Cyanide and Non-Cyanide Gold Processing Alternatives at the Grassy Mountain Project

Are There Non-Cyanide Gold Processing Options That Can Be Used at Grassy Mountain?

An *Environmental Evaluation* was developed to assess the effects of proposed facilities at the Grassy Mountain Gold Mine site in Malheur County, OR. It included an *alternatives analysis* that identified and evaluated potential reasonable alternatives to various project components, including alternative locations for mine facilities, and alternative designs, processes, operations, and scheduling. The evaluation also analyzed non-cyanide ore processing techniques including gravity separation, microbial leaching, biological gold retrieval methods, and non-cyanide leaching agents.

The alternatives analysis determined that none of these non-cyanide gold-extraction processes would be suitable for the type of gold deposit found at the project site, and/or, could create greater environmental impacts than the proposed use of cyanide. Refer to Chapter 2 of the Environmental Evaluation for further details.

Grassy Mountain Cyanide Management Plan

At Grassy Mountain, a Cyanide Management Plan has been developed that complies with the International Cyanide Management Code (ICMC) guidelines for the management of cyanide and design of cyanide ore-processing facilities. The Grassy Mountain project aims to obtain ICMC certification for operations.

Cyanide would be used in carbon-in-leach tanks within a mill in a closed system to prevent cyanide escape into the environment. Following gold extraction, the tailings slurry would undergo cyanide destruction to achieve the State of Oregon's required concentration prior to discharge. The tailings slurry would then be pumped into a lined tailings storage facility (TSF) for containment.

The TSF would be 100 percent geomembrane-lined (using a very-low-permeability synthetic membrane liner) with continuous primary and secondary leakage collection and leak detection systems. Tailings would be deposited in the TSF via a tailings distribution pipeline that uses movable spigot manifolds positioned along the rim of the impoundment to produce an even beach and create a supernatant pool (the liquid that is left after solid material has settled out). Collected process water from the TSF would be returned to the process plant for reuse. The TSF embankments would be constructed of soil and basalt, generated from the quarry and during grading operations built in stages to provide incremental increases to storage capacity. An independent leakage collection and recovery system would be installed to monitor and manage potential leakage between the primary and secondary containment layers within the TSF.

Groundwater monitoring wells would also detect potential TSF liner leaks. The TSF is designed as a zero-discharge facility capable of storing a 500-year, 24-hour storm (the largest storm predicted, with a 1 in 500 chance of occurring in any 1 year). At closure, the TSF tailings would consolidate and dry out, and a closure cover would be installed.

A fence that extends below ground and 8 feet high would enclose the TSF to prevent wildlife from entering the area. Climbing and flying animals could penetrate this boundary, so various wildlife exclusion methods are being considered to deter birds and bats from accessing the area.

The state regulatory limit for weak-acid dissociable cyanide in tailings is set by Oregon regulators. The Grassy Mountain Project would be subject to a regulatory discharge concentration below that threshold. When the tailings slurry is discharged, cyanide volatilization (transition from a liquid to a gas/vapor) would reduce the concentration of cyanide in the supernatant pool. This cyanide vapor would not pose a risk to people or wildlife from inhalation due to the low cyanide concentration in the supernatant pond and large open TSF area. Natural processes such as ultraviolet destruction and biodegradation would further reduce cyanide concentrations in the TSF when exposed to air, sunlight, and natural microorganisms. The strictly regulated cyanide levels in the TSF would prevent toxic effects to wildlife.

Is Thiosulfate a Suitable Alternative to Cyanide at the Grassy Mountain Gold Site?

Thiosulfate was suggested as an alternative to cyanide which was assessed in the Environmental Evaluation. Thiosulfate is not a practicable alternative to cyanide at Grassy Mountain due to the type of gold ore present at the site, as well as other reasons described below. When compared to the proposed modern, and widely used, carbon-in-leach process using cyanide, a thiosulfate leaching process would be difficult to achieve and would likely result in greater impacts to resources:

- **Unsuitable Gold Orebody:** The thiosulfate leaching process has been attempted for double refractory ore, which is rock containing extremely fine-grained gold with sulfide and organic carbon. The type of ore found at Grassy Mountain is not double refractory or carbonaceous, so the thiosulfate leaching process is not a viable alternative to cyanide leaching.
- **High Technological Risk:** Thiosulfate leaching involves complex operations and a high level of technical risk. Gold recoveries from the thiosulfate leaching process are difficult to achieve and sustain in practice due to the complexity of chemical reactions, which rely on narrow ranges of pH and oxidation conditions to be effective. The thiosulfate method has undergone decades of intensive testing in laboratory settings, but there are no operating plants at present using this technology. Thiosulfate remains a "conceptual" alternative to the traditional cyanidation process.
- **Higher Reagent Use:** Thiosulfate leaching is a sensitive process that requires both dependent and independent optimization of each chemical component, as well as a strict range of physical parameters, including pulp density and temperature. The reaction thermodynamics are less favorable than the cyanide leach reaction, resulting in higher concentrations of thiosulfate needed to achieve equivalent rates of gold leaching. A typical thiosulfate leach solution has a reagent concentration of 5 to 20 grams per liter (g/L) versus a cyanide concentration of 0.25 to 1 g/L.
- **Less Gold Recovery:** Thiosulfate recovers less gold (<50–59% recovery) from ores compared to cyanide processes (86–92% recovery).
- **Higher Energy Use:** Thiosulfate manufacturing requires molten elemental sulfur and the use of a boiler, requiring an independent energy supply, likely from natural gas or propane. The thiosulfate manufacturing area would also require a cooling tower.
- **Greater Air Impacts:** Hydrogen sulfide and ammonia would be emitted from the use of sodium bisulfite, molten sulfur, and thiosulfate, resulting in the requirement of air quality controls. Thiosulfate could also have higher emissions from burning fossil fuels to generate steam required for the reaction.
- **Greater Water Use and Treatment:** Water is required for boilers and cooling towers, and a water treatment plant would be needed to reclaim thiosulfate concentrate from recycled process water.
- **Higher Costs:** High capital and operating costs, and lower leach extraction are expected to make this process an uneconomical and infeasible alternative to cyanide use at Grassy Mountain.
- **Similar Metals in Process Water:** Leached constituents by thiosulfate and cyanide are generally similar and depend on the metals contained within the ore body. Leachate from both processes would contain constituents (e.g., copper, selenium, sulfate, total dissolved solids) that would remain in the recirculating process water until closure when that water is evaporated. Similarly, tailings from both processes would be potentially acid-generating and would require pH buffering via the addition of lime.

In summary, the gold ore body at the Grassy Mountain gold site is not suitable for thiosulfate leaching. Instead, a modern carbon-in-leach process is proposed along with strict environmental controls for the transport, management, use, destruction, and disposal of cyanide.

For further information on proposed cyanide use for the Grassy Mountain Project, see: https://www.oregon.gov/dogami/mlrr/pages/chemicalprocess_calico-grassymtn.aspx.