NATIONAL ENERGY TECHNOLOGY LABORATORY

FISCAL YEAR 2024 CRITICAL MINERALS AND MATERIALS (FIELD WORK PROPOSALS) PEER REVIEW

OVERVIEW REPORT

August 2, 2024

Disclaimer

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1 Introduction and Background

The Critical Minerals and Materials (CMM) Program aims to rebuild U.S. leadership in extraction and processing technologies for the production of CMM — including rare earth elements (REEs), critical minerals (CMs; originally defined by the U.S. Geological Survey [USGS]), and materials deemed critical by the U.S. Department of Energy (DOE) — from unconventional resources and secondary byproduct sources to support an economical, environmentally benign and geopolitically sustainable U.S. domestic supply chain.

Unconventional CMM resources include any resource from a geologic or secondary byproduct host that is distinctive from the mechanisms resulting in conventional, established deposits. Unconventional CMM can be sourced from in situ geologic deposits or from secondary byproducts of anthropogenic processes. These sources require revised or new methods and models to characterize and assess that focus on the unique source and temporal controls resulting in these deposits. Examples of unconventional and secondary byproduct sources include sedimentary deposits such as coal, black shale, tonsteins (clay-altered volcanic ash), coal underclays and marine phosphates, as well as secondary byproducts derived from mining and fossil energy-related waste streams such as produced water, coal fly ash, acid mine drainage and alloy production residues.

The National Energy Technology Laboratory's (NETL) CMM Program is focused on the following goals:

- Validate the technical and economic feasibility of domestic small pilot-scale facilities to produce high-purity CMM from carbon ore and coal-based resources.
- Produce 1–3 tonnes/day of high-purity mixed rare earth oxides/salts in domestic demonstration-scale facilities and refine to metals or alternative user-specified products as required for use in the CMM supply chain using coal-based and alternative resources as feedstock materials.
- Perform a regional assessment and production of CMM and novel high-value, nonfuel, carbon-based products covering the entire United States.[a]

The projects subject to peer review leverage the expertise of five DOE national laboratories to develop technologies to improve sensing and characterization of unconventional and secondary sources that contain REEs and other CMs. These sources are typically derived from mining waste streams, including previous and current coal mining operations, or fossil energy-related waste streams, such as produced water from oil and gas operations. The projects focus on technologies, methodologies and approaches to characterize and assess these sources at field scale and on sensor technologies to detect and quantify REEs and other CMs in mine wastes and other waste streams from coal mining and oil and gas production. Improvements in such

[a] Critical Minerals and Materials | netl.doe.gov.

technologies help reduce the costs and time that it takes to evaluate and produce CMs, which is key to accelerating their domestic production to meet the nation's goals.[b]

1.1 OFFICE OF MANAGEMENT AND BUDGET AND U.S. DEPARTMENT OF ENERGY REQUIREMENTS

In compliance with requirements from the Office of Management and Budget (OMB) and in accordance with the DOE Strategic Plan, DOE and NETL are fully committed to improving the quality of research projects in their programs by conducting rigorous peer reviews. DOE and NETL conducted a Fiscal Year 2024 (FY 2024) CMM (Field Work Proposals [FWPs]) Peer Review Meeting with independent technical experts to offer recommendations to strengthen projects during the period of performance. KeyLogic, an NETL site-support contractor, convened a panel of three academic and industry experts[c] May 14–16 and 21–22, 2024, to conduct a peer review of five projects (Exhibit 1-1).

[b] DOE Invests Over $5 Million to Help Secure Domestic Supply Chain for Critical Minerals to Support Development of Clean Energy Technologies | netl.doe.gov.

[c] Please see "Appendix D: Peer Review Panel Members" for panel member biographies.

Exhibit 1-1. FY 2024 Critical Minerals and Materials (Field Work Proposals) Peer Review — projects reviewed

Project Number	Title	Lead Organization	Total Funding*		Project Duration*	
			DOE	Cost Share	From	To
FWP-LANL-AE-1263-1711	A Machine Learning Screening Tool for Rare Earth Elements and Critical Minerals at the Mine Scale	Los Alamos National Laboratory	$1,200,000	$0	03/01/2023	02/28/2025
FWP-FP00016201	Machine Learning-aided Multi-physics Identification and Characterization of REE-CM Hot Zones in Mine Tailings for Economic Recovery	Lawrence Berkeley National Laboratory	$1,200,000	$0	01/01/2023	12/31/2024
FWP-81034	Drone-Based Geophysical Surveying and Real-Time AI/ML Analysis for Sustainable Production of Critical Minerals	Pacific Northwest National Laboratory	$1,200,000	$0	02/09/2023	02/08/2025
FWP-100950	Characterization & Extraction of Critical Minerals from Energy Production Waste Streams	SLAC National Accelerator Laboratory	$500,000	$0	01/01/2023	12/31/2024
FWP-23-025668	Resource Assessment of Unconventional Oil & Gas Shale for Critical Minerals Recovery	Sandia National Laboratory	$1,200,000	$0	02/15/2023	02/14/2025
			$5,300,000	$0		
			$5,300,000			

Recommendations-Based Evaluation: During recommendations-based evaluations, the independent Review Panel provides recommendations to strengthen the performance of projects during the period of performance.

* Data from NETL's Visual User Environment (VUE).

2 Overview of the Peer Review Process

Peer reviews are conducted to help ensure that the Office of Fossil Energy and Carbon Management's (FECM) research program, implemented by NETL, is in compliance with requirements from OMB and in accordance with the DOE Strategic Plan and DOE guidance. Peer reviews improve the overall quality of the technical aspects of research and development (R&D) activities, as well as overall project-related activities, such as utilization of resources, project and financial management, and commercialization.

KeyLogic convened a panel of three academic and industry experts[d] to conduct a peer review of five projects supported by the CMM Program. Throughout the peer review meeting, these recognized technical experts offered recommendations to strengthen the projects during the remaining period of performance. KeyLogic selected an independent Review Panel, facilitated the peer review meeting and prepared this report to summarize the results.

2.1 Premeeting Preparation

Before the peer review meeting, each project team submitted a Project Technical Summary (PTS) and project presentation(s). The Federal Project Manager (FPM) provided the FWP/Project Management Plan (PMP), the latest quarterly report, and supplemental technical papers as additional resources for the Review Panel. The Review Panel received these materials prior to the peer review meeting, which enabled the Review Panel to fully prepare for the meeting with the necessary background information.

To increase the efficiency of the peer review meeting, multiple premeeting orientation sessions were held with NETL, the project teams, the Review Panel and KeyLogic to review the peer review process and procedures, roles and responsibilities, peer review evaluation criteria, and project documentation. The Technology Manager also offered an overview presentation of the program goals and objectives, as well as the rationale behind selecting the projects for peer review.

2.2 Peer Review Meeting Proceedings

At the meeting, each project team offered a presentation describing the project. The presentation was followed by a Q&A session with the Review Panel and then a closed discussion and evaluation session for the Review Panel. The time allotted for the presentation, the Q&A session and the closed discussion session was dependent on the project's complexity, duration and breadth of scope.

During the closed discussion sessions of the meeting, the Review Panel discussed each project (Exhibit 1-1) to identify strengths, weaknesses and recommendations in accordance with the NETL Peer Review Evaluation Criteria.[e] The Review Panel offered prioritized, actionable recommendations to strengthen the project during the remaining period of performance.

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[d] Please see "Appendix D: Peer Review Panel Members" for panel member biographies.

[e] Please see "Appendix A: Peer Review Evaluation Criteria" for more information.

3 SUMMARY OF KEY FINDINGS

This section summarizes the overall key findings of the projects evaluated at the FY 2024 CMM (FWPs) Peer Review Meeting. The Review Panel concluded that the peer review provided an excellent opportunity to comment on the relative strengths and weaknesses of each project. The presentations and Q&A sessions provided additional clarity to complement the premeeting documentation. The peer review also provided insight into the range of technology development and the relative progress that has been made by the project teams. The technical discussion enabled the Review Panel to contribute to each project's development by identifying core issues and making constructive, actionable recommendations to improve project outcomes. The Review Panel generated 28 recommendations for NETL management to review and consider.

The Review Panel stated that the project teams are conducting important work to characterize CMMs in various locations (e.g., Wyoming, Pennsylvania, Texas, Montana) and employing a variety of methods to verify the respective final project outcome(s). The projects are focused on several technologies, methodologies and approaches (e.g., advanced analytical techniques, such as inductively coupled plasma mass spectrometry [ICP-MS], microprobe, and elemental mapping; artificial intelligence [AI]-aided multiphysics; electromagnetic [EM] surveying instrumentation; EM modeling and inversion; AI/machine learning (ML)-based inversion; multisensor classification; X-ray diffraction [XRD]; and X-ray fluorescence [XRF] analysis) to characterize and assess these sources at field scale and detect and quantify REEs and CMs in mine wastes and other waste streams. Improvements in such technologies help reduce the cost and time that it takes to evaluate and produce CMs.

The Review Panel concluded that the project teams are highly skilled and well equipped with the analytical instrumentation needed to execute the work. The Review Panel also commented on the in situ mining aspects and recommended the teams consider the long-term outlook on the issues involved (e.g., evaluate how findings could inform the possibility of in situ mining in unconventional reservoirs, focus on the rate of dissolution in relation to residence time, emphasize thermodynamics and less on kinetics). In multiple cases, project teams were partly comprised of students, which helps to supply the pipeline of future scientists. Regarding samples, the Review Panel offered the following observations to the project teams: supplement the core data by analyzing existing production samples (tied to the mine plan) from the mining operator to increase the dataset; determine the sulfur content on the samples and include in the dataset; evaluate the limits imposed by relying on specimens instead of representative samples; and increase the sample set for the CM survey to include additional relevant samples from unconventional oil and gas horizons and focus the work on CM concentrations in the additional samples, rather than mineralogy and leaching.

Teams were cautioned to direct additional consideration to their respective front-end sample size(s) and (in some cases) the apparent shortage of representative samples. Execution of these projects requires expertise in the fundamental aspects of chemistry, physics, computational chemistry and geochemistry; the Review Panel recommended that some of the project teams revisit their available subject matter expertise and engage in outreach to identify mining, chemistry or geochemistry expertise. Finally, the panel suggested a more streamlined approach may be appropriate (i.e., instead of multiple drone-related efforts, consider one). There appeared to be multiple efforts on the identification methodology of samples and computer software issues rather than the drone itself.

4 PROJECT SYNOPSES

For more information on the CMM Program and project portfolio, please visit the NETL website: https://netl.doe.gov/resource-sustainability/critical-minerals-and-materials.

PROJECT NUMBER FWP-LANL-AE-1263-1711

Project Title	**A Machine Learning Screening Tool for Rare Earth Elements and Critical Minerals at the Mine Scale**
Lead Organization	**Los Alamos National Laboratory (LANL)**
Project Description	The objective is to develop a mine-scale tool that can be used to screen mines and other geologic deposits for potential viability as rare earth element (REE) and critical mineral (CM) mines. Machine learning (ML) techniques will be used in combination with existing and newly collected data from the Wyodak Mine to develop this screening tool. While developed with data from Wyodak, the tool will be site-agnostic and enable users to identify whether a mine has economic potential for mining REEs/CMs and to identify regions within the mine with a high probability of economic viability.

PROJECT NUMBER FWP-FP00016201

Project Title	**Machine Learning-aided Multi-physics Identification and Characterization of REE-CM Hot Zones in Mine Tailings for Economic Recovery**
Lead Organization	**Lawrence Berkeley National Laboratory (LBNL)**
Project Description	Characterization of rare earth elements (REEs) and critical minerals (CMs) in unconventional and secondary sources is a complex task that needs to overcome the challenges of detecting low and variable concentrations and the uniqueness of every source material deposit in terms of composition, host material and disposal environment. As in traditional mineral prospecting, delineation of REE/CM “hot zones” is critical for assessing the economic viability of these sources. Here, *hot zone* is defined as a spatially delineated volume of high REE/CM concentrations within the tailing deposits. The project will develop and field-demonstrate a machine learning (ML)-aided multiphysics approach for rapid identification and characterization of REE/CM hot zones in mine tailings with a focus on coal and sulfide mine tailings or other processing or utilization byproducts, such as fly ash and refuse deposits.

PROJECT NUMBER FWP-81034

Project Title	**Drone-Based Geophysical Surveying and Real-Time AI/ML Analysis for Sustainable Production of Critical Minerals**
Lead Organization	**Pacific Northwest National Laboratory (PNNL)**
Project Description	Pacific Northwest National Laboratory (PNNL) will develop and demonstrate drone-based geophysical and remote-sensing technologies to quantify critical minerals (CMs) in coal, coal-related unconventional and secondary sources, and energy-related waste streams. Drone-based geophysical surveys and remote sensing, combined with artificial intelligence/machine learning (AI/ML) analytics for real-time integration and analysis, has potential to transform characterization and monitoring for CMs from conventional and secondary resources. Sensor technologies, modeling and data analysis capabilities developed would be agnostic with respect to drone platform and, in principle, could be deployed on ground-based robotic mining or excavation equipment as well.

PROJECT NUMBER FWP-100950

Project Title	**Characterization & Extraction of Critical Minerals from Energy Production Waste Streams**
Lead Organization	**SLAC National Accelerator Laboratory**
Project Description	The overall goal of this project is to identify the concentrations and forms of various critical minerals (CMs) in unconventional shale waste streams with a focus on rock cuttings from unconventional oil and gas wells. Due to the high volume and wide range of sedimentological facies represented in the rock cuttings created during the drilling process, these are ideal materials to (1) extract CMs and (2) reduce the environmental impact of the unconventional oil and gas shale process. Two major objectives will be targeted with this project. Objective 1 is a detailed characterization of the concentration, form and leachability of CMs, plus correlating the various CMs with their respective sedimentological facies, both within a specific sedimentary basin and others. Objective 2 is to use findings from Objective 1 to design both universal and targeted extraction protocols for the various CMs in a manner that has a low environmental burden to create a new CM supply chain. These objectives will rely heavily on laboratory-based and synchrotron-based characterization techniques and targeted chemical extractions.

PROJECT NUMBER FWP-23-025668

Project Title	**Resource Assessment of Unconventional Oil & Gas Shale for Critical Minerals Recovery**
Lead Organization	**Sandia National Laboratory (SNL)**
Project Description	The goal of this project is to assess the extractability of rare earth elements (REEs) and critical minerals (CMs) from major oil and shale gas formations across the United States. Specifically, this effort will assess the in situ extractability of REEs and CMs using a newly developed combination of supercritical carbon dioxide (sCO_2), water and chelators (e.g., citric acid). Moreover, this work will establish the technical basis and predictive capabilities to more effectively and efficiently characterize and assess the mineralogy and quantity of REEs and CMs in shale formations. The predictive model to be developed is anticipated to find use in forecasting of resource potential (i.e., resource to reserves). If successful, the in situ leaching concept could be directly integrated into existing oil and gas production and field facilities to obtain REEs and CMs from shale.

APPENDIX A: PEER REVIEW EVALUATION CRITERIA

Peer reviews consist of a formal evaluation of selected National Energy Technology Laboratory (NETL) projects by an independent panel of subject matter experts (SMEs) and are conducted to ensure that the Office of Fossil Energy and Carbon Management's (FECM) research program, implemented by NETL, is compliant with Office of Management and Budget (OMB) guidance, the U.S. Department of Energy (DOE) Strategic Plan, and DOE guidance. Peer reviews reduce project risk (e.g., cost, schedule, technology development) and improve the overall quality of the technical aspects of research and development (R&D) activities, as well as overall project-related activities, such as utilization of resources, project and financial management, and commercialization. NETL uses the peer review findings to guide and redirect projects, as appropriate, underscoring NETL's commitment to funding and managing a portfolio of high-quality research.

NETL PEER REVIEW — RECOMMENDATIONS-BASED EVALUATION

At the meeting, the peer review facilitator leads the Review Panel in identifying strengths[f], weaknesses[g] and prioritized recommendations. A recommendation emphasizes an action that is considered by the project team and/or DOE to correct or mitigate the impact of weaknesses, expand upon a project's strengths, or progress along the technology maturation path. A recommendation has as its basis one or more strengths or weaknesses. Recommendations are ranked from most important to least.

[f] A strength is an aspect of the project that, when compared to the evaluation criterion, reflects positively on the probability of successful accomplishment of the project's goal(s) and objectives.

[g] A weakness is an aspect of the project that, when compared to the evaluation criterion, reflects negatively on the probability of successful accomplishment of the project's goal(s) and objectives.

Exhibit A-1. NETL Peer Review evaluation criteria

Evaluation Criteria
1. Degree to which the project, if successful, supports the DOE Program's near- and/or long-term goals.
• Program goals are clearly and accurately stated. • Performance requirements[1] support the program goals. • The intended commercial application is clearly defined. • The technology is ultimately technically and economically viable for the intended commercial application.
2. Degree to which there are sufficient resources to successfully complete the project.
• There is adequate funding, facilities and equipment. • Project team includes personnel with the needed technical and project management expertise. • The project team is engaged in effective teaming and collaborative efforts, as appropriate.
3. Degree of project plan technical feasibility.
• Technical gaps, barriers and risks to achieving the performance requirements are clearly identified. • Scientific/engineering approaches have been designed to overcome the identified technical gaps, barriers and risks to achieve the performance requirements. • Remaining technical work planned is appropriate considering progress to date and remaining schedule and budget. • Appropriate risk mitigation plans exist, including Decision Points when applicable.
4. Degree to which progress has been made toward achieving the stated performance requirements.
• The project has tested (or is testing) those attributes appropriate for the next Technology Readiness Level (TRL). The level of technology integration and nature of the test environment are consistent with the aforementioned TRL definition. • Project progress, with emphasis on experimental results, shows that the technology has, or is likely to, achieve the stated performance requirements for the next TRL (including those pertaining to capital cost, if applicable). • Milestones and reports effectively enable progress to be tracked. • Reasonable progress has been made relative to the established project schedule and budget.
5. Degree to which an appropriate basis exists for the technology's performance attributes and requirements.
• The TRL to be achieved by the end of the project is clearly stated.[2] • Performance attributes for the technology are defined.[2] • Performance requirements for each performance attribute are, to the maximum extent practical, quantitative, clearly defined, and appropriate for and consistent with the DOE goals as well as technical and economic viability in the intended commercial application.

[1] If it is appropriate for a project to not have cost/economic-related performance requirements, then the project is evaluated on technical performance requirements only.

[2] Supported by systems analyses appropriate to the targeted TRL.

APPENDIX B: DOE TECHNOLOGY READINESS LEVELS

Exhibit B-1. Description of DOE TRLs

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
System Operations	TRL 9	Actual system operated over the full range of expected mission conditions	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	TRL 8	Actual system completed and qualified through test and demonstration	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this Technology Readiness Level (TRL) represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning.[1] Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, as well as analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Technology Demonstration	TRL 6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering-scale prototypical system with a range of simulants.[1] Supporting information includes results from the engineering-scale testing and analysis of the differences between the engineering-scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step-up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.
Technology Development	TRL 5	Laboratory-scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory-scale system in a simulated environment with a range of simulants[1] and actual waste.[2] Supporting information includes results from the laboratory-scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.
Technology Development	TRL 4	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small-scale tests on actual waste.[2] Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4–6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on-hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Research to Prove Feasibility	TRL 3	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative-tested with simulants.[1] Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
Basic Technology Research	TRL 2	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
	TRL 1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.

[1] Simulants should match relevant chemical and physical properties.

[2] Testing with as wide a range of actual waste as practicable and consistent with waste availability, safety, as low as reasonably achievable (ALARA), cost, and project risk is highly desirable.

Source: U.S. Department of Energy, "Technology Readiness Assessment Guide." Office of Management. 2011.

Appendix C: Meeting Agenda

FY 2024 Critical Minerals and Materials Peer Review Field Work Proposals
May 14–16 and 21–22, 2024
Virtual Meeting (via WebEx)

Day 1 — Tuesday, May 14, 2024

FWP-LANL-AE-1263-1711 — A Machine Learning Screening Tool for Rare Earth Elements and Critical Minerals at the Mine Scale

**** All times Eastern ****

12:30–1:00 p.m.	**Peer Review Panel Kickoff Session**
1:00–1:45 p.m.	**FWP-LANL-AE-1263-1711 — A Machine Learning Screening Tool for Rare Earth Elements and Critical Minerals at the Mine Scale** *Daniel O'Malley* — Los Alamos National Laboratory (LANL)
1:45–2:30 p.m.	**Q&A Session**
2:30–2:45 p.m.	**BREAK**
2:45–4:15 p.m.	**Closed Discussion (Recommendations-Based Evaluation; Review Panel)**
4:15 p.m.	**ADJOURN**

Day 2 — Wednesday, May 15, 2024

FWP-FP00016201 — Machine Learning-aided Multi-physics Identification and Characterization of REE-CM Hot Zones in Mine Tailings for Economic Recovery

**** All times Eastern ****

12:30–12:40 p.m.	**Kickoff Session**
12:40–1:25 p.m.	**FWP-FP00016201 — Machine Learning-aided Multi-physics Identification and Characterization of REE-CM Hot Zones in Mine Tailings for Economic Recovery** *Yuxin Wu* — Lawrence Berkeley National Laboratory (LBNL)
1:25–2:10 p.m.	**Q&A Session**
2:10–2:30 p.m.	**BREAK**
2:30–4:00 p.m.	**Closed Discussion (Recommendations-Based Evaluation; Review Panel)**
4:00 p.m.	**ADJOURN**

Day 3 — Thursday, May 16, 2024

FWP-81034 — Drone-Based Geophysical Surveying and Real-Time AI/ML Analysis for Sustainable Production of Critical Minerals

**** All times Eastern ****

12:30–12:40 p.m.	**Kickoff Session**
12:40–1:25 p.m.	**FWP-81034 — Drone-Based Geophysical Surveying and Real-Time AI/ML Analysis for Sustainable Production of Critical Minerals** *Frederick Day-Lewis* — Pacific Northwest National Laboratory (PNNL)
1:25–2:10 p.m.	**Q&A Session**
2:10–2:30 p.m.	**BREAK**
2:30–4:00 p.m.	**Closed Discussion (Recommendations-Based Evaluation; Review Panel)**
4:00 p.m.	**ADJOURN**

Day 4 — Tuesday, May 21, 2024

FWP-100950 — Characterization & Extraction of Critical Minerals from Energy Production Waste Streams

**** All times Eastern ****

12:30–12:40 p.m.	**Kickoff Session**
12:40–1:25 p.m.	**FWP-100950 — Characterization & Extraction of Critical Minerals from Energy Production Waste Streams** *Adam Jew* — SLAC National Accelerator Laboratory
1:25–2:10 p.m.	**Q&A Session**
2:10–2:30 p.m.	**BREAK**
2:30–4:00 p.m.	**Closed Discussion (Recommendations-Based Evaluation; Review Panel)**
4:00 p.m.	**ADJOURN**

Day 5 — Wednesday, May 22, 2024

FWP-23-025668 — Resource Assessment of Unconventional Oil & Gas Shale for Critical Minerals Recovery

**** All times Eastern ****

12:30–12:40 p.m.	**Kickoff Session**
12:40–1:25 p.m.	**FWP-23-025668 — Resource Assessment of Unconventional Oil & Gas Shale for Critical Minerals Recovery** *Guangping Xu* — Sandia National Laboratory (SNL)
1:25–2:10 p.m.	**Q&A Session**
2:10–2:30 p.m.	**BREAK**
2:30–4:00 p.m.	**Closed Discussion (Recommendations-Based Evaluation; Review Panel)**
4:00–4:30 p.m.	**Peer Review Panel Wrap-Up Session (Common Themes and Logistics/Process Feedback)**
4:30 p.m.	**ADJOURN**

APPENDIX D: PEER REVIEW PANEL MEMBERS

FY 2024 Critical Minerals and Materials Peer Review Field Work Proposals
May 14–16 and 21–22, 2024
Virtual Meeting (via WebEx)

Corby Anderson, Ph.D.

Corby Anderson, Ph.D., is a licensed professional chemical engineer and currently the Harrison Western Professor for the Kroll Institute for Extractive Metallurgy at the Colorado School of Mines. He is an expert in the fields of extractive metallurgy, mineral processing, waste minimization, and recycling.

Anderson has more than 40 years of global experience in industry, management, engineering, design, economics, consulting, teaching, research and professional service. He is a Fellow of the Institution of Chemical Engineers (IChemE) and the Institute of Materials, Minerals and Mining (IOM3), and a Distinguished Member of the Society of Manufacturing Engineering (SME) and the University of Idaho Academy of Engineering. He shares 14 global patents, along with four current patent applications and three invention disclosures. Anderson earned a B.S. from Montana State, an M.S. from Montana Tech and a Ph.D. from the University of Idaho.

Kenneth N. Han, Ph.D.

Kenneth Han, Ph.D., is Distinguished Professor Emeritus of Materials and Metallurgical Engineering at the South Dakota School of Mines and Technology (SDSM&T), as well as a National Academy of Engineering member. Prior to joining SDSM&T in 1981, Han was a lecturer and senior lecturer in chemical engineering at Monash University in Melbourne, Australia, from 1971 to 1980. While at SDSM&T, he has served as the head of the Department of Metallurgical Engineering from 1987 to 1994 and as the dean of the College of Materials Science and Engineering from 1994 to 1999.

His research topics include hydrometallurgy, interfacial phenomena, metallurgical kinetics, solution chemistry, fine particle recovery and electrometallurgy. Han has published more than 150 papers in international journals and presented more than 100 papers at international conferences. The author of 10 monographs, he also holds eight patents related to extractive metallurgy and has won numerous awards from academic, technical and professional societies. Han received his B.S. and M.S. degrees from Seoul National University, an additional M.S. degree from the University of Illinois, and his Ph.D. from the University of California.

Richard Winschel

Richard (Dick) Winschel is an independent energy consultant at Longbridge Energy Consulting. Until September 2017, Winschel was Director of Special Projects at CONSOL Energy in Canonsburg, Pennsylvania. He managed projects to control and reduce energy costs and usage across all business units of the corporation, and analyzed and evaluated policy issues of importance to CONSOL. For more than 30 years, Winschel was the Director of Research and Development (R&D) at CONSOL in South Park, Pennsylvania. His research focus was the science and technology of coal, natural gas, energy and the environment, including utilization of coal mine methane, greenhouse gas control (both carbon capture and carbon storage), pollution control, mercury emissions control, coal combustion byproduct utilization, coal liquefaction, coal characterization, coal weathering, coal cleaning, coal combustion, coal coking, the disposal of drilling wastewater, and the substitution of natural gas and electricity for liquid fuels throughout CONSOL operations.

Winschel has also served as Chair of the Advisory Committee of the International Pittsburgh Coal Conference and as a member of the Advisory Board of the Eastern Unconventional Oil & Gas Symposium. He is the former Chair of the Technical Subcommittees on Subsurface of the FutureGen Industrial Alliance, a former Co-Chair of the Technical Committee of the Coal Utilization Research Council, a former member of the review committees for the Illinois Clean Coal Institute and the Ohio Coal Development Office, and he served as a member of the Work Group on Carbon Dioxide Sequestration mandated by the West Virginia legislature. He earned a B.S. in chemistry from the University of Pittsburgh.

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