
HARD ROCK MINING IN OREGON ENVIRONMENT, ECONOMY, AND LAWS

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INTRODUCTION

The League of Women Voters of Oregon members have proposed an update to link hard rock mining with other issues of concern to the League. Our modern society uses many tools and products that require minerals in their manufacture. Yet mining for these minerals has the potential to cause severe impacts to the environment that many Oregonians cherish. This report considers the current status of Oregon's hard rock mining industry and the need to balance the need for minerals with the importance of conserving the environment. The report is not intended to supplement comprehensive information from state and federal agencies. For more detailed information on specific topics, please contact the appropriate resource agencies.

This report seeks to evaluate the current status of hard rock mining in Oregon. It aims to review the history of relevant laws, to summarize the processing and products of hard rock mining, to examine the economic value of mining, to assess the environmental impacts of mining in the state, and finally to consider alternatives to mining.

By carefully evaluating these complex issues, we seek to better inform and educate ourselves and others.

LEGAL HISTORY

FEDERAL LAWS

The General Mining Act of 1872 remains to this day the foundational federal law for hard rock mining on public domain lands in the United States. It replaced the Mining Acts of 1866 and 1870, which largely codified rules and regulations in common use by Gold Rush miners. The act was signed into law by Ulysses S. Grant in order to secure the wealth and production of minerals on federal public lands. It accomplished this by allowing the purchase of mineral-bearing public lands for no more than \$5 per acre and by waiving all royalties on the extraction of minerals from those lands.

Today there are over 350 million acres of public domain land under the jurisdiction of the General Mining Act of 1872, mostly in the West and Alaska, constituting more than 15% of all U.S. land. The \$5 per acre fee is still in effect, but the law no longer applies to all minerals. Exclusions exist for common minerals, such as limestone, and for fuel minerals, such as coal, oil, and natural gas. Yet when it comes to hard rock minerals, any U.S. citizen over 18, as well as any foreign company with subsidiaries incorporated in the U.S., is given free access to public domain lands to explore for minerals and to stake a claim, the exception being within National Parks. In most instances, mining takes precedence over all other potential uses for the lands in question. Individual states are responsible for developing their own claim recordation procedures with guidance from the Bureau of Land Management and the County Recorder's office.

The Organic Act of 1910 created the Bureau of Mines in the aftermath of several catastrophic mine disasters. Its mission was to conduct research to improve the safety, health, and environmental impacts of mining and mineral processing, disseminate mining information around the world, and analyze the

impact of proposed mineral-related regulations. The Bureau was disbanded in 1996, and some of its responsibilities were shifted to various federal agencies, including the Department of Energy, U.S. Geological Survey (USGS), and the Bureau of Land Management. USGS offered grants for minerals resource research to universities, state agencies, industry, and other private sector organizations from 2004 to 2014, but today there is little direct federal research funding.

The Federal Land Policy and Management Act of 1976 governs the way in which public lands are administered. It commissions the National Forest Service, the National Park Service, and the Bureau of Land Management to allow a variety of uses on public lands, while at the same time preserving natural resources. This is referred to as “multiple-use,” defined as “management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people.” However, “multiple-use” did not give the mining industry free rein. The Mining in the Parks Act of 1976 forbids new mining claims within certain National Parks and Monuments, although there remain 1,100 pre-existing mining claims in 15 National Parks, where mining can potentially occur as long as certain environmental terms and conditions are met. No mining has occurred within National Park boundaries since 1976.

The Mining Safety and Health Act of 1977 (the Mine Act), created the Mining Safety and Health Administration (MSHA). MSHA oversees coal mine safety and also administers the office of Metal and Nonmetal Mine Safety and Health. The latter enforces the Mine Act at all U.S. metal and nonmetal mining operations through an inspection process.

Many abandoned hard rock mining sites also come under the jurisdiction of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Commonly known as Superfund, CERCLA was enacted by Congress on December 11, 1980, and amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Abandoned mine lands (AMLs) are those lands, waters and surrounding watersheds where extraction, beneficiation (separating valuable minerals from waste rock), or processing of ores and minerals has occurred. The EPA conducts and supervises investigation and cleanup actions where AMLs pose serious threats to human health and the environment. It is important to note that no mine since 1990 has been added to the CERCLA list.

In 1997, to bring some clarity to the complex web of mining laws and regulations, the Environmental Protection Agency (EPA) released a National Hardrock Mining Framework to help implement a multi-media, multi-statute approach for dealing with environmental concerns posed by hard rock mining. Input came from many stakeholders, including other federal agencies, states, tribes, local government, industry, and environmental groups. The framework provides a comprehensive look at all facets of the hard rock industry to meet the difficult challenge of promoting both economic growth and environmental protection. Besides the laws specific to hard rock mining mentioned above, the EPA Framework provides a partial list of other federal laws applicable to mining activities: National Environmental Policy Act, Clean Water Act, Compensation and Liability Act, Resource Conservation and Recovery Act, Clean Air Act, Emergency Planning and Community Right-to-know Act (EPCRA), Safe Drinking Water Act, Toxic Substances Control Act (TSCA), Endangered Species Act, National Historic Preservation Act, Coastal Zone Management Act, Farmland Protection Policy Act, Rivers and Harbors Act of 1899, Surface Mining Control and Reclamation Act (SMCRA), Wild and Scenic Rivers Act, Fish and Wildlife Coordination Act, Fish and Wildlife Conservation Act and Migratory Bird Protection Treaty Act.

In 2015, Congress considered HR 963, a two-part resolution in support of mining reform, but the bill has shown no movement since then. The first part, the Hard Rock Mining Reform and Reclamation Act of 2015, included royalty limitations, protection of areas of critical environmental concern, mandatory restoration, and the establishment of a Hard Rock Minerals Fund to be used for reclamation and restoration purposes. The second part, the Good Samaritan Cleanup of Abandoned Hard Rock Mines Act of 2015, encouraged remediation of inactive and abandoned mine sites by Good Samaritans (those with no role in creating pollution present at abandoned sites). It would amend the Federal Pollution Control Act (Clean Water Act) to authorize a Good Samaritan program for issuing discharge permits, and it shields from liability those who comply.

Another attempt to mitigate the environmental effects of mining was a rule, proposed by the EPA on December 1, 2016, for the purpose of determining whether to add further financial requirements under the amended Superfund Act in order to increase the likelihood that cleanup costs would not fall to taxpayers. On February 25, 2017, newly appointed EPA director Scott Pruitt extended the rule's comment period due to pushback by the mining industry, as well as by Western governors and congressional delegations. The final EPA determination was that no additional financial assurance was necessary, and the rule was signed on December 1, 2017.

A January 2017 rule passed by House Republicans changes accounting rules to make it easier to transfer ownership of public lands to states, local governments, or tribes. Opponents argue that federal lands should be managed for the benefit of all Americans. While attention is more often focused on fossil fuel opportunities, an April 2017 BLM strategy document included "streamline leasing and permitting for hard rock mining" on its list of priorities.

STATE LAWS

Despite long-standing tensions between mining and other industries, the inherent value of mineral resources was officially recognized when Oregon's 19 Statewide Planning Goals came into being in 1973 upon the adoption of Senate Bill 100. Goal 5 (OAR 660-015-0000(5), dealing with Natural Resources, Scenic and Historic Areas, and Open Spaces, provides specific provisions for the inventory and protection of mineral and aggregate resources. However, it continues to be the case that laws crafted to protect mining often create a situation of "dueling goals," particularly when it comes to Goal 3 (preserve and maintain agricultural lands), and Goal 6 (maintain and improve the quality of the air, water and land resources of the state). Political pressure can build to cause policy shifts, prodding legislators to favor one goal over another.

The Department of Geology and Mineral Industries (DOGAMI), has two program areas: Geologic Survey and Services (GSS) and Mineral Land Regulation and Reclamation (MLRR). MLRR regulates Oregon's mining industry. HB 5011, DOGAMI's 2017 budget bill, indicates that the agency relies on a combination of General Fund dollars, federal GSS grants requiring state match, and MLRR revenue derived from metal, aggregate, gas, and oil fees.

The 1991 Oregon Chemical Process Mining Law marked a turning point for regulating mines that use chemicals, most commonly cyanide or sulfuric acid, to leach metals from mined ore. It was intended to prevent the environmental damage that had occurred elsewhere by establishing bonding requirements to cover potential cleanup costs. HB 2248, passed in 2013, extended the jurisdiction of the 1991 law to include mines using froth flotation methods. The only metal mines excepted from this law are those that exclusively use gravity separation.

In 2015, following a prolonged economic downturn in eastern and southern Oregon, the Oregon Legislature passed HB 3089, authorizing DOGAMI to conduct a study of the mining resource potential of eastern and southern Oregon counties and to present the results by September 2016. The study, performed by a team of DOGAMI geologists, included:

1. a review of the mineral resource potential of eastern and southern Oregon counties,
2. an evaluation of which metallic and industrial mineral commodities are most likely to be economically developable,
3. recommendations for future mineral resource potential assessment activities.

HB 3089 also required that DOGAMI provide a list of all relevant mineral inventories and studies previously completed by the department and a cost estimate for making that information available online.

In 2017, the Legislature followed up by passing SB 644, a multi-faceted mining bill that allows mining sites with significant mineral resources to bypass statewide land use planning goals and rules that apply to exclusive farm use (EFU) zones as long as applicant meet specific requirements. However, there is little overlap of EFU zones and metal mine zones, so this law will most likely have minimal effect on hard rock mining.

Oregon has developed a Consolidated Mining Permit process¹, which is being used in evaluation of Calico Mining's proposed Grassy Mountain gold mine near Vale, Oregon. The permit process seeks to:

- Ensure coordination between state agencies, federal agencies, and local governments
- Consolidate baseline data requirements for needed State permits
- Provide for single comprehensive environmental analysis and socioeconomic study
- Provide a clear path for application processing including required opportunities for public input
– *Efficient schedule with specified deadlines*
- Designate a single lead agency to provide coordination, accountability, and to mediate disagreements between agencies
- Provide certain and limited permit requirements for applicant
- Ensure Environmental Standards are met.

¹ Division 7: Consolidated Permitting Process,
http://www.oregongeology.org/mlrr/noi/DOGAMI_Pres_Division_37_Consol_Per_Proc-Presentation.pdf

PROCESS AND PRODUCTS

Mining operations can be categorized by: leasable, such as oil and coal; salable, such as rock and gravel; or locatable which includes precious and base metals. This report discusses locatable operations. Generally locatable commercial operations start with reconnaissance which may consist of a literature search for areas of interest using publications, maps, aerial photographs and LIDAR². Prospecting comes second and involves hand tools for casual on the ground testing. Next is exploration, which may involve road building (most operations use existing roads) and drilling. For five acres or fewer, only a notice of operation is needed. For more than 5 acres a plan of operation and NEPA (National Environmental Policy Act) is required. These plans include an economic evaluation and a description of the reclamation of the mine site to pre-mining conditions. Once approved, the mine development begins.

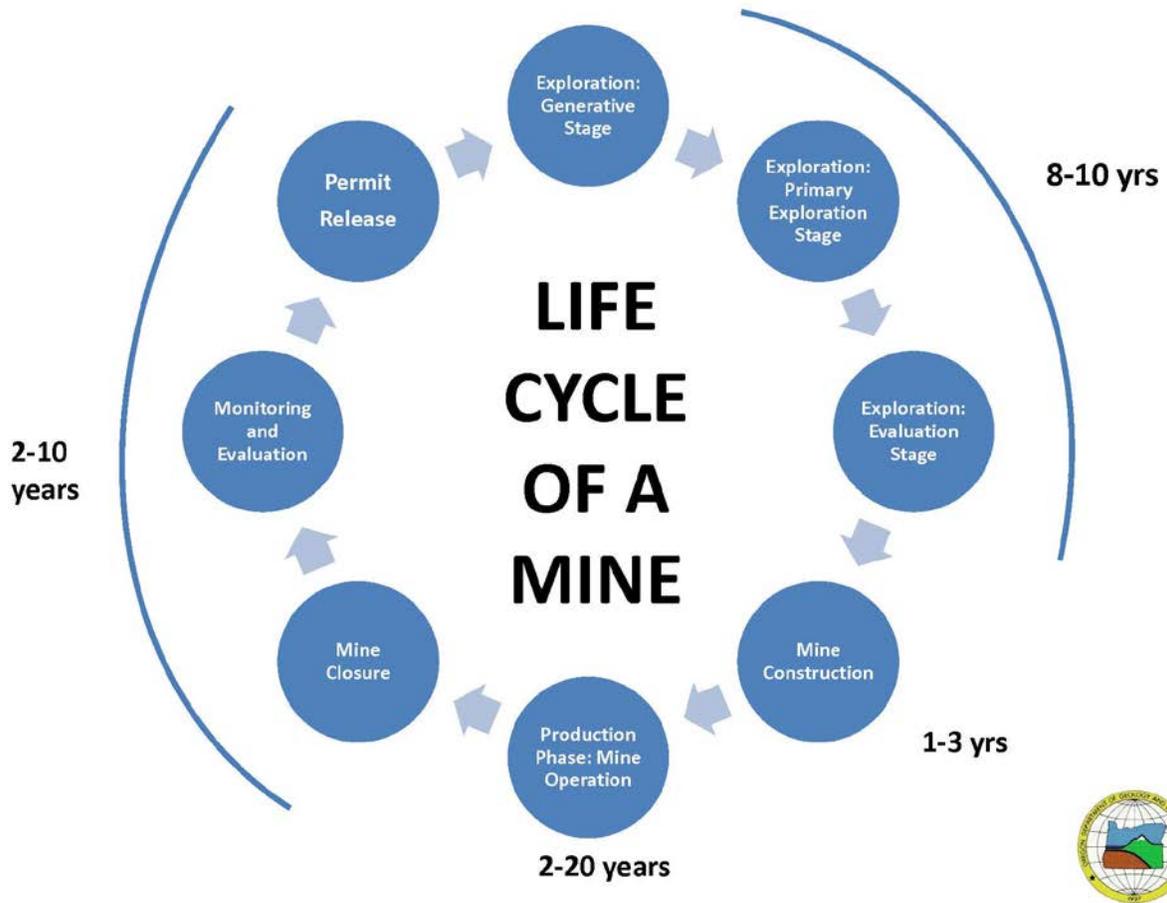
Mill sites to support lode mine operations must be located on non-mineral land. These can include mills for grinding, crushing, flotation, chemical processing or reduction works for chemical processing of ore such as furnaces and related facilities. Mill sites also include tailing impoundments, waste dumps, leach pads, repair shops, labs and offices. Although the maximum mill site size is five acres, as many mill sites as necessary to support the mining operation are allowed.

The estimated value of US metal mine production in 2014 was \$31.5 billion and principal contributors were:

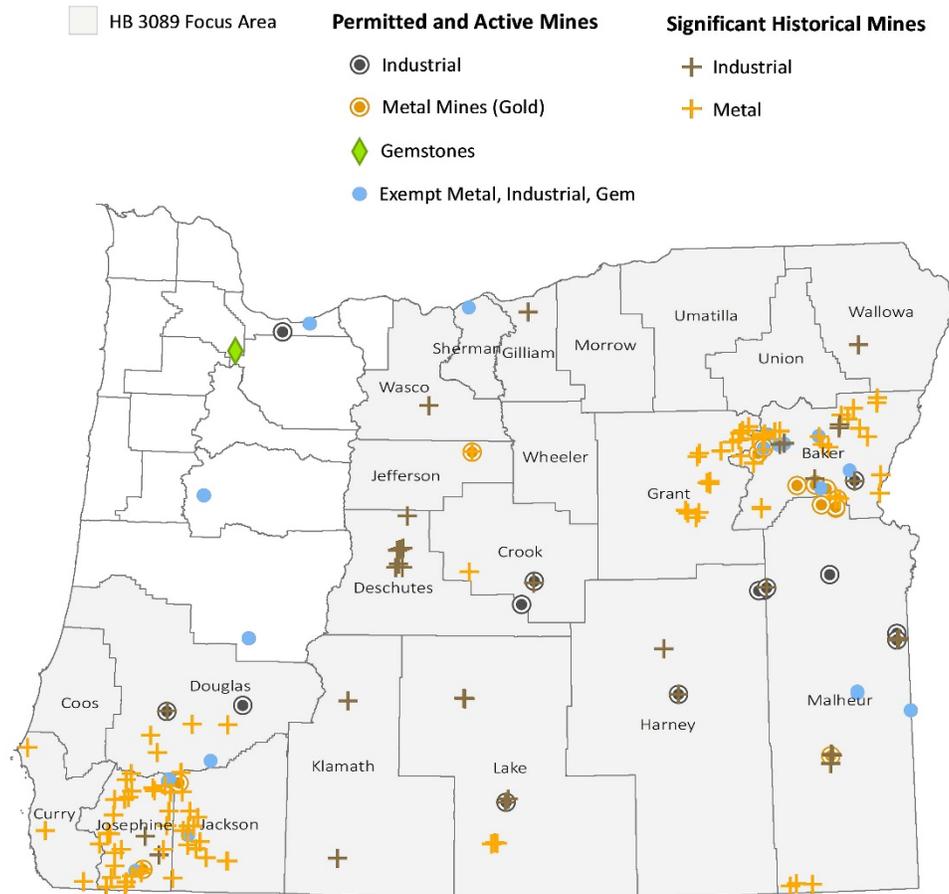
- Copper (Cu) 32%
- Gold (Au) 27%
- Zinc (Zn) 6%.

Oregon ranks 36th in the nation with 0.46 % of total US non-fuel mineral production. Oregon's mining industry is focused primarily on salable minerals, such as stone (crushed), cement (Portland), sand and gravel (industrial), sand and gravel (construction), and helium (Grade A).

² a detection system similar to radar but using light from a laser



Owing to its predominantly volcanic geologic heritage, there are few areas in Oregon suitable for mining of locatable minerals, and there are currently no active commercial-scale metal (precious and base metal) mines in Oregon.



FROM DOGAMI 2016 REPORT TO THE OREGON LEGISLATURE ON THE METALLIC AND INDUSTRIAL MINERAL POTENTIAL OF SOUTHERN AND EASTERN OREGON

According to DOGAMI, the following minerals have been mined in the past and may in the future be mined in Oregon. How each metal is mined depends on the parent ore and the mining company's method preference. For that reason, the following process descriptions should be considered generic for each metal. See Appendix 1 for more detail about mining potential in southern and eastern Oregon.

GOLD

Gold production in Oregon peaked in the early 1900s and again in the 1940s. 50% of the gold produced in Oregon derived from lode and placer deposits in the Blue Mountain area. For this study we are only describing lode mining or hard rock mining. The gold is extracted from the rock where it was originally deposited, usually by one of two methods: open pit which strips surface layers off to reveal ore/seams underneath or underground tunnels drilled or blasted to the source of ore. Then the ore is trucked to primary crushers where large rocks are broken down and then fine grinding occurs. A slurry of this finely ground ore is then mixed with water and a cyanide solution in a leaching process whereby gold is dissolved. Heap or vat leaching accumulates the gold into what is called a pregnant solution. Activated

carbon or zinc precipitation refines into a gold powder. This is melted into a doré³, and eventually electrolysis separates the gold. Finally, this is smelted into bars of bullion. Generally, there are two mining by-products; waste rock which is non-mineralized rock or rock with insufficient gold to process economically and tailings, which is the slurry that remains once gold, has been extracted. There are regulations for cyanide destruction which rapidly breaks down before tailing storage.

Because gold is highly valued and in limited supply, it has long been and continues to be used as money (18%) and of course, jewelry (41%). Today, its most important industrial use is in the manufacturing of electronic devices (35%). Gold is also used in dentistry (4%), some medical procedures, and in circuitry and as a lubricant for the aerospace industry.

SILVER

Historically, most silver in Oregon was produced as a byproduct of gold and copper mining. Hard rock mining extraction of the ore was through strip mining or underground tunnels. The parent ore was then crushed. Extraction and refining depend on the major silver pairing metal. If copper, smelting or roasting concentrates silver with copper, and it is refined by electrolysis. This is further smelted to a metal called doré, which is refined again by electrolysis to a purity of 99.99% silver. If silver is paired with gold, the cyanide method is used. Heap or vat leaching accumulates the gold and silver in a pregnant solution. Activated carbon or zinc precipitation refines into a gold/silver powder. This is melted into a doré, and eventually electrolysis separates the gold and silver.

Silver is used in jewelry and coins, but today the primary use is industrial, from cell phones to solar panels: 35% use in electronics, 25% for coins and metals, 10% in photography, 6% in jewelry and 24% in one hundred other different and varied uses, such as antibiotic properties.

COPPER

The U.S. is the world's 4th largest copper producer after Chile, China and Peru. We have the 5th largest remaining reserves in the world, located primarily in Utah and Arizona. In Oregon, the leading copper mining district was located in the Baker County Homestead district.

Copper mining methods vary with country, ore source, and local environmental regulations. Again, hard rock excavation of the ore is through underground tunnels or open pits. The ore is crushed and treated with dilute sulfuric acid, resulting in copper sulfate. Copper is then smelted to produce a matte and refined by electrolysis. For economic and environmental reasons, many of the by-products of extraction are reclaimed. Copper is used in a variety of products used in plumbing and building construction (43%), electronics and electronic products (19%), transportation equipment (19%), consumer and general products (12%), and industrial machinery (7%). America's most famous structure made from copper is the Statue of Liberty.

³ a semi-pure alloy

LEAD

Worldwide, mines produce about 5 million metric tons of lead annually, which is about half of what is consumed. The remainder is obtained by recycling, mostly auto batteries.

Lead ore is extracted in deep underground tunnels. The most common parent ore is galena, but much of the lead is obtained as a byproduct of zinc or silver mining. The ore is initially crushed into small 0.1mm size particles. Next, a flotation process of water, ore, pine oil (or other agitate) is made. The pine oil attracts the galena, air is bubbled through and an oily froth forms on top, waste rock sinks to the bottom. 90% of the water is filtered out. The waste rock is dumped in a pond which eventually fills and can be made into natural habitat. Roasting the lead concentrate further refines it by removing sulfur. Sulfur dioxide gas is converted to sulfuric acid, a used byproduct. The lead is now a brittle material called sinter. Sinter is blasted at 1,200 degrees centigrade to produce molten lead, non-metallic slag and CO₂. The slag is toxic and must be contained. Lead must be 99.99% pure, so it is heated again to 330° centigrade where any copper, silver, gold, or zinc will float and be skimmed off.

The lead acid battery industry accounts for 90% of US consumption of lead, both auto/truck and industrial batteries for stand-by power. Lead is also used in sound barriers, X-ray shields, pipes, glass, solder and nuclear waste containment. Lead is a health hazard if inhaled or ingested and therefore is outlawed as a paint and gasoline additive.

ZINC

The US is the 4th largest zinc producer in the world. Zinc is primarily mined underground (80%), while about 8% comes from open pits, and another 12% derives from a combination of both. The ore deposit is crushed and roasted (smelter) resulting in oxidation. It is then reduced and leached with dilute sulfuric acid. This is neutralized, and contaminants are removed via filtration.

80% of zinc is used in galvanizing, an anti-corrosion coat for steel, brass and other metals. In alloys, it is used for die casting and precision components. It is also used in cosmetics and pharmaceuticals and as a micronutrient source for people, plants, and animals. It also has some semiconductor properties.

NICKEL

Nickel is the 5th most abundant element on earth. 70% of nickel is found in laterite ores. Nickel content in laterites is relatively low and variable, but most of the expansion in nickel production over the next decades will come from laterite ore. Capital and operating costs will have significant impacts on supply and price. Since the 1950's, demand for nickel has increased about 4% per year.

Laterite ore is generally extracted via open pit or strip mining of overburden rock. The mineral is extracted either by pyrometallurgical (35%) or hydrometallurgical (65%) processes. Both begin with crushing the ore and separating it by screening, hydro-cyclone, or spiral classifiers. If a pyro process is used, the mineral also needs to be de-watered before smelting to avoid explosions. Removing water has high energy costs.

In Oregon, because nickel laterite ore is low grade, a hydrometallurgical process has been most commonly used for processing. After the initial crushing and separation, there are a couple of options for next steps. The Caron process involves reduction roasting the dried ore to 700 degrees Celsius and leaching in an ammoniacal solution, followed by purification and heating of the pregnant leach solution to recover nickel as a precipitate.

High pressure acid leach (HPAL) avoids drying and reduction steps, resulting in energy savings. The ground ore is leached with sulfuric acid at high temperature and pressure. Further neutralization and purification steps result in nickel and cobalt. The disadvantage of this process is the high cost of titanium autoclaves. This is currently the most popular treatment of low grade laterites to produce nickel. Atmospheric leaching is competitive to HPAL. It operates at lower temperatures in open vessels, which avoids expensive autoclaves but increases risks for spills in high precipitation environments. Heap leaching is even cheaper but has low recovery, acid waste and long leach times.

Nickel increases strength, toughness and corrosion resistance of metals upon alloying. Nickel consumption includes:

- steel production 45%
- non-ferrous alloys and super alloys 43%
- electroplating 7%.

Among end uses are:

- transportation and defense at 34%,
- fabricated metal products at 20%,
- electrical equipment at 13%,
- chemical and petroleum industries with 7% each,
- construction and household appliances at 5%.

In 2017, approximately 90,000 tons of nickel were recovered from purchased scrap. This represented about 39% of consumption for that year.

URANIUM

Uranium is used almost entirely for making electricity. A small portion is used for medical isotopes, and some is used in naval marine propulsion. Only 5 percent of the nation's domestic use is produced within the US border, although we get 20 percent of our electricity from nuclear power plants.

Uranium mining is similar to other kinds, except for the fact that the ore has radioactive qualities, especially if it is high grade. If so, dust suppression and remote handling techniques are employed to limit worker radiation exposure. If the ore lies close to the surface, open pit mining involves the removal of rock as well as heaps of waste rock. Underground mining involves shafts and tunnels but less waste rock. The ore is processed by grinding to a uniform particle size and extracting the uranium by chemical leaching. This yields "yellow cakes" of uranium oxide ready for market. Most US production is by in situ recovery. Ore lies in groundwater or water pumped in. The weak acidified groundwater is circulated

through an enclosed underground aquifer, and the leaching solution is pumped to the surface where the uranium is recovered as a precipitate. When mining ends, the in-situ wells are capped, the process facilities are removed, and any evaporation ponds are re-vegetated. Because of uranium's radioactivity, these mines are regulated by DOGAMI, the Oregon Energy Facility Siting Council, the US Department of Energy and the EPA.

ENVIRONMENT

Hard rock mining has the potential to disturb large amounts of land area and to have detrimental impacts on many aspects of the natural environment. Real and potential environmental impacts from hard rock mining include: physical disturbance; contamination of surface and ground water, air, and soil; and habitat and ecosystem disturbance.

Early mining operators were not aware of nor interested in preventing long-term environmental consequences of hard rock mining. Usually their operations were of limited extent with limited or transitory environmental impacts. In contrast, modern mining operations are typically more extensive and can have significant short- and long-term detrimental impacts on the environment.⁴ No mines permitted since 1990 have been added to the list of 'Superfund' sites identified by EPA as posing risks to human health or the environment. However, both abandoned and active mining sites continue to present a potential for significant risks to the environment because of incomplete operation plans⁵, regulatory exemptions or inadequate inspection and regulation⁶, or because of insufficient attention to the long-term maintenance required for closed or inactive mines resulting from limited agency allocation of resources.⁷

The Environmental Protection Agency's 2013 annual Toxic Release Inventory report compared different industries and found that metal mining is the most polluting industry and is responsible for almost half (47%) of the toxic pollution (both water and air) in the U.S. In 2016, the EPA inventory found that metal mines released 1,520,000,000 pounds of toxins into the environment, 3 times more than the next polluting industry, which is the chemical industry.⁸

The State of Oregon through the Department of Geology and Mineral Industries (DOGAMI) works with a county and/or federal agency to coordinate environmental analyses for mining operations. Oregon state law only requires an environmental analysis for the chemical process aspects of mining, and that analysis is completely separate from any Federal NEPA (National Environmental Policy Act) analysis for the site, although the state and federal agencies are required to coordinate efforts to reduce conflicts and redundancy.

Oregon Administrative Rule (OAR) 632 Division 37 outlines the permitting process for chemical process mines only. For chemical processing of metals, through a Memorandum of Understanding, DOGAMI

⁴ Seymour, 2004, Hard Rock Mining and the Environment: Issues of Federal Enforcement and Liability

⁵ GAO, 2016, Hard Rock Mining

⁶ EPA, 1997, Risks Posed by Bevill Wastes 4

⁷ EPA, 1997, National Hard Rock Mining Framework (NHMF)

⁸ EPA, Toxic Release Inventory, 2013/ 2016

leads the effort in conjunction with pertinent county or federal agencies, as well as the Department of Environmental Quality (DEQ), Oregon Water Resources Department (OWRD), Oregon Department of Fish and Wildlife (ODFW), and Oregon Department of Agriculture (ODA).

Calico Resources USA Corporation is currently considering construction of an underground gold mine and surface mill complex at Grassy Mountain in Malheur County that falls under the current OAR rules.

Ian Madin, Deputy Director and Chief Scientist at DOGAMI shared that:

There is very little hard rock metals mining going on in Oregon, and there are no sites permitted for large scale mining using chemical processing. Calico Resources started the application process for an underground chemical process gold mine in 2013, and we are expecting their application next year. It will be the first ever since the chemical process mining statutes and rules were developed in the early 1990s. (personal communication, 2017).

WATER QUALITY

Environmental impacts can vary greatly depending on the type and location of the mining operation. The impacts to water quality have the potential to be more profound in areas of steep topography and a wetter climate. Issues at the above-mentioned Calico Mine in the high desert area of Malheur County would be different than those possible at a proposed nickel mine in the maritime climate of Curry County. Water quality impacts include those resulting from ground disturbance, and those resulting from chemical processing or use of water in processing.

Erosion and Sedimentation: Mining operations disturb large areas of land and thus generate great quantities of sediment. Erosion and transport of material from mine discharge or storm runoff carry contaminated sediments to streams and flood plains. Sediments (soil or fine material eroded and transported by wind or water) can contain high concentrations of pollutants, especially heavy metals such as mercury. Contaminated sediments have the potential to move and release pollutants to surface waters or be a source of toxicity to aquatic vegetation, fish and other aquatic life. However, even uncontaminated sediment can alter riparian areas, impair aquatic habitat, and cause downstream flooding. Design and monitoring guidelines can mitigate the problems caused by excessive erosion and sedimentation, but once again, these practices require long-term implementation and monitoring which may not be done after a mine is closed or becomes inactive.

Ground Water Drawdown: Especially in arid areas such as in Central and Eastern Oregon, ground water drawdown from heavy water usage or pumping of a mine pit or underground mine can cause substantial degradation of surface waters, wetlands and agriculture or residential water wells. These impacts can last for many years after pumping is discontinued until the groundwater table has recovered.

Acid Mine Drainage: Many aspects of mining can contribute to the pollution of ground and surface water. Excavations at open pit mines, tailing ponds, piles of waste rock or leach piles and construction sites that use waste rock are all potential sources of toxic contaminants. Leaching and mobilization of

soluble minerals from these sites are exacerbated in areas that receive significant rain or snowfall. Many types of ore and waste rock contain metallic sulfide minerals, commonly iron sulfide or pyrite (FeS₂). Exposure to air and water can result in acidification of both surrounding soils and surface and ground water, inhibiting vegetation growth and degrading water quality. Acid mine drainage can also occur in underground mines, which can fill with groundwater and discharge pollution to surface waters. Acid mine drainage has been one of the most significant environmental impacts associated with mining.⁹ Acid mine drainage is generated at both abandoned and active mine sites.¹⁰

Cyanide Heap Leaching: Cyanide is used to economically extract gold from low grade ores and to depress the formation of pyrite in metal flotation. Cyanide is very toxic and presents a hazard to wildlife, surface and ground water, and air quality. More than 1000 million pounds of sodium cyanide were used in gold and silver leaching in 1990.¹¹ Aqueous cyanide can form compounds with metals in ore. Very basic cyanide compounds can form HCN, a poisonous gas that evaporates at surface atmospheric pressure besides compounds that can be released to ground or surface waters. The chemistry of mine tailings or leach heaps can change over time, adding to the potential of contaminants being released perhaps years after a mine is closed. Federal and state agencies have developed guidelines on design and allowable concentrations in cyanide-containing water and waste but have not always made rules to enforce the designs or guidelines.¹²

Metals and Dissolved Pollutants: Besides Acid Mine Drainage, other sources of dissolved mineral pollutants from mining can come from mine workings, waste rock, leaching, and tailings piles and impoundments, discharges from ore processing (beneficiation¹³) and chemical storage areas. Accidental water discharge from exploration, processing, mine water, runoff and seepage are the primary methods of transport to ground and surface waters. Naturally occurring minerals can be mobilized during and after mining operations at high enough concentrations to be pollutants. Although EPA and various state agencies issue water quality criteria, water quality at mining operations can be difficult for agencies to evaluate and regulate because of variability in the local geology, climate or hydrologic conditions, and changing chemical interactions at the sites.

Perhaps the greatest potential impact of mining to water quality owes to accidental spills from failed tailings ponds that can result in contamination and pollution of waterways and water supplies downstream. In 2014, at the Mount Polley Mine (an open pit copper and gold mine) in British Columbia, failure of a tailings pond structure caused a flood of 10 million cubic meters of water and 4.5 million cubic meters of slurry that scoured streams and polluted pristine lakes downstream. In 2015, an accidental spill at the closed Gold King Mine near Silverton Colorado, (a Superfund site), released 3 million gallons of toxic wastewater into the Animas River in Colorado, which polluted more than 70 miles of river affecting public water supplies in Colorado, New Mexico and Utah, recreation opportunities, and agricultural water supplies on the Navajo Reservation downstream.

⁹ AGI, 1999, Metal Mining and the Environment

¹⁰ EPA, 1997, NHRMF

¹¹ 1999, AGI, Metal Mining and the Environment

¹² 1997, EPA NHMF

¹³ Any process that improves the economic value of ore or to improve physical or chemical properties

SOILS

Environmental impacts to soils include disturbance, contamination, and reduced slope stability. Erosion of exposed soils from cleared land and tailings piles can increase sedimentation to surface waters. Soils surrounding mining operations can be contaminated by mining processes that utilize chemicals such as cyanide, mercury, or arsenic used in leaching. Strip or pit mining requires the removal of many acres of vegetation and soils (overburden). Soils are required to be stockpiled for future site restoration, but fragile or nutrient-poor soils such as those developed on serpentinite or high desert areas often require many years to develop the structure, nutrients, and biological components necessary to establish vegetative cover. Removal of vegetation can also lead to decreased slope stability from increased storm runoff resulting in rill and gully erosion and increased erosion. Overburden and tailings piles are often unstable and may be situated at steep drainage breaks. Slope failures and/or landslides from these piles can precipitate debris flows that smother stream drainages, threatening riparian and fish habitat. Tailings deposited in impoundments present stability, seepage, and spill concerns.¹⁴ High concentrations of waste minerals such as sulfides (acid mine drainage) or processing minerals such as cyanide can be released into the soils from the mine or leachate pond leakage, contaminating the soils and leading to vegetation kill. Tailings and leachate impoundments require long-term monitoring to maintain hydrostatic pressure and stability. Soils can concentrate heavy minerals. Windblown dust from tailings piles may spread pollutants (e.g. arsenic, lead, and radionuclides) into the air that can contaminate soils surrounding the mining operation, creating long-term detrimental impacts on vegetation, soils, water, air quality, and public health.

Removal of vegetation and soils, especially from strip mining operations, also eliminates wildlife habitat and recreational opportunities for camping, hiking and hunting.

AIR QUALITY

Air quality standards are set for mining operations by the National Ambient Air Quality Standards for particulate matter. Fugitive dust is of most concern at hard rock mining sites and adjacent to haul routes. Wind can entrain dust from mining operations, from crushers, spoil piles, or other disturbed sites and distribute them downwind. Mining sites can contain trace concentrations of heavy or toxic metals that can build up heavy metal concentrations in areas downwind of the mining site.¹⁵ Truck transport of ore to smelters or ports away from the mining operation can disperse dust along the haul route leading to similar heavy metal concentrations. For example, airborne dust from nickel processing has been known to cause respiratory problems for people exposed to it. Contaminated dust from uranium mining sites and adjacent to haul routes are of particular concern because of the radioactive material in the dust.

HABITAT QUALITY

¹⁴ EPA, 1997, NHMF

¹⁵ Ibid.

Mining can degrade, reduce or eliminate habitat for birds, fish, wildlife, and unique plants. Mining can impact streams and other aquatic habitats, such as lakes and wetlands, by releasing sediments, pollutants and toxins, by physically disturbing the morphology of drainage basins, by eliminating vegetation, and by altering surface or ground water flows. These impacts can have lethal or sub-lethal effects on macro invertebrates in streams that become the food of fish and birds, on fish and fish spawning, and on groundwater dependent plant communities. Mining can also impact terrestrial habitats by actual removal of vegetation—including forests, grasslands, or rare plants and by defoliation and soil contamination from mining processes. Impacts to vegetation can affect wildlife resources. Additional impacts to wildlife from mining sites include noise, bright lights at processing facilities, and roads that create hazards. Although wildlife habitat is addressed with mitigation in current operating plans, habitat impacts caused by mining can persist for many years, including after the mining operation is closed or abandoned.

MULTIPLE USE

In Oregon, the majority of hard rock mining claims and activities occur on public lands, which are governed by a series of federal land management laws that specify the goal of using public lands for many valuable public purposes. However, mining has been accorded priority over many other uses on public lands.

The Organic Act of 1897, which established America's National Forests, states:

Nor shall anything herein prohibit any person from entering upon such forest reservations for all proper and lawful purposes, including that of prospecting, locating, and developing the mineral resources thereof: Provided, that such persons comply with the rules and regulations covering such forests.

The Multiple Use, Sustained Yield Act of 1960 (as amended through 1996, P.L. 104-333) states:

Nothing herein shall be construed so as to affect the use of administration of the mineral resources of national forest lands or to affect the use or administration of Federal lands not within national forests.

Because access to mining operations is accorded to claimants, and mining operations are industrial areas that are inherently dangerous to the public, the public is generally restricted from accessing areas claimed through Mining Law. Such restrictions can reduce opportunities for hunting, fishing, recreation, foraging, and timber harvest – other resources mandated by the Multiple Use, Sustained Yield Act. Wildlife and fish habitat can be damaged or eliminated by land clearing, hauling, or mining operations that may include clearing, drilling, blasting, excavation, and processing. Aesthetic qualities of the natural environment can be impacted or eliminated for many generations, especially in areas of strip mining. Areas designated to protect special values, such as National Wild and Scenic Rivers, BLM Areas of Critical Environmental Concern, Forest Service Research Natural Areas, and Botanical Areas, may be degraded, reduced, or eliminated by mining operations.

Stipulations such as that included in the Organic Act require mining operators to work with Federal agencies to mitigate potential impacts to public and natural resources wherever possible. Examples of such mitigation could be buffer zones along waterways or sensitive wildlife habitat, timing of operations, or relocating trails. Mitigation also includes restoration plans for both temporary and permanent mine closure.

Mineral prospectors and mine operators, who work on National Forest System lands in Oregon, do so subject to the Forest Service's relations published in the Code of Federal Regulations published in Chapter 36 CFR § 228. Prior to providing approval of any Plans of Operation, mineral administrators review the Plans of Operation provided by miners to assure an assessment and disclosure of the impacts of their activities, whether those impacts can be mitigated, and to reduce the impacts of operations in National Forest resources. Examples of such mitigation could be run-off and sediment management, buffer zones along waterways, avoidance or reclamation of sensitive habitat, timing of operations, the relocation of roads and trails and many others. Plans of Operation contain reclamation plans to address temporary and permanent mine closure. Monitoring is often conducted to assess the effectiveness of mitigation to ensure the practicable restoration of beneficial uses enjoyed prior to mineral activities. Coordination between other Federal and State agencies assures compliance with the respective statutory and regulatory requirements. On National Forest System lands, bonds are required to cover the costs the government would incur to complete reclamation objectives described in the plan. In the event an operator defaults on their operational or reclamation requirements, Forest managers would utilize assigned bonds for that purpose.¹⁶

RECLAMATION AND LONG-TERM MONITORING

The U.S. Government Accountability Office (GAO) reported to Congress in 2016 that Federal Agencies could do more to regulate and enforce reclamation of hard rock mining sites. In 1981, the Bureau of Land Management (BLM) issued regulations that required all hard rock mining operations to reclaim land disturbed by mining after mining operations had ceased. In 2001, BLM amended those regulations to require all mining operators to provide bonds or financial assurances before beginning exploration or mining operations on land managed by the BLM.¹⁷

In 2016, the Environmental Protection Agency was ordered by the U.S. Court of Appeals to issue rules that required mining operations to provide financial assurance that they would be able to follow CERCLA Section 108(b) (costs of mining clean up, reclamation and long-term monitoring). However, in December 2017, the EPA decided not to issue final regulations. The EPA cited the adequacy of existing state and federal regulator controls and risk of tax payer-funded actions vs the risk of environmental impacts with modern mining practices.¹⁸

¹⁶ Jeff Jones, USDA FS, Minerals and Geology Management, Program Manager, Pacific Northwest Region, personal communication

¹⁷ GAO Key Issues, 2016

¹⁸ EPA, 2017, Final Action: Financial Responsibility Requirements Under CERCLA Section 108(b) For Classes of Facilities in the Hardrock Mining Industry

In 2000, the National Wildlife Federation (NWF) published a summary of Hard Rock reclamation bonding practices in the Western United States and gave general recommendations based on present reclamation and closure statutes and practices from the Western States. The report also provided a summary of strengths and weaknesses in the statutes by state. Weakness listed by the NWF in Oregon's Mined Land Reclamation Act (MLRA) include:¹⁹

- Several provisions on resources and public safety are too general, including aesthetics and wildlife habitat.
- No specific closure regulations are included in the Oregon MLRA.
- Oregon's bond release statutes do not address liability of the operator or surety provider. There are no provisions to allow the state to modify the agreement to fulfill requirements. No specific standards have been developed to measure revegetation.

In Oregon, DOGAMI coordinates with BLM on reclamation bonds to incorporate stipulations for restoration laid out in Oregon Administrative Rule, Chapter 517, Mining and Mining Claims (2015). This collaboration includes the development and cost estimate of a restoration and reclamation plan – including an annual reassessment of the cost of reclamation. The cost of long-term monitoring may be included in the restoration bond. On federal lands, monitoring is performed by local minerals staff from the managing agency.

ORS [517.987](#) (7) The department may require security or an annuity for post-reclamation monitoring and care to be paid before the final bond release. The security or annuity shall be sufficient to cover long-term site care and monitoring needs. The department shall determine the amount of the proposed security or annuity and distribute a proposal to all permitting and cooperating agencies. [1991 c.735 §24a; 2007 c.318 §27]

Because there has been little hard rock mining occurring in Oregon, the effectiveness of the 2001 BLM requirements for reclamation and the Oregon mining rules have not yet been tested.

ECONOMY

Currently hard rock mining contributes very little to Oregon's economy. Evaluating the economic potential of future mining projects is difficult, because each potential mining operation's cost and benefit will vary depending on which metal is extracted, the mining company's method of extraction, the size and location of the mine and mill site, and the local community's support or aversion to the extraction. The cost and benefit also will vary with the richness of the ore body (percent of metal vs. waste rock), the expected lifespan of the ore, and the volatility of the global market for that particular mineral, which affects its price.

In its 2016 report to the Legislature, DOGAMI notes that the path between discovery and a profitable mine is long, difficult and expensive, and that most discoveries never become mines.

¹⁹ 2000, Kuipers and Carlson, NWF, Hardrock Reclamation in Bonding Practices in the Western United States

Mapping, chemical analysis, exploratory drilling, and permits are among the factors that lead to high initial expenses. The report notes that:

The result is that costs for exploration and development of a mine can be tens to hundreds of millions of dollars. These requirements, coupled with volatile mineral prices and markets, makes mining an inherently risky venture. Modern metal mines are very large-scale industrial operations that require long mine life and large reserves in order to justify the enormous investment required to go into production.

For example, a Preliminary Economic Assessment for the proposed Calico gold mine at Grassy Mountain suggests that “the project will require \$144 million in capital, of which ~\$1.5 million is for permitting and will ultimately net ~\$156.6 million, assuming a constant gold price of \$1,300/oz.”

OREGON Mining

Total Direct, Indirect, and Induced Contribution of Mining, 2012

Employment (Number, Percent of State Total) = 17,450 0.8%

Labor Income (\$ Millions, Percent of State Total) = \$968, 0.9%

Contribution to GDP (\$ Millions, Percent of State Total) = \$1,775, 0.8%

State & Local Taxes Paid (\$ Millions) = \$118

Federal Taxes Paid (\$ Millions) = \$207

Source: The Economic Contributions of U.S. Mining, September 2012, A report prepared by the National Mining Association



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The economic benefits of mining may include expenditures associated with exploration, new jobs associated with mine development and operation, new income to households, and the products made from the extracted minerals. The mining company may buy products and services, and the new income

for employees may be spent in the community, creating a multiplier effect. Mining companies also pay local and state taxes. When the mine comes to the end of its useful life, there may be jobs associated with reclamation and monitoring.

The feasibility report for the proposed Grassy Mountain Gold line identified proposed salaries for mine personnel.

Role	Role per Shift	Shift	Schedule (days on/off)	N° of employees	Base Wage (\$/y)	Cost per employee (\$/y/employee)	Cost per year (\$/y/role)
Mine Superintendent	1	1	5/2	1	125,000	\$168,750	\$168,750
Planning Engineer	1	2	5/2	2	90,000	\$121,500	\$243,000
Geologist	1	2	5/2	2	90,000	\$121,500	\$243,000
Mine Shift Foreman	1	2	4/3	2	95,000	\$128,250	\$256,500
Surveyor	1	2	4/3	2	44,533	\$60,120	\$120,239
Assistant Surveyor	1	2	4/3	2	38,000	\$51,300	\$102,600
Sampler	2	2	4/3	4	38,000	\$51,300	\$205,200
Mine Operation Personnel							
Maintenance	5	2	4/3	10	56,846	\$76,742	\$767,421
Horizontal Drill	2	2	4/3	4	61,776	\$83,398	\$333,590
Bolter	1	2	4/3	2	61,776	\$83,398	\$166,795
LHD	4	2	4/3	6	61,776	\$83,398	\$667,181
Front end Loader	1	2	7/7	4	61,776	\$83,398	\$166,795
Truck	3	2	4/3	6	61,776	\$83,398	\$500,386
Support Equipment	4	2	4/3	8	43,368	\$58,547	\$468,374
Diamond Drill	1	2	4/3	2	43,368	\$58,547	\$117,094
Support Services	3	2	4/3	6	20,000	\$27,000	\$162,000
Total Mining Labor	32			63			\$4,688,925

In contrast to these salaries, a July 2018 Technical review Meeting report listed the mean household income in Malheur County as \$48,070.

Economic impacts of mining for four levels of activity:

1. Exploration expenditures (includes soft costs, e.g., permits, environmental services)
2. Mine construction expenditures
3. Mine operation expenditures
4. Mine closing/reclamation expenditures

Types of economic impact:

Direct impacts

- Number of workers, payroll and benefits, and mine output for a given year

Indirect impacts

- Purchases of goods and services from firms that are directly associated with the mine

Induced impacts

- Purchases by employees directly related to the mine



However, it's important to also consider the costs, which include the instability and volatility of mining jobs (often a boom/bust scenario), the displacement of other more sustainable economic activity, and potential long-term environmental damage that sometimes incurs substantial future costs. For example, an EPA 2013 toxic release inventory national analysis comparing industry sections concluded that metal mines are responsible for almost half (47%) of the toxic pollution in the US.

Although chromite is not one of the metals highlighted in this report, the chromite mine in Coos County illustrates the volatility of the mining industry. The Oregon Resource Corporation (ORC, an Australian owned company) found chromite in Coos County in the 1990's and began the permitting and leasing process to mine chromite specifically and potentially zircon and garnet. Their plan was to process chromite into specialty sand to be used by factories to create casting molds. The mining site included land leased from Weyerhaeuser, Kimberly Clark, and Coos County. ORC claimed it would provide close to 100 well-paying jobs and build a \$45 million plant, contracting the construction with local companies. Because the processing plant was built in an enterprise zone they were granted a 3-year tax abatement beginning in 2010. This was extended 2 more years because ORC promised to pay 150% of the local average wage to their employees. This tax abatement had the potential to cost various tax districts as much as \$1 million in revenue. After a little over a year of production, the global market for chromite faltered, and by 2012 the plant closed. The proposed 20-year project lasted less than two years. The plant was constructed mostly by out of state companies, because ORC claimed local bids were

nonexistent or too expensive, and the high paying jobs promised in bargaining for the local tax abatement disappeared. ORC did pay an annual community fee of \$300,000 and had a road improvement budget of \$450,000. The company also secured a bond for reclamation, and according to a DOGAMI inspection report of July 2013, it was fulfilling its responsibilities to reclaim the mine sites. As of 2016, the company sold or is selling its assets.

Mining might displace other industries. For example, in Oregon, commercial fishing, sport fishing and recreation-based tourism all depend on clean water. According to the Oregon Department of Fish and Wildlife, Oregon's marine waters support commercial fisheries that annually contribute more than \$500 million in personal income to Oregon, a critically important economic driver for the coast and the state. Recreational sport-fishing also contributes tens of millions of dollars (\$68.9 million in 2014) of total personal income to Oregon's coastal economies.

Finally, some critics of the General Mining Law of 1872 have argued that the federal government should receive some economic benefit from allowing extraction of valuable minerals from public lands. Industries pay royalties when extracting leasable minerals such as oil and gas and purchase the rights to mine salable minerals such as sand and gravel, but there is no royalty collected from companies that extract locatable hard rock minerals. Mining companies say that mineral exploration is expensive and economically risky. They believe that requiring royalties would discourage mining and thereby reduce domestic production of minerals and forego local jobs and any state and local tax revenues.

Some states require miners to post bonds to pay for clean-up. Critics of the General Mining Law of 1872 propose that adding environmental regulations to the original law would strengthen post bond precaution and potentially save taxpayers from costly clean up. Mining companies argue the environmental laws and oversight is adequate and should continue under current federal regulations.

ALTERNATIVES TO MINING

Technology, transportation, construction, energy, and more - our modern society is dependent on the minerals we mine from the earth. Examples are: nickel, the key to making stainless steel; copper, silver, and gold, used in electronic devices; and zinc, a critical component in galvanized metals. Alternatives to using these metals usually incorporate other non-renewal materials such as limestone for cement, or plastics (derived from oil) in fabrication. The best 'alternatives' to reducing the amount of primary mineral use are the three R's of recycling: reducing consumption, reuse, and recycling of these precious, non-renewable earth materials. The Environmental Protection Agency has a website devoted to the three R's and can be found at <https://www.epa.gov/recycle>.

RECYCLING

Recycling is the most obvious and readily accessible alternative to using newly mined or primary minerals. With the exception of uranium, the metals explored in this study readily lend themselves to recycling and can contribute to their sustainability.

Electronic Devices: Recycling of electronic devices has been shown to be economical as well as environmentally responsible. The Apple Corporation reported in April 2016 that, in 2015, their customers recycled 61 million pounds of electronic devices worth over \$50 million. This included gold (\$40 million), copper (\$6.4 million), aluminum (\$3.2 million), silver (\$1.6 million), nickel (\$160,426), zinc (\$109,503), and lead (\$33,999) (7).

In all cases, but especially with electronic products, product design is critical for ease of recycling, including both disassembly and material separation. This has not a priority for manufacturers. There is also a low awareness in the public about the loss of non-renewable resources and environmental effects from mining that occur when metals are not recovered through recycling. The costs of recycling for many metals is often comparable to primary mining because of the lack of a robust infrastructure for recycling, or the lack of old scrap. Regulations for battery and electronic recycling in Oregon as well as several other states have improved ease of disposal, collection rates, availability of scrap material, and contributed to developing technologies and an industry infrastructure for recycling.

As of January 2010, the State of Oregon enacted an Electronics Recycling Law (Oregon Revised Statute 459A.300 - .365). Oregon E-cycles offers free recycling for computers, monitors, TVs, printers, keyboards and mice. The Statute requires that products are recycled responsibly, meeting both environmental and human health requirements (www.deq.state.or.us). To sell the electronic devices covered in the statute, manufacturers must label their products with a permanent brand, register their products, pay a registration fee to cover administration costs, and either pay a recycling fee to participate in the DEQ administered E-cycling program or provide for their own statewide program. All recycling programs must provide a collection site in every city with a population of 10,000 or greater, and a collection service in every county.

Electronics Take Back Coalition reported that Oregon has had the highest volume of e-waste collected of the 25 states studied. After analyzing their statistics, the study concluded that there were ten lessons to be learned for success from other national e-cycling programs, which included:

1. Collection volumes are high when laws either make collection convenient, and/or collection goals are established.
2. State laws cover collection rates.
3. Goals for recycling should be high and set as minimums, not ceilings.
4. Focus on urban rather than rural areas.
5. Landfill bans boost recycling efforts (in Oregon, all computers, monitors, and televisions are banned from disposal in landfills).
6. States need to be proactive with responsibly handled e-recycling.
7. E-cycling programs need to promote reuse over recycling.
8. The scope of e-cycling needs to be expanded to include all electronic devices.
9. In general, manufacturers will only do what the law requires.
10. There needs to be more transparency and reporting in recycling efforts.

Battery Recycling: As of 2008, the recycling rate for lead in the United States exceeded 75%. Much of this rate is due to the high percentage (96%) of recycled lead-acid batteries. Battery recycling legislation adopted by 45 states helped develop a recycling infrastructure that expedites the recycling of batteries. Industry has developed means to not only recycle batteries, but to refine secondary lead and to use this

material in the production of new batteries. Other regulations have reduced the amount of lead that can be used in products such as fishing weights and wheel weights. USGS reports that during the last 20 years there has been a decrease in primary production because of the increased use of secondary material. They report that 80% of domestic lead consumption in 2008 was from secondary material.²⁰

Nickel Recycling: Nickel recycling in the US has been increasing since 1990 in response to increased nickel prices and new world markets for the mineral. Most of the recycled nickel comes from and is then re-incorporated into the production of stainless steel.

In 2009, stainless steel produced in the United States contained 78% of secondary nickel material. Technology in producing and using recycled nickel has also improved. State and national regulations have also encouraged more recycling of both lead and nickel, both of which are considered toxic to humans. This has applied most directly to the recycling of nickel-cadmium and nickel-metal batteries. As has happened with lead regulations, the new battery regulations encouraged technology and made the recycling industry more economical feasible.

Scrap Metal: A significant amount of scrap metal collected in Oregon is exported to China for processing into new steel. With the recent downturn in the Chinese economy, scrap metal collection has not been profitable enough to maintain many collection and transfer facilities.²¹

Cascade Steel Rolling Mills was founded in 1968 in McMinnville OR and exclusively uses scrap metal to produce high-quality steel products. Cascade Steel Rolling Mills was purchased in 1984 by Schnitzer Steel Industries, and the company continues to use scrap metal purchased from Schnitzer Steel. Cascade Steel prides itself on its focus on environmental and social responsibility, citing energy efficient facilities, low power costs, high recycled contentment of its products, and high reclamation rates. According to their website, "Creating products from recycled steel instead of virgin ore uses 40% less water and reduces mining wastes by 97%."²²

Schnitzer Steel was founded in 1906 and is based in Portland OR. The company deals in collection and processing of scrap metal into finished steel products. They recycle iron, steel, copper, lead, stainless steel, and zinc. Besides recycling metal scrap into new products, they also collect and resell used auto parts and auto bodies for reuse. They operate 95 recycling facilities and scrap metal collection sites throughout North America, including Portland Metro.²³

REUSE

Statistics were not found for the reuse of specific minerals but can be extrapolated from recycling data such as the availability of old scrap. Although many metals can be recycled and reused an infinite number of times, the products made from these minerals can also be refurbished and reused without the reprocessing necessary for mineral reuse. One ubiquitous example is the used car which can be

²⁰ Overview of Flow Studies for Recycling Metal Commodities in the United States, <https://pubs.usgs.gov/circ/circ1196-AA/pdf/circ1196-AA.pdf>, pg. AA19, 8/18/17

²¹ Ibid., pg. AA20

²² http://www.cascadesteel.com/company_profile.aspx, 8/18/17

²³ <http://www.schnitzersteel.com/company.aspx>, 8/18/17

resold and reused adding many years to the product end-of-life. Motors for other vehicles, machines, and generators can also be refurbished and reused.

Catalysts are used extensively in industry to change the rate of chemical reactions. Catalysts can be restored to usefulness, or regenerated, and used for many years before needing to be replaced, and in the process, the silver and other minerals in the catalyst recycled.

Electronics contain small but significant amounts of minerals that are difficult to recycle at this time because of the lack of an electronic recycling infrastructure. Products could be designed as modules to allow repairs, updates, and upgrades to be easily inserted into the original device, allowing reuse for many years.

There has also been a change in manufacturing, marketing, and societal values since the middle of the last century. Where once it was considered frugal, prudent, and patriotic to repair and reuse a product until it was no longer functional, society is now anxious to discard last year's product and replace it with the newest model being marketed. Manufacturers no longer use longevity and reliability over time for marketing durable goods such as appliances. In economic statistics, one gauge of the economy is the amount of individual wealth spent on durable goods, which are goods that retain their economic value for longer periods of time.

Currently, marketing now promotes the 'latest and greatest' applications and upgrades for new products. Older electronic devices are not supported or upgraded by the companies that have developed them. It is often more expensive to replace a part on an electronic device than it is to replace the entire device. Recycling technology and infrastructure has not kept up with consumer demand leading to more products, and precious non-renewal minerals, being discarded in landfills.

CONSERVATION

Conservation of non-renewable resources such as minerals will require reuse and recycling of products and also personal and societal assessments that ask 'how much is enough?' Consumer demand has kept pace with marketing, but this pace may no longer be sustainable for non-renewable resources. Changing buying habits and consumer desires will take concerted efforts, similar to those currently led by conservation and environmental groups for the protection of watersheds, fisheries, and wilderness. Conservation marketing will need to be as aggressive as consumer marketing and will require support from elected officials to promote conservation as prudent and patriotic.

APPENDIX

APPENDIX 1: DOGAMI MINING POTENTIAL CRITERIA

DOGAMI'S 2016 Report to the Oregon Legislature looked at Oregon counties and rated mining potentials for 16 materials, using these criteria: **High potential- (H)**

Historic production or identified resources are present. Meets at least one criteria:

- Significant past or active production
- Presence of repeated positive sampling results
- *Numerous* high-density areas identified (MILO's, Mineral Information Layer for Oregon, or active and closed claims <http://www.oregongeology.org/sub/milo/>)

Moderate potential- (M)

Scientific data suggest further testing would discover new resources. At least 2 criteria are met in areas with:

- *Multiple* MILO points with positive sample/assay results
- *Multiple* active and closed claims
- "Above background" chemical data, based on *numerous* points

Low potential (L)

Favorable geology and limited data suggest further exploration might discover resources. At least 2 criteria are met:

- Scattered MILO results, with or without positive assay results
- Scattered active or closed claims
- Scattered areas or data points with "above background" chemical data
- Well-mapped geology with known occurrence of these minerals

Present (P)

At least one mineral finding is reported but no additional data suggest widespread occurrence.

Not Found (NF)

No records show evidence of presence of the mineral.

County	Metallic Minerals							Industrial Minerals							
	Precious	Base Metals:	Nickel	Chromite	Uranium	Platinum	Lithium	Limestone	Bentonite	Diatomite	Zeolites	Silica	Pumice	Perlite	Sunstones
Baker	H	M	L	L	L	P	NF	H	M	L	M	N F	N F	M	N F
Coos	M	M	N F	H	N F	L	NF	P	N F	N F	N F	H	N F	N F	N F
Crook	H	L	N F	N F	M	NF	NF	P	H	L	L	N F	N F	N F	N F
Curry	H	H	H	M	P	L	NF	P	N F	N F	N F	L	N F	N F	N F
Deschutes	L	NF	N F	N F	N F	NF	NF	N F	N F	H	N F	N F	H	N F	N F
Douglas	H	H	H	M	N F	M	NF	L	N F	N F	N F	H	L	N F	N F
Gilliam	NF	NF	N F	N F	N F	NF	NF	N F	L	N F	N F	N F	P	N F	N F
Grant	H	H	L	H	P	L	NF	P	L	P	P	N F	N F	N F	N F

Harney	H	M	N F	N F	M	NF	M	P	M	H	H	N F	L	P	H
Jackson	H	M	L	M	L	P	NF	H	M	N F	N F	H	P	N F	N F
Jefferson	H	P	N F	P	N F	NF	NF	P	L	N F	N F	N F	N F	N F	N F
Josephine	H	H	H	H	P	M	NF	H	N F	N F	N F	P	N F	N F	N F
Klamath	NF	NF	N F	N F	N F	NF	NF	N F	L	M	N F	N F	H	P	N F
Lake	H	L	N F	N F	H	NF	L	P	P	H	L	P	P	H	H
Malheur	H	P	P	P	H	NF	H	P	H	H	H	L	L	L	L
Morrow	NF	NF	N F	N F	N F	NF	NF	N F	N F	N F	N F	P	N F	N F	N F
Sherman	P	NF	N F	P	N F	NF	NF	N F	N F	N F	P	N F	N F	N F	N F
Umatilla	L	NF	N F	N F	P	NF	NF	N F	P	N F	N F	P	N F	L	N F

Union	M	P	N F	N F	P	P	NF	P	P	P	N F	N F	N F	P	N F
Wallow a	L	M	N F	N F	P	P	NF	H	N F	N F	N F	P	N F	N F	N F
Wasco	L	NF	N F	N F	N F	NF	NF	N F	H	N F	N F	N F	N F	L	N F
Wheeler	L	P	N F	P	P	NF	NF	P	L	L	L	N F	N F	N F	N F

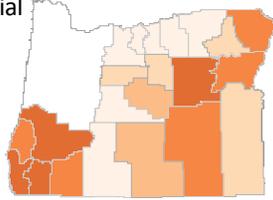
Mineral Potential Key

High	H
Moderate	M
Low	L
Present	P
Not Found	NF

BASE METALS: COPPER, LEAD, AND ZINC

Mineral Resource Potential

- High
- Moderate
- Low
- Present
- Not Found



Copper, lead, and zinc, often historically gold mining by-products, have a high development potential. They may face serious challenges to meet environmental standards because they typically generate acidic drainage.

High Potential in:

Curry, Douglas, Grant, and Josephine counties

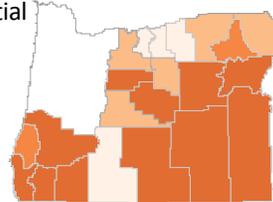
Moderate Potential in:

Baker, Coos, Harney, Jackson, and Wallowa counties

PRECIOUS METALS: GOLD AND SILVER

Mineral Resource Potential

- High
- Moderate
- Low
- Present
- Not Found



Gold and silver are found as bedrock lodes and disseminated particles in ore and stream sediment. Both show significant potential for further development.

Disseminated ore sources recognized in the last 30 years hold very large amounts of very low-grade ore. These would require large-scale operations with high development costs. Placer deposits are typically near streams. Mining activity would face competing land use pressure and costs to observe environmental protections. These factors reduce their appeal to mining firms.

Most Oregon gold mines have small lodes or deposits, are inactive, and would need substantial reinvestment to activate. They have not been mined to significant depth by current standards. Predicted high potentials warrant application of current geologic technology, for further exploration and development.

Oregon's gold rush was mostly in Baker and Josephine counties. The amount of hobby or subsistence mining is unknown.

High Potential in:

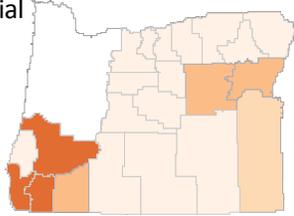
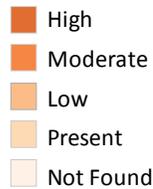
Baker, Crook, Curry, Douglas, Grant, Harney, Jefferson, Jackson, Josephine, Lake, Malheur

Moderate Potential in:

Coos, Union

NICKEL

Mineral Resource Potential



Like chromite, nickel is a critical specialty steel component. The Douglas County Hanna nickel mine operated from 1953 – 1987, then the only US nickel mine. Smelter operations continued there with imported ore until 1998. Like chromite, this mineral is found in “severely deformed” rock, making discovery difficult. New sources could be found.

High Potential in:

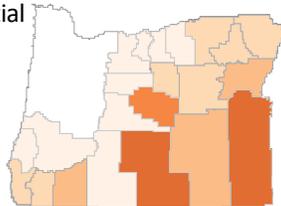
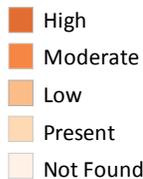
Curry, Douglas, and Josephine counties

Low Potential in:

Baker, Grant, and Jackson counties

URANIUM

Mineral Resource Potential



Uranium is used as a nuclear power fuel, including for nuclear submarines, and also in nuclear weapons. Both important Oregon deposits are near lithium mining reserves mentioned near the Nevada border. Relatively low current price and environmental issues challenge development of the 17 million ton

McDermitt ore reserves

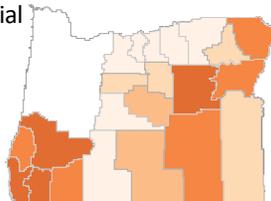
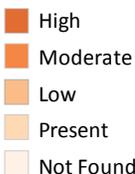
High Potential in:

Lake and Malheur counties

Moderate Potential in:

Crook and Harney counties

Mineral Resource Potential



Copper, lead, and zinc, often historically gold mining by-products, have a high development potential. They may face serious challenges to meet environmental standards because they typically generate acidic drainage.

High Potential in:

Curry, Douglas, Grant, and Josephine counties

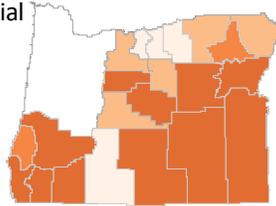
Moderate Potential in:

Baker, Coos, Harney, Jackson, and Wallowa counties

PRECIOUS METALS: GOLD AND SILVER

Mineral Resource Potential

- High
- Moderate
- Low
- Present
- Not Found



Gold and silver are found as bedrock lodes and disseminated particles in ore and stream sediment. Both show significant potential for further development.

Disseminated ore sources recognized in the last 30 years hold very large amounts of very low-grade ore. These would require large-scale operations with high development costs. Placer deposits are typically near streams. Mining activity would face competing land use pressure and costs to observe environmental protections. These factors reduce their appeal to mining firms.

Most Oregon gold mines have small lodes or deposits, are inactive, and would need substantial reinvestment to activate. They have not been mined to significant depth by current standards. Predicted high potentials warrant application of current geologic technology, for further exploration and development.

Oregon’s gold rush was mostly in Baker and Josephine counties. The amount of hobby or subsistence mining is unknown.

High Potential in:

Baker, Crook, Curry, Douglas, Grant, Harney, Jefferson, Jackson, Josephine, Lake, Malheur

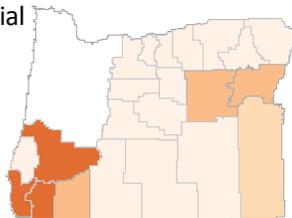
Moderate Potential in:

Coos, Union

NICKEL

Mineral Resource Potential

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- Moderate
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Like chromite, nickel is a critical specialty steel component. The Douglas County Hanna nickel mine operated from 1953 – 1987, then the only US nickel mine. Smelter operations continued there with imported ore until 1998. Like chromite, this mineral is found in “severely deformed” rock, making discovery difficult. New sources could be found.

High Potential in:

Curry, Douglas, and Josephine counties

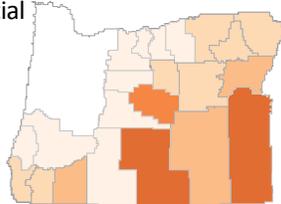
Low Potential in:

Baker, Grant, and Jackson counties

URANIUM

Mineral Resource Potential

- High
- Moderate
- Low
- Present
- Not Found



Uranium is used as a nuclear power fuel, including for nuclear submarines, and also in nuclear weapons. Both important Oregon deposits are near lithium mining reserves mentioned near the Nevada border. Relatively low current price and environmental issues challenge development of the 17 million ton

McDermitt ore reserves

High Potential in:

Lake and Malheur counties

Moderate Potential in:

Crook and Harney counties

APPENDIX 2: MINING COSTS – A CURRENT SAMPLE

DOGAMI provided figures for the Grassy Mountain venture in Malheur County. The claim was posted in 1984 and has gone through a series of more than five owners. Relevant figures show:

- **\$30 million**, DOGAMI estimates for exploratory drilling and sample analysis already done in 245 separate holes, roughly totaling 38 miles
- **\$144 million**, Calico Resources PEA (Preliminary Economic Assessment) estimate, called for additional project funding needed, including \$1.5 million for permitting, to dig and process. This assessment estimates
- **\$156.6 million**, ultimate predicted project net, assuming a constant gold price of \$1300/oz.

Total reported Oregon metals and industrial:

Limestone 2,451,000 tons (cement)	Manganese 317 tons
Chromite 127,531 tons	Mercury 95,319 flasks
Clay 11,210,000 tons (brick and specialty)	Nickel 435,816 tons
Gemstones \$57,873,000	Perlite 16 tons (likely very low estimate)
Copper 17,640 tons	Pumice 15,518,000 tons
Diatomite 75,000 tons	Silver 6,270,491 troy oz.
Emery 1,150 tons	Talc 1,554 tons
Gold 6,362,228 troy oz.	Uranium 6,672 tons
Lead 1,150 tons	Zinc 1,277 tons

Exploration Expenditures

Josephine Mining Corp – Turner Gold Project

Josephine County

1974-2010 Exploration Expenditures (\$ Millions): \$16

Alamos Gold Inc – Quartz Mountain Project

Lake County

Exploration Expenditures (\$ Millions): \$60

Calico Resource Corp – Grassy Mountain Project

Malheur County

Total Exploration Expenditures (2013) (\$ Millions): \$30

Bayhorse Silver Inc – Bayhorse Silver Mine Project

Baker County

Estimated Costs of Exploration 2013 to 2015 (\$ Millions): \$1.5



APPENDIX 3: RECENT NOTICES AND PLANS OF OPERATION BY BLM DISTRICT

COOS BAY: no notices or plans of operation

SALEM: 7 active mine claims (3 individuals and 4 associations), one notice and no plans of operations

EUGENE: 36 hobby claims

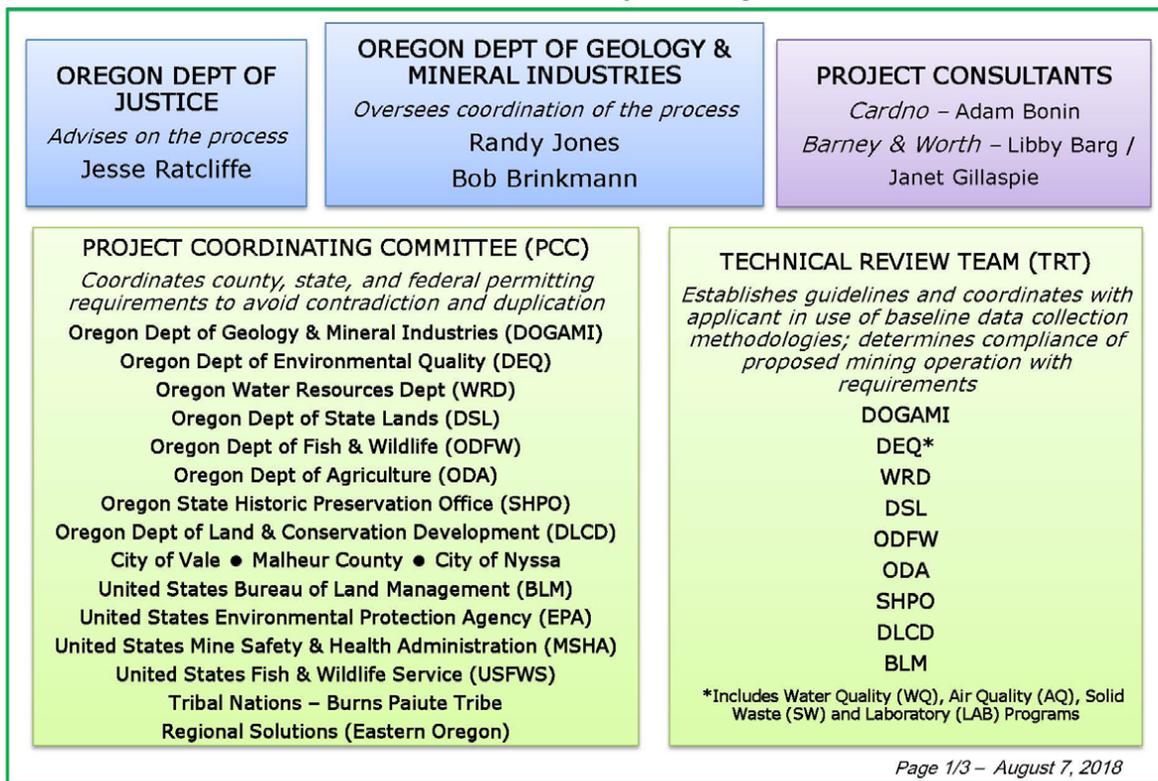
ROSEBURG: 123 mine claims, no notices and one plan of operation

MEDFORD: 840 mine claims, 24 notices, and 10 plans of operation. The notices are testing or very small scale. The plans of operation are gold placer claims, probably short-lived. There is medium potential for gold in the Applegate region at mid to high elevations.

LAKEVIEW: Alamos Gold, Quartz Mt. Project recently suspended its exploration activities, the price of gold isn't high enough. 50 km W NW of Lakeview eventual open pit, heap leach operation. BLM LR 2000 area anticipates 10 to 15 gold sites, notices, so less than 5 acres.

APPENDIX 4: CONSOLIDATED PERMITTING ORGANIZATION FOR GRASSY MOUNTAIN GOLD MINE

Oregon Chemical Process Mine Consolidated Permitting Organizational Chart Calico Resources USA Corp – Grassy Mountain



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