# A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals

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# Executive Summary

The assured supply of critical minerals[1] and the resiliency of their supply chains are essential to the economic prosperity and national defense of the United States. The United States is heavily dependent on foreign sources of critical minerals and on foreign supply chains resulting in the potential for strategic vulnerabilities to both our economy and military. Mitigating these risks is important and consistent with our country's National Security Strategy and National Defense Strategy to promote American prosperity and to preserve peace through strength.

The United States imports most critical mineral commodities. Specifically, the United States is import-reliant (imports are greater than 50 percent of annual consumption) for 31 of the 35 minerals designated as critical by the Department of the Interior.[2] The United States does not have any domestic production and relies completely on imports to supply its demand for 14 critical minerals.[3]

To address this problem and reduce the Nation's vulnerability to disruptions in the supply of critical minerals, President Donald J. Trump issued Executive Order 13817, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, on December 20, 2017. The Executive Order directs the Secretary of Commerce, in coordination with heads of selected executive branch agencies and offices, to submit a report to the President that includes:

(i) "a strategy to reduce the Nation's reliance on critical minerals;

(ii) an assessment of progress toward developing critical minerals recycling and reprocessing technologies, and technological alternatives to critical minerals;

(iii) options for accessing and developing critical minerals through investment and trade with our allies and partners;

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[1] As defined in Executive Order 13817, a critical mineral is "a mineral identified by the Secretary of the Interior [pursuant to the Executive Order] to be (i) a non-fuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption, and (iii) that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security." 82 Fed. Reg. 60835; 2017; https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals

[2] Department of the Interior, "Final List of Critical Minerals 2018," 83 Fed. Reg. 23295; 2018, https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018

[3] U.S. Geological Survey, "Mineral Commodity Summaries 2018," 2018, https://doi.org/10.3133/70194932

(iv) a plan to improve the topographic, geologic, and geophysical mapping of the United States and make the resulting data and metadata electronically accessible, to the extent permitted by law and subject to appropriate limitations for purposes of privacy and security, to support private sector mineral exploration of critical minerals; and

(v) recommendations to streamline permitting and review processes related to developing leases; enhancing access to critical mineral resources; and increasing discovery, production, and domestic refining of critical minerals."

This report, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,* presents 6 Calls to Action, 24 goals, and 61 recommendations that describe specific steps that the Federal Government will take to achieve the objectives outlined in Executive Order 13817.

When executed, this strategy will improve the ability of the advanced technology, industrial, and defense manufacturing sectors that use critical minerals to adapt to emerging mineral criticality issues; reduce risks for American businesses that rely on critical minerals; create a favorable U.S. business climate for production facilities at different stages of critical mineral supply chains; and support the economic security and national defense of the United States; all of which will reduce the Nation's vulnerability to critical mineral supply disruptions.

The Calls to Action outlined in this Strategy are listed below.

1. **Advance Transformational Research, Development, and Deployment Across Critical Mineral Supply Chains:** Assesses progress toward developing critical minerals recycling and reprocessing technologies, technological alternatives to critical minerals, source diversification, and improving processes for critical mineral extraction, separation, purification, and alloying.
2. **Strengthen America's Critical Mineral Supply Chains and Defense Industrial Base:** Discusses ways to improve critical mineral supply chains, which could help reduce risks to U.S. supply by increasing domestic critical mineral resource development, building robust downstream manufacturing capabilities, and ensuring sufficient productive capacity.
3. **Enhance International Trade and Cooperation Related to Critical Minerals:** Identifies options for accessing and developing critical minerals through investment and trade with America's allies, discusses areas for international collaboration and cooperation, and ensures robust enforcement of U.S. trade

laws and international agreements that help address adverse impacts of market-distorting foreign trade conduct.

4. **Improve Understanding of Domestic Critical Mineral Resources:** Provides a plan to: improve and publicize the topographical, geological, geophysical, and bathymetrical mapping of the United States; support mineral information collection and analysis of commodity-specific mitigation strategies; focus and prioritize interagency efforts; and conduct critical mineral resource assessments to support domestic mineral exploration and development of conventional sources (minerals obtained directly through mining an ore), secondary sources (recycled materials, post-industrial, and post-consumer materials), and unconventional sources (minerals obtained from sources such as mine tailings, coal byproducts, extraction from seawater, and geothermal brines) of critical minerals.
5. **Improve Access to Domestic Critical Mineral Resources on Federal Lands and Reduce Federal Permitting Timeframes:** Provides recommendations to streamline permitting and review processes related to developing mining claims or leases and enhancing access to domestic critical mineral resources.
6. **Grow the American Critical Minerals Workforce:** Discusses the activities related to critical minerals needed to develop and maintain a strong domestic workforce to foster a robust domestic industrial base.

# Introduction

Critical minerals[4] are needed for many products used by Americans in everyday life, such as cell phones, computers, automobiles, and airplanes. These minerals are also used to make many other products important to the American economy and defense, including advanced electronics; manufacturing equipment; electricity generation, storage, and transmission systems; transportation systems; defense systems and other military supplies; cutting-edge medical devices; and other critical infrastructure systems.

The assured supply of these critical minerals, and the resiliency of their supply chains, are essential to the United States' economic security and national defense. As shown in Figure 1, the United States is heavily dependent on foreign sources of critical minerals. Specifically, the United States is import-reliant (imports are greater than 50 percent of annual consumption) for 31 of the 35 minerals designated as critical by the Department of the Interior (DOI).[5] The United States does not have any domestic production and relies completely on imports to supply its demand for 14 critical minerals.

Mitigating risks associated with foreign dependence on sources of critical minerals is important and consistent with the National Security Strategy[6] and National Defense Strategy[7] to promote American prosperity and to preserve peace through strength. The dependency of the United States on foreign sources of critical minerals creates a strategic vulnerability for both our economy and our military with respect to adverse foreign government actions, natural disasters, and other events that could disrupt supply.

All stages of the critical mineral supply chain are important and can impact one another. For example, increasing the rate of mining without increasing corresponding

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[4] As defined in Executive Order 13817, a critical mineral is "a mineral identified by the Secretary of the Interior [pursuant to the Executive Order] to be (i) a non-fuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption, and (iii) that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security." 82 Fed. Reg. 60835; 2017; https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals

[5] Department of the Interior, "Final List of Critical Minerals 2018," 83 Fed. Reg. 23295; 2018, https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018

[6] Trump, Donald J., "National Security Strategy of the United States of America," 2017, https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf

[7] Department of Defense, "Summary of the 2018 National Defense Strategy of the United States of America," 2018, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

processing and manufacturing capabilities will simply move the source of economic and national security risk further down the supply chain and create dependence on foreign sources for these capabilities.

| Commodity | Net Import Reliance (%) | | Major import sources (2013-16), share of net import reliance (%)[1] | Imports 2017[e] |
|---|---|---|---|---|
| ARSENIC ($ArO_3$) | 100 | | Morocco, 52; China, 41; Belgium, 6; other,1 | 7300 |
| CESIUM | 100 | | Canada, 100 | NA |
| FLUORSPAR | 100 | | Mexico, 71; China, 8; South Africa, 8; Vietnam, 5; other, 8 | 460,000 |
| GALLIUM | 100 | | China, 33; Germany, 23; United Kingdom, 22; Ukraine, 17; other, 5 | 22 |
| GRAPHITE (natural) | 100 | | China, 35; Mexico, 31; Canada, 17; Brazil, 8; other, 9 | 50,000 |
| INDIUM | 100 | | Canada, 23; China, 22; France, 11; Republic of Korea, 11; other, 33 | 120 |
| MANGANESE | 100 | | South Africa, 29; Gabon, 22; Australia, 14; Georgia, 11; other, 24 | 310,000 |
| NIOBIUM | 100 | | Brazil, 72; Canada, 18; Russia, 3; other, 7 | 11,300 |
| RARE EARTHS | 100 | | China, 78; Estonia, 6; France, 4; Japan, 4; other, 8 | 12,000 |
| RUBIDIUM | 100 | | Canada, 100 | NA |
| SCANDIUM | 100 | | China,100 | NA |
| STRONTIUM | 100 | | Mexico, 87; Germany, 11; China, 2 | 17,000 |
| TANTALUM | 100 | | Brazil, 40; Rwanda, 26; Australia, 8; Canada,7; other, 19 | 1300 |
| VANADIUM | 100 | | Czechia, 32; Austria, 22; Canada, 19; Republic of Korea, 18; other, 9 | 11,500 |
| BISMUTH | 96 | | China, 74; Belgium, 12; Peru, 3; other, 7 | 2400 |
| URANIUM ($U_3O_8$ equivalent)[e, 2] | 93 | | Canada, 33; Australia, 19; Russia, 16; Kazakhstan,11; other, 14 | 21,000 |
| POTASH ($K_2O$ equivalent) | 92 | | Canada, 76; Russia, 7; Israel, 3; Chile, 2; other, 4 | 5,700,000 |
| TITANIUM MINERAL CONCENTRATES ($TiO_2$ content)[3] | 91 | | South Africa, 34; Australia, 26; Canada, 13; Mozambique, 10; other, 8 | 1,050,000 |
| ANTIMONY | 85 | | China, 60; Belgium, 9; Bolivia, 5; other,11 | 24,000 |
| RHENIUM | 80 | | Chile, 69; Belgium, 3; Germany, 3; Poland, 2; other, 3 | 34 |
| BARITE | >75 | | China, 52; India, 10; Mexico, 7; Morocco, 5; other, 1 | 2,220,000 |
| BAUXITE | >75 | | Jamaica, 35; Brazil, 22; Guinea, 16; Guyana, 2 | 4,300,000 |
| TELLURIUM | >75 | | Canada, 43; China, 22; Belgium, 5; Philippines, 3; other 2 | 113 |
| TIN | 75 | | Peru, 19; Indonesia, 15; Malaysia, 15; Bolivia, 13; other, 13 | 32,400 |
| COBALT | 72 | | Norway, 12; China, 11; Japan, 8; Finland, 6; other, 35 | 12,100 |
| CHROMIUM | 69 | | South Africa, 26; Kazakhstan, 7; Russia, 4; other, 32 | 600,000 |
| PLATINUM-GROUP METALS | 57 | | South Africa, 19; Russia, 10; Italy, 5; United Kingdom, 5; other, 18 | 508 |
| TITANIUM (sponge metal)[3] | 53 | | Japan, 41; China, 4; Kazakhstan, 3; Ukraine, 3; other, 2 | 23,000 |
| GERMANIUM | >50 | | China, 31; Belgium, 12; Russia, 3; Germany, 2; other, 2 | 23 |
| HAFNIUM | >50 | | Germany, 23; France, 16; United Kingdom, 8; China, 3 | 160 |
| LITHIUM | >50 | | Chile, 25; Argentina, 24; China, 1 | 3430 |
| TUNGSTEN | >50 | | China, 17; Canada, 5; Bolivia, 5; Germany, 4; other, 19 | 13,900 |
| ZIRCONIUM MINERAL CONCENTRATES ($ZrO_2$ content)[3] | <50 | | South Africa, 30; Australia, 11; Senegal, 7; other 2 | 28,000 |
| ZIRCONIUM[4] | <50 | | China, 34; Germany, 8; Japan, 6; other, 2 | 1080 |
| MAGNESIUM METAL | <25 | | Israel, 7; Canada, 6; China, 3; United Kingdom, 2; other, 7 | 43,000 |
| BERYLLIUM | 14 | | Kazakhstan, 7; Japan, 2; Brazil, 1; United Kingdom, 1; other 3 | 49 |
| HELIUM (reported in million cubic meters of He)[4] | Net exporter | | | 21 |

[e]Estimated. NA Not available. Source: U.S. Geological Survey, Minerals Commodity Summaries 2018 and imports are metric tons unless otherwise noted. [1]In descending order of import share. May include combined data from other countries that are not listed. [2]Source: U.S. Energy Information Administration, Uranium Marketing Annual Report and Domestic Uranium Production Report—Annual. (Accessed September 11, 2018, via https://www.eia.gov/uranium/marketing/ and https://www.eia.gov/uranium/production/annual/.) [3]Multiple rows are shown for titanium and zirconium to reflect different material forms and import sources. [4]The United States exports more helium than it imports. 95% of U.S. imports are from Qatar. Helium imports are in million cubic meters.

Figure 1: 2017 U.S. Net Import Reliance for Critical Minerals[8]

[8] Adapted from U.S. Geological Survey, "Mineral Commodity Summaries 2018," 2018, https://doi.org/10.3133/70194932

Currently, the United States lacks domestic processing and manufacturing capabilities for some critical minerals, which results in the export of domestically produced ores and concentrates for further processing into more value-added products. Lack of domestic processing and manufacturing capabilities for critical materials makes the United States vulnerable to potential geo-economic and geo-political actions from foreign governments that may lead to price and demand volatility for specific minerals, as well as potential supply disruptions causing mineral shortfalls.

Addressing vulnerabilities in the critical minerals supply chain through an increase in domestic exploration, production, recycling, reprocessing, industry incentives, and research and development (R&D) investments would help reduce our Nation's reliance on imports, preserve our leadership in technological innovation, support job creation, and improve our national security and balance of trade. Implementing these investments and policies also enhances the technological superiority and readiness of our Armed Forces, which are among the United States' largest and most important consumers of critical minerals.[9]

To address the risk to critical mineral supply chains, President Donald J. Trump issued Executive Order 13817, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*.[10] The order states, "It shall be the policy of the Federal Government to reduce the Nation's vulnerability to disruptions in the supply of critical minerals, which constitutes a strategic vulnerability for the security and prosperity of the United States. The United States will further this policy for the benefit of the American people and in a safe and environmentally responsible manner, by:

(a) identifying new sources of critical minerals;

(b) increasing activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing critical minerals;

(c) ensuring that our miners and producers have electronic access to the most advanced topographic, geologic, and geophysical data within U.S. territory to the extent permitted by law and subject to appropriate limitations for purposes of privacy and security,

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[9] Department of Defense, "Fiscal Year 2017 Annual Industrial Capabilities Report to Congress," 2018, https://www.businessdefense.gov/Portals/51/Documents/Resources/2017%20AIC%20RTC%2005-17-2018%20-%20Public%20Release.pdf?ver=2018-05-17-224631-340

[10] Trump, Donald J., "Presidential Executive Order on a Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," 2017, https://www.whitehouse.gov/presidential-actions/presidential-executive-order-federal-strategy-ensure-secure-reliable-supplies-critical-minerals/

including appropriate limitations to protect critical infrastructure data such as those related to national security areas; and

(d) streamlining leasing and permitting processes to expedite exploration, production, processing, reprocessing, recycling, and domestic refining of critical minerals."

The Executive Order directed the Secretary of the Interior, in coordination with the Secretary of Defense and other heads of relevant U.S. Government executive branch agencies, to develop a list of critical minerals. On May 18, 2018, DOI, in consultation with other Federal agencies and after review of public comments, published a list of 35 critical minerals.[11]

The Executive Order also directed the Secretary of Commerce, in coordination with heads of selected executive branch agencies, to submit a report containing the following:

(i) "a strategy to reduce the Nation's reliance on critical minerals;

(ii) an assessment of progress toward developing critical minerals recycling and reprocessing technologies, and technological alternatives to critical minerals;

(iii) options for accessing and developing critical minerals through investment and trade with our allies and partners;

(iv) a plan to improve the topographic, geologic, and geophysical mapping of the United States and make the resulting data and metadata electronically accessible, to the extent permitted by law and subject to appropriate limitations for purposes of privacy and security, to support private sector mineral exploration of critical minerals; and

(v) recommendations to streamline permitting and review processes related to developing leases; enhancing access to critical mineral resources; and increasing discovery, production, and domestic refining of critical minerals."

This document, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, is the report called for by the Executive Order. The strategy outlined in this report complements the National Security and Defense Strategies and lists specific

[11] Department of the Interior, "Final List of Critical Minerals 2018," 83 Fed. Reg. 23295; 2018, https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018

actions Federal agencies should complete in order to ensure the Nation has access to a reliable and robust source of critical minerals to support the Nation's economic prosperity and national defense.

# Approach

Increasing America's critical minerals exploration, mining, processing, and manufacturing base requires an integrated, government-wide strategy. The Department of Commerce (DOC) developed this Strategy in coordination with the Federal departments and agencies of the National Science and Technology Council's Subcommittee on Critical Minerals (CMS).[12]

The Calls to Action in this Strategy contain goals, with accompanying recommendations that describe specific actions that the Federal Government should take to meet these goals. In some recommendations, a lead agency is identified in bold font. Recommendations without an identified lead agency will be completed cooperatively between the listed agencies. Each recommendation also lists the anticipated timeframes for implementation.

This Strategy outlines a coordinated approach by the Federal Government in response to Executive Order 13817 to reduce the Nation's vulnerability to disruptions in the supply of critical minerals. An organizing principle of this strategy is to address the full supply chain of critical minerals, which spans from securement of raw materials to end-uses in both civilian and defense applications. Some Federal Government actions outlined in this strategy can be taken in the short-term, such as stockpiling and improving reliable trade options. Other actions, such as catalyzing exploration, designing and constructing new mines, and re-establishing domestic downstream manufacturing supply chains take longer to implement. In addition, the results of applied R&D efforts implemented today may take many years to fully integrate into the private sector. Overall, Federal agencies are already working towards completing many of the goals identified in this report.

The Calls to Action listed in this report support the Administration's objectives to strengthen the United States' manufacturing base and enhance U.S. industrial competitiveness. When executed, this Strategy will improve the ability of the advanced technology, industrial, and defense manufacturing sectors that use critical minerals to adapt to emerging mineral criticality issues; reduce risks for American businesses that rely on critical minerals; create a favorable U.S. business climate for production facilities at different stages of critical minerals supply chains; and support the economic

[12] The Federal departments and agencies represented on CMS are: the Central Intelligence Agency, Department of Homeland Security (DHS), DOC, Department of Defense (DOD), Department of Education (ED), Department of Energy (DOE), DOI, Department of Justice, Department of Labor (DOL), Department of State (DOS), Department of Transportation, Environmental Protection Agency (EPA), National Aeronautics and Space Administration, National Science Foundation (NSF), and U.S. Department of Agriculture (USDA).

security and national defense of the United States; all of which will reduce the Nation's vulnerability to critical mineral supply disruptions.

# Calls to Action

## Call to Action 1: Advance Transformational Research, Development, and Deployment Across Critical Mineral Supply Chains

*Over the past ten years, the United States has invested in science and technology to reduce the Nation's growing dependency on foreign sources of critical minerals and foreign manufacturing supply chains. These investments primarily support three principles: diversifying sources, improving efficiency, and developing substitutes. These principles promote adaptability, resilience, and competitiveness within critical mineral supply chains. While considerable progress has been made, the United States needs an updated Federal R&D strategy and stronger support for private sector adoption of early-stage research to achieve secure and reliable supplies of critical minerals.*

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American ingenuity and entrepreneurship have long been a source of global leadership, economic growth, and strength in national defense. U.S. excellence in science and technology, in part, enabled U.S. dominance in minerals and mineral products in the nineteenth and twentieth centuries. Drawing upon and fostering these capabilities helps the Nation advance towards reducing disruptions in the supply of critical minerals. Accordingly, the United States has been pursuing multiple R&D investments that apply across the supply chain, including:

- diversifying domestic critical mineral sources;
- more efficiently processing, manufacturing, and recycling critical minerals to minimize waste and increase supply; and
- developing alternatives to critical minerals.

Innovations in these areas allow firms and markets to mitigate the wider potential economic and strategic harm of supply chain disruptions. Furthermore, these efforts can also help create new domestic businesses, such as recycling firms and permanent magnet start-ups; revitalize ailing industries and their communities by harnessing the value of by-products and waste streams; and increase the competitiveness of existing firms via technological spillover developed from Federal R&D, where new technologies or innovations are adapted to other industries or processes.

R&D into extracting critical minerals from a diversified set of sources could greatly increase domestic capacity. For example, many minerals are traditionally obtained from conventional sources (minerals obtained directly through mining an ore), but some can be obtained from secondary (recycled materials, post-industrial, and post-consumer materials) and unconventional sources (minerals obtained from sources

such as mine tailings, coal byproducts, extraction from seawater, and geothermal brines) as well. R&D efforts to optimize methods for extraction, concentration, separation and purification of conventional, secondary, and unconventional sources of critical minerals could increase yields and build in supply redundancy and resiliency.

All 35 critical minerals are produced from conventional mining sources; however, some minerals can also be obtained from underutilized secondary and unconventional sources. Developing a diverse set of domestic critical mineral reserves will improve domestic capacity, offset growing consumer demands, and mitigate foreign dependencies. The continual development of secondary and unconventional sources will require optimization of separation and purification methods, while also providing an opportunity to apply transformative, novel approaches. Improvements in purification and separation methods would increase yields and build in redundancy across supply chains.

The National Science and Technology Council's (NSTC) Subcommittee on Advanced Manufacturing released a strategy, *Strategy for American Leadership in Advanced Manufacturing,*[13] that highlights the need for developing cost-effective critical minerals processing and separation technologies as well as reducing the Nation's reliance on critical materials by investigating alternative materials and developing critical mineral recycling. The recommendations and goals listed in this strategy should leverage the work being accomplished to respond to this NSTC report.

**Diversifying the range of sources of critical minerals**

The Federal Government has many initiatives to incentivize critical mineral development from secondary and unconventional sources. Research managed through DOE's Office of Fossil Energy and the National Energy Technology Laboratory has produced rare earth elements (REEs) from coal refuse materials and demonstrated nearly complete removal from acid mine drainage. This program supports over 30 related extramural and intramural projects with various academic institutions, industrial partners, and other national laboratories. Similarly, research by the Critical Materials Institute (CMI)—an R&D public-private partnership funded by DOE's Advanced Manufacturing Office—has produced several inventions related to REEs including one

[13] Subcommittee on Advanced Manufacturing of the National Science and Technology Council, "Strategy for American Leadership in Advanced Manufacturing," October, 2018, https://www.whitehouse.gov/wp-content/uploads/2018/10/Advanced-Manufacturing-Strategic-Plan-2018.pdf

for the extraction of REEs from phosphoric acid streams[14] and multiple inventions for lithium extraction from brines.[15]

Another source of critical minerals can be found in our oceans and in our Nation's Exclusive Economic Zone.[16] Though the U.S. currently has no offshore mineral recovery activity, Pacific Northwest and Oak Ridge National Laboratories are currently developing technologies to extract minerals from seawater, including REEs, lithium, and uranium.[17] In order for offshore mining to be successful, more R&D is needed to develop exploration and mining tools suitable for the cold, saline, and pressurized deep sea. In many cases, ocean-derived minerals with unique chemical properties will also require novel processes for refining and extracting high-value minerals. Countries such as Japan, Canada, and the United Kingdom have been aggressively developing and investing in their own domestic offshore mining industry and seawater extraction technologies. As of October 2018, the International Seabed Authority has issued permits for 29 contractors, none of which are U.S. companies.[18]

**Efficient use and reuse of critical minerals**

Ensuring a secure and sustainable supply of critical minerals also requires efficient use and reuse. Efficiency can be achieved in a variety of ways, including:

- content reductions in products;
- minimizing material waste during manufacturing;
- reusing postproduction waste; and
- recycling at the end of a product's life.

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[14] Critical Minerals Institute, "CMI Annual Report," 2017, https://cmi.ameslab.gov/sites/default/files/cmi-annual-report-2017.pdf

[15] Department of Energy, "EERE Success Story—Geothermal Technology to Help Meet High Lithium Demand," 2016, https://www.energy.gov/eere/success-stories/articles/eere-success-story-geothermal-technology-help-meet-high-lithium-demand

[16] The area extending no more than 200 nautical miles from the territorial sea baseline and is adjacent to the 12 nautical mile territorial sea of the United States, including the Commonwealth of Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, the Commonwealth of the Northern Mariana Islands, and any other territory or possession over which the United States exercises sovereignty.

[17] S. Das et al. "Extracting Uranium from Seawater: Promising AF Series Adsorbents." Special Issue on Uranium in Seawater. Ind. Eng. Chem. Res., 2016, 55 (15), pp 4110–4117. https://pubs.acs.org/doi/abs/10.1021/acs.iecr.5b03136

[18] International Seabed Authority, "Deep Seabed Minerals Contractors," 2018, https://www.isa.org.jm/deep-seabed-minerals-contractors

Such improvements and innovations can also increase product cost-competitiveness. In addition, U.S. technological leadership benefits from the domestic development of innovations related to processing, manufacturing, or recycling.

Federally-supported efforts have yielded many new technologies, products, and processes. For example, a small U.S. startup licensed patents from Oak Ridge National Laboratory to recycle REEs from hard drives and to produce 3D-printed REE magnets from recycled materials. Similarly, CMI developed a new aluminum-cerium alloy that is moving towards commercialization. This new alloy is superior to existing technologies and could increase incentives to develop domestic REE deposits.

DOE, through the Vehicles Technology Office, has increased its focus on lithium-ion battery recycling to support environmental, economic, and supply chain reliability objectives. The lithium-ion battery strategy includes research to reduce the amount of cobalt needed for next-generation batteries and to economically recover components and materials from lithium-ion batteries through the ReCell Center. DOE also announced in February 2019 the Lithium-Ion Battery Recycling Prize[19] – focused on optimized logistics for the domestic collection of spent batteries. Similarly, the U.S. Advanced Battery Consortium announced several contracts related to lithium-ion battery recycling, including an award that will assist a firm to implement a direct cathode-to-cathode recycling process that will decrease costs and decrease industry reliance on virgin material.

Other federally-supported efforts are increasing the reuse and recycling of various critical minerals. For example, the DOD Defense Logistics Agency Strategic Materials Division has worked with industry to reclaim nickel-based super alloys from turbine engines and germanium from infrared and night vision equipment, which has offset the requirement to purchase virgin germanium for the stockpile. The EPA's Sustainable Materials Management program is also working to refine data on U.S. waste and recycling streams, which can show where potential new sources of critical minerals can be found.[20]

While some reuse and recycling of products containing critical minerals is occurring, minerals embedded in existing products or waste streams represent a largely untapped reservoir of potential supply due to the complexity of extracting critical minerals from

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[19] Department of Energy, "Energy Department Announces Battery Recycling Prize and Battery Recycling R&D Center," 2019, https://www.energy.gov/articles/energy-department-announces-battery-recycling-prize-and-battery-recycling-rd-center

[20] Environmental Protection Agency, "Advancing Sustainable Materials Management: 2016 Recycling Economic Information Report," 2016, https://www.epa.gov/sites/production/files/2017-05/documents/final_2016_rei_report.pdf

an end-of-life product. Accordingly, additional research could allow industry to make full use of these resources.

**Developing alternatives**

Another way to minimize the Nation's growing dependency on foreign sources of critical minerals and foreign manufacturing supply chains is to use alternative minerals and components. When possible, substituting critical minerals with abundant, less-expensive replacements can conserve critical minerals, reduce vulnerability to disruptions, and lower product costs. Work supported by CMI yielded several permanent magnets (for various applications from motors to hard drives) and phosphors (for lighting) suitable for replacing current commercial products. These components contain few or no REEs and use only domestically-sourced ores and processes.[21] Under the Advanced Research Projects Agency-Energy's Rare Earth Alternatives in Critical Technologies program, researchers at Northeastern University developed iron-nickel alloys to replace neodymium and dysprosium. Similarly, researchers at Los Alamos National Laboratory, Oak Ridge National Laboratory, and the University of Minnesota invented a permanent magnet made of iron and nitrogen in 2016. Finally, the DOE Vehicle Technologies Office funded research at Argonne National Laboratory that has contributed to commercialization of electric vehicle batteries that use cathode chemistries with less cobalt.[22]

**Fundamental and crosscutting R&D**

Fundamental and crosscutting research provides a foundation for applied research. Fundamental research is helping to advance our understanding of the role that critical minerals play in the determination of the properties of minerals at length scales ranging from electronic interaction distances to atomic and microstructural scales. This research includes the development of novel synthesis techniques that control properties at the atomic level to develop unique capabilities for the preparation, purification, processing, and fabrication of well-characterized materials. Potential fundamental research needs to include the development, validation, and application of models to theoretically and computationally identify compounds that are promising critical material substitutes.

Recent advances in computer science and programming have expanded the universe of mineral substitutes and can help accelerate movement from discovery to deployment.

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[21] Critical Minerals Institute, "CMI Success Stories," 2016, https://cmi.ameslab.gov/resources/success-stories.

[22] Department of Energy, "2018 Annual Merit Review Vehicle Technologies Office," 2018, https://www.energy.gov/eere/vehicles/downloads/2018-annual-merit-review-report

Current computational efforts have focused on understanding fundamental material properties. Expanding these efforts to model scarcity, toxicity, and sustainability would help improve the ability to identify new substitutes. Advanced modeling techniques can improve subsurface resource characterization by blending conventional geoscience methods with data science techniques such as machine learning, 3D visualization, and advanced data computing approaches.

Across the critical minerals supply chain, there is also a need to improve understanding of environmental health and safety issues. Protecting the environment and ensuring the health of miners and surrounding communities are crucial components of a sustainable critical minerals industry.

**Goal: Develop an R&D strategy to enhance scientific and technical capabilities across critical mineral supply chains**

Significant R&D needs exist across critical mineral supply chains. Coordinating these efforts among the relevant Federal agencies should ensure that resources are used efficiently and effectively. The United States needs a strategy to identify key R&D needs for source diversification; more efficient use and substitution of critical minerals; and mining, fundamental materials science, manufacturing, and environmental health and safety. The Federal Government should design this R&D strategy in coordination with existing efforts by the CMI, the various DOE applied energy research offices, the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean Exploration and Research, the National Institute of Standards and Technology (NIST), DOD, EPA, and the Nation's National Laboratories. In addition, programs like the Small Business Innovation Research program and the Small Business Technology Transfer program can create opportunities to leverage ongoing investments in R&D.

As new materials are developed through research, the Federal Government should provide support for the private sector to demonstrate, evaluate, test, and qualify these new materials for civilian and defense applications.

To achieve this goal, the following actions are recommended:

**1.1** Develop a roadmap that identifies key R&D needs and coordinates on-going activities for source diversification, more efficient use, recycling, and substitution for critical minerals; as well as cross-cutting mining science, data science techniques, materials science, manufacturing science and engineering, computational modeling, and environmental health and safety R&D. *(**DOE**, DOC [NIST, NOAA], DOD, and EPA; 2-4 years)*

**1.2** Establish new public-private partnerships (e.g. consortia based in National Laboratories and universities) and leverage existing public-private partnerships to more efficiently address the underlying scientific and early-stage applied research

challenges and enable the validation and verification of new materials and processes in key technical areas across the supply chains of critical minerals. *(DOC [NIST], DOD, and DOE; 2-4 years)*

**1.3** Complete technical and economic feasibility studies of the production of critical minerals and related manufactured materials from secondary and unconventional sources (including coal-based resources, mine tailings, smelter slag, waste streams, end-of-life products, and seawater deposits). *(**DOE**, DOC (NOAA), DOD, DOI [United States Geological Survey (USGS)], and EPA; 1-2 years)*

**1.4** Provide private industry and other external stakeholders access to computing capabilities, testing, and validation support facilities by lowering barriers to engage with government and academic laboratories, institutes, and organizations. *(**DOE**, DOC [NOAA], DOD, and DOI [USGS]; 2-4 years)*

**Goal: Increase U.S. private industry investment in innovation and improve technology transfer from federally funded science and technology**

There has been significant investment from the Federal Government and in the private sector in science and technology focused towards developing and expanding domestic capabilities for key critical mineral resource extraction, downstream processing, and manufacturing across critical mineral supply chains. Further, the U.S. has statutory authorities and programs that can facilitate and incentivize the transition of this science and technology to full scale production and integration into the U.S. industrial base.[23] For non-military related requirements in similar areas, DOE, DOI, and other agencies have supported R&D programs that could be further leveraged.

Existing Federal Government initiatives such as the 2018 President's Management Agenda[24] should be leveraged to support this goal. Specifically, the cross-agency priority goal focused on improving the transfer of federally funded R&D to the private sector.

**1.5** Evaluate and provide recommendations to incentivize the development and use of advances in science and technology in the private industry. Options that could be considered include: (1) tax incentives for investment in new technologies, (2) government purchase programs based on the use of new technologies using domestic ores in the production of goods purchased and (3) leveraging existing

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[23] Relevant DOD statutory authorities, programs, and funds include Title III of the Defense Production Act, the Strategic and Critical Materials Stock Piling Act, the Defense Manufacturing Technology Program, the Rapid Innovation Fund, and the Industrial Base Analysis and Sustainment Fund.

[24] President's Management Council and the Executive Office of the President, "President's Management Agenda," https://www.whitehouse.gov/wp-content/uploads/2018/03/The-President%E2%80%99s-Management-Agenda.pdf

DOE and DOD authorities to incentivize private sector investment in critical mineral processing and manufacturing R&D and commercialization. *(CMS, DOD, DOE, and DOI; 2-4 years)*

**1.6** Provide support for small and medium business regarding critical mineral issues by leveraging and expanding the existing coordination between DOE's CMI, NIST's Manufacturing Extension Partnership, relevant Manufacturing USA institutes, national laboratories, and universities. Provide periodic status updates to the CMS. *(DOC [NIST], DOD, and DOE; ongoing)*

## Call to Action 2: Strengthen America's Critical Mineral Supply Chains and Defense Industrial Base

*Developing robust domestic supply chains and a resilient defense industrial base for critical minerals can help sustain domestic critical mineral resource development and reduce supply risk at all stages of the supply chain, including materials processing, and manufacturing intermediate and final products. The United States needs to further encourage and incentivize U.S. private industry investment and innovation in developing, expanding, modernizing, and sustaining capabilities and industrial-scale capacity throughout the supply chain.*

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Executive Order 13817 identifies the need to increase activity at all levels of the critical minerals supply chain. This includes activities such as development, mining, concentration, separation, refinement, reduction, and alloying, as well as processing and manufacturing of intermediate and final products. Developing robust domestic supply chains and a resilient defense industrial base for critical minerals should help sustain domestic critical mineral resource development and reduce supply risk, while also improving U.S. industrial competitiveness, expanding production capacity, spurring job creation, and supporting U.S. economic prosperity and national defense.

The U.S. has endured a long period of decline in the domestic production of critical mineral downstream value-added material processing and associated product manufacturing, as identified in the response[25] to Executive Order 13806, *Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States*. For certain critical minerals, former U.S. material producers and their downstream customers have relocated U.S. production to foreign countries such as China. Further, U.S. producers have struggled to compete with foreign producers and have experienced downsizing or business failure. For example, the REE industry has experienced downsizing, business failure, and relocation in all phases of the supply chain, including mining, separation, metal reduction, alloying and downstream manufacturing of advanced technology products such as high performance rare earth permanent magnets.

The REE industry also provides a good example of why increased activity—from R&D investments to industry incentives—is needed across the entire U.S. supply chain. Mining of ore containing REE has resumed in the U.S., which has diversified the supply

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[25] Department of Defense, "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," September 2018, https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20DEFENSE-INDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF

of the raw material. However, the U.S. does not possess the capability to separate and process the REE concentrate and must send the concentrate to foreign facilities to perform this process. Similarly, the U.S. lacks the domestic capability to manufacture REE based high performance magnets from the separated and purified material. This results in U.S. reliance on imported magnets, which are crucial for both civilian and defense applications. Accordingly, increasing mining without increasing processing and manufacturing capabilities simply moves the source of economic and national security risk down the supply chain and creates dependence on foreign sources for these capabilities.

The U.S. needs to pursue strategies, policies, and investment that reduce our rapidly growing dependence on foreign sources of critical minerals and manufacturing supply chains while minimizing the potential vulnerability to foreign supply disruption. The U.S. should seek opportunities to expand public-private partnerships that further incentivize U.S. private industry investment; promote innovation in developing, expanding, modernizing, and sustaining domestic capabilities; enhance downstream value-added processing and associated manufacturing; and more effectively leverage the National Defense Stockpile (NDS) Program and other industrial base business assistance support programs. In addition to increasing activity, transformational R&D is needed across the entire supply chain to foster the establishment of these domestic capabilities. Therefore, actions completed under Call to Action 1, which is focused on R&D, should be leveraged and coordinated with actions completed under this Call to Action in order to increase activity across the entire critical minerals supply chain.

**Goal: Understand and support the critical minerals industry and related supply chain**

Critical mineral supply chain networks should be made more robust so that domestically produced critical minerals can support our Nation's economic security and national defense. The Federal Government should better understand the organization of these networks to improve the flow and competitiveness of critical minerals and their downstream supply chains.

To achieve this goal, the following actions are recommended:

**2.1** Develop an interagency methodology to periodically assess market trends and competitiveness of the U.S. critical mineral industry and its downstream supply chains in order to recommend policies and strategies such as government investment in R&D, capacity expansion, stockpiling, and trade actions. (***DOD****, DOC* [*Bureau of Industry and Security (BIS)], DOE, and DOI [USGS]; 2 years*)

**Goal: Leverage critical mineral expertise from stakeholders outside of the Federal Government**

Federal agencies would benefit from increased collaboration with critical minerals experts from industry; academia; non-governmental and non-profit organizations; and State, local, and Tribal governments. Agencies should strive to leverage stakeholder expertise to solve complex challenges related to the critical mineral supply chain.

**2.2** Establish a National Critical Minerals and Supply Chains Council through the Federal Advisory Committee Act to seek advice on the metal and non-metallic sectors of U.S. industry producers and primary processors. *(**DOD**, DOC, DOE, and DOI; 1-2 years)*

**2.3** Convene stakeholders from across the critical mineral supply chain to:

- Identify key needs and challenges related to implementing innovations in all stages of the critical minerals supply chain, including: developing, expanding, modernizing and sustaining domestic land and offshore mining; downstream processing; associated manufacturing; and improving U.S. industrial base resiliency.
- Improve national recycling and materials recovery infrastructure to create more secure domestic supplies of critical minerals.
- Identify uses of secondary and unconventional sources of critical minerals, improve product designs that facilitate critical mineral recovery, and explore technological/R&D needs to facilitate material recovery. (*DOD, DOE, DOI [USGS], EPA; 1-3 years)*

**Goal: Develop, expand, modernize, and sustain U.S. critical minerals downstream materials production capacity and supply chain resiliency**

The United States continues to be increasingly dependent on foreign producers of critical minerals and as a result is vulnerable to potential supply disruptions. The U.S. faces supply chain gaps in key production capabilities and capacities. Further, many U.S. companies face significant foreign competitive pressures, declining revenue, company downsizings, production facility closures, and business failures.

As described in the response to Executive Order 13806 and to Congress,[26] certain U.S. critical minerals and their downstream materials processing and manufacturing

[26] Office of the Deputy Assistant Secretary of Defense for Manufacturing & Industrial Base Policy, "Fiscal Year 2017 Annual Industrial Capabilities Report to Congress," March 2018, https://www.businessdefense.gov/Portals/51/Documents/Resources/2017%20AIC%20RTC%2005-17-2018%20-%20Public%20Release.pdf?ver=2018-05-17-224631-340

capabilities and capacity represent particularly high-risks to U.S. essential civilian demands and military requirements. These risks include potential wartime shortfalls and other associated risks to the U.S. industrial base and supply chains.

**2.4** Evaluate and provide recommendations to incentivize the U.S. private industry specific to national defense requirements, to: (1) invest in domestic capabilities and industrial-scale production of key critical mineral sources; (2) innovate in material substitution and alternative approaches to processing and recycling; and (3) support critical minerals related processing capabilities and essential productive capacity at DOD's industrial base facilities. *(DOD; ongoing)*

**2.5** Assess different policies to stimulate increased private sector investment in: domestic industry production capabilities and capacity; investment tax credits and capital gains tax exemptions; low-interest loans and loan guarantees; workforce training funds; domestic sourcing policy; trade adjustment assistance, and small business-related procurement opportunities. *(CMS, DHS, DOD; 1 year)*

**2.6** Assess opportunities to strengthen the use of Federal Government domestic sourcing requirements, including the Buy American Act[27], as a means for supporting U.S. critical mineral material resources and their domestic downstream manufacturing supply chains that are deemed essential to U.S. national defense and security. (*DOD and White House Office of Trade and Manufacturing Policy; ongoing)*

**Goal: Stabilize and strengthen the NDS Program's abilities to respond rapidly to urgent and unanticipated military and essential civilian requirements during U.S. wartime and other national emergencies**

The United States is heavily dependent on critical mineral imports. If China or Russia were to stop exports to the United States and its allies for a prolonged period – similar to China's rare earths embargo[28] in 2010—an extended supply disruption could cause significant shocks throughout U.S. and foreign critical mineral supply chains.

The NDS Program provides important protection to the United States and its domestic manufacturers from vulnerability to foreign supply disruptions. Its mission is to provide critical materials to support emergency industrial investment requirements and help address essential civilian needs during a national emergency. The Program also

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[27] Buy American Act, Pub. L. No. 72-428 (1933), codified at 41 U.S.C. §§ 8301-8305, http://uscode.house.gov/view.xhtml?path=/prelim@title41/subtitle4/chapter83&edition=prelim

[28] Keith Bradsher, "Amid Tensions, China Blocks Vital Exports to Japan," New York Times, 22 September 2010, https://www.nytimes.com/2010/09/23/business/global/23rare.html

assesses and mitigates nationwide critical material risks to U.S. military and essential civilian requirements under near-peer wartime and other potential supply disruption scenarios.

The NDS Program is not financially sustainable following more than two decades of Congressionally-directed disbursements[29] of NDS Program funds to other accounts. The Program also has substantial unfunded requirements as discussed in Senate Report 115-262.[30]

**2.7** Investigate the use of existing DOD rapid acquisition authorities and other operating practices to increase the NDS Program's response capabilities to urgent warfighter requirements and during non-wartime national emergencies. *(DOD; ongoing)*

**2.8** Address Congressional concerns stated in Senate Report 115-262 (Title IV, Subtitle D) regarding the lack of long-term financial stability of the NDS Transaction Fund. *(DOD; 1-2 years)*

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[29] Select recipients of NDS funds include the American Battle Monuments Commission, the Defense Health Program, the Operations and Maintenance accounts of the Military Services, the Spectrum Sales program to the reclamation of previously-sold frequencies, the Foreign Military Sales Program, the Federal Hospital Insurance Trust Fund, and the Federal Supplementary Medical Insurance Trust Fund.

[30] United States Senate, Committee on Armed Services, "Report No. 115-262 - The John S. McCain National Defense Authorization Act for Fiscal Year 2019," page 322, June 5, 2018, https://www.congress.gov/115/crpt/srpt262/CRPT-115srpt262.pdf

## Call to Action 3: Enhance International Trade and Cooperation Related to Critical Minerals

*The United States imports many critical minerals. Maintaining access to these sources is vital for U.S. economic security and national defense. Increasing trade and cooperation with allies and partners can help reduce our Nation's reliance on sources of critical minerals that could be disrupted. Robust enforcement of U.S. trade laws and international agreements could also help address adverse impacts of market-distorting foreign trade conduct.*

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The United States imports many critical mineral commodities from markets around the world. Specifically, of the 35 minerals designated as critical, the United States is import-reliant (imports are greater than 50 percent of annual consumption) for 31 of these minerals, and is 100 percent reliant on imports from other countries for 14 of these 31 minerals, as demonstrated in Figure 1.

As the world economy grows, the United States will face increased competition for access to critical minerals sourced from foreign suppliers. Increasing trade with allies and partners can help reduce the likelihood of disruption to critical mineral supply chains. For example, Canada and Mexico supply all or part of U.S. consumption for many critical minerals. The United States has historical trade relationships, established logistic chains, and geographic proximity with these countries. Working with them to develop their critical mineral deposits can help improve the security of U.S. supply.

The United States cooperates with many partners around the globe on issues related to the sourcing of critical minerals. For example, the USGS has Memoranda of Understanding (MOUs) with partner countries' geological surveys to conduct research on topics of mutual interest. These MOUs have led to many joint activities, such as an ongoing dialogue on mineral information and resource assessments with Australia. The DOE has led cooperative discussions with the European Union and Japan in a trilateral R&D critical materials group for diversifying supply, developing substitutes, improving recycling, and performing criticality analyses. The USGS and the NDS Program have an ongoing relationship with U.S. allied countries to share information and best practices on critical and strategic mineral stockpiling.

Establishing and maintaining close collaboration with U.S. allies and other security partner countries to ensure national defense and economic security is also a priority for DOD. DOD has several existing authorities and mechanisms to foster collaboration with our allies and foreign partners, which can reduce vulnerabilities to critical mineral

supply disruptions, including Reciprocal Defense Procurement[31] (RDP) agreements, Security of Supply Arrangements[32] (SOSAs), and cooperation through the National Technology and Industrial Base.[33] These mechanisms are available to expedite U.S. access to ally and other security partner country suppliers. DOD is pursuing opportunities to utilize these and related forms of collaboration to reduce U.S. vulnerabilities to potential supply disruptions of critical mineral resources and their downstream supply chains.

In 2016, the U.S. Government Accountability Office issued a report[34] that called on Federal agencies to assess other countries' or regions' approaches to mitigating risks to critical mineral supply chains and to identify useful examples and approaches. Several Federal agencies have pursued opportunities to learn from other nations' strategies and experiences with critical mineral supply chains. For example, the USGS's effort to collect new geophysical, geological, and topographical data is modeled on Canadian and Australian investments in similar geoscience datasets. In July 2018, the geological survey authorities began discussing ways to learn from one another as well as leverage their respective minerals research investments. Similarly, EPA's Sustainable Materials Management program has hosted multiple meetings in the past several years that engaged stakeholders from the entire supply chain in conversations addressing the full life cycle of products and materials, including a G7 Alliance on Resource Efficiency workshop in March 2016.[35]

U.S. access to critical mineral resources abroad and the viability of industries producing these minerals in the United States can be negatively impacted by trade and investment restrictions, and by foreign conduct that distorts markets through various forms of unlawful or otherwise unfair competition. U.S. trade laws and relevant international agreements provide tools to remedy such conduct, address the adverse impacts of such

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[31] RDP agreements are used to strengthen the defense industrial base, by among other means, allowing greater participation from friendly countries in U.S. defense procurements.

[32] SOSAs can be used to prioritize acquisitions of industrial resources to meet urgent warfighter needs and critical defense requirements in participant's industrial bases.

[33] The National Technology and Industrial Base is a framework for integrating defense industrial base activities between United States, Canada, Australia, the United Kingdom of Great Britain, and Northern Ireland.

[34] U.S. Government Accountability Office, "Strengthened Federal Approach Needed to Help Identify and Mitigate Supply Risks for Critical Raw Materials," September 2016, https://www.gao.gov/products/GAO-16-699

[35] Environmental Protection Agency, "U.S.-hosted Workshop on the Use of Life Cycle Concepts in Supply Chain Management to Achieve Resource Efficiency: Workshop Summary Proceedings," 2016, https://www.epa.gov/sites/production/files/2016-09/documents/g7_us_workshop_summary_proceedings_final.pdf

conduct on U.S. industries, and ensure U.S. national security interests are not threatened by import reliance.

**Goal: Increase international exchanges with partner nations to share best practices and identify opportunities for trade and collaboration**

International exchanges of information on best practices for addressing critical mineral issues would improve the ability of the United States to secure access to these minerals and reduce critical mineral market risks. The Federal Government should organize delegations composed of U.S. Government officials and private sector representatives to visit partner countries to study how they have addressed critical mineral issues. Intergovernmental agreements with partner nations are important mechanisms for ensuring continued access to critical minerals.

To achieve this goal, the following actions are recommended:

**3.1** Continue and expand cooperation and collaboration with interested partners – particularly Canada, Australia, the European Union, Japan, and South Korea – related to: (1) critical mineral resource identification and exploration, (2) critical mineral processing and recycling, (3) mitigating supply risk and preventing supply chain disruptions, (4) R&D related to critical mineral materials and manufacturing, and (5) tracking and sharing information on foreign investment and acquisitions of mineral rights, property, and development. (*DOC [International Trade Administration (ITA)]; DOD, DOE, DOI [Bureau of Ocean Energy Management* (*BOEM), USGS], and DOS; ongoing)*

**3.2** Establish accurate estimates of supply and demand of critical minerals in partner countries through consultations in conjunction with Ministerial-level forums for producers, buyers and investors. *(DOD, DOS, and DOI [BOEM, USGS]; 5 years)*

**3.3** Complete a best practice report by evaluating other countries' approaches to private industry supply chain issues (e.g., Canadian Mining Labor Reports). *(**DOD**, DHS, DOC [BIS], DOE, DOI, DOL, and NSF; 2 years)*

**Goal: Secure access to critical minerals through trade and investment with international partners, while ensuring that foreign trade practices do not harm U.S. industries and broader national interests**

Sourcing imported critical minerals from allies and partner countries helps ensure continued access and reduces reliance on uncertain sources. Facilitating international trade with allies and partner countries could also lead to linkages that increase investment in domestic mines, mineral processing facilities, and factories. At the same time, U.S. trade laws and international agreements provide tools to address not only restrictions that impede U.S. access to necessary mineral resources abroad, but also

market-distorting foreign economic conduct that place critical mineral industries in the United States at a disadvantage.

**3.4** Explore opportunities to utilize existing and future SOSAs, RDP agreements, and National Technology and Industrial Base collaborations to reduce U.S. vulnerability to potential supply disruptions of critical mineral materials and their downstream supply chains*. (DOD; ongoing)*

**3.5** Monitor foreign countries' barriers to critical mineral-related trade and investment and seek to remove such barriers when they arise. *(DOC [ITA], United States Trade Representative (USTR), and DOD; ongoing)*

**3.6** Use international trade agreements to challenge unlawful or otherwise unfair trading practices of foreign countries, where applicable. *(USTR and DOC [ITA]; ongoing)*

**3.7** Consider whether the circumstances of U.S. reliance on imports of high risk materials merit investigations to determine the effect on U.S. national security. (*DOC [BIS] and DOD; ongoing)*

## Call to Action 4: Improve Understanding of Domestic Critical Mineral Resources

*Enhancing the United States' ability to identify and use domestic critical mineral resources requires advanced earth observation data products; robust mineral information collection and analysis; publication of critical mineral supply and consumption data; and critical mineral resource assessments. All data products that are developed should be made publicly available in a readily discoverable, accessible, and usable electronic format.*

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Identifying new sources of critical minerals requires a focused, ongoing effort to evaluate the domestic potential of conventional, secondary, and unconventional resources. The lack of geophysical, geological, topographical, and bathymetrical mapping at the scale required for mineral resource assessments and private sector exploration is a critical information gap that must be closed to facilitate domestic development. USGS data has shown that less than 18 percent of the U.S. land mass has been geologically mapped at the necessary scale, and less than five percent of the Nation has regional aeromagnetic datasets at the required resolution to perform robust mineral resource assessments. Similarly, less than 35 percent of the Nation's Exclusive Economic Zone has been bathymetrically mapped with modern methods, and even less has been geologically mapped or characterized with enough resolution to facilitate mineral assessments.[36]

In contrast, both Australia and Canada, countries with major mining economies with similar health, safety, and environmental concerns as the United States, have developed geological and geophysical surveys and made these available to the private sector.[37] The availability of these national data in Australia and Canada has created a more favorable environment for private sector investment in mineral exploration and development. In the United States, improved mapping and geophysical surveys would

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[36] Westington, M., Varner, J., Johnson, P., Sutherland, M., Armstrong, A., & Jencks, J. 2018, "Assessing Sounding Density for a Seabed 2030 Initiative," in proceedings of the 2018 Joint Canadian Hydrographic and National Surveyors' Conference, Victoria, British Columbia, 26-29 March 2018, https://www.eiseverywhere.com/ehome/chc-nsc2018/711593/

[37] United States Senate, Committee on Energy and Natural Resources, "The United States' Increasing Dependence on Foreign Sources of Minerals and Opportunities to Rebuild and Improve the Supply Chain in the United States: Hearing Before the Senate Committee on Energy and Natural Resources," 115th Cong., 115–183, 2017, https://www.govinfo.gov/content/pkg/CHRG-115shrg24976/pdf/CHRG-115shrg24976.pdf

facilitate improved critical mineral resource assessments and resource development, which would mitigate strategic vulnerabilities.

Federal agencies should improve the discoverability, accessibility, and usability of existing and future data. USGS is improving the discoverability of useful datasets by hosting a portal that contains a wide spectrum of minerals-related information and data including geological, geochemical, and geophysical databases; mineral assessments; ore deposit models; and more.[38]

Data accessibility is a challenge because not all existing useful data are in electronic form. Some mineral data remain on paper or in other difficult-to-access formats; other datasets are not being maintained or updated. In a few cases, data rescue programs preserve existing paper records and increase their accessibility by converting them to digital formats. Other initiatives seek to translate different forms of information, such as images, into parameters compatible with existing datasets and models. USGS, for example, has developed the National Geological and Geophysical Data Preservation Program.[39] These programs and initiatives aid the interpretation of geological maps and geophysical datasets for critical mineral occurrences. In order to maximize data discoverability, accessibility, and usability, Federal data providers should use a common framework or set of standards to support data development.

For the offshore environment, BOEM and NOAA developed the Marine Cadastre, which is an integrated marine information system that provides data, tools, and technical support for offshore energy and marine planning. As discussed in Executive Order 13840, *Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States*, the Marine Cadastre will increase access to offshore mining and mapping data, which can support private sector investment.

In addition to Federal datasets, a wealth of commercial data could be leveraged through public-private partnerships that support R&D and mineral assessments. However, any such partnership would need to balance access to the data with protection of proprietary information.

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[38] U.S. Geological Survey, "Mineral Resources Online Spatial Data," 2019, https://mrdata.usgs.gov

[39] U.S. Geological Survey, "National Geological and Geophysical Data Preservation Program," 2019, https://datapreservation.usgs.gov/

**Goal: Use critical mineral supply and consumption data to develop metrics to enable commodity-specific mitigation strategies addressing strategic vulnerabilities**

DOI, in collaboration with the CMS, developed the critical minerals list[40] using a documented methodology. The list served as the initial focus for this Strategy document. Mineral criticality is not static, but changes over time. Accordingly, the critical minerals list should be updated periodically using a transparent, documented methodology that considers changes to supply, demand, concentration of production, and current policy priorities.

Strategic vulnerabilities for minerals on the list should be mitigated in different ways, such as: development of domestic mining, trade with reliable allies and partners, substitution, recycling, or some combination of these, as identified in Executive Order 13817. The United States should evaluate potential mitigation strategies on a commodity-by-commodity basis to address the unique characteristics of each material supply chain. However, the United States requires more comprehensive data to effectively evaluate vulnerabilities over the entire material supply chain for individual mineral commodities.

USGS and the DOC's Bureau of Economic Analysis (BEA) have collaborated to evaluate the feasibility of developing natural capital accounts that could track the Nation's natural resource wealth. However, due to data limitations, the scope for developing these accounts is narrow. As a pilot effort, USGS mineral resource and industrial activity data on copper was used, with the intent that the approach could be expanded to apply to additional mineral commodities. This interagency collaboration, which includes support from Canadian and Australian subject matter experts who already use this technique, has received support from the NSF, but efforts could be expanded with better data.

To achieve this goal, the following actions are recommended:

**4.1** Periodically update the list of critical minerals based on changes to mineral supply, demand, concentration of production, and current policy priorities. This list should be reviewed every two years and updated when necessary. Updates to the critical minerals list will inform the rest of the work being performed by agencies in this Strategy. *(**DOI [USGS]**, CMS, DOD, and DOE; 2-4 years)*

[40] Department of the Interior, "Draft Critical Mineral List – Summary of Methodology and Background Information – U.S. Geological Survey Technical Input Document in Response to Secretarial Order No. 3359," 2018, https://pubs.usgs.gov/of/2018/1021/ofr20181021.pdf

**4.2** Categorize and prioritize minerals on the critical minerals list to enable commodity-specific mitigation strategies. *(**DOI [USGS]**, CMS, DOD, and DOE; 2 years)*

**4.3** Develop a pilot effort to track indicators of the Nation's critical mineral wealth and investments in critical mineral-related economic activity. *(**DOI [USGS]** and DOC [BEA]; 2-4 years)*

**Goal: Conduct critical mineral resource assessments and identify methods to encourage the use of secondary and unconventional sources of critical minerals**

Mineral resource assessments at regional, national, and global scales are essential to understanding the Nation's critical mineral endowment in a global context. These assessments would contribute to the understanding of the geologic occurrences, spatial distribution, and characteristics of mineral deposit types that are prospective for hosting one or more critical minerals, either as primary or byproduct commodities.

When performing critical mineral resource assessments, it is important to note that some minerals are geologically coupled with primary products and can only be produced as byproducts. Gallium, for example, a critical mineral that is utilized in many domestic high technology military and civilian applications, is produced commercially as a byproduct of bauxite and zinc ore processing. Byproduct mineral production is heavily dependent on the profitability of the main resource, as byproduct minerals are typically produced in low volumes and have low economic value when compared to the main resource being mined.

**4.4** Based on prioritization, deliver at least one national or regional domestic multi-commodity critical mineral resource assessment every two years on prospective deposit types. *(DOI [BOEM, USGS]; ongoing)*

**4.5** Develop critical mineral resource assessment methods; characterize and map the critical mineral potential from secondary and unconventional sources; and provide a periodic status update to the CMS. *(**DOI [USGS]**, DOE, EPA, DOS in collaboration with private sector partners; ongoing)*

**4.6** Identify potential significant secondary and unconventional sources of critical minerals, as well as the technological developments needed to improve domestic recovery capability. Provide a periodic status update to the CMS. (***DOE**, DOD, DOI [USGS], and EPA; ongoing*)

**4.7** Recommend appropriate measures for Federal agencies to procure products that use secondary and unconventional sources of critical minerals. *(DOD and EPA; 2-4 years)*

**Goal: Improve the geophysical, geological, topographical, and bathymetrical mapping of the United States and associated coastal and ocean territory**

Understanding the Nation's critical minerals resources requires accurate and detailed maps. Geophysical, geological, and topographical maps can reveal possible deposits of critical minerals. Some mapping techniques, such as aeromagnetic surveys, can help users infer the presence of subsurface resources. In addition to terrestrial mapping, accurate and detailed mapping of the United States' ocean and coastal territory is needed to understand mineral potential.

**4.8** Identify priority regions with significant critical mineral resource potential on land and in ocean regions. *(DOC [NOAA] and DOI [BOEM, USGS]; 1-2 years)*

**4.9** Develop regional scoping studies to identify and prioritize critical mineral mapping projects based on existing datasets, the expected density of critical minerals, a mineral's level of criticality, supply chain security, mineral demand, and impacts on scientific research. *(DOC [NOAA] and DOI [BOEM, USGS]; 1-2 years)*

**4.10** Develop and use a multi-agency protocol to assess ocean mineral resource potential in the U.S. Exclusive Economic Zone. *(DOC [NOAA], DOE [Water Power and Technology Office] and DOI [BOEM, USGS]; 2-4 years)*

**Goal: Improve the discoverability, accessibility, and usability of geophysical, geological, topographical, and bathymetrical data**

Many mapping datasets generated by Federal, State, Tribal, local governments, and private companies contain information pertinent to critical minerals. Improving the discoverability, accessibility, and usability of these data is challenging due to the volume and heterogeneity of relevant datasets, which are managed by a variety of Federal agencies, as well as a diverse set of user groups.

**4.11** Continue data rescue programs to convert paper and difficult-to-access data to more usable forms, with an increased focus on records pertaining to critical minerals. Provide a periodic status update to the CMS. *(DOC [NOAA] and DOI [BOEM, USGS]; ongoing)*

**4.12** Make geophysical, geological, geochemical, topographical, and bathymetrical survey data generated by Federal Government agencies publicly available and easily accessible in an easy-to-use electronic format through new or existing Federal data archives and dissemination portals. *(DOC [NOAA] and DOI [BOEM, USGS]; 2-4 years)*

**4.13** Improve data discoverability, accessibility, and usability by using a common framework or set of standards to support data development and dissemination. Best practices from existing frameworks such as the *Common Framework for Earth*

*Observation Data*[41] could be adopted to achieve this goal. *(**DOI**, DOC [NOAA], and DOE; 2-4 years)*

**4.14** Increase government access to proprietary mapping datasets by building public-private partnerships. Provide a periodic status update to the CMS. *(**DOI [BOEM, USGS]**, DOC [NOAA], DOD, DOE, and the Federal Geographic Data Committee**]**; ongoing)*

[41] Committee on Environment, Natural Resources, and Sustainability of the National Science and Technology Council, "Common Framework for Earth Observation Data," March 2016, https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/common_framework_for_earth_observation_data.pdf

## Call to Action 5: Improve Access to Domestic Critical Mineral Resources on Federal Lands and Reduce Federal Permitting Timeframes

*Critical minerals are vital for maintaining U.S. economic and national security. Accordingly, improving access to these resources is extremely important. Access includes all aspects of making minerals available for exploration and development: infrastructure to reach the mineral or mine, land-use policies (including designations), permitting reform, and economic support required to develop and maintain access over the long-term.*

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The United States is endowed with rich mineral deposits. Specifically, U.S. mines produced an estimated $75.2 billion of raw mineral materials and created an estimated $2.9 trillion in value-added products in 2017.[42] Unfortunately, Federal permitting and land management policies have inhibited access to and the development of domestic critical minerals, which has contributed to increased reliance on foreign sources of minerals.

Each mining project is unique and may require different types of permits depending on its geologic setting, climatic conditions, and proximity to infrastructure. Navigating the complex labyrinth of local, State, Federal, and Tribal regulations for each mine is challenging, and difficulties in navigating this regulatory landscape may often lead to lengthy permitting timelines.

Mineral development can be further complicated by mixed ownership patterns that include private, Federal, State, or Tribal lands. Specifically, many lands on which economic mineral deposits are discovered may include a combination of patented mining claims (private), unpatented mining claims (Federal lands), fee lands (private), State lands, or Tribal/Alaska Native Corporation lands. In addition to the myriad of land-use designations, complications in the permitting process also arise from a complex system of statutory and administrative withdrawals from applicable mining laws including: military sites, wilderness areas, national parks, national monuments, preserves, and wildlife refuges. These withdrawals may prevent or limit mining of mineral-rich lands.

While regulatory requirements can delay the issuance of permits, mining permit applications often lack sufficient quality or key information needed for regulators to make a decision on an application. Insufficient information in the mining application can significantly delay the permitting process as it may require multiple application

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[42] U.S. Geological Survey, "Mineral Commodity Summaries 2018," 2018, https://minerals.usgs.gov/minerals/pubs/mcs/2018/mcs2018.pdf

iterations until the application is of sufficient quality to allow the permitting agencies to make a decision. Permitting decisions are then subject to various forms of appeal, protest, and litigation in State and Federal courts. All of these factors can significantly delay mine development and the mine permitting process. Accordingly, improvements to the permitting process is necessary in order to enhance access to our Nation's supply of critical minerals.

**Goal: Revise the Bureau of Land Management's (BLM) and U.S. Forest Service's (USFS) land-use planning process to identify and protect access to mineral resources**

BLM's resource management plans and the USFS's forest plans provide a programmatic framework for multiple use resource management and describe discretionary activities that may be authorized on lands. Federal land managers are not required to initiate a mineral resource inventory or assessment prior to the start of a land-use plan or revision. Mineral assessments for an area covered by a land-use planning document generally take two to three years to complete. In order to ensure that areas prospective for mineral development are not encumbered by a special land-use designation, the mineral inventory and assessment should be completed prior to initiation of the land-use planning process.

Increased coordination between BLM and USFS with the USGS, State and Tribal agencies, and the mining industry can help land management agencies identify the presence of minerals prior to initiating the land-use planning process, which would help reduce lengthy permitting times. For minerals that may be leased under the Mineral Leasing Act, this coordination could be accomplished through requests for information or solicitations of expression of interest to evaluate for the presence of valuable leasable minerals within the land-use planning area.

To achieve this goal, the following actions are recommended:

**5.1** Revise land-use planning processes to require a resource inventory and assessment of minerals, including critical minerals, prior to or during the revision or creation of new land-use plans. Such an assessment should be developed with public input and any data used to inform the land-use planning process should be provided publically. *(DOI [BLM]; 2 years)*

**5.2** Revise land-use planning processes to require that Surface Management Agencies (SMAs) designate and classify lands based on whether they are prospectively valuable for mineral development. This classification should consider the potential for the presence of or favorability for exploration and discovery of deposits of mineral resources and specifically discuss the potential for the development of critical minerals. *(DOI [BLM]; 1 year)*

**5.3** Revise policies to ensure Federal lands identified as prospectively valuable for exploration or development of mineral resources are properly considered before they can be recommended for withdrawal or encumbered with a land-use designation that would restrict the development of these resources. *(DOI [BLM] and USDA [USFS]; 1 year)*

**Goal: Complete a thorough review of withdrawals from applicable mining laws and areas restricted from mineral exploration and development on the Federal mineral estate**

Many mineral resources cannot be accessed due to existing withdrawals, reservations, and other land-use restrictions. Withdrawals and reservations can serve a variety of useful purposes, including designation for wilderness, national parks, military reservations, and areas of critical environmental concern. BLM and the USFS should coordinate with the USGS, State and Tribal agencies, the mining industry, and other interested parties through requests for information or solicitations of expression of interest under the Mineral Leasing Act to evaluate withdrawn or restricted areas for the presence of minerals.

**5.4** Review existing withdrawals, land-use designations, and planning allocations and recommend appropriate measures to reduce unnecessary impacts that they may have on mineral exploration, development, and other activities. Any analysis performed should quantify and qualify the economic and national security implications of: reducing the size of an existing withdrawal, reducing the area affected by a land-use designation, changing planning allocations, or revoking an existing withdrawal. When deciding the order in which to review existing withdrawals, restrictions, or allocations, land management agencies should prioritize consideration of areas with the greatest potential for discovery of critical minerals. *(DOI [BLM] and USDA [USFS]; 2 years)*

**Goal: Review travel management plans and existing infrastructure capabilities on Federal lands for impacts to mineral exploration and development**

Mining claim holders may be guaranteed reasonable access across Federal lands to their mining claims by law.[43] However, the term "access" is not clearly defined under existing policies and this leads to problems with the implementation of travel management plans. Travel management plans identify which roads or trails are open to motorized vehicles, off highway vehicles, and identifies areas that may be closed altogether and blocked from motorized use. However, these plans do not adequately

[43] "The Mining Law of 1872", 30 U.S.C. §§ 22-54, http://uscode.house.gov/view.xhtml?path=/prelim@title30/chapter2&edition=prelim

account for the importance of access to lands for mineral development. Accordingly, SMA's travel management plans should be created or amended to prioritize access for mineral exploration. Further, existing infrastructure should be maintained or improved to allow access to mineral resources. Maintaining infrastructure may be the responsibility of the SMA or the private sector and depends on the purpose of the infrastructure.

**5.5** SMAs should create or amend travel management plans to facilitate access for exploration and development of minerals to the extent practicable. When deciding the order in which to amend or create new travel management plans, land management agencies should prioritize consideration of areas that contain the greatest critical mineral potential. *(DOI [BLM] and USDA [USFS]; 1-2 years)*

**Goal: Adopt a model of mineral resource development to track permitting requirements and timelines**

Currently, there is no agreement between Federal and State regulatory agencies, industry, non-governmental organizations, and the Government Accountability Office on a uniform definition for time spent reviewing, processing, and issuing permits for prospecting, exploring, and developing a mine or mine site. Accordingly, land-use management and permitting agencies do not have suitable tools to analyze the performance of permitting processes.

**5.6** Develop a publicly accessible online system to track milestones for mining projects, including the time it takes State and Federal agencies to review, process and issue permits. (*DOI [BLM] and USDA [USFS]; 1-2 years)*

**Goal: Evaluate the National Environmental Policy Act (NEPA) and other regulations to provide timely processing of permit applications for mineral projects**

Environmental reviews for advanced mineral exploration, development, mining and reclamation is often time consuming and can delay project development. SMAs should examine their NEPA processes and other regulations to expedite environmental reviews—without compromising environmental standards—to ensure developers of mineral projects receive a timely response to their applications. BLM Secretarial Order

3355[44] and Revisions to NEPA Procedures[45] should be used as a starting point to improve the permitting process. However, it is important to note that any proposed regulatory revisions should continue to provide protection of Federal lands, while removing cumbersome, redundant, and unnecessary restrictions.

**5.7** Update agency NEPA processes to streamline NEPA analysis with an emphasis on providing timely processing of mining Plans of Operations.[46] *(DOD [U.S. Army Corps of Engineers (USACE)], DOI [BLM], and USDA [USFS]; 2-4 years)*

**5.8** Evaluate existing NEPA categorical exclusions and, if warranted, provide recommendations to create new categorical exclusions for authorizing mineral exploration and development activities that can be shown to be routine and cause no significant environmental impact. *(DOD [USACE], DOI [BLM] and USDA [USFS]; 2 years)*

**5.9** Develop procedures that allow project proponents to participate in discussions between agency staff and NEPA contractors regarding additional requests for information. *(Council on Environmental Quality, DOI [BLM], and USDA [USFS]; 1-2 years)*

**5.10** Revise BLM and USFS procedures to allow for the incorporation and validation of existing environmental review and analysis for mining projects completed by States and other entities. *(DOI [BLM] and USDA [USFS]; 1-2 years)*

**5.11** Provide recommendations for revisions to 43 CFR 3809, *Surface Management*, and to 36 CFR 228 Subpart A, *Locatable Minerals,* to streamline and reduce redundant reviews. *(DOI [BLM], USDA [USFS]; 1-2 years)*

**5.12** Harmonize regulations that affect surface mining. *(DOD [USACE], DOI [BLM], and USDA [USFS]; 1-2 years)*

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[44] Bureau of Land Management, "Secretarial Order 3355, Streamlining National Environmental Policy Act Reviews and Implementation of Executive Order 13807, 'Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects,'" 2017. https://www.doi.gov/sites/doi.gov/files/uploads/3355_-_streamlining_national_environmental_policy_reviews_and_implementatio.pdf

[45] U.S. Forest Service, "2018 Revisions to NEPA Procedures (36 CFR 220) and Directives," 2018, https://www.fs.fed.us/emc/nepa/revisions/index.htm

[46] Mining Plans of Operation are prepared by the mining company once they have determined there is an economic ore body to mine. The plan is then submitted to the SMA for review and analysis. Depending on the complexity of the project, an Environmental Assessment or Environmental Impact Statement may be required.

**5.13** Recommend revisions to current mining regulations, including those governing locatable, salable, and leasable minerals, to reduce redundancy and streamline the permitting process. *(DOI [BLM] and USDA [USFS]; 1 year)*

**5.14** Execute MOUs for the review of Plans of Operation for mines with mixed ownership status that includes timelines and procedures for participation and dispute resolution. *(DOI [BLM] and USDA [USFS], in coordination with State agencies; 1-2 years)*

### Goal: Evaluate the Clean Water Act and the Rivers and Harbors Act to improve the permitting processing

Section 404 of the Clean Water Act requires a permit before dredged or fill material can be discharged into navigable waters or certain wetlands. Infrastructure projects—including mining operations—require such permits. On July 30, 2018, the Department of the Army, in coordination with other agencies, signed a memorandum that carries out the recommendations made by a Federal advisory committee on how the Federal Government can help states and tribes assume stream and wetlands permitting authority under the Clean Water Act.[47] This is the first step in a multi-step effort to improve the process for States and Tribes to assume authority for stream and wetland permitting under the Clean Water Act to improve water quality and accelerate job-creating economic development and infrastructure.

**5.15** Execute Memoranda of Agreement with States and Tribes to help them assume stream and wetlands permitting authority under the Clean Water Act. *(DOD [USACE] and EPA; 1-2 years)*

**5.16** Evaluate Sections 404 and 408 of the Clean Water Act and Sections 10 and 14 of the Rivers and Harbors Act and develop recommendations to streamline and improve the permitting process. *(DOD [USACE]; 2-4 years)*

### Goal: Review regulations and consider proposing legislation to facilitate offshore critical mineral development

Offshore underwater mining from the seafloor and seawater represents an unexplored frontier in minerals production. Minerals are known to be located off the Pacific and Atlantic coasts as well as off the coast of Alaska and U.S. territories and possessions. Domestically, BOEM has authority over offshore mineral development on the Federal Outer Continental Shelf, which largely overlaps the U.S. Exclusive Economic Zone. NOAA has the primary responsibility for authorizing activities for the exploration and

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[47] James, R.D. "Clean Water Act Section 404(g) – Non-Assumable Waters", July 30, 2018, https://www.army.mil/e2/c/downloads/525981.pdf

commercial recovery of manganese nodules by U.S. companies under the Deep Seabed Hard Mineral Resources Act.

**5.17** Provide recommendations to revise existing regulations to facilitate offshore mineral leasing. *(DOC (NOAA), DOI [BOEM]; 1 year)*

**5.18** Provide recommendations to improve the two-step exploration license and commercial recovery permitting process. *(DOC (NOAA), DOI [BOEM]; 1-2 years)*

**Goal: Evaluate the feasibility of including high-priority mineral projects for review as part of Title 41 of the Fixing America's Surface Transportation (FAST) Act and One Federal Decision Framework**

Title 41 of the FAST Act (FAST-41) and the One Federal Decision Framework were designed to improve the timeliness and predictability of the Federal environmental review and authorization for high priority infrastructure projects. These processes provide assurance that agencies will work together to develop a single permitting schedule for environmental review and authorization decisions, prepare a single environmental impact statement, sign a single record of decision, and issue all necessary authorization decisions within 90 days of issuance of the record of decision, subject to limited exceptions. Currently, mineral projects are not considered under these frameworks.

**5.19** Provide recommendations to the Executive Director of the Federal Permitting Improvement Steering Council on the feasibility of allowing mineral projects to be included as part of FAST-41 and the definition of "infrastructure project" under Executive Order 13807, which established One Federal Decision framework. (*DOI [BLM], USDA [USFS]; 1 year*)

## Call to Action 6: Grow the American Critical Minerals Workforce

*The entire U.S. critical minerals supply chain faces workforce challenges, including aging and retiring personnel and faculty; public perceptions about the nature of mining and mineral processing; and foreign competition for U.S. talent. Unless these challenges are addressed, there may not be enough qualified U.S. workers to meet domestic production needs across the entire critical minerals supply chain.*

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The mineral supply chain sector workforce is currently decreasing in number as there are more retirements than graduating students. As noted in a 2013 National Academies study on emerging workforce trends in the domestic energy and mining industries, this workforce faces a wide array of challenges such as: aging and retiring workforce and faculty; a decrease in mining, mineral engineering, and economic geology programs; negative perceptions with respect to the nature of the work; and foreign competition for U.S. talent.[48]

The contractions in the supply of individuals with skills in the mining industry reflect broader declines in R&D in this field. A renewed interest by the Federal Government has contributed to the initiation of programs to help address reductions in the minerals supply chain sector workforce. For example, DOE's CMI is looking to build necessary skills that have been lost in recent decades. Further, several centers of excellence at U.S. universities have been or are being established to focus on engineering challenges, including training individuals to respond more quickly to economic volatility. However, broader advances in exploration, mining, separation techniques, refining, processing, and manufacturing are still required.

The NSTC has begun to address workforce issues related to science, technology, engineering and mathematics (STEM) and outlined a five-year strategic plan in a December 2018 report, *Charting a Course for Success: America's Strategy for STEM Education.*[49] Similarly, the NSTC's Subcommittee on Advanced Manufacturing released

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[48] National Research Council, "Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action, National Academies," pages 83-85, 2013, https://www.nap.edu/catalog/18250/emerging-workforce-trends-in-the-us-energy-and-mining-industries

[49] Committee on STEM Education of the National Science and Technology Council , "Charting a Course for Success: America's Strategy for STEM Education," December 2018, https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

a 2018 report, *Strategy for American Leadership in Advanced Manufacturing,*[50] which highlighted the need to educate, train, and connect the manufacturing workforce. Many of the goals and recommendations listed below should leverage existing Federal initiatives, such as the STEM and advanced manufacturing reports to help bolster the minerals supply chain sector workforce.

**Goal: Bolster education in mining engineering, geology, and other fields related to critical minerals mining and manufacturing**

Joint support for innovation in mining techniques and technology by Government, academia, and industry partners could improve the industry as well as graduate and undergraduate education. Fostering university faculty and departments involved in cutting-edge research to contribute new knowledge could enhance the quality of higher education and ensure the ability of universities to meet future demand for mineral supply chain sector engineers after impending faculty retirements. Community and technical colleges could also promote relevant education and training efforts.

To achieve this goal, the following actions are recommended:

**6.1** Develop partnerships with academia and the private sector to support universities involved with mineral-related research and courses to enhance the quality of higher education. Provide periodic status updates to the CMS. *(DOC [NOAA], DOD, DOE [DOE National Laboratories], DOI [USGS], ED, and NSF; ongoing)*

**6.2** Evaluate opportunities to facilitate partnerships between industry, community colleges, and technical colleges to coordinate necessary credentialing/skillset alignment, with special attention to the regional nature of extractive industries and critical minerals. Provide periodic status updates to the CMS. *(DOI and ED; ongoing)*

**6.3** Bolster the mineral supply chain sector workforce by leveraging provisions in the Strengthening Career and Technical Education for the 21st Century Act.[51] *(ED; 2-4 years)*

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[50] Subcommittee on Advanced Manufacturing of the National Science and Technology Council, "Strategy for American Leadership in Advanced Manufacturing," October, 2018, https://www.whitehouse.gov/wp-content/uploads/2018/10/Advanced-Manufacturing-Strategic-Plan-2018.pdf

[51] United States Congress, "Strengthening Career and Technical Education for the 21st Century Act," Pub. L. No. 115-224, 132 Stat. 1564, https://www.congress.gov/115/bills/hr2353/BILLS-115hr2353enr.pdf

**Goal: Promote interdisciplinary collaboration among material science, computer science, and related disciplines to modernize the minerals supply sector industry and make the field more attractive to new talent**

Traditional mining engineering programs have had trouble attracting students. Interdisciplinary collaboration among fields such as material science, computer science, and other disciplines could attract top talent while modernizing the industry. Interdisciplinary programs are an important step to train individuals with the skills necessary to staff modern 21st century mining operations, including autonomous heavy equipment, drones, process automation, and bio-mediated refining processes and controls.

**6.4** Foster collaboration among fields such as material science, computer science, and other disciplines to attract top talent while modernizing the industry. Provide periodic status updates to the CMS. *(DOC [NOAA], DOD, DOE, ED, and NSF; 2-4 years)*

**Goal: Implement personnel and management reform to ensure appropriate human capital to support exploration and development of critical minerals on Federal lands**

BLM and USFS have major challenges in recruiting and retaining a trained workforce to support critical mineral programs (e.g., biologists, archaeologists, geologists, and engineers). These challenges cause delays and bottlenecks in permitting mining projects. Undertaking personnel and management reform could help improve the efficiency of BLM and USFS.

**6.5** Develop policies and training to ensure appropriate managers and staff at DOI and USDA recognize the importance and high national priority of critical mineral exploration and development. *(DOI [BLM] and USDA [USFS]; 2-3 years)*

**6.6** Examine and consider an increase in field staff expert positions, including the National Mineral Examination Team and Certified Mineral Examiner programs. Finalize BLM and USFS Mining Law Administration MOU to facilitate staffing across agencies. *(DOI [BLM] and USDA [USFS]; 1-2 years)*

**Goal: Facilitate sustained interaction with critical mineral stakeholders and the general public**

The Federal Government and critical mineral stakeholders need to effectively communicate the importance of critical minerals to the general public. Options such as public service announcements, social media, educational curricula, interpretive displays, online products, and presentations at public fora could be used.

**6.7** Develop effective outreach efforts to the general public to convey the importance of critical minerals to the U.S. economy and national security by working with academia and educational partners. *(CMS, DOE, and DOI [BLM, BOEM, USGS]; ongoing)*

# Next Steps

This Strategy identifies a number of goals and recommended actions Federal departments and agencies can pursue to improve the availability of critical minerals and their downstream supply chains in the United States, reducing the Nation's vulnerability to supply disruptions. In order for the Strategy to be successful, agencies should coordinate and dedicate resources to accomplish each goal.

Given the dynamic, crosscutting nature of critical minerals issues, pursuing the goals and recommendations in this Strategy demands adaptive, coordinated efforts across the Federal Government. This requires ongoing analysis and stakeholder outreach activities that monitors changing conditions and synthesizes information across a range of topics, including critical minerals R&D, production, trade, consumption, and recycling. Such activities provide the capacity for the U.S. Government to continuously adapt by identifying emerging issues, prioritizing responses, and assessing progress.

The CMS is the interagency coordinating body for critical minerals. As part of their work, the CMS should be the entity that coordinates implementation of this Strategy. Overall, the Strategy should be evaluated 5 years after issuance to determine the efficacy of the recommendations and to determine the relevance of the recommendations given current priorities and challenges the U.S. Government is facing. Further, the CMS should adaptively coordinate the implementation of this Strategy to reflect emerging critical mineral priorities and challenges.

The list of Critical Minerals published by DOI in May 2018 in response to Executive Order 13817 is also an important part of this Strategy. Accordingly, DOI, in coordination with the CMS, should evaluate the list of critical minerals biennially based on changes to mineral supply, demand, concentration of production, and current policy priorities. Based on this evaluation, the list should be updated if necessary, which should in turn inform adjustments to the implementation of this Strategy.

# Conclusion

Minerals are the raw materials needed to build many products used by Americans in everyday life, such as cell phones, computers, automobiles, and airplanes. The United States is heavily dependent on foreign sources of many minerals and on foreign supply chains that build value-added products, resulting in the potential for strategic vulnerabilities to our Nation's economic prosperity and national security. Accordingly, President Donald J. Trump issued Executive Order 13817, which seeks to address these vulnerabilities and tasked the Department of the Interior, in coordination with other Federal agencies, to develop a list of minerals deemed critical, and the Department of Commerce, in coordination with other Federal agencies, to develop a strategy to reduce the Nation's vulnerability to disruptions in the supply of critical minerals.

The Department of the Interior published a list of 35 critical minerals in May 2018. This report, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,* is the strategy requested by the Executive Order. It is a comprehensive interagency strategy that seeks to address vulnerabilities within the full critical minerals supply chain, which spans from securement of raw materials to end-uses in both civilian and defense applications. Specifically, this Strategy identifies 24 goals and 61 recommendations that will:

- help identify new sources of critical minerals;
- enhance activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing;
- seek to stimulate private sector investment and growth of domestic downstream value-added processing and manufacturing;
- ensure that miners, producers, and land managers have access to the most advanced mapping data; and
- outline a path to streamline leasing and permitting processes in a safe and environmentally responsible manner.

Given the crosscutting nature of critical minerals issues, pursuing the goals and recommendations in this Strategy demands adaptive, coordinated efforts across the Federal Government. Accordingly, this Strategy should be periodically evaluated to determine the efficacy and relevance of the recommendations given current U.S. Government priorities and challenges.

# Abbreviations

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| BEA | Bureau of Economic Analysis |
| BIS | Bureau of Industry and Security |
| BLM | Bureau of Land Management |
| BOEM | Bureau of Ocean Energy Management |
| CMI | Critical Materials Institute |
| CMS | Subcommittee on Critical Minerals |
| DHS | Department of Homeland Security |
| DOC | Department of Commerce |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOI | Department of the Interior |
| DOL | Department of Labor |
| DOS | Department of State |
| ED | Department of Education |
| EPA | Environmental Protection Agency |
| FAST | Fixing America's Surface Transportation Act |
| ITA | International Trade Administration |
| MOUs | Memoranda of Understanding |
| NDS | National Defense Stockpile |
| NEPA | National Environmental Policy Act |
| NIST | National Institute of Standards and Technology |
| NOAA | National Oceanic and Atmospheric Administration |
| NSF | National Science Foundation |
| NSTC | National Science and Technology Council |
| R&D | Research and Development |
| REE | rare earth elements |
| RDP | Reciprocal Defense Procurement |
| SMA | Surface Management Agencies |
| SOSA | Security of Supply Arrangement |
| STEM | science, technology, engineering and mathematics |
| USACE | United States Army Corps of Engineers |
| USDA | United States Department of Agriculture |
| USFS | United States Forest Service |
| USGS | United States Geological Survey |
| USTR | United States Trade Representative |