Management and Stewardship; https://www.energy.gov/em/articles/network-national-laboratories-environmental-management-and-stewardship-nnlems-charter) effort, not yet published.

2.1 Agentic Methods and Large Language Model Approach

A PNNL team led by Inci Demirkanli investigated development of a prototype tool that used agentic methods with retrieval-augmented generation (RAG) to assemble information about remediation to address user-supplied questions.

The knowledgebase for this prototype tool consisted of a subset of U.S. Environmental Protection Agency (EPA) Superfund, formally known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), data of two types: spreadsheet data files and about 165 records of decision (RODs) from years 2010-2025. These sources provided the prototype with both structured data (from the spreadsheet files) and unstructured data (ROD PDFs) on which to draw and synthesize answers.

The prototype used agentic methods to orchestrate and execute workflows, autonomously planning and directing agents (Figure 1). The prototype architecture used a LLM and included document and metadata query agents that used schema definitions and RAG to extract relevant information from structured metadata and unstructured PDF documents. Generative methods allowed agents to create content based on direct instructions while RAG provided access to relevant foundational knowledge/data and was a critical subsystem for both generative and agentic methods.

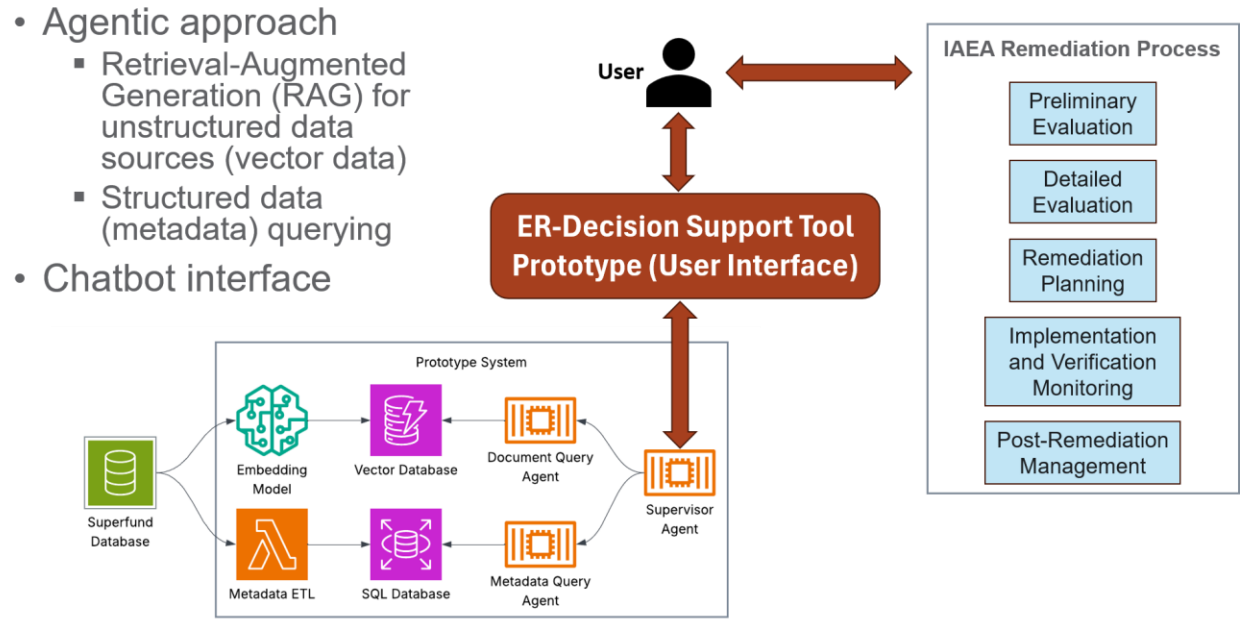


Figure 1. Architecture for the prototype implementation of an agentic tool using a large language model for natural language processing and a chatbot type user interface to address questions related to the environmental remediation process.

The user interface to this tool was a chatbot type interface where the user could ask natural language questions. Figure 2 shows an example where a question was asked about possible uranium groundwater contamination remediation technologies.

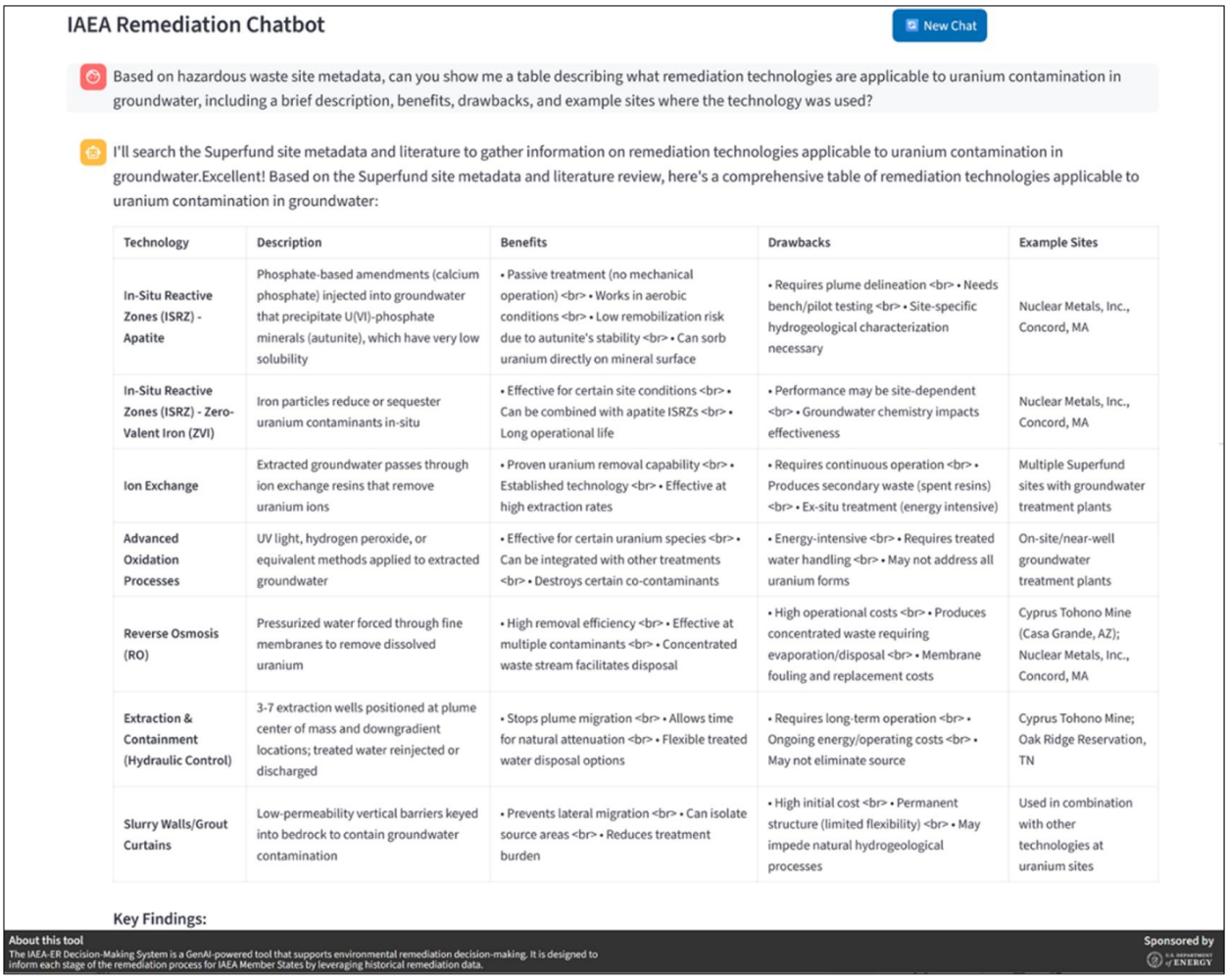


Figure 2. Example of the prototype tool chatbot interface for answering questions about the remediation process. Here, a question was posed about technologies for treating uranium contamination in groundwater, and part of the response is displayed.

2.2 Decision Tree Learning

PNNL's Theresa Pham explored the use of DTL to support ER decision-making as part of this IAEA project. The target of the work was to investigate how DTL can help answer the question: "Given the characteristics of a waste site, what remedial technologies should be applied to achieve cleanup?" The intent was to develop a DTL model that, based on defined inputs (e.g., the types of contaminants, the nature of the site, the receptors), could down-select from a comprehensive list of potential remedies (or classes of remedy) to a recommended subset that should be considered for a waste site.

DTL is a machine learning algorithm that predicts outcomes using a hierarchical sequence of decisions that can be represented as a tree-like structure (Figure 3). The method provides traceable, interpretable decision-making paths where the decision about which path to follow comes from rule-based logic reasoning. The decision pathways determine inclusion or exclusion of items as relevant recommendations. DTL is a supervised learning method, meaning that it requires labeled data. Additionally, the data must be structured (e.g., a

tabulated list or database). While the nature of the decision trees means that the method is very explainable, it also has limited flexibility and is prone to overfitting. That is, the model only knows what it knows and cannot extrapolate outside of that knowledge.

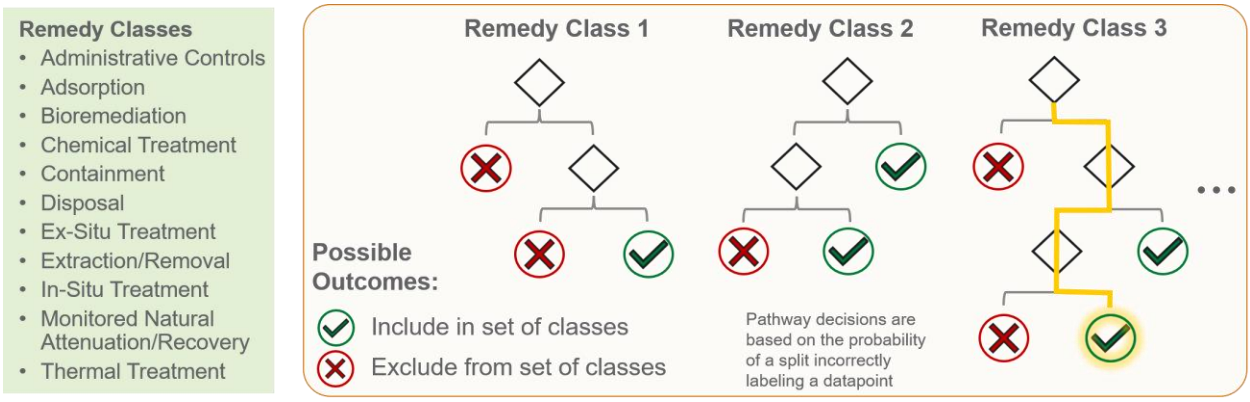


Figure 3. Conceptual depiction of decision tree learning (DTL) where the DTL model learns from data (e.g., Superfund Records of Decision) to define pathways and decision points for recommending whether a particular remedy class (type of remedy, such as bioremediation) could be suitable for a waste site. Here an example path resulting in inclusion of Remedy Class 3 (i.e., being recommended) is highlighted in yellow.

For this work, the data for the model consisted of select conceptual site model (CSM) waste site characteristics, such as contaminant type, contaminated media, geology, receptors, etc. These characteristics were selected based on relevance and availability in the data sources. EPA Superfund information was used as the data source for training the DTL model. Out of the 7,000 some RODs in the Superfund database, a subset of 426 arbitrarily selected RODs (for distinct waste sites) were used for this proof-of-principle work. Of those, 80% (341) RODs were used to train the DTL model and the other 20% (86) RODs were used to test the DTL model. Data from both ROD documents (PDF files) and the EPA spreadsheet data files were combined for each site represented by a ROD. For standardization and simplification, remedies for the sites in these RODs were organized into remedy classes (e.g., different flavors of bioremediation were all identified as a bioremediation remedy class).

Figure 4 illustrates the steps for compiling data, training the DTL model, and evaluating performance. Data were extracted from the data sources described above. Remedies were mapped to remedy classes (Figure 3). Note that a given waste site (ROD) often involved multiple remedy technologies. The data was split into training and testing sets. The DTL model was trained. Finally, the model was evaluated with the testing data set. The model evaluation showed that the model correctly matched at least one remedy 79% of the time, but only matched all of the site remedies 13% of the time. Out of all predictions of remedy inclusion for a site, 41% were correct. This illustrated a successful proof of principle, albeit with a small set of data for training and evaluation.

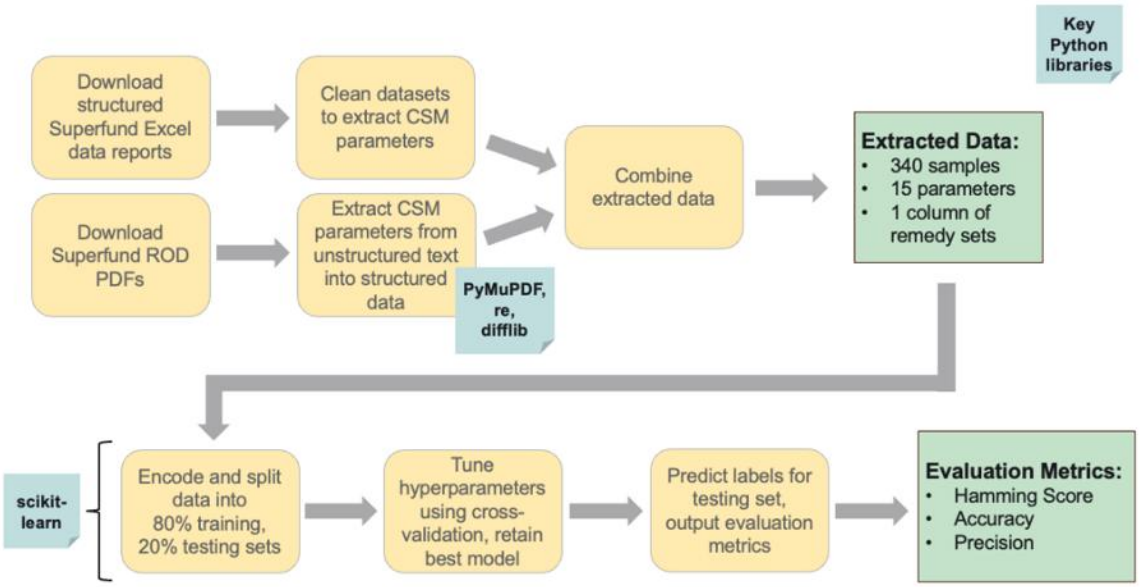


Figure 4. Steps for data compilation and DTL model implementation and evaluation.

This work showed that decision tree learning can provide promising decision-making support with respect to remedy selection under specific contexts and parameters. However, incorporating data for additional waste sites and inclusion of other document types (e.g., ROD Amendments, feasibility studies, remedial design, etc.) would be important next steps to increase the robustness and accuracy of this DTL method for remedy recommendations, allowing the model to capture more relationships and to significantly decrease overfitting. Additionally, temporal data aspects (changes in the remedy for a waste site over time, development of new treatment technologies, etc.), the use of treatment trains at waste sites, and having multiple sites per ROD are other important aspects that should be considered in future DTL model refinement.

2.3 Conclusions on AI Prototypes

Both prototypes showed great promise in supporting decision making, although 1) the decision-tree learning model is more likely best used as an agent for the envisioned agentic system and 2) the availability of ER data in a suitable format is a key component to supporting tools like these.

The exploration of U.S.-focused Superfund data highlighted importance of data with respect to the data format/extraction and completeness in terms of key information about the conceptual site model and remediation activities. More data is needed to make these tools more robust, including data on international remediation efforts. Temporal data aspects are important to include so that responses reflect currently relevant information and recommendations for successful and multi-step remediation efforts.

The prototypes that were developed showed that decision tree learning and agentic/LLM methods have potential to facilitate decision-making throughout the remediation process. Decision tree learning can provide explainable decision-making support under specific contexts and parameters. Agentic/LLM systems are useful for synthesizing data from a curated

knowledge base to answer a wide range of remediation questions. Both approaches have limitations and cautions. An agentic approach with multiple agents and more complex reasoning, coupled with an expansion in the underlying knowledgebase will improve the robustness and usefulness of these tools.

A range of things could be done in future work to improve the robustness, depth, and accuracy of the responses provided by these types of tools. One of the key actions would be to expand the underlying remediation knowledgebase. For both tools, only a few hundred RODs (sites) were used, whereas there are some 7,000 Superfund RODs available. In addition, waste sites have a range of other decision and planning documents that could be utilized, including ROD Amendments, Explanation of Significant Differences (ESD), remedial investigations, feasibility studies, remedial designs, performance evaluations, monitoring reports, etc. The Superfund (CERCLA) program is also not the only relevant program with data. Waste sites and remediation conducted under the Resource Conservation and Recovery Act (RCRA), the Uranium Mill Tailings Radiation Control Act (UMTRCA), the U.S. Army Corps of Engineers Formerly Utilized Sites Remedial Action Program (FUSRAP), and other U.S. programs would also be relevant. And international environmental remediation site information would be critical to better address questions from IAEA Member State practitioners. Where possible, expanded coverage of structured data would be useful to allow more expansive searches. Beyond data, employing more complex reasoning to concurrently handle multiple concepts would help answer questions like “How many sites with arsenic contamination in groundwater are utilizing chemical reduction treatment?”. The vision for the agentic approach is to employ multiple agents, each agent doing a specific task in parallel, which would improve efficiency of responses. That is, more advanced techniques and tools will lead to faster inference times. This expanded agentic approach would move from the architecture depicted in Figure 1 to something more like that depicted in Figure 5.

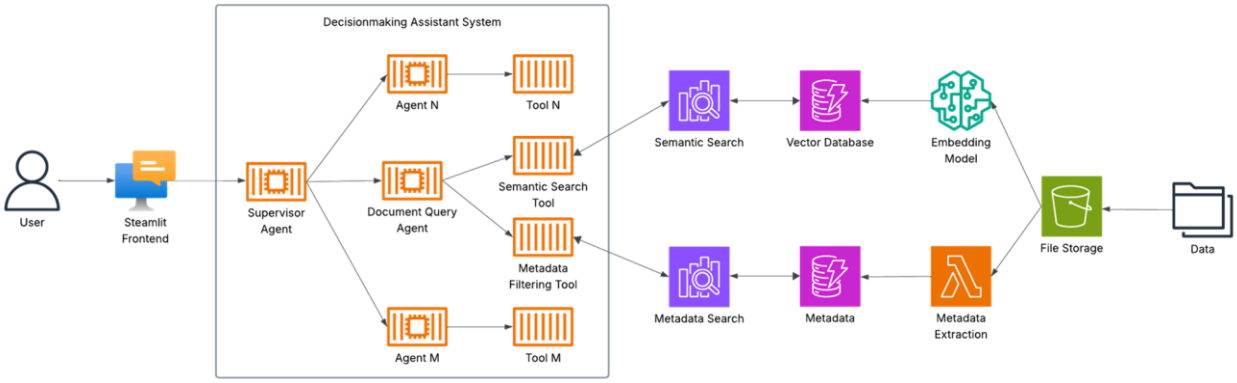


Figure 5. Scaled-up vision of the agentic/LLM approach for a tool to support questions about and decision-making for the environmental remediation process.

These tools have the potential, with expansion of the knowledgebase and refinement of the implementations, to be a great resource to support remediation decision making, not just for IAEA member states, but also for DOE and other U.S. entities.

3.0 REMPOR

The ENVIRONET REMPOR (REMediation PORtal) project has been supported by PNNL for several years as work has gone through phases. PNNL was instrumental in formulating the design concepts for the remediation portal web application (Figure 6). Building from expertise with the DOE-EM Tracking Restoration and Closure (TRAC) software[4], the REMPOR project sought to provide some similar resources to describe IAEA-relevant environmental remediation efforts worldwide. Working with consultants from Germany and Brazil, the collaborative team developed a database structure and the front-end interface, and started populating the database with site information. In addition to site information, REMPOR includes information on remediation technologies drawn from trusted resources, such as the Federal Remediation Technologies Roundtable[5] (FRTR) and EPA CLU-IN[6], to provide insights for IAEA Member State personnel about how remediation technologies work and which ones might be applicable to a given site.

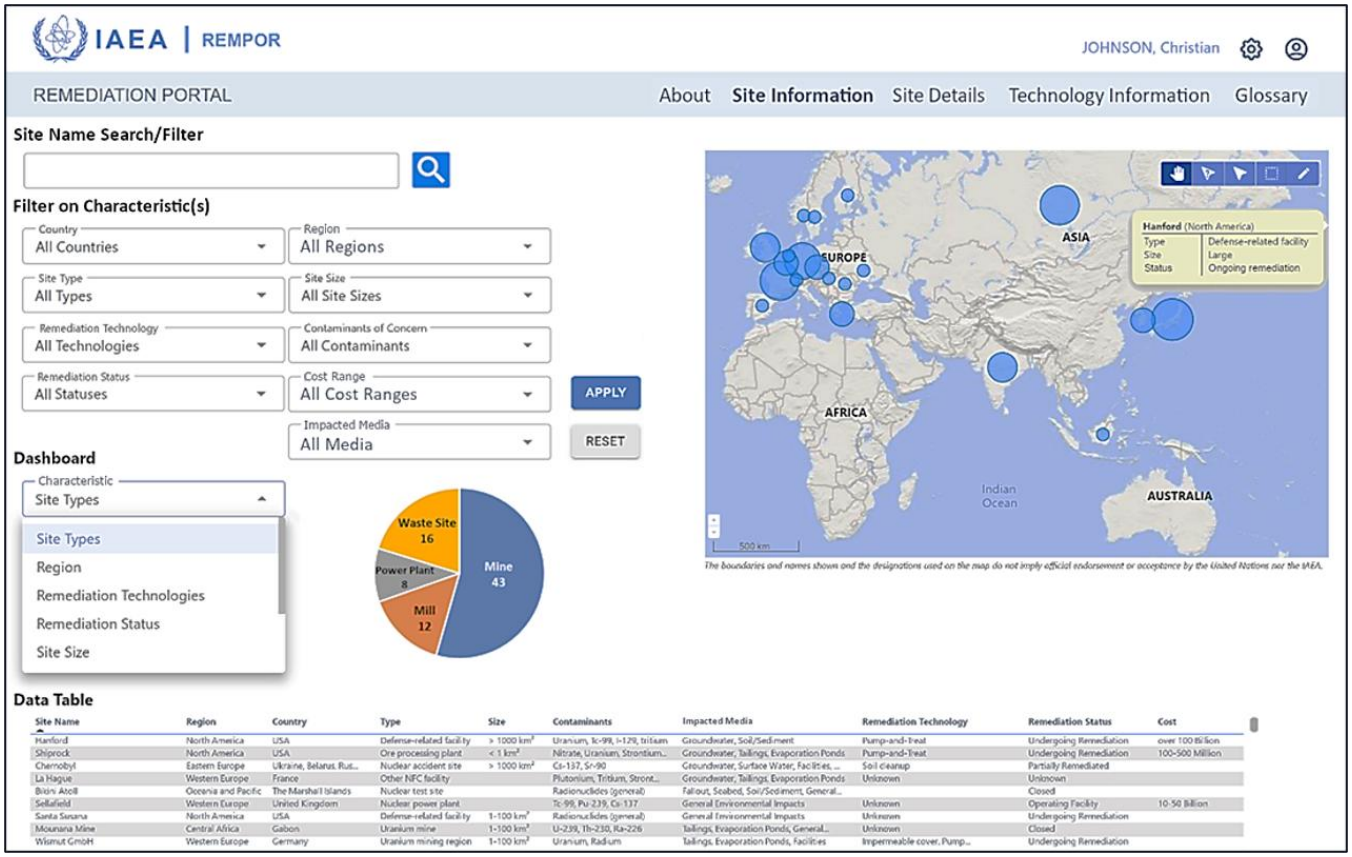


Figure 6. Design concept for the REMPOR remediation information portal that is intended to provide summary information on worldwide environmental remediation activities and insight to remediation technologies.

[4] https://www.pnnl.gov/projects/trac
[5] https://www.frtr.gov/
[6] https://clu-in.org/

In FY26, the REMPOR project added additional site data and a web application prototype was developed. The prototype (Figure 7) was unveiled on the final day of the 2026 ENVIRONET Forum (Section 5.0) as a beta version application[7] in the ENVIRONET area of the IAEA CONNECT platform. Future expansion is expected to include over 600 legacy remediation sites and over 1900 sites pertaining to naturally occurring radioactive material (NORM). After initial data is loaded, REMPOR is expected to have site information updates every five years.

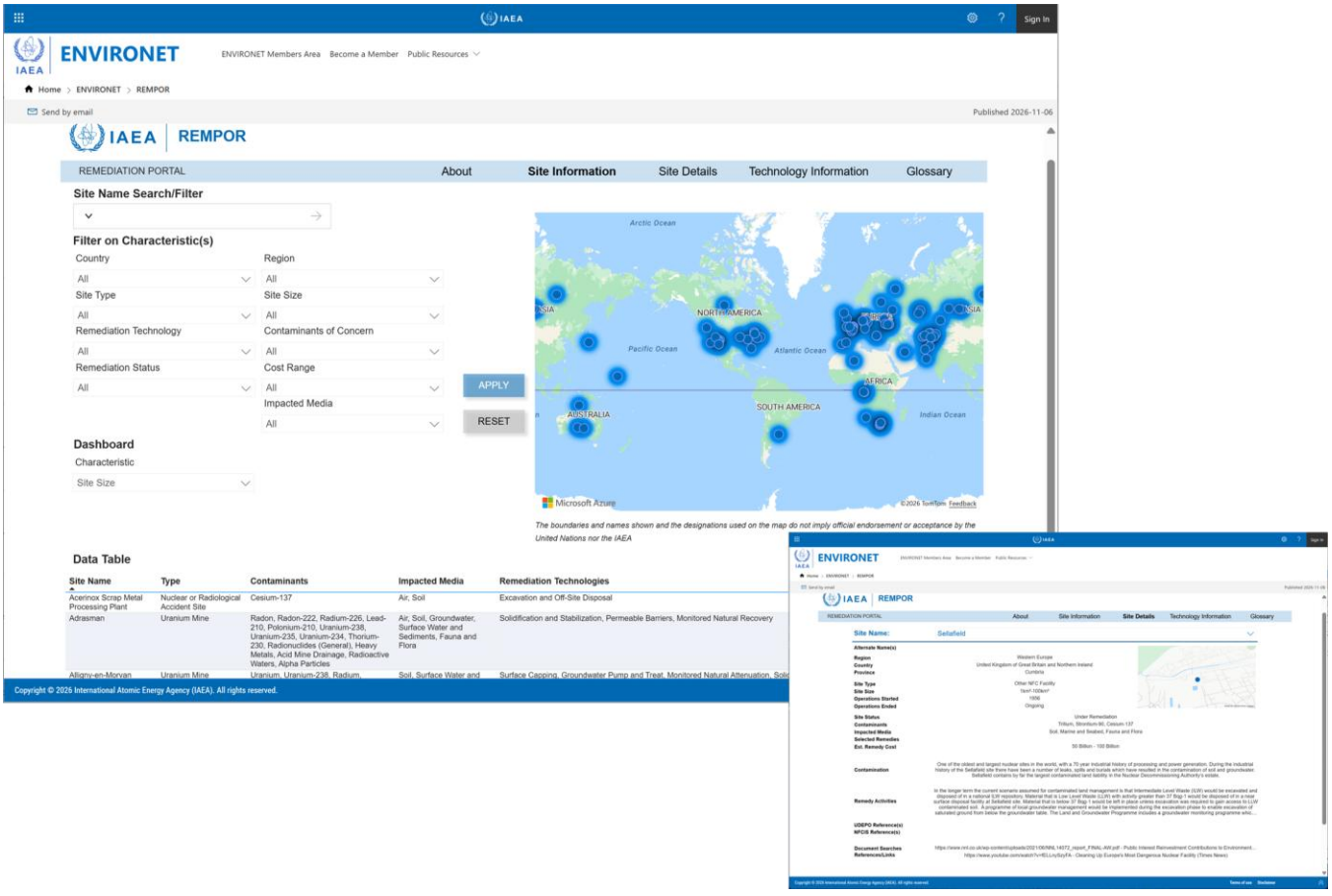


Figure 7. Beta version of REMPOR, published on November 6, 2026. The main page shows summary site information, while other pages show site details, technology information, and a glossary of terminology.

[7] https://nucleus.iaea.org/sites/connect/ENVIRONETpublic/SitePages/REMPOR.aspx

4.0 IAEA Characterization and Remediation Workshop

PNNL's Christian Johnson was one of the instructors for the April 2026 IAEA training workshop on "Techniques and Technologies for Characterization to Support Environmental Remediation" that was held at the United Kingdom Health Security Agency (UKHSA) Training Centre in Harwell, UK. As the "birthplace of the UK nuclear industry", now being transitioned back to the community as the Harwell Science and Innovation Campus, the site provided a great setting for 33 highly engaged participants (Figure 8) from a range of IAEA Member States to learn about approaches, technologies, and equipment for site characterization and remediation.



Figure 8. IAEA member state participants and instructors at the April 2026 site characterization training workshop in Harwell UK, working in groups as part of the hands-on exercises, and listening/engaging during topical lectures.

Joining instructors from the UK and Europe, Christian taught on the topics of developing and using conceptual site models, designing and implementing groundwater monitoring programs, and the fundamentals of AI/ML with application to environmental remediation. His workshop segments included lectures, hands-on exercises, and demonstrations of relevant tools. Specific objectives covered how to collect data, interpret that data, and incorporate it into a CSM to support remediation decision-making and effective communication with regulators. Participants greatly benefited from these segments and the rest of the week-long training to be better prepared for their work back home and for sharing methods and techniques with their colleagues.

Following this 2026 workshop, PNNL and IAEA initiated discussions about the potential to host the 2027 workshop at PNNL in Washington State. A potential benefit of this location was holding the workshop at a time just before or after the 2027 RemPlex Global Summit on Environmental Remediation. This would allow workshop participants to benefit from both activities and the Summit to benefit from experiences shared by the additional international attendees.

5.0 ENVIRONET

In March 2026, Christian Johnson was recommended for and accepted as a member of the IAEA ENVIRONET Steering Committee. This committee is instrumental in defining the purpose and scope of ENVIRONET, assessing potential ENVIRONET projects, and the planning and execution of the Biennial Forum of the Network on Environmental Remediation and NORM Management[8] (ENVIRONET Forum).

In the process of planning the November 2026 ENVIRONET Forum, Christian was selected as a co-chair (along with Dmitri Bugay of Ukraine) for the session on "Use of Artificial Intelligence and Other Digital Tools in Environmental Remediation." Thus, Christian was tasked with overseeing solicitation and selection of talk abstracts and will be a moderator for the session where research and application of AI/ML for environmental remediation is presented and discussed. Other sessions at the meeting covered guiding principles and holistic approaches for environmental remediation, environmental remediation technologies, uranium mining remediation, legacy waste trenches, complex nuclear sites, and NORM management.

Over 60 in-person (Figure 9) and virtual attendees participated in the presentations and discussions on the topics and Member State needs.



Figure 9. In-person attendees at the 2026 ENVIRONET Forum.

[8] Website for the 2026 ENVIRONET Forum: https://www.iaea.org/events/evt2503691

6.0 Conferences and Meetings

In addition to planning for the ENVIRONET Forum meeting in FY27 (Section 5.0), PNNL had engagement with IAEA and presentations about ENVIRONET projects at several other conferences in FY26, which are described in the following sections.

6.1 2025 Global Summit on Environmental Remediation

IAEA staff cooperated in the organization of the Global Summit on Environmental Remediation (RemPlex Summit) held at PNNL in November 2025. The IAEA staff helped solicit abstracts, make connections to potential speakers and case study sites, and co-chaired technical sessions. The cooperation with IAEA undoubtedly contributed to having 44 international attendees (24 in-person, 20 virtual) out of 208 total.

IAEA staff member Horst Monken-Fernandes provided opening remarks for the Summit, along with the RemPlex Director and the PNNL Associate Lab Director for Energy and Environment.

IAEA staff were co-chairs on several of the technical sessions. Mr. Monken-Fernandes co-chaired both the session on “Rethinking Remediation from Sustainability and Circularity Perspectives” and the session on “Revolutionizing Environmental Remediation with Artificial Intelligence.” The technical session on “From Earth to Orbit: Autonomous Measurements and Remote Sensing” was co-chaired by IAEA staff member Milan Matos.

IAEA staff and projects were featured in multiple talks and panels, which are listed in Table 1.

Table 1. 2025 RemPlex Summit panels/presentations by IAEA staff and about IAEA projects.

Name	Org.	Role	Talk/Panel	Technical Session
Horst Monken-Fernandes	IAEA	panelist	Panel: The Role of Research and Development (R&D) in Cleanup	Morning Plenary Session
H. Monken-Fernandes	IAEA	speaker	Resilient Remediation of Radioactively Contaminated Sites, Long-term Stewardship and Institutional Control: Challenges to Developed and Developing Countries	Resilience Planning and Long-Term Stewardship
Christian Johnson	PNNL	speaker	REMPOR Web Application for Access to Site and Technology Information	Data Management as a Foundation for Environmental Decision-Making
Inci Demirkanli	PNNL	speaker	Leveraging Artificial Intelligence and Large Language Models for Enhanced Decision-Making in Environmental Remediation	Revolutionizing Environmental Remediation with Artificial Intelligence
Milan Matos	IAEA	speaker	IAEA Activities in Support of Radiological Site Characterization	From Earth to Orbit: Autonomous Measurements and Remote Sensing
Chantal Mommaert	IAEA	speaker	New IAEA Safety Guide on Long Term Post-Remediation Management	Rethinking Remediation from Sustainability and Circularity Perspectives
Edgar Carvalho	IAEA	speaker	Perspectives and Challenges to Sustainable Remediation of Uranium Legacy Sites in Africa	Rethinking Remediation from Sustainability and Circularity Perspectives
H. Monken-Fernandes	IAEA	co-facilitator	Panel: Advancing Sustainability and Resiliency in Remediated Sites Worldwide	Rethinking Remediation from Sustainability and Circularity Perspectives

6.2 2026 Waste Management Symposia

PNNL and IAEA collaborated on organizing and running several sessions at the Waste Management Symposia in March 2026 in Phoenix, Arizona.

PNNL and IAEA organized a panel session titled “Concepts of Sustainability and Circularity in the Back End of the Nuclear Fuel Cycle” session. PNNL staff member Christian Johnson co-chaired this panel session (with John Mathieson of WM Symposia). Panelists included four IAEA staff: Amparo Gonzalez Espartero, Edgar Domingues De Carvalho, Horst Monken-Fernandes, and Gerald Nieder-Westermann. The panel session focused on how sustainability and circularity can be operationalized in the domains of used fuel management, radioactive waste management, decommissioning, and environmental remediation—not as abstract concepts, but as practical strategies that reduce burdens, optimize resources, and strengthen public trust.

PNNL and IAEA also organized the panel session on “Basis for Implementation of Environmental Remediation in a Broader International Perspective.” IAEA’s Horst Monken-Fernandes was one of the co-chairs for the panel. Diverse perspectives on environmental remediation implementation worldwide were used in the session to explore transformation of legacies into assets, with an interpretation of the ALARA (as low as reasonably achievable) principle for reducing doses and maintaining safety as the paramount condition while also considering social and economic dimensions.

6.3 Battelle Conference on Remediation of Chlorinated and Recalcitrant Compounds

The work on a DTL model as part of an IAEA ENVIRONET project (Section 2.2) was presented by PNNL’s Theresa Pham (Figure 10) at the Battelle 14th International Conference on Remediation of Chlorinated and Recalcitrant Compounds[9] in early June 2026. Although this was Theresa’s first-ever research conference experience, she did an excellent job presenting and there was strong turnout and Q&A engagement for her presentation. The presentation was entitled “Decision Tree Learning for Environmental Remediation Decision-Making” and was given in the session on “Data Analytics: Use of Machine Learning and Artificial Intelligence Tools for Improved Analysis, Optimization, Remediation, and Decision Making.” PNNL was the only DOE national laboratory represented (by Theresa and her mentor Christian Johnson) at this 1,600-person remediation conference.

[9] https://www.battelle.org/conferences/chlorinated-conference



Figure 10. PNNL post-master's research associate Theresa Pham presents "Decision Tree Learning for Environmental Remediation Decision-Making" in June 2026 at the Battelle 14th International Conference on Remediation of Chlorinated and Recalcitrant Compounds.

Theresa's presentation summarized the DTL tool, which focused on supporting decisions about the remedy selection portion of the remediation process. This tool used "decision tree learning," which is an ML algorithm that predicts outcomes using a hierarchical sequence of decisions. Using historical U.S. Superfund Site remediation data to train the tool, the goal was to provide accurate and fast answers to recommend remediation technology types that are expected to be effective for cleanup based on the characteristics of the waste site of interest.

7.0 Conclusions

PNNL has helped the IAEA strengthen Member States' ability to safely and cost-effectively address radioactive contamination while advancing capabilities relevant to the cleanup mission of DOE-EM. PNNL's leadership in artificial intelligence-enabled remediation decision-support prototypes and the REMPOR information portal has laid the groundwork for broader access to proven technologies, site experience, and lessons learned that can inform remedy selection and reduce technical uncertainty. Training for 33 IAEA Member State participants, combined with leadership in ENVIRONET and international technical exchanges (through events like the Global Summit on Environmental Remediation and Waste Management Symposia), has built practical expertise in site characterization, groundwater monitoring, and remediation planning. Together, these efforts have extended the value of DOE-EM's technical investments internationally and have created opportunities to bring global experience and emerging approaches back to the EM complex to support risk reduction and more effective cleanup decisions.

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