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The Honorable Pete Stauber
Chair, Subcommittee on Energy and Mineral Resources
House Natural Resources Committee
1324 Longworth House Office Building
Washington, D.C. 20515

To the esteemed members of this committee, it is a great privilege to speak before you today.

I am a Professor of Environmental Studies at San José State University. This testimony reflects my views and expertise on the topics herein, and I am not speaking on behalf of my affiliated organizations or anyone but myself.

My areas of expertise and research are on land use change, life cycle analysis, and recycling & waste impacts of energy technologies, supply chains, and infrastructures with an extensive emphasis on the life cycle impacts of solar photovoltaics and lithium-ion batteries. I have a Ph.D. in Environmental Studies from the University of California, Santa Cruz, a Master's of Science degree in Environmental Policy Studies, and a Bachelor's of Science degree in Chemical Engineering, the latter two from the New Jersey Institute of Technology. Professional private sector experience includes work in chemical manufacturing, environmental remediation, and environmental consulting. I have been an expert witness at the California, New York and Utah Public Utilities/Service Commissions, and have participated in the development of waste, land use, and energy policy with legislators, across federal, state, county, and service agencies and commissions over the past decade and a half. I serve on the Technical Advisory Committee to the Recycling and Waste Reduction Commission of Santa Clara County, the Technical Committee for Sustainability and Ultra-Low Carbon Solar standards for photovoltaics developed by the Green Electronics Council, advisor to the PV Perovskite Accelerator for Commercial Technologies hosted by Sandia National Labs/National Renewable Energy Laboratory, and was selected to be an author of the southwest chapter of the 6th National Climate Assessment of the U.S. Global Change Program. I am also part of the Lithium Valley Equity Technical Advisory Group advising Comite Civico del Valle on issues related to the development of geothermal and lithium near the Salton Sea in Imperial County, California.

Introduction

The development of domestic supply chains for critical minerals is crucial to energy, technology, and military applications. We are in the midst of a low carbon energy transition—one where solar, wind, batteries, and electric vehicles are outpacing even the expectations of professional analysts. This means high demand for materials like lithium, nickel, graphite, cobalt, rare earth elements, and others.

Supply chain disruptions from bottlenecks, geographic concentration, and trade restrictions in recent years have shown vulnerabilities to the domestic economy and energy systems. The dependence on critical minerals of many key technologies to the U.S. economy make securing adequate supplies crucial to national security, economic prosperity, and safeguarding this planet we share.

1. **Mining's legacy of water contamination and waste warrants a more sustainable approach to mining and mineral extraction.**

From acid mine drainage and heavy metal tailings pollution, to groundwater overextraction and stream dewatering, mineral extraction has impacted to groundwater and freshwater across the U.S. Water contamination from mining can impact drinking water and affect aquatic plants, fish, and wildlife. Groundwater depletion can occur from over-extraction. Using global data from the U.S. Geological Survey, the World Resource Institute found that "at least 16% of the world's land-based critical mineral mines, deposits and districts are located in areas already facing high or extremely high levels of water stress."[1]

The Thacker Pass mine under construction in Nevada will use 2,500-acre feet per year for 41 years, which is about 104,000 acre-feet of water total, posing threat to over-drafting the Kings River aquifer. There are several new gold mines under development and proposed in Nevada not far from Death Valley National Park, that are using substantial amounts of water, including one mining operation that will use water from a spring in the park, which receives about two inches of rain per year.

Even alternative extraction techniques can impact groundwater. Direct Lithium Extraction (DLE) for example near the Salton Sea, where several pilot projects are underway to extract lithium from brines in the Salton Sea geothermal anomaly. DLE project proposed near the Salton Sea has raised questions about where water will come from, as the region already is the largest customer of Colorado River water, and impacts such as wastewater reinjection and subsidence, and was fined by the USEPA in 2024 for 1,200 dewatering 1,200 acres of wetlands.[2] The dead vegetation made fuel for a wildfire in the wetland in November 2024.

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[1] WRI. 2024. Critical Minerals Mining Water Impacts. https://www.wri.org/insights/critical-minerals-mining-water-impacts

[2] USEPA. 2024. EPA Settles with Hell's Kitchen Geothermal over Wetlands Discharge, Impact on Salton Sea.

The extraction of metals and minerals can be made cleaner. Even the most controversial mining projects today, when comparing old versus new techniques and best practices, the difference could not be more stark. New mines are cleaner and better, more efficient, and less polluting, and produce less waste. However, questions about mining can be more complicated by impacts to specific places indigenous communities, wildlife, landscapes, and water. One can have the most sustainable mining practices in the world, but if the site is a place people value, it will face opposition. To build infrastructure projects, getting community support in a collaborative way that provides communities with benefits is imperative. Finding a way to get communities, NGOs, and Tribes involved from the start can help ensure the community accepts and gives consent to the project, an makes it more likely benefits from the project recirculate in the community.

2. The development of new sites of mineral extraction cannot come at the expense of our wildlife, water-dependent ecosystem, and riparian habitat.

The impacts of mining to water resources and riparian habitat across the United States cannot be understated. According to an analysis from Trout Unlimited, "half of the known critical mineral deposits in the U.S. are within trout and salmon habitat, and one in ten deposits are in protected public land areas like wilderness."[3] The same report notes that many critical minerals overlap with sage grouse habitat and major big game wildlife corridors. Rhyolite Ridge is a lithium mining project being developed by an Australian mining company that will impact Tiehm's buckwheat (*Eriogonum tiehmii*), a species that only exists on that particular site.

In Nevada's Amargosa Valley near the Ash Meadows reserve, an exploratory lithium development project was almost allowed under that 1872 law to drill 30 boreholes without any environmental review, within 2,000 feet of springs that are critical habitat for the endangered Ash Meadows Amargosa pupfish. If not for the community and an environmental group recognizing the BLM mistake, this critical habitat could have been comprised by a speculative venture.

Things we all agree on is the importance of our nation's water, wildlife, and other natural resources. The question is what approaches help to achieve that. Some say we need to reform the Endangered Species Act or National Environmental Act or take away community inputs. But this would be counterproductive and runs contrary to the best practices for mining or any energy infrastructure development. Public policy efforts to develop critical minerals should do so responsibly and should not undermine bedrock environmental laws.

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https://www.epa.gov/newsreleases/epa-settles-hells-kitchen-geothermal-over-wetlands-discharge-impact-salton-sea

[3] Trout Unlimited.2023. Critical Minerals Report. A Path Forward. https://www.tu.org/cmr-a-path-forward/

Predictability to developers is often emphasized when describing environmental oversight of mining, but predictability is also important to environmental groups and Tribes to know what land, water, and air is protected, and that there are community safeguards like strong environmental rules and opportunities for public participation. More predictability on all sides will help avoid the most intractable controversies.

3. Domestic critical minerals development should protect Native American sovereignty, self-determination, and meaningful consultation cultural resources.

Critical minerals development is likely to be significantly impactful to Native American tribes. Most mining activity in the United States is in the American West, and within close proximity to Native American communities. Morgan Stanley Capital International states that 79% of lithium mining claims, 89% of copper deposits, and 97% of nickel deposits are within 35 miles of a Native American reservation. Furthermore, the Bureau of Land Management has an obligation to conduct prior consultation on projects proposed across public lands because of important sacred sites off-reservation on their ancestral territories.

Mining activities that put drinking water and cultural resources at risk, making it crucially important to ensure community acceptance and respect for tribal sovereignty and cultural resources. It is not uncommon to hear that the federal consultation process for National Historic Preservation Act to take one example is "failing tribes" on adequate and meaningful consultation. Instead of looking for ways to short circuit environmental and cultural resource review—by undermining nation-to-nation consultation or fast-tracking review—the United States should strengthen Tribal consultation around the ideas of self-determination and "Free, Prior and Informed Consent" as described by International Labour Organization's Convention number 169, the United Nation Declaration on the Rights of Indigenous Peoples.

It is frequently stated that the United States' mining practices are the best in the world because they have the strongest global environmental regulations. That may be true. But the issue of Tribal consultation needs significant improvement to catch up with international norms and standards on relations between mining activities and Indigenous peoples. The Department of the Interior's Interagency Working Group report makes a variety of recommendations to improve the permitting process for mining projects, including prioritizing mine plans that maximize environmental and social best practices, and developing clear procedures for engaging stakeholders earlier in the process and in a more meaningful way. The Department of the Interior's new "pre-plan coordination" is a step in the right direction by bringing stakeholders together to understand each other's priorities and concerns.[4] Several projects proposed in recent years including the Oak Flat-

[4] BLM. 2024. BLM announces actions to improve mine permitting, early engagement. https://www.blm.gov/press-release/blm-announces-actions-improve-mine-permitting-early-engagement

Resolution Copper case study, show that Tribal concerns are still not adequately considered in the decision-making process. We have to respect that some places are sacred to Indigenous communities and should not be developed.

4. Domestic critical mineral supply chain resilience means reshoring the entire supply chain

Importantly, it is crucial to realize that without ensuring the entire supply chain is domestic, it is still vulnerable to disruption. Domestic mining that still requires overseas smelting or chemical processing before returning to domestic manufacturing is still a system vulnerable to disruption and geopolitical tensions. Increased mining alone will not solve this. If the entire supply chain is not reshored, it is not a domestic supply chain, and it is still vulnerable to global geopolitical or trade issues. Not that reshoring should be the goal, but that national security risks from supply chain disruption do not simply go away because the extraction phase of the commodity chain is located in the U.S.

The fact that the U.S. lacks many of the processing, separation and production steps in the critical minerals supply chain, is why there were so many investments in the Infrastructure Investment and Jobs Act and Inflation Reduction Act intended to increase domestic production, separation, and processing.

5. Move away from the "take-make-waste" economy, towards a circular economy

We cannot recycle our way out of critical minerals challenges. But more progress is needed away from take-make-waste and towards a circular economy. The U.S. lacks a comprehensive federal policy to encourage electronics and electrical equipment recovery and recycling, leaving states to patch together policies. These are critical mineral resources in our hands that we let slip through our fingers.

It is common hear about the urgency to develop mines for the materials that are foundational to our technological development and energy technologies. Copper for example is crucial to modern economies and energy systems and forecasted supplies risk falling short and may be subject to price volatility, leading analysts to emphasize the need to develop new copper mines. Yet, according to the Copper Alliance, less than 40% of global copper is currently recycled. Research from Fraunhofer Institute for Systems and Innovation finds similarly that 2/3rds of end-of-life copper are sent to landfills annually.

Building a circular economy means developing resources, but ensuring those resources stay in the economy after the end-of-life. This means extracting critical minerals from waste streams, end-of-life products, reduce demand through resource efficiency and material substitution.

Waste flows from end-of-life electronic products often have significantly more critical minerals by percent than the ores they are obtained from in mining. Rare earth elements in end-of-life electronics are almost all lost through waste flows in the United States. Less than 5% of rare earth elements globally are recycled according to the trade press *Recycling International*. Recycling consumer electronic products and utilizing byproducts of other materials processing could yield double to ten times the rare earth elements that could be extracted through processing the raw materials. Three to four times more dysprosium can be obtained from recycling headphones than from rare earth element ores. An iPhone touch screen has more lanthanum to make those bright colors, than is typically found in rare earth element ores. Similarly, there is a higher percent of neodymium obtained from recycling wind turbine magnets, than are found in those rare earth element ores. In an era of declining ore grades, these waste flows should be seen as resources to boost critical mineral supplies.

Critical minerals from mine waste

Here is an example from today's headlines. Tellurium is critical to the development of thin film photovoltaics. US-based thin film photovoltaic manufacturer First Solar – arguably the only solar manufacturing company that has successfully fought off competition from China over the past decade and a half—uses about 40% of the global supply of tellurium.

On Tuesday February 4th 2025, China announced tellurium and four other key critical minerals would be subject to tariffs and export controls. USGS reports that China supplies about 67% of global tellurium. First Solar's tellurium supplier 5NPlus doesn't disclose their tellurium suppliers, but First Solar's conflict minerals SEC disclosure says a quarter of the smelters and refineries in their supply chains are in China.[5]

Tellurium is found with copper but not profitable enough to extract at most copper mines. Rio Tinto partnered with First Solar and 5NPlus in 2021 to invest $2.9 million in a tellurium plant to produce about 20 tons annually, or about 4% of estimated global production last year, at its Kennecott mine near Salt Lake City, Utah. This production did not require opening new mines or changing environmental laws. The production is the mines waste stream. Waste and "tailings valorization" approaches like these are another strategy to augment critical mineral supplies.

Critical minerals from recycling and resource efficiency

First Solar also recycles their photovoltaic modules and can recover 95% of the tellurium from their process. These materials are recovered and sent to their supplier who can make new tellurium feedstock for cadmium telluride semiconductors.

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[5] M. Copley. 2021. First Solar's growth plans hinge on opaque market. SBC Global. https://www.spglobal.com/market-intelligence/en/news-insights/articles/2021/12/first-solar-s-growth-plans-hinge-on-opaque-market-for-tellurium-68010925

First Solar also has worked to reduce the material intensity of tellurium in First Solar's modules has been reduced by over 50% in the past decade.

The government has an important role to play. A recent partnership between First Solar and the Department of Energy created the Cadmium Telluride Accelerator Consortium and intends to make solar more affordable and develop and "Maintain or increase domestic CdTe PV material and module production through 2030."[6]

A well-supported National Science Foundation can also play an important role. The Infrastructure Investment and Jobs Act section 40210 on critical minerals mining and recycling research, directs the Secretary of Energy, in coordination with the Director of the National Science Foundation to issue grants to support research on critical minerals mining, recycling, and reclamation strategies and technologies to make better use of domestic resources and to eliminate national reliance on minerals and mineral materials that are subject to supply disruptions.

Critical minerals research and development

A circular economy approach to tellurium involves (1) recovering the critical mineral from mine waste, (2) recycling end-of-life products that contain critical minerals, and (3) reducing demand for critical materials through greater material utilization and resource efficiency.

Materials recovery in mining and downstream processing is optimized for profitability not maximizing materials or biproducts. More incentives to develop biproducts, recover materials at smelters, or increase recovery rates could help drive up recycling of materials. Smelters in the United States are not designed to recover many critical minerals. For example, there are no smelters that can recover cobalt in the United States.

There are also excellent examples of resource efficiency avoiding significant amounts of materials. A photovoltaic module today, thanks to increased resource efficiencies, uses about five times less silver than a photovoltaic module yesterday. Similar, semiconductor wafers in the same technology are two to three times thinner than just a decade ago. This has translated to lower energy inputs and silicon feedstocks needed for the solar industry.

Other ways to increase resource efficiency across society as well. In a recent report from the Climate and Community Project they found up to 90% of lithium demand can be reduced by encouraging public transportation and more lightweight electric vehicles and other modes of transportation.

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[6] First Tellurium. 2022. China Mineral Export Restrictions Could Restrict Future Tellurium Supply. https://firsttellurium.com/china-mineral-export-restrictions-could-restrict-future-tellurium-supply/

To date, much of the conversation and public policy effort on critical minerals has focused solely on mining. But recycling, alternative extraction techniques, resource efficiency, and harvesting materials from waste streams offer significant promise for enhancing the nation's supply of critical minerals, and lessening the risks of and exposures to supply chain disruptions. It seems profoundly wasteful that we would allow critical materials be landfilled at the same time we talk about the dire national security consequences of a lack of supply and promote greenfield mine development elsewhere.

The United States has some of the premier research institutions in the world that could be working on these. My friend and colleague here from the Colorado School of Mines for example, can tell you more about work that's happening at the nation's premier mining university. They are ahead of the game, and working on projects from recovering minerals from mining waste to mining asteroids. More emphasis on research and development will help close the loop for a circular economy in critical minerals. This wouldn't preclude the development of mines of course, no one is saying that recycling will meet the future demand for all the materials we need. Multiple resource streams including wastes will be required to for a holistic approach to ensuring resilient supply chains.

6. Undermining environmental laws will increase the time to build mines

Ask any scholar or mining executive and they will tell you the most important thing to help a mine move forward is a social license to operate. This trust is something gained through notification, consultation, listening, providing community benefits, offering an ownership stake, etc. This becomes extremely difficult to do under circumstances such as "fast-tracking" without substantial coordination.

The need to prioritize development of domestic minerals supplies should not undermine meaningful environmental review. Conservation groups, Indigenous peoples, and local communities feel that environmental review, even where an environmental impact statement might be required, is a foregone conclusion. Many communities view the NEPA process as a "decide-announce-defend" development strategy where developers and investors decide where they want to propose a project, announce it to the public, and then spend the review process defending the project.

I disagree with the sentiment of advocates of "permitting reform" that we can wave a magic wand and make mine approvals move faster. This a bipartisan sentiment shared by climate hawks and energy dominance narratives alike, and unfortunately it is not based in fact. Instead, more collaborative approaches are shown to be effective at gaining community support and trust – the social license to operate. Transparent and meaningful public participation processes should result in responsible mine development and reduced community opposition to new mines.

It is often claimed that it takes 7 to 10 years or more to permit a new mine. The memo for this hearing says it takes 27 years to develop a mine from idea to production. But most of this time is exploring and making business decisions, not permitting.

The reality is the time to permit a hard rock mine is two years according to the Government Accountability Office. The GAO found some mines take up to eleven years, but their interviews with agencies and mine operators found delays were overwhelming caused by the applicant. More broadly, another GAO report found only 1% of NEPA covered projects need an Environmental Impact Statement. Only 5% of covered projects require an Environmental Assessment, a shorter environmental disclosure document that typically is completed in nine months or so.

Critical minerals designations are used to develop resources with fewer safeguards, less community engagement and Tribal consultation, and shorter time for public review. Designation of certain minerals as critical minerals simply to have the ability to fast-track projects does not help ensure we have domestic supply chains and undermines efforts to gain the social license to operate.

The US already has tools to expedite mine permitting like FAST-41. The IRA made the FAST-41 Act permanent, extended the provisions of the law to mining, and provided significant funding for agencies to process permits.

What appears to some to be an industry stalled by "red tape and bureaucracy" is probably better explained by low commodities prices and business decisions in the face of uncertainty.

7. Build a modern critical minerals program around a modern mining law

The 1872 mining law makes mining the highest and best use of public lands and reflects a time long since passed. The 1872 law was intended for settler colonialism on the western frontier not for mining in a modern high-tech economy. Federal and public lands should not be new sacrifice zones for critical minerals. Without key reforms, the antiquated mining law will continue to cause unnecessary environmental degradation and environmental inequality.

The exploratory claims-based system is outdated, with most other parts of the world having lease-based systems that are more competitive and result in better decision-making on land uses.

Mining law needs a better plan to pay for remediation of old mines. The 1872 mining law set the bar too low for bonding mine sites for reclamation and cleanup. The Government Accountability Office (GAO) estimates that federal agencies spent $2.9 billion in the decade from 2008 to 2017 on cleanup activities, and this could cost taxpayers up to $54

billion to clean up the nation's 400,000 to 500,000 abandoned mine sites that pose hazardous threats to communities.

The Initiative for Responsible Mining Assurance (IRMA) could be a model for reforming the 1872 law. IRMA allows for independent audits of mines to ensure environmental and social performance. Even the White House refereed to IMRA as a "method for U.S. companies and the Federal Government to ensure that minerals are being sourced from mines with robust environmental, social, and financial responsibility policies."[7]

The mining law also is a bad deal for U.S. taxpayers. Because of an outdated mining law, developers of these minerals get them royalty free. This is not a deal just for American companies, foreign companies can also mine materials before shipping them to be processed overseas. Reforming the mining law signed by Ulysses S. Grant would go far to bring the law into conformance for what is needed in a modern economy. Reform to the royalty system would benefit taxpayers, given there are no royalties for hard rock mining under the law today. Reform of the royalty program could raise substantial revenues to help finance the clean up and remediation of legacy mine pollution.

8. Provide community benefits for developing critical minerals

Where mines will be developed, bringing community benefits to the table will be important tools for public support, buy-in, and trust. Furthermore, to reap more community benefits, more value-added industries to support the development of critical minerals supplies can ensure more jobs and local revenues are generated. Mining tends to have a very low value added without these downstream manufacturing activities.

Community benefits should be broadly construed to benefit as many as possible. The widely celebrated community benefits agreement between Lithium Americas and Thacker Pass and the Fort McDermitt Paiute and Shoshone Tribe is a one example worth looking at closely. While benefits accrue to some communities from this project, other tribes with ancestral claims to the landscape such as the People of Red Mountain feel their voices were not acknowledged and will receive no benefits.

Other examples that could be a model for how to build in community benefits is the approach used in the Salton Sea and suggested by the Blue Ribbon Commission on Lithium Extraction in California. That process is early on, but will be worth watching closely.

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[7] The White House, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews Under Executive Order 14017,* June 2021, https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf

Community benefits will help gain local acceptance and collaboration with project development.

9. **Reshoring domestic supply chains while undermining incentives for electric vehicles will result in contradictory outcomes**

What many mistake for an investors lack of commitment to mining projects is more about ensuring projects are economically viable. This often requires partnerships. China's state-backed enterprises mean that mine developers there have a backstop to ensure projects are completed. In the US, extractive industry developments around critical minerals often seek out OEM partners, including many automobile manufacturers.

Developing critical minerals supplies would be strengthened by maintaining policies to encourage electric vehicles include the Clean Car rule and Inflation Reduction Act incentives. But uncertainty about the fate of these laws and policies sends signals to buyers that perhaps demand for lithium and other key battery parts do not materialize.

In summary, we need to be strategic and thoughtful about how to grow domestic extractive industries, especially mining industries, and build a low carbon economy. Failure to do so will undermine the benefits that critical minerals development and an energy transition will bring and risk leaving vulnerable and historically marginalized communities behind, and falling short of meeting broader national security and technological development imperatives. I believe we can responsibly safeguard environmental protections, cultural resources, respect Native American self-determination and sovereignty, and create quality high-road domestic jobs in a critical minerals circular economy. Durable due diligence and risk management grounded in international best practice to evaluate impacts and make good decisions can reduce potential harms to communities, maintains companies' social license to operate, and protects US investments.

Critical minerals are exhaustible. Earth will not endlessly provide these resources. We have to steward the lands and water where critical minerals are extracted, and close the loop to keep them in our economy.

Thank you again to this committee for hosting this discussion and I look forward to any questions and a productive conversation.

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