Environmental Evaluation: Appendices

Grassy Mountain Gold Project
Malheur County, Oregon

Calico Resources USA Corp. 2015. Geology and Soils Baseline Study. Grassy Mountain Project. Cover Photo. February 2015.

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APPENDIX A

BEST AVAILABLE, PRACTICABLE AND NECESSARY TECHNOLOGY

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A-1 INTRODUCTION

Chemical process mining regulations in Oregon, including extraction, processing, and reclamation, must be undertaken in a manner that minimizes environmental damage through the use of the best available, practicable, and necessary technology (BAPNT) to ensure compliance with environmental standards (Oregon Administrative Rule [OAR] 632-037-0118). These regulations require the Technical Review Team (TRT) to consult with Calico Resources USA Corp. (the Applicant) in determining the BAPNT for use in the proposed Grassy Mountain Gold Project (Project) mining operation.

The BAPNT review process first requires the TRT to determine the necessary technologies, if such technologies exist, and second to determine if necessary technologies are available and practicable. Per OAR 632-037-0010, the definitions for available, practicable, and necessary are as follows:

- "Available Technology" means technology that is obtainable and has been demonstrated to meet environmental standards at an existing mine or a demonstration project of similar size and scale, or is reasonably expected to meet or exceed environmental standards at the proposed mine.
- "Practicable Technology" means available and necessary technology whose costs are not significantly disproportionate to the potential environmental benefits. A technology is not practicable if the cost is so high it renders a mining operation infeasible.
- "Necessary Technology" means technology that is required to ensure compliance with environmental standards.

The TRT reviews the identified necessary, available, and practicable technologies to select the technologies with the most effective environmental benefits that becomes the BAPNT. The TRT then recommends the BAPNT to the Department of Geology and Mineral Industries (DOGAMI) to ensure compliance with environmental standards, which the Applicant must use. In the event that the TRT and DOGAMI are unable to identify a necessary technology that is available and practicable, a Consolidated Permit cannot be issued.

This review of BAPNT considers site-specific conditions including climate, mineralization, geological, geotechnical, hydrogeological, and morphological conditions that differ in gold mining areas throughout the world where technologies have been developed.

The information contained in this appendix is based on professional experience and available information at the time of writing. It is not meant to be inclusive of *all* available technologies for gold mining. The assessment focuses on the more environmentally impactful aspects of mining Grassy Mountain so that other potential methods can be identified that may have lower adverse effects. The "best" available, practicable, and necessary technologies are those with the least damaging environmental effects.

A-2 SCOPE AND METHOD OF THE BAPNT REVIEW

The TRT proposed a list of items to research for technologies used in gold mining, which was supplemented with areas of interest arising from the review of alternatives (see Section 2.2 of the Project environmental evaluation [EE]).

The application of best available technologies for environmental protection included research and review of the following:

1. Mine construction methods, including extracting ore, backfilling, and transporting mined materials;
2. Mill operations, including chemical processing, cyanide management, air quality controls, process solution containments, wildlife exclusion, and mill closure;
3. Tailings management including disposal, tailings storage facility (TSF) design, leak detection, long-term pollution prevention controls, long-term monitoring, wildlife exclusion, and TSF closure;
4. Operations management including water management, fugitive dust control, equipment maintenance, and operations monitoring;
5. Acid rock drainage management;
6. Hazardous materials handling, storage, and management; and
7. Spill and emergency response.

These are described in Section A-3, and a summary of recommendations is provided in Section A-4.

A-3 IDENTIFICATION OF TECHNOLOGIES

A-3.1 Mine Construction Methods

The review of BAPNT for mine construction methods includes extracting ore, backfilling, and transporting mined materials and is described in further detail below.

Extracting Ore

Section 2.2 of this EE describes and compares underground and open-pit mining options. Of the two mining methods, underground mining would have the lower environmental impact since it requires far less surface area for extraction and produces less waste.

The underground mining method proposed for this Project is a mechanized cut-and-fill method in an underhand direction, which involves excavating waste rock and ore and backfilling the area with cemented rock fill (CRF) as support (see Figure 2-3 in Chapter 2 for a diagram showing this method). The underhand sequence starts at the top and works down in elevation.

Alternative underground mining methods include longhole open stoping and blind bench stoping, among others. These alternative mining methods are not suitable for the Grassy Mountain ore body due to the geotechnical properties of the ore and surrounding rock that are not amenable to these larger scale underground mining methods, which leave larger volumes of the ore body open before backfilling. The backfill utilized in the Applicant's proposed underhand cut-and-fill mining method provides a more stable ground condition suitable for extracting ore from this ore body.

Backfilling

The cut-and-fill method requires articulated haul trucks, water trucks, a blast hole drill, crushing area bobcat, dozer, elevated work platforms, front-end loaders, and other mining equipment. A more extensive equipment list is outlined in Table 2-4 in Section 2.1.14 of the EE. Using this equipment, the proposed mine would be accessed via a main mine portal and decline. The decline would lead to five level stations below the surface, each of which would be mined, followed by multiple level access ramps. The ore in the production levels would be mined using topcuts and undercuts. After extraction of waste rock and ore, the excavated areas would be backfilled with a CRF and/or rock fill for stability. Rock used as fill would be mostly basalt borrow material with some waste rock. This method and equipment are necessary, available, and practicable for their intended purpose.

The fill material used to backfill mining operations can be one of three options:

- **Dry fill.** Dry backfill material (i.e., quarry rock or non-acid-generating waste rock) is transported to the stopes using trucks or other mechanical equipment. This option would not include cement as structural support or as neutralization for potentially acid-generating rock.
- **Hydraulic fill.** Waste material is mixed with water to form a slurry, which is then transported to the stopes using pipelines. Similar to dry fill, this option would not include cement as structural support or as neutralization for potentially acid-generating rock and would also result in additional land disturbance arising from the installation of pipelines and associated environmental effects.
- **Cemented fill.** Waste material is mixed with cement to form a paste, which is then transported to the stopes using haul trucks. This option provides structural support for underground workings to allow excavation of ore in areas below and also provides neutralization for backfilled material to prevent acid rock generation.

Section 2.2.3.5 of the EE provides additional information on alternative tailings management. The proposed backfill method for the Project is cemented fill due to the requirement for structural supports for excavated areas. The cemented fill would comprise 85 percent basalt from the quarry and 15 percent waste rock. Since the waste rock has acid-generating potential, the use of cement as binder material would increase the physical and chemical stability of the fill and provide neutralization capacity to prevent acid rock generation and metals leaching. The other fill options would not be structurally sound (in the case of hydraulic fill) or provide neutralization capacity for underground workings (in the case of dry fill).

Transporting Mined Materials

The Applicant proposes to use haul trucks and hydraulic loaders to move mined material around the site, including within the underground mine. Blasted material (including ore and waste rock) would be transported to an underground stockpile using a loader and then put onto conventional load-haul-dump low-profile underground mining trucks and hauled to the surface. Haul trucks would be used to transport backfill materials from the surface to the underground workings to be used for backfilling. The Applicant proposes using mining equipment that is primarily fueled by diesel, with some equipment being electrically powered. Table 2-4 in Section 2.1.14 provides a list of mobile mining equipment for the Project. Effective fuel and power consumption can be accomplished through using appropriate speeds, reducing idle time, and conducting regular truck maintenance (Kaul and Soofastaei 2022). An alternative would be to use biodiesel as discussed in Section 2.2.3.13, which would lower greenhouse gas emissions both at the surface and in enclosed spaces.

The transport of mined material becomes less efficient the more frequently materials change mode of transportation such as loading and off-loading onto trucks. Material can also be lost or damaged and accidents can become more likely during transitions (Mining Technology 2021). Productivity and efficiency of transporting material throughout the site may be reduced by haul truck waiting queues, where engines are left to idle. Idling not only reduces efficiency in terms of time and money, but also burns fuel and increases air emissions. There are tools available to assist with mining processes including mining, hauling, and processing, that may reduce waste and improve operational efficiency. For example, commercial fleet management solutions can help manage truck haulage cycles and improve communication among the different operators (Kaul and Soofastaei 2022) and short interval control can help identify and act on opportunities to improve effectiveness and efficiency of mining processes (Global Mining Guidelines Group 2019). See Section 2.2.3.10 of the EE for further discussion of short interval control. These operational improvement technologies are not strictly necessary to manage the Project, but they may provide some benefits, such as increased productivity and revenue, and potentially minimize waste and emissions associated with transportation.

A-3.2 Mill Operations and Closure

The mill design was developed by Ausenco Engineering Canada Inc. (Ausenco), a consulting firm with global mill design experience and Oregon Professional Engineer licensing. Elements considered in the review of BAPNT for mill operations include chemical processing, cyanide management, air quality controls, process solution containments, wildlife exclusion, and closure of the mill.

Chemical Processing

The Applicant proposes to use cyanide to extract gold and silver from ore using a carbon-in-leach cyanide closed-loop circuit, elution, electrowinning recovery, cyanide detoxification, and tailings disposal (see Section 2.1.5 of the EE for descriptions of these processes). Some alternative methods of gold extraction include gold roasting and mercury amalgamation. Gold roasting is a process in which gold-aggregated ore is heated to remove sulfur compounds that would otherwise interfere with chemical leaching processes and is a common activity in a number of developing countries but is no longer practiced in North America because newer technologies have been developed that are less environmentally damaging (Hilson and Murck 2001). Similarly, mercury amalgamation is used in a number of gold mining regions throughout the world, including Brazil, Indonesia, and many African countries, but has been replaced almost completely by cyanidation technologies in both the US and Canada (Hilson and Murck 2001).

Other alternative chemical processing options were evaluated as part of the alternatives analysis, including gravity concentration, hydrometallurgical methods, pyrometallurgical methods, flotation, froth flotation, whole mud cyanide leaching, heap leaching, pressure oxidation, use of thiosulfate instead of cyanide, and offsite ore shipment for processing at an existing gold extraction facility. Additional information on these alternative chemical processing options evaluated in the alternatives analysis is provided in Sections 2.2.3.6 through 2.2.3.9 of the EE, where it was determined that the Applicant's proposed chemical processing method for ore extraction is the preferred option for extracting gold from ore since it would likely have the least impact to environmental resources.

Cyanide Management

The Applicant's mill design includes equipment and infrastructure for the detoxification and neutralization of cyanide in the mill tailings. When combined with personal protective equipment and industrial hygiene controls during operations, these control measures are typical for mill facilities that effectively reduce or remove cyanide concentrations in process solutions to levels where their presence in supernatant and process water ponds does not pose a risk to environmental receptors.

Cyanide would be managed in accordance with the general principles in the International Cyanide Management Code (ICMC) because the Applicant would seek ICMC certification (Ausenco 2023). Companies that use cyanide and adopt the ICMC must be audited by an independent third party to determine the status of ICMC implementation, which ensures that best practices for handling cyanide are followed. Many of the specific ICMC compliance actions, cyanide handling, storage design criteria, and operating procedures required would be developed during future phases of the Project. Participation in the ICMC and obtaining certification would be a best practice for the transport and management of cyanide at the Project site and for its disposal.

An alternative cyanide use strategy would be to reduce the amount of cyanide used to process gold and silver, which may reduce the concentration of cyanide in the tailings. However, using lower concentrations of cyanide in process solution for the proposed Project would result in lower gold and silver production, thus incurring environmental effects without realizing the full production benefits. Managing cyanide concentrations in process solutions (tailings) following the removal of gold from ore would be environmentally protective without affecting gold and silver production.

Cyanide concentrations in tailings and process solution would be managed via cyanide destruction. The carbon-in-leach tailings would be pumped to the cyanide detoxification tank, where lime would be added to buffer pH, copper sulfate added as a reaction catalyst, and sodium meta-bisulfite added as a source of sulfur dioxide. The feasibility study conducted for the Project demonstrated that the sulfur dioxide/air process is an effective detoxification method at reducing weak-acid dissociable (WAD) cyanide levels to 15 milligrams per liter (mg/L) (30 mg/L maximum) for the Grassy Mountain gold deposit (Ausenco 2020). This cyanide destruction technique is a well-known and effective method of reducing cyanide levels in tailings.

For monitoring of cyanide, typically samples are analyzed by a certified analytical laboratory to ensure quality and consistency with monitoring data. The Applicant proposes to monitor cyanide levels in samples collected from the TSF and reclaim pond during operations (Ausenco 2023). An alternative cyanide monitoring method would be through the use of an in-line device that generates more frequent monitoring data capable of capturing fluctuations in the process cyanide solution. This would allow for rapid adjustments to be made in the cyanide destruction process. The Applicant has indicated that the Cynoprobe™ equipment would be used to monitor cyanide prior to going into tailing (Van Treek pers comm. 2023). The use of sampling and laboratory analyses and an in-line device would be an effective strategy for cyanide monitoring and management.

Principle 7 of the Global Industry Standard on Tailings Management (2020) describes best practices for designing, implementing, and operating monitoring systems in all phases of the TSF lifecycle. This principle covers important monitoring designs including designing a monitoring plan with adaptive management, using the observation method to mitigate or reduce risk in unfavorable situations, creating specific and measurable performance objectives, recording and evaluating data at appropriate frequencies, addressing values outside of the expected range, and reporting results to meet company and regulatory requirements (Global Industry Standards on Tailings Management 2020). GKM Consultants reviewed the current recommendations for monitoring TSFs and compared manual monitoring, data loggers, and telemetry-enabled loggers. Manual monitoring is useful at large, stable sites, but produces sparse readings. This method allows monitors to make observations and inspections while sampling, but more effort is needed for data storage and quality control. Data loggers collect data more frequently and can be retrieved as needed, which allows more information to track events and changes. Telemetry-enabled loggers collect readings and transmit remotely and are typically newer technologies (Le Borgne et al. 2024).

In Chapter 13 of *Gold Ore Processing: Project Development and Operations*, Donato and Overdevest (2016) review Cyanide Code compliance for TSF monitoring programs. They cite various methods for measuring cyanide concentrations in groundwater, tailings solutions, and surface waters in laboratory settings. For sampling techniques, they emphasize the importance of careful and consistent field sampling methods to determine accurate measurements. In particular, Donato and Overdevest state “the use of screw-topped lids and opaque and labeled containers that are chilled while in transit to the laboratory are important in accurately preserving cyanides in solution samples” (Donato and Overdevest 2016). The Nevada Gold Mines LLC North Block Project determined WAD cyanide levels by sampling the tailings slurry liquid fraction following neutralization quarterly (Nevada Division of Environmental Protection 2019).

See Section 2.2.3.8 of the EE for further information on cyanide alternatives.

Air Quality Controls

A standard Air Contaminant Discharge Permit (ACDP) would be required from the Oregon Department of Environmental Quality (DEQ) for the Project prior to commencing construction and operation, and appropriate emission control equipment would be installed and operated in accordance with DEQ requirements. Pollution control devices would control combustion emissions and would be installed, operated, and maintained in good working order to minimize emissions.

The Applicant’s proposed process of extracting gold and silver from ore includes the use of a mercury retort oven that collects elemental mercury from the refining process. Gas scrubbers would be equipped with mercury control carbon beds for absorption of mercury from the gas streams. Prior to construction, air quality permits typically require a maximum available control technology analysis of the mercury control devices to confirm that they are up to date per industry and regulatory standards. There are mercury retorts available from various suppliers that may have varying degrees of efficiency, such as the FLS Mercury Retort (FLSmidth 2024) and the EnviroCare Mercury Retort Furnace (EnviroCare International 2024). Lochhead Precision Engineering has both an electric and a propane gas-fired mercury retort (Lochhead Precision Engineering 2024). Regardless of which mercury retort is selected by the Applicant, these modern devices would be installed and operated in accordance with the DEQ operating air permit.

The Applicant’s mill design includes dust collection provided in the gold room for smelting operations. Extraction fans would be included for the kiln, electrowinning cell, retort/drying oven, and smelting furnace, and all extraction fans would lead to a gas scrubbing system, called a wet scrubber.

Wet scrubbing processes for gaseous control involve using a liquid to remove pollutants from an exhaust stream. The removal of pollutants in the gaseous stream is done by absorption. Wet scrubbers used for this type of pollutant control are often referred to as absorbers. Most absorbers have removal efficiencies in excess of 90 percent, depending on the pollutant absorbed. Wet scrubbers have relatively small space requirements and are capable of achieving relatively high mass-transfer efficiencies; however, they may create a liquid disposal problem (US Environmental Protection Agency [EPA] 2023a).

Different methods for removing particulates from air streams include electrostatic precipitators and baghouse filters. For an electrostatic precipitator, as particulates enter the unit, they get laden with an electric charge and are then removed by the influence of an electric field. The charged particles are attracted to collector plates carrying the opposite charge. These systems have low energy requirements and operating costs because they act only on the particulate to be removed and only minimally hinder flue gas flow. They are capable of very high efficiencies, even for very small particles. However, they are susceptible to corrosion, are difficult to install in sites with limited space, and require specialized maintenance (EPA 2023b). As such, they would not be as practicable as the Applicant's proposed use of a wet scrubber.

Baghouse filters are a collection of fabric-filter bags that remove suspended particulates from the air stream. A baghouse consists of an array of long, narrow bags with a diameter of about 25 centimeters (10 inches) each. These are suspended upside down in a large enclosure. Dust-laden air is blown upward through the bottom of the enclosure by fans. Particulates are trapped inside the filter bags, while the clean air passes through the fabric and exits from the top of the baghouse. This method offers relatively high resistance to airflow, which leads to substantial energy usage for the fan system (EPA 2023c). This method of particulate removal would likely have higher energy requirements than the Applicant's proposed use of a wet scrubber.

Process Solution Containments

The Applicant's proposed secondary containments are appropriately sized to contain at least 110 percent of the largest container volume within the secondary containment plus allowances for design storm events (2.28 inches over a 24-hour period) and approximately 2 inches (50 millimeters) of freeboard. Containments are typically concrete structures sized per these requirements.

Additional secondary containment measures include installing water stops to protect against process solutions exiting containment via joints and seams in poured concrete and installing concrete coatings (e.g., acid-resistant epoxy coating) for all concrete containments (not just in the hydrochloric acid use areas). These additional containment measures would provide an additional layer of protection against spills migrating beyond containment systems.

Wildlife Exclusion from the Mill

The Applicant's Wildlife Mitigation Plan (EM Strategies and Mason, Bruce & Girard 2023) and Wildlife Protection Plan (Mason, Bruce & Girard 2023) outline a variety of methods to prevent wildlife from accessing the mill. A perimeter fence would be constructed around the Mine and Process Area consisting of an 8-foot-high chain-link fence with a 0.5-inch galvanized hardware cloth mesh that extends a minimum of 18 inches below the ground surface and 30 inches above the ground surface (total height 48 inches). Access to the site would be via a main gate with security guard. This perimeter fence around the Project boundary would prevent many wildlife species, including burrowing mammals, from entering the site, including the mill. Monitoring the perimeter fence would identify any wildlife accessing the Project area, signs of wildlife activity would be addressed, and appropriate measures would be taken. To reduce the attractiveness of the Project facilities, birds and bats would be excluded from potential nesting structures such as open pipes or vents by installing covers, mesh, or netting. Staff would monitor potential nesting structures during the nesting season to detect any failure of exclusion apparatus. In addition, the Applicant's Waste Management Plan (Calico Resources USA Corp. 2023a) describes proper and regular garbage disposal using covered waste bins, which would prevent corvids and other wildlife accessing waste that may be a food source.

No other necessary exclusion methods have been identified for excluding wildlife from the mill.

Closure of the Mill

The Reclamation Plan (Calico Resources USA Corp. 2023b) describes dismantling, salvaging, selling, and authorized offsite disposal of mill infrastructure. Non-movable mill components such as slabs and foundations would be broken, buried, and then recontoured in place. These are appropriate measures to remove infrastructure from the Project site.

An alternative strategy would be to remove all foundation materials after it is broken up for transport to an offsite disposal facility. Foundation materials consist of hardened concrete, which is chemically unreactive with the environment and once broken and buried does not represent a barrier to revegetation. Therefore, removal of foundation materials for offsite disposal involves an activity without a benefit to reclamation and revegetation.

Post-reclamation and removal of surface facilities, disturbed areas would be regraded and 12 inches of growth media placed over regraded surfaces and revegetated. The goal of reclamation is to establish a sustainable ecosystem similar to pre-mining conditions that supports defined land uses of livestock grazing or rangeland, wildlife habitat, and recreational land. For more native communities, such as the Big Sagebrush/Bluebunch Wheatgrass Community, it would take many years to re-establish a similar vegetation community post-mining. Additional measures to establish sagebrush habitats include using soil amendments and planting sagebrush plugs/seedlings, perennial grasses, and perennial forbs in appropriate quantities/ratios to achieve viable sagebrush habitats. Considering that sagebrush recovery and restoration are slow processes with high risks of failure, a robust monitoring program specifically designed to address re-establishment of sagebrush communities would assist with restoration success.

The internal electrical power distribution lines installed to support the Project are proposed to be removed as part of reclamation activities under the Applicant's proposed Project. An alternative would be to leave these power lines in place to support monitoring power requirements. Electrical power transmission lines installed to support the Project are the property of the power supplier and are maintained or removed by their owner. Following reclamation activities, electrical power requirements for the closed facility would be minimal. Power for ongoing monitoring of groundwater wells and piezometers would be supplied by batteries or generators associated with the monitoring and sampling equipment. Therefore, retaining power distribution lines within the Project area following the conclusion of reclamation activities is not required and does not have a foreseeable benefit.

In addition to these proposed measures, it is best practice to establish closure-period inspections of process facility components to detect contamination prior to closing those components in place. If contamination is identified, appropriate remediation should be undertaken prior to burying and recontouring the components in place to avoid contamination of the site.

A-3.3 Tailings Management

The review of BAPNT for tailings management and disposal includes tailings disposal, TSF design, leak detection, long-term pollution prevention controls, wildlife exclusion, and closure of the TSF.

Tailings Disposal

Options for tailings disposal include permanent storage of tailings in a lined TSF and mixing with cement and rock to create CRF to use as backfill in underground workings. The option for converting all tailings to paste tailings for use as backfill was eliminated from further review in the EE because this option would result in greater environmental effects than the use of a TSF only (see Section 2.2.3.5 for further information).

For storing tailings in a TSF, the Applicant considered different levels of pre-disposal dewatering technologies (Golder Associates 2019), including:

- Conventional tailings slurry (25 to 60 percent solids, weight by weight [w/w]); a pumpable slurry.
- Filtered tailings (75 to 85 percent solids w/w); vacuum or pressure filtration removes water to create the consistency of a solid material.
- High-density thickened tailings (50 to 80 percent solids w/w); paste tailings are dewatered to a non-segregating but pumpable slurry that typically has minor bleed water after placement.

The filtered tailings and high-density thickened tailings options would require the construction of additional infrastructure to mechanically dewater the tailings prior to storage/disposal, including a large aboveground waste disposal area and additional stormwater management and diversion structures. These options would require additional geotechnical design, closure, and reclamation planning and design (Golder Associates 2019). The conventional tailings slurry option was considered to be the preferred alternative for tailings management since it would result in less surface area disturbance and fewer infrastructure requirements and is included in the Applicant's proposed action.

The TSF process solutions recovered from the supernatant pond plus overdrain and leak detection systems would be monitored for pH to check the efficacy of lime addition in controlling potential acid generation by sulfide minerals within the tailings.

The TSF facility would maintain a facility water balance reflecting measured tailings slurry discharges, supernatant pond volumes and recycling, and meteorological inputs (i.e., measured precipitation) and withdrawals (i.e., calculated evaporation). The water balance accounting would also check the capacity of the TSF facility to contain deterministic design storm events plus stochastic representations of future meteorological conditions. The water balance would be used to confirm the ability of the facility to maintain containment of tailings and process solution under the foreseeable site meteorological conditions.

Tailings Storage Facility Design

The Applicant's TSF design was developed by Golder Associates (now WSP), a consulting firm with global tailings design experience and Oregon Professional Engineer licensing. The tailing facility design criteria were based on:

- Water Resources Department, Dam Safety Regulations OAR 690, Division 20;
- DOGAMI, Chemical Process Mine Regulations, OAR 632, Division 37;
- DEQ, Chemical Mining, OAR 340, Division 43; and
- Oregon Department of Fish and Wildlife (ODFW), Chemical Process Mining Consolidated Application and Permit Review Standards, OAR 635, Division 420.

The TSF is proposed to be located in a broad valley with embankments constructed on the north and west sides. This location requires smaller volumes of embankment fill (as compared to a TSF located outside of the valley), structural stability, and relatively short haul distances between the mine portal, processing mill, and TSF and represents the best location for the TSF. The Oregon Department of Water Resources (WRD) was consulted regarding applicable requirements for a tailings dam at this location. The WRD designated the proposed tailings design as a low-hazard dam, and its design criteria (e.g., stability factors of safety) conform with that classification. The WRD hazard-designation process is based on consideration of the effects of a dam in releasing stored water rather than tailings. The consideration of media impounded behind a dam (e.g., water, tailings) in establishing hazard designations varies by regulatory jurisdiction. However, the different systems for hazard designations commonly focus on dam failure risks to human life, public health, infrastructure damage, property losses or damage, and losses or damage to surface water bodies regardless of the impounded media. Water quality effects associated with release of tailings via dam breaches are generally not a component of the hazard designation.

The Applicant has designed the TSF as a zero-discharge facility that would contain all process solutions during operations and closure. The design includes double lining or containment for the impoundment, channels, piping, and other systems that would contain or convey process solutions. Facilities that would contain process solution would be equipped with leak detection infrastructure. The TSF design included a dam breach analysis with forecasting of effects in the event of a dam breach through examination of the potential tailings runout. The infrastructure predicted to be affected by a full-depth breach is limited to segments of Rock Canyon Road and Twin Springs Road. No habitations are predicted to be affected. No subsurface water at depths shallower than 120 feet was encountered during the site investigation below the TSF footprint (Ausenco 2020). Therefore, unwanted upward pressure from groundwater on TSF facilities is unlikely. Also, any uncontained seepage or releases from the facilities would need to infiltrate at least 120 feet into the subsurface before contacting groundwater.

Design drawings C1, C8, C10, and C12 in the TSF design report (Golder Associates 2021) appear to illustrate the tailings supernatant pond in contact with exposed liner on the eastern side of the tailings impoundment. Best practices for operating a tailings facility involve keeping the supernatant pond on tailings rather than in direct contact with the liner. Fine-grained tailings have low permeability and inhibit leakage through liner defects. The design grind size for the mill facility is particles passing a US mesh #150 sieve (89 microns). At this grind size, tailings particles would consist of clays, silts, and very fine sands that would exhibit low-permeability properties (but would not be impermeable). Further, placement of tailings on the liner limits the liner’s exposure to sunlight and environmental conditions that could weaken liner integrity, while supernatant pond water is not protective to the same extent. Therefore, the placement of tailings across the entire liner is the best method for placement of tailings to protect liner integrity.

Geosynthetic liner systems are reparable from the time of their installations until they are covered by stored materials that preclude further physical access to the liner system. Liner patches and seam repairs are affected by welding new liner material to the installed portions or re-welding installed liner together. These repairs require the ability to observe the location of the liner defect and then access it with welding equipment.

Alternative embankment designs would utilize engineered materials (e.g., concrete) in place of earthen materials in full or in part. Full replacement designs would resemble concrete water dams while partial replacement designs would use a starter dam constructed of engineered materials with subsequent dam phases constructed by earthen materials. For a mining application, earthen materials are readily available for embankment construction and have been demonstrated to be effective for TSFs. Laser imaging, detection, and ranging (LiDAR) is a remote-sensing technology that provides accurate measurements of objects and landforms. For geological and mining purposes, LiDAR can be used to detect changes in slopes that may reflect slope stability; to detect ground subsidence and wall stability in open-pit mines; and to detect landslide activity before other types of monitoring and sensors, among other applications (An et al. 2024, Casagli et al. 2023; Duffell et al. 2012). Since the Project is an underground mine, LiDAR is not an appropriate method for assessing mine wall stability because LiDAR is not able to detect changes under the ground surface. However, it could be used to monitor the stability of the TSF.

The TSF is designed to fill an existing valley at the Project site and requires staged embankment construction on two sides. LiDAR could be used to monitor the embankments and the valley walls during the period of operation of the TSF by periodically scanning the sides of the TSF. Comparing the data obtained from each scan could reveal changes in the slope or profile of the TSF walls that could indicate shifting or instability. For a relatively small area such as the TSF, LiDAR could be flown with a helicopter or obtained from a stationary ground- or water-based platform. However, this technology is not required to assess the stability of the TSF embankments because the embankment location would be static following construction compared to the changing conditions in ongoing excavations. The stability of the TSF embankment can be monitored via optical surveys, inspections for deformations, and pressure transducers that quantify changes in hydraulic pressure on the embankment.

The Applicant’s TSF design incorporates technologies to design, build, operate, and monitor a tailings facility that are necessary, available, and practical, as demonstrated by their effective use at numerous regional tailings facilities constructed in accordance with regulatory requirements. When installed to design specifications, the Applicant’s proposed synthetically lined TSF using prepared subgrades, an embankment dam designed for seismic conditions, plus leak detection, monitoring, and inspection equipment and procedures would be as protective or more protective of water resources compared to other designs in use.

Leak Detection

The Applicant’s TSF design using a double-liner system with leak detection and collection would detect leaks quickly, contain waste and waste solutions effectively, and prevent releases to the environment. Leakage through the primary liner would appear in the leak detection sump in the amount of time that it takes for the water to flow through the collection pipes to the sump. The flow time in the collection pipes would be on the order of a few hours depending on the distance from the leak location to the sump. The detection of the leak would occur at the time that the leak detection sump was inspected and evacuated which is typically weekly. Therefore, leaks would be detected within approximately one week.

There are numerous other methods in common practice for detecting leaks through geosynthetic liners such as groundwater monitoring, electromagnetic methods, and geophysical methods (Oh et al. 2008). These are indirect (and often time-delayed) methods for detecting leaks that rely on a substantial volume of leakage for detection and are subject to other environmental influences such atmospheric electrical conditions and other constituent sources that require consideration and interpretations for their usage in assessing leaks. Leak collection systems using dual liners constitute the most accurate means for identification of leaks (Gilson-Beck 2019). See Section 2.2.3.4 for further information on alternative leak detection methods.

Long-Term Pollution Prevention Controls and Monitoring

Long-term pollution prevention controls and monitoring are important aspects of a mine project so that the environment is protected from contamination after a mine closes. Various features of a mine are monitored over the long term to ensure that the pollution controls and measures taken to prevent contamination are working as placed and actions can be taken to address identified problems should they occur. According to Hilson and Murck (2001), most gold mines operated by larger senior mining companies have implemented state-of-the-art measures that best prevent environmental problems in cyanidation practices and acid rock drainage management, but that small- and medium-sized junior mining companies are doing only what is necessary to comply with environmental regulations. Environmental controls used as best practices by other mining companies are considered here.

For this Project, the Applicant's long-term pollution prevention controls include:

- Backfilling the underground mine with CRF to prevent acid rock drainage and metals leaching;
- Plugging the mine portal to prevent oxygen and water from entering;
- Retaining liners on facilities in perpetuity, including the TSF and reclaim pond, to protect groundwater;
- Reclaiming mine areas, including the TSF, temporary stockpiles, building foundation areas, and parking lot, by grading, placement of growth media, and revegetating to provide long-term stability, mimic adjacent landforms, facilitate revegetation, control drainage, and minimize erosion;
- Converting the reclaim pond to an evaporation cell (e-cell) by covering the geomembrane-lined pond with growth media and revegetating to allow for long-term management of stormwater at the TSF; and
- Retaining stormwater diversion channels and surface water run-on diversion berms at the TSF and quarry to prevent stormwater from entering these areas.

These are necessary and appropriate long-term pollution prevention controls for the Project.

In the western United States, stormwater controls and diversions around mine facilities, including TSFs, are standard regulatory requirements. The Applicant would retain stormwater diversion channels and surface water run-on diversion berms at the TSF and quarry post-closure to prevent stormwater from entering these areas. Stormwater diversions are effective in protecting mine facilities as long as they retain their designed physical condition and do not experience larger-than-design events or erosion. Design requirements are typically specified by state regulations, and diversion construction is subject to quality controls and regular inspections during operations. Diversion failures during operations affect the operation of revenue-generating facilities and are therefore repaired as part of the operations. In the post-closure period, diversion failures have the potential to affect the physical and chemical stability of reclaimed facilities. Therefore, inspection and maintenance of diversions into the post-closure period is a best practice.

Monitoring of mined materials quarterly during operations could also be added to long-term pollution controls to confirm and update the potential for acid generation and metal leaching per the *a priori* site geochemical characterization and to allow adaptation of operational and closure plans, if necessary, to the observed conditions while mining.

With regard to long-term monitoring, the Applicant would create and submit a detailed post-closure monitoring plan to the Bureau of Land Management and DOGAMI prior to execution that would include methods, parameters, and frequencies of monitoring actions. The Applicant’s long-term monitoring plans include:

- Installing groundwater monitoring wells in locations close to the facility perimeter to detect contamination in groundwater;
- Monitoring for noxious weeds to identify and treat infestations;
- Conducting inspections, cleaning, maintenance, and repairs of catch basins, grates, screens, oil/water separators, and sedimentation basins to prevent possible contamination of stormwater equipment and systems;
- Conducting inspections and sampling of all non-contact stormwater discharge points if water is present to determine if stormwater discharge is causing or contributing to a violation of any instream water quality standard established in OAR 340-041 and to take corrective action if needed;
- Sampling of stormwater discharges for compliance with the Stormwater General Discharge Permit; and
- Inspecting and sampling stormwater diversion channels for 15 years during the reclamation monitoring period to ensure that sediment has not accumulated and that the lining in the channels has not been compromised.

Monitoring strategies used in other mine areas may include biomonitoring and vegetation cover indexes. Biomonitoring can be used to evaluate mining effects on aquatic ecosystems. Under this method, quantification of microbiota and the taxonomic richness of water invertebrates and basic physicochemical parameters are used to assess mining pollution. This method offers a cost-effective alternative to expensive monitoring methods (Borda et al. 2023). However, considering that there are no aquatic ecosystems at the Project site, this would not be a practicable alternative. Vegetation cover indexes can also be used as a pollution indicator in gold mining areas. Under this method, vegetation cover indexes created for areas surrounding mine facilities are tracked and analyzed over time, allowing for quantification of mining activity impacts on the surrounding vegetation (Andaryani et al. 2023). This method has been employed as a pollution warning tool in gold mining areas in the northwest of Iran that use heap leaching. However, considering that all mine areas containing contaminated materials would be protected with liners, stormwater diversion channels, and revegetated, this method would not likely succeed and is therefore not considered a necessary technology.

Rather than using biomonitoring and vegetation cover indexes, the Applicant proposes to use groundwater monitoring wells to detect contamination of groundwater from mine facilities. These groundwater monitoring wells would be installed close to the facility perimeter (e.g., within 250 feet) with a relatively short screen interval (e.g., 20 feet), with the top of the screen located approximately at the local groundwater surface elevation. This location targets the groundwater most likely to be affected by the facility, with minimal opportunity for dilution of samples by mixture with other groundwater areas or depths. The Applicant’s groundwater monitoring program is therefore considered to be effective in identifying contamination of groundwater.

Tailings Storage Facility Wildlife Exclusion

The Wildlife Mitigation Plan (EM Strategies and Mason, Bruce & Girard 2023), Wildlife Protection Plan (Mason, Bruce & Girard 2023), and Section 3.5 of the EE outline a variety of methods to deter wildlife from using the TSF. The perimeter fence around the Project area would prevent many wildlife species, including burrowing mammals, from entering the Project area and accessing the TSF. A permanent stormwater diversion channel would act as a physical barrier along the south side of the TSF, and the Applicant proposes installing an additional fence around the reclaim pond for extra protection. Monitoring the perimeter fences would ensure that wildlife are not accessing the Project area or the TSF. Any signs of wildlife activity would be addressed and appropriate measures taken.

Wildlife that can climb the fences or fly into the area would be able to access the TSF. The Applicant proposes deploying bird deterrent balls on the TSF reclaim pond to deter birds and bats from landing on the surface or drinking the water. Although specific studies on the effectiveness of bird balls as a deterrent are not available, the ICMC recommends this technique in the Cyanide Code guidance (International Cyanide Management Institute 2021).

Other types of deterrents such as radar-activated sounds, human or bird effigies, and propane cannons that activate when birds are detected may be used. One study conducted at the oil sands region of Alberta, Canada, found that the on-demand deterrent system significantly reduced the probability of birds landing in comparison with a continuous, randomly activated deterrent system and control periods with no deterrents (Ronconi and St. Clair 2006). The efficacy of different stimuli types within the on-demand system was also assessed and cannons were found to elicit significantly more response by birds in flight than mechanized peregrine falcon effigies with speakers broadcasting peregrine sounds. In addition, birds were more likely to land earlier in the spring and when they flew at lower altitudes, and shorebirds were more likely to land than ducks, geese, and gulls

The best deterrence techniques for birds appear to be the use of varied (i.e., changing the location, timing, and/or frequencies of sound and visual techniques) and targeted deterrence techniques in specific areas for known species or family taxa (Chilvers 2024). Applying this approach to the Project would require additional monitoring or surveys to determine the species most likely to be in the Project area in a given season and targeting deterrent methods toward those species. In summary, the most effective methods for deterring birds from landing on the TSF may:

- Use radar-activation;
- Be operational in the early spring when tailings ponds appear to be most attractive to migrating waterfowl;
- Target low-flying waterfowl and shorebirds;
- Be specific to species or groups of birds; and
- Be effective during both day and night.

Alternative deterrent methods may include non-lethal “hazing” methods such as sound air cannons, explosives, or bird tear gas. Since these methods are more disturbing to wildlife, they should be used in emergency situations only, such as if cyanide levels in the TSF were to become elevated beyond permitted levels. Such emergency hazing techniques would be coordinated with the ODFW prior to use.

Potential additional measures to prevent waterbirds from landing on the TSF pond and wildlife from entering the TSF area include the use of visual deterrents, motion-activated devices, laser deterrents, emergency hazing techniques, bio-exclusion zones, decoy ponds, use of hypersalinity, and netting and wires, as described herein. Using habitat management to attract birds to an alternate habitat nearby such as a decoy pond has the advantage of targeting waterfowl and is a more passive technique once constructed. However, disadvantages of decoy ponds include difficulty accessing freshwater, avian botulism outbreaks, high cost of development (Bradford et al. 1991), and attracting more birds to the area (Chilvers 2024). For these reasons, decoy ponds are not recommended as a wildlife exclusion method for this Project.

An alternative strategy to deter wildlife from consuming water at the TSF is to create an inhospitable hypersaline environment. Elevated levels of salinity in open impoundments have been shown to reduce wildlife drinking and foraging (Griffiths et al. 2014). Hypersalinity involves increasing the salt concentration in the water to levels that are unpalatable. This can be achieved by adding salts directly to the water or by manipulating natural salt deposits in the surrounding geology. The specific salts used and their concentrations depend on the local environment and the types of wildlife typically found in the area. Salinity levels need to be carefully monitored and maintained to ensure they are high enough to deter wildlife but not so high that they create other environmental issues, such as soil degradation or harm to other wildlife. Hypersalinity can affect the surrounding ecosystem if not responsibly managed. The challenges and limitations to using hypersaline tailing ponds is the initial cost of installation and maintaining the correct salinity levels required which requires ongoing monitoring and management including regular addition of salts and checking for dilution effects from rainwater or other sources. The salt can also cause significant wear and tear on equipment used to manage the ponds. This necessitates the use of corrosion-resistant materials and regular maintenance. Hypersalinity deterrence effects can vary based on bird species and environmental conditions. Some birds might be more tolerant of higher salinity levels, and local conditions such as climate and availability of fresh water sources can influence effectiveness. While hypersalinity can be effective, it is often used in conjunction with other avian deterrence strategies to enhance effectiveness and mitigate any potential negative impacts.

With regard to using netting and wires to exclude birds and bats from the TSF, the majority of studies on netting and wires have been conducted at smaller scales, and the National Academies of Sciences, Engineering, and Medicine suggest large-scale use of total exclusion measures, such as netting and wires, is impractical and cost prohibitive. Netting may interfere with routine daily maintenance, can be damaged by the wind or buildup of snow and ice, and if not maintained correctly may also present a hazard to wildlife, such as loose netting resulting in entanglement of bird species. (Bishop et al. 2003; Lowney 1993; National Academies of Sciences, Engineering, and Medicine 2011).

Several studies have reviewed the effectiveness of techniques to exclude birds from accessing ponds or sites such as airports where there is risk to human activity or wildlife. The National Academies of Sciences, Engineering, and Medicine reviewed literature on the effectiveness of bird deterrent techniques and found varying levels of effectiveness dependent on the surrounding area and species being deterred (2011). Therefore, monitoring of the deterrents' effectiveness and contingency plans in the event of cyanide concentrations increasing are outlined in the Wildlife Protection Plan (Mason, Bruce & Girard 2023).

To reduce the attractiveness of the Project area in general, birds and bats would be excluded from potential nesting structures such as open pipes or vents by installing covers, mesh, or netting. Monitoring the TSF during operations for the presence of fish, aquatic invertebrates, aquatic algae, and vegetation and removing any findings would prevent the reclaim pond from becoming more attractive to other wildlife as a water or food source.

Closure of the Tailings Storage Facility

TSF closure options include dry closure, wet closure, and wetland establishment closure.

Dry closure methods involve allowing water content in the tailings to evaporate or drain to the reclaim pond, regrading the surface to shed water, installing a composite cover designed to prevent water and air infiltration, adding a soil layer, and revegetating. A dry closure is the most common closure method approved by the Nevada Division of Environmental Protection (2018). The Applicant proposes dry closure of the TSF due to the arid climate at the site (Calico Resources USA Corp. 2023b).

Wet closure methods are used in areas with low evapotranspiration and on sites when tailings facilities are situated in pits. This method involves permanent immersion of deposited tailings with water discharged into the TSF (Komljenovic et al. 2020). A simple soil cover can be added to the top of the tailings, and the groundwater level is raised to permanently cover the tailings, which eliminates sulfide oxidation. This method is applicable where the natural groundwater level in the tailings is very shallow.

Wetland establishment closure involves constructing a wetland on and around tailings as a nature-based solution to restoring waters polluted with heavy metals and other contaminants. Conditions and contaminants at each site influence the type of wetland constructed. Many mines use wetlands to treat tailings since they are cost-effective, low-maintenance, and can provide habitat and other benefits to wildlife. However, wetlands may take a long time to establish before they are self-sustained, require large areas to construct, may not address all contaminants in tailings, and may be less effective in climates with cold winters. In arid regions with prolonged droughts, there may be significant water loss due to evapotranspiration, in which case a supplemental source of water would be needed to maintain adequate water levels (Davis 1995).

The dry closure method is identified as the most suitable method for closure of the TSF due to the arid climate and deep water table, which are not suitable conditions for the other water-based closure methods.

The TSF closure method proposed by the Applicant includes decommissioning the reclaim pond liner in place. During the early closure period, the lined reclaim pond would be used to collect draindown from the TSF for active management (i.e., recirculation and evaporation) of that process water. Once draindown flow diminishes to a few gallons per minute, the lined reclaim pond would be backfilled with alluvial material in a way that residual draindown is introduced into the alluvial material above the liner. The backfilled material would be revegetated so that draindown water entering the backfill material is subject to evaporation and transpiration. This evapotranspiration rate would balance the draindown rate entering the backfilled pond to remove the process water from the system so that it does not accumulate.

The current cover design for the TSF uses a geosynthetic liner placed over the tailings surface and then covered with growth material and revegetated. Other regional closures for TSFs use store-and-release covers, which consist of a revegetated growth media without the geosynthetic liner. The store-and-release covers are sufficiently thick to contain winter season infiltration of meteoric waters that are subsequently removed by evapotranspiration during the summer season. While the store-and-release covers have been effective at other locations, they are not consistent with Oregon regulations requiring the use of geosynthetic covers.

At closure, the TSF and reclaim pond would be covered with 12 inches of growth media and revegetated. Hydroseeding is one potential method for revegetating the TSF area. Hydroseeding involves spraying a mixture of seed, mulch, and fertilizer in a water-based slurry onto the soil surface. The benefits of hydroseeding are that it is less labor intensive than hand seeding and can quickly cover large areas (approximately 1–2 hours per acre, depending on tank size) (Utah State University n.d.). Hydroseeding has been used to restore various types of mine waste areas, including waste rock areas and disposal ponds (Lorite et al. 2021).

The hydroseeding process involves a hydroseeder, a large tank with a sprayer attached that may be mounted on a truck or pulled as a trailer, and a substantial amount of water. A typical hydroseeder with a 500-gallon tank can cover 6,600 square feet, while a 1,000-gallon hydroseeder seeds 13,000 square feet (Turbo Turf 2024). With regard to seed germination and establishment, hydroseeding has been shown to be effective, but not substantially more effective than manual or broadcast seeding (Montalvo et al. 2002). According to the Natural Resources Conservation Service, when both mulch and seed are applied, split applications are generally more effective than applying all materials in one pass (Natural Resources Conservation Service 2024). The cost of hydroseeding is much greater than the cost of other seeding methods (estimates range from $550–$4,000 per acre for hydroseeding, compared with $10–$30 acre for broadcast seeding or $25–$55/acre for planting with a seed drill) (Pawelek et al. 2015). Due to the high cost and comparable effectiveness of other seeding approaches, hydroseeding is not recommended as an appropriate choice for revegetating the TSF after mine closure.

A-3.4 Operations Management

The BAPNT review for operations management includes water management, fugitive dust control, and operations monitoring.

Water Management

Water is required for the Project for mining, ore processing, fire protection, potable uses, dust suppression, and various other uses. Inflows to the system include precipitation and snowmelt falling on lined facilities; runoff from an upstream basin reporting to the TSF; seepage into the underground mine; and makeup water from the production well field as needed. Outflows include evaporation from the tailings surface, supernatant pool, and reclaim pond; dust control; CRF preparation; and water lost in the void spaces of the stored tailings. Overall, the proposed Project would have a negative water balance, requiring additional water. Water makeup requirements would vary during operations based on seasonal meteoric contributions and variable seepage flows in the underground mine.

Additional water required for operations would come from site production wells. A well field design report (SPF Water Engineering 2019) was prepared to support the Project needs. Currently, there are three wells onsite. One of the existing wells and two new wells would be sufficient to fill the raw water tank. Additional wells would be proposed and constructed if they become necessary. The other two existing wells onsite may be used for local water supply uses such as dust suppression.

Alternative water supplies were considered as part of the alternatives evaluation in Section 2.2 of the EE. There are no surface water supplies suitable for this Project, so the options for additional water supply are (1) from groundwater wells, or (2) from a municipal water supply via a buried pipeline. The alternatives analysis found that there would be greater detrimental environmental effects from installing a pipeline to supply municipal water than to install onsite wells. Considering that the Applicant has designed the Project to capture precipitation and recycle process water, no other water management options have been identified.

Water management is a continuous process that must be monitored and adjusted as needed throughout the mine's lifetime. A water balance maintained during operations monitors inflow versus outflow, which reduces the risk of operational water deficits. The Applicant's dedicated weather station to be installed onsite would allow for accurate data collection to estimate meteoric inputs and other factors affecting water during operations. Reliable weather data combined with regular monitoring of operational water levels, surface waters, and groundwater allows for forecasting hydrological conditions to prepare necessary adjustments such as constructing new wells if additional water makeup is required (Punkkinen et al. 2016). For this Project, water level and water quality sampling at each well would be conducted quarterly, with testing starting shortly after well construction and development. Background monitoring would occur at all new wells for at least a year prior to any facility use. Monitoring at all wells would occur throughout the mine's operation and after mining operations cease (SPF Water Engineering 2022).

Rather than collecting groundwater entering underground mine workings using sumps (see Section 2.1.2.2), perimeter pumping wells outside the workings could be used to intercept groundwater prior to it entering the underground workings. This dewatering technique would increase the volume of groundwater managed by the dewatering system by handling more groundwater than would actually enter the mine. However, intercepting groundwater prior to entering the underground workings decreases the potential for geotechnical failures in the workings associated with hydraulic pressures on the excavated areas and decreases the interaction between collected groundwater with mined materials and mine equipment. This interaction potentially results in acid rock drainage in mine areas prior to installation of cement ground support and/or backfill, increased analyte concentrations due to leaching, or introduction of equipment-related contaminants. However, the use of perimeter pumping wells requires sufficiently permeable aquifer characteristics to draw water away from the underground workings and sustain groundwater pumping from the wells. Pumping of existing wells in the vicinity of the Project orebody has not yielded the sustained groundwater production suitable for mine dewatering.

At closure, water supply pipelines would be removed from their operational alignment for salvage or disposal. Pipeline removal is preferred over decommissioning in place to eliminate conduits that could inadvertently convey flows or collapse resulting in uneven ground surface conditions in the post-closure period.

Fugitive Dust Control

Fugitive dust can arise from travel on roadways, construction and demolition activities such as concrete mixing and blasting, and from mine operations such as rock crushing. Dust is not expected to occur at the TSF due to the continual placement of wet tailings slurry on the surface. After operations cease, the tailings would settle and consolidate to allow for surface regrading and cover placement. When covered, the TSF would not be a source of dust. However, there is potential for the tailings to dry and create a dust hazard during the dry summer period after operations cease. For this reason, the closure plan should include regular monitoring of the TSF surface during the period after final TSF slurry placement and prior to cover placement.

To address fugitive dust from roadways, the Applicant would use CAT 777G and Normet Multimec MF100 water trucks to spray water in high traffic areas for dust suppression such as in the underground mine, at the quarry, and on roadways. Water used for fugitive dust suppression would be supplied by existing production Wells 1 and 2 at the Project site.

To address fugitive dust from mine facilities, certain equipment would be fitted with enclosures, hoods, curtains, movable and telescoping chutes, and shrouds as appropriate. Table A-1 provides a summary of the Project's dust and particulate matter sources and the Applicant's proposed control methods.

Table A-1 Dust Sources and Control Methods

Fugitive Dust and Particulate Matter Sources	Possible Control Methods
Unpaved roads	Dust suppression chemicals and water application
Stockpile (run-of-mine ore)	Inherent moisture content of the ore
Crushing units and associated handling (e.g., bins, conveyors)	Inherent moisture content of the ore
Lime silo loading	Bin vent
Carbon regeneration kiln	Wet scrubber/carbon filter
Electrowinning cells and pregnant solution tank	Carbon filter
Mercury retort	Condenser/carbon filter
Melting furnace	Baghouse/carbon filter
Laboratory operations	Fume hoods
Mixer loading	May include water sprays, enclosures, hoods, curtains, shrouds, movable and telescoping chutes, and central dust collection systems
Ore and waste rock crushing	Water application or other methods, to be determined
Rock drilling	Water application or other methods, to be determined
Rock blasting	Water application or other methods, to be determined
Material transfers	Water application or other methods, to be determined
Wind erosion	Water application or other methods, to be determined

Source: Ausenco 2022

The standard ACDP required for the Project would include the regulation of particulate matter emissions and fugitive dust from mining operations and onsite haul roads, including air quality monitoring requirements.

Other methods to control fugitive dust may include the following best practices suggested by the EPA (EPA 2022):

- Cover or enclose material piles;
- Install wind breaks and barriers around storage piles;
- Install wheel wash stations to minimize material tracked by vehicles;
- Install and maintain dust curtains at material transfer points;

- Enclose conveyor belts and spray water/dust suppressant at conveyor belts during material transfer;
- Cover open-bodied trucks when they are carrying materials that can be released into the air; and
- Provide fugitive dust control training and safety for staff.

In the event one is granted, the ACDP would identify the best management practices (BMPs) to be used for the proposed Project.

Equipment Maintenance

Common approaches for maintaining mining equipment in working order include reactive, preventative, and predictive maintenance. Reactive maintenance is the most costly and inefficient since it results in unplanned outages and unnecessary maintenance costs that may not have been required otherwise. Calendar-based preventative maintenance often proves to be inefficient because machine failures occur at random times. Predictive maintenance strategies use sensors and other monitoring equipment to collect data on the performance of equipment to identify issues and enable repairs before equipment fails. The most recent advances in mine maintenance technology are prescriptive methods, which involve the integration of big data, analytics, machine learning, and artificial intelligence to implement an action to solve an impending issue, rather than simply recommending an action.

The Applicant should conduct regular inspections and maintenance of equipment to ensure that it remains in good working order. While installing predictive maintenance sensors and other monitoring equipment is not a necessary technology to accomplish maintenance, it would likely result in cost-savings by identifying and conducting maintenance actions on equipment to avoid a major equipment failure and costly downtimes.

Operations Monitoring and Mitigation

The Applicant would monitor various systems and facilities as described in the Monitoring Plan Inventory (Calico Resources USA Corp. 2023c). Table A-2 summarizes the monitoring plans for the proposed Project, as required by future facility permits and to comply with applicable regulations.

Table A-2 Summary of Monitoring Requirements

Resource to Monitor	Monitoring Plan
Fugitive dust and process air emissions	N/A; air quality monitoring would be conducted pursuant to conditions of pending facility air permits
Stormwater	Stormwater Pollution Control Plan as required by an Industrial Stormwater Permit
Groundwater	Monitoring plan for groundwater and leakage detection systems as required by a Water Pollution Control Facility Permit
Hazardous wastes	Waste Management Plan
Tailings (TSF cyanide concentrations and net neutralization potential)	Tailings Chemical Monitoring Plan
Petroleum storage containers (including planned diesel fuel tanks) and spills	Spill Prevention, Control, and Countermeasures Plan; inspection requirements are provided in the Emergency Response Plan
Noxious weeds	Noxious Weed Monitoring and Control Plan

Resource to Monitor	Monitoring Plan
Wildlife, TSF pond, fences, exclusion devices	Wildlife Protection Plan
Noise	Noise Monitoring Plan
TSF and temporary waste rock storage facility leak detection systems	Monitoring plan for groundwater and leakage detection systems
Potable water	Public Drinking Water System Permit Conditional Approval Water System ID #4195624

Some monitoring actions have been identified in the Applicant's plans and others would be specified in future permits (Table A-2). It is assumed that regulatory authorities would impose monitoring requirements for resources under their purview.

With regard to long-term noxious weed management, noxious weed mapping approaches can range from on-the-ground field surveys, such as those performed at the project site, to unmanned aerial vehicle (UAV) surveys, to satellite data interpretation (Ubben et al. 2024; Xing et al. 2024). In UAV surveys, UAVs can be equipped with various camera systems, ranging from red-green-blue to hyperspectral imaging equipment. Due to the relatively low flight altitude of UAVs, spatial resolutions of well below 1 centimeter can be achieved, and a relatively large area can be mapped (Ubben et al. 2024). To identify noxious weed populations at even larger scales, vegetation indices can be applied to satellite imagery to detect spectral and textural differentiations between native plant species and invasive species with above 90 percent accuracy (Xing et al. 2024). Noxious weed mapping data can also be crowd-sourced. In Oregon, the Oregon Department of Agriculture supports an online weed mapping tool called WeedMapper to provide a clearinghouse for noxious weed presence data accumulated by public and private groups as well as individuals (WeedMapper). All these approaches can be useful in recording and monitoring changes in noxious weed coverage at different scales and assessing the effectiveness of noxious weed treatment and eradication strategies.

According to the Noxious Weed Monitoring and Control Plan for the Project, a noxious weed survey was performed at the Project site in 2019 (Calico Resources USA Corp. 2024). The results of this inventory were mapped to show the presence of noxious weeds within the Permit Area. The plan states that two types of weed survey would be conducted in the Project area through final reclamation: an annual informal noxious weed survey would be carried out by environmental department staff, and biennial formal weed surveys would be performed. The results of these surveys would be documented in a report provided to the Bureau of Land Management. Areas of noxious weed infestations noted during the annual and biennial surveys would be recorded with a global positioning system (GPS) unit and documented on area maps and in photographs. The maps generated with these survey data would be useful in determining the spread or containment of noxious weed species and whether weed management strategies applied in the Project area are effective. Noxious weed surveys conducted on the ground are considered appropriate for a Project of this scale and allow for areas with infestations to be targeted for specific management actions that would depend on the weed species.

The Applicant proposes to conduct monitoring of springs and seeps as described in the Spring and Seep Monitoring and Mitigation Plan (SLR International Corporation 2024). Alternative monitoring methods for springs and seeps may include observations of vegetation change in these areas. Wetland and riparian plant species have a strong connection to groundwater depth and soil water content and the cover of plants within wetland indicator groups, and the frequency of wetland indicator species can be an indication of depth of groundwater (Barrick Cortez Gold Mines and JBR Environmental Consultants, Inc.

2010). A water table decline can result in vegetation shift from obligate wetland to facultative wetland or upland species. Hydrophytic vegetation is broken into indicator categories based on the conditions under which the species can survive. Plant indicator groups requiring prolonged inundation or saturated soil conditions are considered obligate wetland species (plants that occur almost always in wetlands), facultative wetland species (plants that usually occur in wetlands but also occur in non-wetland areas) and facultative species (plants that have similar likelihood to occur in wetlands and non-wetlands). Shallow-rooted herbaceous hydric species (obligates and facultative wetland species) that require saturated soils or shallow water to survive are the first group to be influence by groundwater decline. Monitoring would consist of vegetation evaluations twice a year during spring and summer to determine the cover of species present. Effects to springs and seeps would be apparent when less than 50% of the total species present are obligate, facultative wetland, or facultative species.

If water levels in springs or seeps are affected by mine operations, mitigation measures would be followed as described in Section 3.3.4.2. Alternative spring and seep mitigation measures may include installing a water supply pump in an existing well to replace water in a spring or seep, installing a new production well, piping water from a new or existing resource, enhancing flow from an existing seep or spring by installing piping into the source to direct more flow to the surface, and installation of a guzzler (Barrick Cortez Gold Mines and JBR Environmental Consultants, Inc. 2010). Guzzlers are systems used to collect precipitation and runoff and store the water in a surface or buried container which feeds an open trough for use by wildlife.

A-3.5 Acid Rock Drainage Management

The Project site would have a negative water balance, where annual evaporation exceeds annual precipitation. Formation of acid rock drainage requires exposure of sulfide minerals in mined materials to both oxygen and water for the sulfide oxidation reaction and acid generation to occur. While a negative water balance does not preclude acid generation, it does limit the rate of sulfide oxidation and acid generation to the availability of water to generate that oxidation reaction. In practice, sulfide-bearing materials in this type of negative water balance environment are slow to oxidize, allowing management of acidic drainage by covers for surface facilities and cement ground controls in underground applications. Upon mine closure, underground workings would eventually be inundated with groundwater. This would saturate the sulfide minerals, limiting their exposure to atmospheric oxygen and, hence, acid generation.

For this Project, the use of inert rock fill and 7 percent cement would constitute CRF, which would eliminate the potential for acidic drainage in the CRF-backfilled portions of the underground workings because sulfide minerals in the rock fill would be neutralized by the cement. The 7 percent cement required to meet structural strength requirements for the underground mine is a higher percentage of cement than that needed to geochemically stabilize sulfide minerals in the rock fill materials. The neutralization effects of cement application are immediate.

In addition to adding neutralizing potential, the cement reduces the air and water permeability of the backfill material (compared to un-cemented material). Because the sulfide oxidation reaction that generates acidity requires both atmospheric oxygen and water, the reduced air and water permeability of the CRF rate-limits the sulfide oxidation reaction by limiting the availability of oxygen and water to the sulfide minerals. Further, most of the rock fill and CRF would be formulated from inert basalt with no acid-generating potential.

In cases where the sulfide concentration in exposed rock is very high and the cement does not inhibit oxygen exposure, acid drainage could occur once the neutralization capacity of the cement is exhausted. In practice, these instances are rare and location-specific. Such areas of high sulfide concentration can be addressed by adding cement to the specific locations that have been identified as forming acidic drainage based on ground support inspection.

Acidic rock drainage could occur in underground mine access drifts, which are not backfilled with CRF. However, when the access drifts are excavated, exposed rock would be covered with a cement ground support that would limit exposure of sulfides in the exposed rock to oxygen and would neutralize any acid drainage that occurs up until the neutralization component of the cement is exhausted. Additional cement may need to be added in areas of high sulfide concentrations.

Once placed in the underground workings, the backfilled materials are physically and geochemically stable. However, additional monitoring and testing can be conducted to confirm expectations and refine operations. For example, during operations, inspections of the backfill can be conducted to note, quantify, and characterize any seepage and its chemistry. In addition, the different type of mined materials (e.g., ore, waste rock, borrow material) can be sampled at least quarterly and analyzed for acid-generating potential (e.g., acid-base accounting) and metal leaching potential (e.g., meteoric water mobility procedure). By characterizing mined materials at the time they are produced, potential acid-generating conditions can be observed and addressed during active operations ahead of mine closure. This would confirm the pH and leachability of these backfill materials. If there is variability in the source material used for backfill or in the CRF mixture used, sampling frequency can be adjusted or samples can be collected from each backfill type to refine the characterization. The amount of cement added to the rock fill can be adjusted depending on the sampling results. See Appendix D for further information on acid rock drainage and its management.

The Applicant proposes to test waste rock stored at the temporary waste rock storage facility for acid-generating potential weekly for the first 6 months of mine operations, at which time sampling frequency would be re-evaluated to account for variations (or lack thereof) in the mineralogy and the physical and chemical composition of the waste rock (Calico Resources USA Corp. 2023d). The basalt borrow used for CRF does not have a potential to generate acid and is not proposed to be tested for acid-generating potential (SRK Consulting 2022).

Additional water quality monitoring can be conducted to detect acid rock drainage as the underground mine area is dewatered. During operations, water produced from mine dewatering can be sampled and analyzed quarterly for evidence of acid-generation reactions (e.g., changing pH, alkalinity, sulfate). The Applicant's proposed Cynoprobe™ equipment also measures pH. If monitoring results indicate acid generation or its precursors during operations, measures to apply additional neutralizing agents (e.g., cement) or preclude exposure of sulfides to atmospheric oxygen (e.g., cemented backfill placement around sulfide-bearing rock) can be employed.

Following mine closure, direct observation of backfill performance is difficult as groundwater recovers into the mine workings when dewatering ceases. At this point, any further oxidation of sulfide minerals becomes inhibited by the groundwater's displacement of atmospheric oxygen, which is a necessary component of the oxidation reaction. The oxidation reaction would only continue until the remnant oxygen at the time of closure was consumed by the reaction. In the presence of sulfide minerals, this reaction would occur in a short time span (i.e., weeks, as occurs in laboratory kinetic testing). In the closure and post-closure periods, potential formation of acid rock drainage from rock fill and CRF on groundwater chemistry can be monitored via groundwater monitoring wells located downgradient of the underground workings.

The Applicant's groundwater monitoring plans consist of 15 groundwater monitoring wells, including seven existing wells and eight wells proposed to be constructed. The new wells to be constructed include one monitoring well upgradient of the facility, six monitoring wells downgradient of the TSF, and one monitoring well downgradient of the reclaim pond. Groundwater quality would be monitored by routinely collecting and testing groundwater from these 15 monitoring wells. Monitoring would occur quarterly for 5 years, semi-annual monitoring would occur for 10 years, and annual monitoring would occur for 15 years (Calico Resources USA Corp. 2023b). In addition to these plans, in the event acid rock drainage is found in groundwater samples, passive or active treatment can be implemented to prevent metals from being released into the environment.

The Applicant plans to store ore temporarily at the run-of-mine (ROM) ore stockpile before it is processed. Ore would be processed daily, and material is not expected to reside in the stockpile for more than a week, which would reduce the likelihood of acid rock drainage. BMPs for management of ore include processing stockpiled ore material within a period of weeks from mining. Potentially acid-generating ores should not reside in the stockpile for more than one-quarter of a year following their excavation. In addition to these plans, in the event of a temporary or unexpected shut-down of the process plant for an extended period of time, accommodations can be made to relocate stockpiled ores to the temporary waste rock storage facility or another facility with the capacity for permanent containment of acid-generating rock to prevent potential release of contaminants from the ROM ore stockpile.

For further information on acid rock drainage, see Appendix D.

A-3.6 Hazardous Materials and Waste Handling, Storage, and Management

The Applicant has developed a Toxic and Hazardous Substances Transportation and Storage Plan (Calico Resources USA Corp. 2021) and a Waste Management Plan (Calico Resources USA Corp. 2023a), which describe procedures and training for proper transportation, use, storage, and disposal of hazardous materials. These plans have been developed in accordance with applicable federal, state, and local provisions regarding the management of hazardous and non-hazardous materials and wastes. In addition, the Applicant has developed a Stormwater Pollution Control Plan (WSP USA Inc. 2023) that describes the management of spills to secondary containment and pallets to prevent leaks and spills into stormwater runoff. Regular inspections of hazardous materials storage areas would be conducted to identify potential cracks, deterioration, or other signs of leakage.

These Applicant management plans would be updated and revised as the Project proceeds and new information is developed, such as finalizing hazardous substances quantities and storage locations and changes in procedures or processes, or in response to modifications to applicable regulations. The plans would be reviewed and updated on a regular basis to ensure they remain applicable to the hazardous or toxic substances transported to, and stored at, the facility. No alternative hazardous materials handling, storage, spills, or management methods are identified.

A-3.7 Spill and Emergency Response

A Spill Prevention, Control, and Countermeasures (SPCC) Plan would be created by the Applicant in accordance with the requirements of 40 Code of Federal Regulations (CFR) 112 and stamped by an Oregon Professional Engineer. The SPCC Plan would include regular inspections of oil storage tanks, piping, and secondary containment areas and would specify the frequency of these inspections, typically monthly (Calico Resources USA Corp. 2023e). The SPCC Plan is a necessary document that would adhere to applicable regulations and be reviewed by appropriate parties. An additional spill measure would be to install water stops concrete coatings for all concrete containments as described in Section A-3.2 to provide an additional layer of protection against spills migrating beyond containment systems.

Per the regulation at Oregon Revised Statute (ORS) 517.971, the Applicant has an Emergency Response Plan (Calico Resources USA Corp. 2023e), which provides information needed to respond to an incident, including equipment, procedures, training, and clean-up methods in the event of a spill of hazardous material. The Emergency Response Plan would minimize the potential for accidental spills and environmental degradation by describing precautionary measures that must be adhered to and by being prepared for potential emergencies.

Two mobile emergency refuge stations would be installed in the case of a fire or rockfall that block the primary decline evacuation route and secondary vent raises evacuation routes. These refuge stations can accommodate up to 20 people within the protected chamber and remain safe within the underground mine for 48 hours. These are mobile stations that would be moved as the mine is developed, so that they are never more than 1,000 feet from the areas where mine operation personnel are located.

Other technologies to assist mine workers and responders during emergency situations requiring rapid escape include strobe lights to mark underground areas and escapeways, light vests to identify team members, laser pointers to negotiate travel through smoke, and lifelines to aid escape (Conti 2001). Lifelines consist of rope or other material secured to the rib of the mine leading to the exit portal that miners physically hold and follow to escape. Cones that point in the direction of the exit and reflective strips can be added to the lifeline to assist in following the line in the correct direction.

To alert underground personnel of an emergency, the Applicant would provide and maintain an operating fire alarm system in the underground mine area per Mine Safety and Health Administration (MSHA) regulations at 30 CFR 57.4360. This alarm system would be used to initiate evacuations and alert personnel of emergency situations. Alternative warning system technologies include wireless signaling systems, which transmit an emergency warning to quickly reach every underground miner using a transmitter loop antenna on the surface, and a receiver/transmitter loop antenna underground, with small wearable receivers incorporated into a miner's cap lamp assembly. Upon receiving an emergency or paging signal, the cap lamp begins to flash, which in turn alerts the miner to evacuate the mine or call the surface for a message, depending on which signal is received.

The Applicant's Emergency Response Plan identifies evacuation procedures for workers, which include a full evacuation drill every 60 days, emergency firefighting drills at least once every 6 months for persons assigned surface firefighting responsibilities, and mine evacuation drills every 6 months following MSHA regulations to assess the ability of all persons underground to reach the surface or designated safety point within a time limit. In addition, all personnel who work underground would be instructed in the escape and evacuations plans, procedures, and warning signals for an emergency on an annual basis.

The MSHA regulations and guidelines for emergency response incorporated into the Applicant's Emergency Response Plan are the health and safety standards for the protection of life and prevention of injuries in US mines.

A-4 SUMMARY OF BEST AVAILABLE, PRACTICABLE, AND NECESSARY TECHNOLOGIES

The identified technologies were reviewed to determine if they achieved the objectives of being available, practicable, and necessary for the specific site at Grassy Mountain (Table A-3). The analysis considered site-specific conditions including climate, mineralization, geological, geotechnical, hydrogeological, and morphological conditions when determining whether a technology is necessary and practicable. All technologies are available, with the exception of gold roasting and mercury amalgamation, which are no longer practiced in North America because newer technologies have been developed that are less environmentally damaging.

The BAPNT review process first requires the TRT to determine the necessary technologies to achieve the objectives of the Project. If a technology is considered to be unnecessary, it is not considered further. For the technologies that are needed, the TRT must determine if these are available and technically feasible.[1] If a technology is considered not to be technically feasible, it is not considered further. The technologies that are deemed necessary, available, and technically feasible were then ranked according to their environmental benefits, as follows:

- 0 = the technology has a negative implication for the resource;
- 1 = the technology has a neutral implication for the resource, or is approximately equal to another technology that would achieve the same purpose;
- 2 = the technology has some environmental benefit when compared with an alternative technology.

Those technologies that are deemed to be necessary, available and practicable are also assessed for economic feasibility. Those that are not economically feasible are not considered to be the best option. The BAPNTs that are technically and economically feasible have the highest scores. Table A-3 provides this information. The Applicant's proposed technologies are identified in bold.

[1] A technology is technically feasible if it would meet the Project purpose and environmental standards.

Table A-3 Ranking of Best Available, Practicable, Necessary Technology for Project Components

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Practicable / Environmental Benefit (Score 0 to 2)					Economically Feasible	Total Score
						Air Quality	Water Resources	Waste	Energy	Wildlife		
Mine Construction Methods												
Extracting Ore	2.1.3, 2.2.3.2, A-3.1	**Underground Mining**	Yes	Yes	Yes	2	2	1	2	2	Yes	9
	2.2.3.2, A-3.1	Open-Pit Mining	Yes	Yes	No	-	-	-	-	-	-	-
	2.1.3, A-3.1	**Mechanized Cut-and-Fill with CRF**	Yes	Yes	Yes	1	2	2	2	2	Yes	9
	A-3.1	Longhole Open Stoping	No	-	-	-	-	-	-	-	-	-
	A-3.1	Blind Bench Stoping	No	-	-	-	-	-	-	-	-	-
Backfilling	A-3.1	Dry Fill	No	-	-	-	-	-	-	-	-	-
	A-3.1	Hydraulic Fill	No	-	-	-	-	-	-	-	-	-
	2.1.3, A-3.1	**Cemented Fill**	Yes	Yes	Yes	1	2	2	2	2	Yes	9
	2.2.3.5, A-3.3	Paste Fill	Yes	Yes	No	-	-	-	-	-	-	-
Transporting Mined Materials	2.1.15, A-3.1	**Diesel Fuel (Trucks and Loaders)**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	2.2.3.13, 2.2.5, 5.4, A-3.1	Biodiesel Fuel (Trucks and Loaders)	Yes	Yes	Yes	2	1	1	2	1	Yes	7
	2.2.3.10, 2.2.5, 5.4, A-3.1	Operational Improvement Technologies (e.g., Short Interval Control)	No	-	-	-	-	-	-	-	-	-
Mill Operations												
Chemical Ore Processing	2.1.6.2, 2.1.6.3, 2.1.6.4, 2.2.3.6, A-3.2	**CIL Cyanide Circuit, Elution, and Electrowinning Recovery**	Yes	Yes	Yes		1	1	1	1	Yes	5
	2.2.3.6, A-3.2	Gold Roasting	No	-	-		-	-	-	-	-	-
	A-3.2	Mercury Amalgamation	No	-	-	-	-	-	-	-	-	-
	2.2.3.9, 2.2.5, 2.2.6.3, A-3.2	Thiosulfate Leach	Yes	Yes	No	-	-	-	-	-	-	-
	2.2.3.6, A-3.2	Alternative Mill Processing (gravity concentration, hydrometallurgical, pyrometallurgical, flotation, pressure oxidation)	Yes	Yes	No	-	-	-	-	-	-	-
	2.2.3.6, A-3.2	Heap Leaching	Yes	Yes	Yes	2	0	1	0	0	No[2]	-
	2.2.3.6, A-3.2	Offsite Ore Processing	Yes	Yes	Yes[1]	0	2	1	0	1	No[2]	-
	2.2.3.9, A-3.2	Non-cyanide Gold Extraction Processes (gravity separation, microbial leaching, biological, leaching agents)	Yes	Yes	No	-	-	-	-	-	-	-
Cyanide Management	2.1.7, 2.2.3.7, A-3.2	**Detoxification and Neutralization of Cyanide**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	2.2.3.8, A-3.2	Cyanide Reduction	No	-	-	-	-	-	-	-	-	-
	2.1.6, A-3.2	**Cyanide Destruction Circuit**	Yes	Yes	Yes	1	1	2	1	2	Yes	7
Cyanide Monitoring	2.2.3.8, A-3.2	**Certified Laboratory Testing**	Yes	Yes	Yes	1	2	2	1	2	Yes	8
	2.1.7, 2.2.3.8, A-3.2	**In-Line Device (e.g., Cynoprobe)**	Yes	Yes	Yes	1	2	1	1	2	Yes	7

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Practicable / Environmental Benefit (Score 0 to 2)					Economically Feasible	Total Score
						Air Quality	Water Resources	Waste	Energy	Wildlife		
Air Quality Controls	2.1.6.4, A-3.2	**Mercury Retort Oven**	Yes	Yes	Yes	2	1	0	0	1	Yes	4
	A-3.2	**Wet Scrubber**	Yes	Yes	Yes	2	1	1	1	1	Yes	6
	A-3.2	Electrostatic Precipitator	No	-	-	-	-	-	-	-	-	-
	A-3.2	Baghouse Filter	No	-	-	-	-	-	-	-	-	-
Process Solution Containments	A-3.2	**Concrete Secondary Containments**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	A-3.2	Water Stops and Concrete Coatings	Yes	Yes	Yes	1	2	1	1	1	Yes	6
Wildlife Exclusion from Mill	3.5.4.2, 5.3, A-3.2	**Perimeter Fencing and Monitoring**	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	3.5.4.2, 5.3, A-3.2	**Covers, Mesh, or Netting to Reduce Bird and Bat Nesting**	Yes	Yes	Yes[1]	1	1	1	1	2	Yes	6
	5.3, A-3.2	**Covering Waste Bins**	Yes	Yes	Yes	1	1	2	1	2	Yes	7
Closure of the Mill	2.1.17, 2.2.3.14, A-3.2	**Dismantling, Salvaging, Selling, or Authorized Disposal of Mill Infrastructure**	Yes	Yes	Yes	1	2	2	1	1	Yes	7
	2.1.17, 2.2.3.14, A-3.2	**Breaking, Burying, and Recontouring Foundations**	Yes	Yes	Yes	1	1	2	2	1	Yes	7
	A-3.2	Removal of Foundation Materials	Yes	Yes	Yes	0	2	0	0	1	Yes	3
	A-3.2	Retaining Power Lines Post-Closure	No	-	-	-	-	-	-	-	-	-
	2.1.17, 2.2.3.14, 5.3, 5.4, A-3.2	Planting Sagebrush Plugs/Seedlings and Perennial Grasses and Forbs with a Monitoring Program	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	2.1.17, A-3.2	Closure-Period Inspections	Yes	Yes	Yes	2	2	2	1	2	Yes	9
Tailings Management												
Tailings Disposal	2.1.8, A-3.3	**Permanent Storage of Tailings in Lined TSF**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	2.1, 2.1.5.2, 2.1.6, A-3.2	**TSF Lime Addition**	Yes	Yes	Yes	0	2	2	1	2	Yes	7
	2.2.3.5, A-3.3	Mix with Cement and Use as Backfill in Underground Mine	Yes	Yes	No	-	-	-	-	-	-	-
	A-3.3	**TSF pH Monitoring**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
Tailings Water Content	2.2.2.2, A-3.3	**Conventional Tailings Slurry**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	2.2.2.2, A-3.3	Filtered Tailings	No	-	-	-	-	-	-	-	-	-
	2.2.2.2, A-3.3	High-density Thickened Tailings	No	-	-	-	-	-	-	-	-	-
	A-3.3	Water Balance Accounting (including probabilistic and deterministic meteorological water projections)	Yes	Yes	Yes	1	2	1	1	2	Yes	7
TSF Design	2.1.8, 2.2.2.4, 2.2.3.3, 2.2.3.4, A-3.3	**Zero-discharge with Synthetic Double Lining**	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	2.2.3.4, A-3.3	Alternative Liners	Yes	Yes	Yes	1	2	1	1	1	No[2]	-
	A-3.3	Reparable Liner	Yes	No	-	-	-	-	-	-	-	-

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Practicable / Environmental Benefit (Score 0 to 2)					Economically Feasible	Total Score
						Air Quality	Water Resources	Waste	Energy	Wildlife		
	A-3.3	Alternative Embankment Designs (using different materials)	No	-	-	-	-	-	-	-	-	-
	A-3.3	LiDAR Slope Monitoring	No	-	-	-	-	-	-	-	-	-
Leak Detection	2.1.4, 2.1.8, 2.2.3.4, 5.3, A-3.3	**Liner Leak Detection and Collection**	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	2.1.19.1, A-3.3	**Groundwater Monitoring for Leaks**	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	2.2.3.4, A-3.3	Electromagnetic Leak Detection	No	-	-	-	-	-	-	-	-	-
	A-3.3	Geophysical Leak Detection	No	-	-	-	-	-	-	-	-	-
Long-Term Pollution Prevention Controls and Monitoring	2.1.19.3, A-3.3	**Backfilling using CRF**	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	2.1.17, A-3.3	**Plugging the Mine Portal**	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	2.1.17, A-3.3	**Retaining Liners in Perpetuity**	Yes	Yes	Yes	1	2	2	1	1	Yes	7
	2.1.17, A-3.3	**Reclaiming Mine Areas**	Yes	Yes	Yes	2	2	2	1	2	Yes	9
	2.1.17, A-3.3	**Converting the Reclaim Pond to an Evaporation Cell**	Yes	Yes	Yes	1	2	2	2	1	Yes	8
	2.1.17, A-3.3	**Retaining Stormwater Infrastructure**	Yes	Yes	Yes	1	2	1	2	2	Yes	8
	D-5.1, A-3.3	Monitoring Mined Materials Quarterly During Operations	Yes	Yes	Yes	1	2	2	2	2	Yes	9
Long-Term Monitoring	2.1.19.2, A-3.3	**Monitoring Groundwater**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	2.1.19.2, A-3.3	**Monitoring Noxious Weeds**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	A-3.3	Noxious Weed Mapping via UAV or Satellite Imagery	No	-	-	-	-	-	-	-	-	-
	2.1.19.2, A-3.3	**Facility Inspections, Maintenance, and Repairs**	Yes	Yes	Yes	1	2	2	1	2	Yes	8
	2.1.19.2, A-3.3	**Inspections and Sampling of Stormwater Facilities and Discharges**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	A-3.3	Spring and Seep Monitoring	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	2.1.19.2, A-3.3	Biomonitoring	No	-	-	-	-	-	-	-	-	-
	2.1.19.2, A-3.3	Vegetation Cover Indexes	No	-	-	-	-	-	-	-	-	-
TSF Wildlife Exclusion	3.5.4.2, 5.3, A-3.3	**Perimeter Fence and TSF Fences and Barriers**	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	3.5.4.2, 5.3, A-3.3	**Bird Deterrent Balls on TSF Pond**	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	3.5.4.2, 5.4, A-3.3	Visual Deterrents: Effigies, Predator Models	Yes	Yes	Yes1	1	1	1	1	2	Yes	6
	3.5.4.2, A-3.3	Radar-activated Propane Cannons	Yes	Yes	Yes1	1	1	1	0	2	Yes	5
	3.5.4.2, 5.4, A-3.3	Laser Bird Deterrents	Yes	Yes	Yes1	1	1	1	1	2	Yes	6
	3.5.4.2, A-3.3	Emergency Hazing	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	3.5.4.2, 5.4, A-3.3	Bio-exclusion Zones	Yes	Yes	Yes1	1	1	1	1	2	Yes	6

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Practicable / Environmental Benefit (Score 0 to 2)					Economically Feasible	Total Score
						Air Quality	Water Resources	Waste	Energy	Wildlife		
	3.5.4.2, A-3.3	Decoy Ponds	No	-	-	-	-	-	-	-		-
	3.5.4.2, A-3.3	Hyper-salinization	Yes	Yes	Yes	0	0	1	0	1	No2	
	3.5.4.2, 5.3, A-3.3	**Monitoring Perimeter for Signs of Wildlife**	Yes	Yes	Yes	1	1	1	1	2	Yes	6
	3.5.4.2, 5.3, A-3.3	Netting and Wires on TSF	No	-	-	-	-	-	-	-	-	-
	5.3, A-3.3	**Monitoring and Removal of Aquatic Species in TSF Pond**	Yes	Yes	Yes	1	1	1	1	2	Yes	6
Closure of the TSF	A-3.3	**Dry Closure**	Yes	Yes	Yes	1	2	2	1	2	Yes	7
	2.1.16, A-3.3	**Conversion of Process Pond to Evapotranspiration Cell**	Yes	Yes	Yes	1	2	1	2	2	Yes	8
	A-3.3	Wet Closure	No	-	-	-	-	-	-	-	-	-
	A-3.3	Wetland Establishment Closure	No	-	-	-	-	-	-	-	-	-
	A-3.3	Alternative TSF Cover Design	No	-	-	-	-	-	-	-	-	-
	A-3.3	Hydroseeding	Yes	Yes	Yes	1	1	1	1	1	Yes	5
Operations Management												
Water Management	2.1.9.1, 2.1.9.2, A-3.4	**Site Groundwater Production Wells and Water Level and Quality Monitoring**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	2.2.2.5, A-3.4	Pipeline from Municipal Supply	No	-	-	-	-	-	-	-	-	-
	A-3.4	Perimeter Well Dewatering	Yes	Yes	No	-	-	-	-	-	-	-
	A-3.4	Groundwater Production Sumps for Dewatering	Yes	Yes	Yes[1]	1	0	0	1	1	Yes	3
	A-3.4	Closure Reclamation of Water Supply Piping	Yes	Yes	Yes	1	1	1	1	1	Yes	5
Air Quality Control Measures	A-3.4	Monitor TSF for Dust after Operations Cease and Prior to Cover	Yes	Yes	Yes	2	1	1	1	1	Yes	6
	5.3, A-3.4	**Dust Suppression Water Spray**	Yes	Yes	Yes	2	0	1	0	1	Yes	4
	5.3, A-3.4	**Equipment Hoods, Curtains, Chutes**	Yes	Yes	Yes	2	1	1	1	1	Yes	6
	A-3.4	**Cover/Enclose Material Piles**	Yes	Yes	Yes	2	1	1	0	1	Yes	5
	5.3, A-3.4	**Air Permit BMPs**	Yes	Yes	Yes	2	0	1	1	1	Yes	5
	A-3.4	**Dust Control Staff Training**	Yes	Yes	Yes	2	1	1	1	1	Yes	6
Equipment Maintenance	A-3.4	Reactive Maintenance	Yes	Yes	Yes	0	0	1	1	1	Yes	3
	A-3.4	**Preventative Maintenance**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	A-3.4	Predictive Maintenance	No	-	-	-	-	-	-	-	-	-
Operations Monitoring	2.1.19.1, 5.3, A-3.4	**Resource-Specific Monitoring Plans**	Yes	Yes	Yes	2	2	2	1	2	Yes	9
	A-3.4	**Permit Monitoring Requirements**	Yes	Yes	Yes	2	2	2	2	2	Yes	10
Acid Rock Drainage Management	D-3, D-4.6, A-3,5	**CRF**	Yes	Yes	Yes	0	2	1	1	1	Yes	5
	A-3.5	Additional Monitoring and Testing (by mine level)	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	A-3.5	Additional Water Quality Monitoring	Yes	Yes	Yes	1	2	1	1	1	Yes	6

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Practicable / Environmental Benefit (Score 0 to 2)					Economically Feasible	Total Score
						Air Quality	Water Resources	Waste	Energy	Wildlife		
	A-3.5, D-6.1	**Groundwater Monitoring for Acid Rock Drainage**	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	A-3.5	Passive or Active Treatment of Acid Rock Drainage	Yes	Yes	Yes	1	2	1	1	1	Yes	6
Hazardous Materials Handling, Storage, and Management	5.3, A-3.6, B-3.2	**Toxic and Hazardous Substances Transportation and Storage Plan**	Yes	Yes	Yes	2	2	2	1	2	Yes	9
	5.3, A-3.6, B-3.2	**Waste Management Plan**	Yes	Yes	Yes	2	2	2	1	2	Yes	9
	2.1.5, 2.1.10.3, A-3.6	**Offsite Hazardous Materials Disposal**	Yes	Yes	Yes	1	2	2	1	2	Yes	8
	A-3.6	Toxic and Hazardous Substances Transportation and Storage Plan	Yes	Yes	Yes	1	2	2	1	2	Yes	8
	3.1.4, 5.3, A-3.6	**Stormwater Pollution Control Plan**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	A-3.6	**Regular Inspections of Hazardous Materials Storage Areas and Updates to Management Plans**	Yes	Yes	Yes	2	2	2	1	2	Yes	9
Spill and Emergency Response	A-3.7, B-3.2	**Spill Prevention, Control, and Countermeasures Plan**	Yes	Yes	Yes	1	2	1	1	2	Yes	7
	A-3.2	Water Stops and Concrete Coatings	Yes	Yes	Yes	1	2	1	1	1	Yes	6
	A-3.7, B-3.2	**Emergency Response Plan**	Yes	Yes	Yes	2	2	2	1	2	Yes	9
	A-3.7, B-4.3, B-5.1	**Mobile Emergency Refuge Stations**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	A-3.7, B-3.2	Strobe Lights, Light Vests, Laser Pointers, Lifelines, Cones, and Reflective Strips	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	A-3.7, B-4.2	**Fire Alarm System**	Yes	Yes	Yes	1	1	1	1	1	Yes	5
	A-3.7, B-3.2	Wireless Signaling System	No	-	-	-	-	-	-	-	-	-

Notes:

[1] Technically feasible for many but not all applications.

[2] Alternative performance does not merit cost difference.

Necessary Technology: A technology that is required or can substituted for an alternative technology to ensure compliance with environmental standards.

Available Technology: A technology that is obtainable and has been demonstrated to meet environmental standards.

Practicable Technology: A technology that is technically feasible (i.e., has been demonstrated to meet project purpose and environmental standards), has assessable implications for environmental resources (i.e., air, water, waste, energy, and wildlife scored as 0 = negative implication, 1 = neutral implication, 2 = positive implication), and is economically feasible (i.e., has costs that do not render the project uneconomic and do not exceed the expected environmental benefit of the alternative).

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APPENDIX B

ANALYSIS OF CREDIBLE ACCIDENTS

APPENDIX B ANALYSIS OF CREDIBLE ACCIDENTS

Table of Contents

B-1 INTRODUCTION

The purpose of an analysis of credible accidents is to identify the most common types of accidents historically associated with mining tasks likely to be performed at the Grassy Mountain mine. Credible accidents may include, but are not limited to, potential releases of contaminants into the environment as a result of mine operation or closure, precipitation events and other natural events such as earthquakes that exceed the design standards of the mine facilities, fires, unplanned detonation of explosives, equipment failures, fuel and chemical spills, and accidents resulting from human errors. This analysis of credible accidents has been prepared to (1) characterize common accidents that occur at mining sites, (2) discuss the causes and effects of these accidents, and (3) identify methods of preventing such accidents from occurring.

The analysis of credible accidents uses historical Mine Safety and Health Administration (MSHA) data and statistics, including investigation findings and preventative controls that may help eliminate future accidents and fatalities. This information can be used by the Technical Review Team and Oregon Department of Geology and Mineral Industries (DOGAMI) in assessing potential Grassy Mountain Gold Project (Project) effects to the proposed workforce and environment and in developing appropriate permit conditions to reduce the potential for accidents and their associated effects.

The information contained in this appendix is based on professional experience and available information. It is recognized that while the potential for some accident types is very low (e.g., major earthquake), there is a possibility that such an event could occur, and the effects of an accident would depend on the specific circumstances of the event. It is not possible to foresee and identify measures to prevent *all* accidents, but it *is* possible to identify the most common and most damaging accidents and to identify measures to reduce the potential for these accidents and/or effects to occur. This appendix is not meant to be inclusive of (1) all potential accidents, (2) all health and safety measures proposed by Calico Resources USA Corp. (the Applicant), or (3) all health and safety measures that are available to reduce the instance of a credible accident or its effects.

B-2 HISTORY OF MINING ACCIDENTS

Mining accidents occur during the process of mining minerals or metals. Each year thousands of miners die globally, particularly in countries where health and safety measures are less stringent than those in the US. Accidents regularly occur in hard rock mining, but coal mines historically have had the highest number of fatalities.

Gold mining has occurred in the US since the discovery of gold in the 1800s. In 1881, the first mining safety legislation was passed. However, this legislation only applied to coal mines, where the majority of accidents occurred. In 1910, the Bureau of Mines was created within the Department of the Interior after a decade in which coal mine fatalities exceeded 2,000 annually. In 1961, Public Law 87-300 authorized the Bureau of Mines to conduct a study investigating the causes and prevention of injuries and health hazards in metal and nonmetal mines, and federal officials were given the right of entry to collect information. The Federal Metal and Nonmetallic Mine Safety Act of 1966 (Public Law 89-577) was created with procedures for developing safety and health standards for metal and nonmetal mines. One annual inspection was required by this act for underground mines, and federal inspectors were given the authority to issue notices of violation and orders of withdrawal. In 1977, the Federal Mine Safety and

Health Act of 1977 (Public Law 95-164), commonly known as the Mine Act, was established along with the MSHA (US Department of Labor 2024).

MSHA is responsible for safety and health in US mines and has made significant progress in reducing fatalities since its inception. In 1978, the first year MSHA operated under the Mine Act of 1977, 242 miners died in mining accidents. In 2022, this number fell to 29 fatalities. MSHA develops and promulgates mandatory safety and health standards, ensures compliance with such standards, assesses civil penalties for violations, and investigates accidents. MSHA cooperates with and provides assistance to US states in the development of effective state mine safety and health programs; improves and expands training programs in cooperation with the states and the mining industry; and contributes to the improvement and expansion of mine safety and health research and development. All of these activities are aimed at preventing and reducing mine accidents and occupational diseases[1] in the mining industry.

Figure B-1 shows mining-related fatalities in the US over a 100-year period. It shows a significant decline in mining accidents from 1915 through 1960, followed by a more modest decline from the 1960s through 2015 (MSHA 2015).

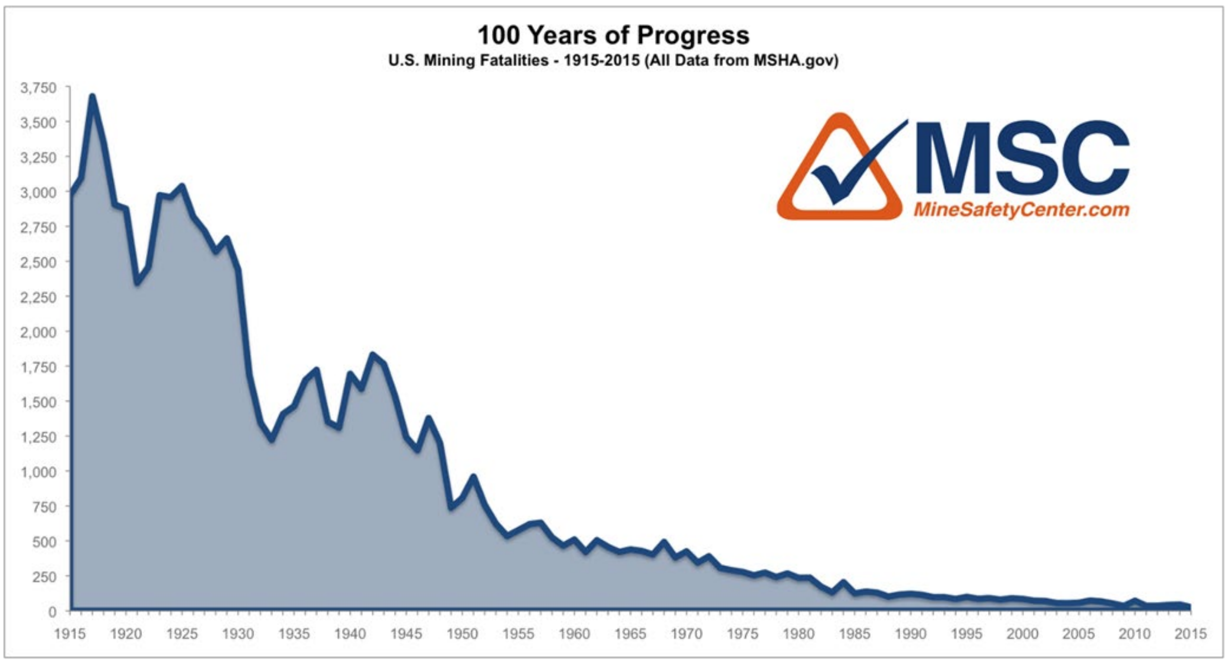

Figure B-1 Annual Mining-Related Fatalities in the US from 1915 through 2015

Source: MSHA 2015

Table B-1 provides the number of fatalities from metal and nonmetal mines from January 2003 through October 2023, which ranges from 12 mining fatalities (in 2017) to 33 incidents (in 2007). The year 2023 saw a relatively high number of mining-related deaths, at 32 incidents. Metal mines include gold,

1 An occupational disease is a chronic ailment that occurs as a result of work or occupational activity, such as coalworker's pneumoconiosis (black lung) among coal miners.

platinum, silver, steel, copper, and aluminum mines. Nonmetal mines include sand, gravel, limestone, and cement mines.

In Oregon from 2005 through 2023, one fatality was reported—in 2017, at a diatomaceous earth processing facility in Malheur County. A groundskeeper was electrocuted when he contacted overhead high-voltage power lines with an aluminum irrigation pipe. The accident occurred because the operator did not de-energize overhead power lines, did not install barricades or post signs to indicate dangerous overhead conditions existed in the area where the accident occurred, and did not conduct workplace examinations in the area (MSHA 2017). This fatal accident could have been prevented with proper operating and repair procedures, installation of barriers and signage, and workplace examinations.

Table B-1 Number of US Fatal Mine Incidents from Metal and Nonmetal Mines per Year from 2003 through 2023

Year	Number of Miners	Number of Fatalities
2003	215,325	26
2004	220,274	27
2005	228,401	35
2006	240,522	26
2007	255,187	33
2008	258,918	23
2009	221,631	17
2010	225,676	24
2011	237,772	16
2012	250,228	16
2013	251,263	22
2014	250,574	30
2015	247,091	17
2016	247,107	16
2017	238,843	12
2018	249,523	13
2019	253,031	19
2020	237,527	20
2021	237,858	27
2022	247,663	22
2023	254,172	32

Source: MSHA 2023a

Root causes of accidents that have occurred in metal and nonmetal mines historically have been due to failure to provide task training; failure to conduct examinations, risk assessments, and pre-operational checks; failure to maintain equipment; and failure to provide policies, procedures, and controls and to provide appropriate personal protective equipment (PPE).

B-3 ANALYZING CREDIBLE ACCIDENTS

Analyzing credible accidents typically involves both quantitative and qualitive data. Quantitative data are numbers-based, countable, or measurable. They tell us how many, how much, or how often in numbers. Qualitative data are interpretation-based and descriptive. They help us to understand what happened, why something happened, and how our actions result in certain consequences. This analysis is reliant on published data from MSHA and other mine safety resources. Although this analysis is predominantly quantitative in nature, the inclusion of qualitive data, such as personal accounts and witness statements, are also an important part of MSHA's investigative process and can be used to revise guidance and practices for prevention of future accidents.

Accidents are generally caused by either natural events or human error. Natural events that may cause accidents at a mine site include earthquakes that exceed design standards of facilities, floods that enter underground working areas, and wildlife encounters, among others. Accidents caused by human error may include incorrect use of equipment, not wearing appropriate PPE, not adhering to safety protocols, or poor judgement. Human activity is the overwhelming main contributor to mining accidents. It is inevitable that humans will make mistakes, and many of these mistakes are fully preventable. Organizations across the globe, including MSHA, have focused their energies on the identification and elimination of such mistakes and on developing policies to reduce the impacts of natural events.

The results of mining accidents can be minor or major, depending on the incident. They can include unintended releases of hazardous materials; fires and explosions; damage to project infrastructure, buildings, or equipment; damage to public or private property; damage to the environment; and injuries and deaths. The remainder of this section describes the types of natural and human-induced events that can cause accidents, their associated effects on mining operations, the potential for such events to occur at the Project site, and actions to prevent such accidents from occurring in the first place.

Sections B-4 and B-5 provide information on accident prevention and emergency response in the event of an accident, respectively.

B-3.1 Natural Events

Malheur County is exposed to a wide range of natural hazards and threats, including earthquakes, wildfires, severe weather, flooding, and animal conflicts (Malheur County 2022).

Earthquakes

Damage from a major earthquake could have catastrophic effects on any form of excavation, including surface or underground mines, although there is little evidence of earthquakes affecting mines in the US. The Project site is located in the Columbia Plateau, a region of relatively low historical earthquake activity. Malheur County experienced a 3.7 magnitude earthquake in 1989 and a 3.2 magnitude earthquake in 2009. According to the Federal Emergency Management Agency (FEMA), the risk of an earthquake in Malheur County is "relatively low" (FEMA 2024).

To prevent accidents arising from earthquakes, proposed Project facilities have been designed to account for seismic activity:

- The tailings storage facility (TSF) embankment has been designed to withstand the maximum credible earthquake, which exceeds the regulatory standards at Oregon Administrative Rule (OAR)

690-020-0038 for low-hazard dams as defined in OAR 690-020-0022. A seismic hazard analysis was used to inform the TSF design, which meets a 1.5 minimum factor of safety for static conditions and 1.1 minimum factor of safety for pseudo-static conditions (i.e., seismic conditions with peak ground acceleration of 0.15g associated with the maximum credible earthquake). The design also examined the effects of embankment foundation and crest settlement in its analysis. Material specifications for embankment material were developed to support the design (Golder Associates 2021: Appendix I), and some local materials (e.g., weathered arkosic sandstone) were excluded as unsuitable for construction material because of their brittle and erosive nature. A Construction Quality Assurance Plan (Golder Associates 2021: Appendix J) has been included in the design to define the monitoring, testing, and verification requirements to ensure that the construction conforms to the design specifications.

- The TSF design meets or exceeds requirements found in FEMA P-64 and 65 (FEMA 2005, 2013) and 30 Code of Federal Regulations (CFR) 77.216.
- In accordance with the MSHA Dam Inspection and Plan Review Handbook (MSHA 2021) and 30 CFR 77.216-3, the TSF would be constantly monitored and inspected by the operator at intervals not exceeding 7 calendar days. Additionally, regular inspections of the TSF would be performed by the MSHA (bi-annual for surface, quarterly for underground).
- If an earthquake occurs and creates the potential for hazardous conditions at an impoundment, 30 CFR 77.2163(b)(4) requires the operator to examine the structure and monitor the instrumentation at least once every 8 hours.
- FEMA P-64 and 30 CFR 77.213-3 instruct the mine operator to develop an emergency action plan addressing evacuation plans for miners and sets out the examination, monitoring, hazard abatement, planning, and reporting requirements for the mine property including the TSF and other similar containment structures. The plan should be reviewed and updated as site conditions change. The Grassy Mountain Mine Emergency Action Plan can be found as Table 2 in the Emergency Response Plan (Calico Resources USA Corp. 2023a).

The temporary waste rock storage area (TWRSF) would be temporary and in use during the 8 years of active mine operations. Therefore, the facility design (Golder Associates 2021: Appendix C) is based on geotechnical stability of the TWRSF using an operational basis earthquake (rather than the maximum credible earthquake) with peak ground acceleration of 0.08g for a 475-year return period event.

Golder Associates conducted a dam breach inundation analysis for the TSF (Golder Associates 2021) using two hydrodynamic model software packages to estimate the inundation area: FLDWAV (1998) and FLO-2D (2009). A worst-case scenario of the TSF at full capacity and maximum embankment height on a rainy day during a storm event was used to model the locations of inundation of tailings. The analysis found that the total tailings slurry deposition area inundated would be approximately 834 acres; there are no occupied structures within the tailings slurry inundation area; the modeled maximum tailings runout distance from the TSF would be approximately 12 miles; the peak flood travel time from the TSF to the maximum tailings runout distance (12 miles) would be approximately 48 hours; and public access to the Project site and areas south along Rock Canyon Road and Twin Springs Road would either be inaccessible, or access-limited, until tailings solids could be removed (Golder Associates 2021). In the event of a partial TSF embankment failure, contained solutions would affect a smaller area due to the assumed lower volume of solutions that would escape containment.

While unlikely, the consequences of a TSF dam breach and subsequent release of contaminated material would depend on many factors including the extent of dam failure (partial or full breach), the volume of tailings stored in the TSF at the time, the weather conditions and time of year, and emergency response actions. It is not possible to provide a concise summary of effects as each event is unique. Instead, the general consequences of a release of tailings to the environment is provided.

A TSF embankment failure would result in a release of process solution and tailings solids to the drainage downstream. The consequences of the immediate failure event would be related to flood risks to human health, property, wildlife, vegetation, and the drainage channel. Post-event consequences have the potential to affect soils, surface water, groundwater, vegetation, wildlife, and geotechnical hazards associated with potential subsequent re-mobilization of the tailings solids. Post-event response and associated costs would depend on the physical and chemical stabilization of the tailings solids, treatment of any impacted surface water and/or groundwater, and restoration of the drainage channel and its vegetation. Likely mitigating activities would include:

- Removal of tailings materials from the drainage channel, covering tailings materials in place, or a combination of both;
- Collection, treatment, and discharge of affected surface water and/or groundwater; and
- Drainage channel restoration and revegetation.

Activities associated with the tailings solids, surface water treatment, channel restoration, and revegetation could be completed within a few construction seasons following adoption of a remediation design. Capture and treatment of groundwater would begin upon adoption of a remedial design but could continue for several years depending on the extent and hydraulic properties of the affected native subsurface material.

The mine portal would be constructed using anchored mesh and shotcrete; the decline ramp excavation would use reticulated steel frames spaced every 3.28 feet with shotcrete placed in the roof and walls and would be armed with electro-welded grid mesh to provide structural support to the portal and decline areas (Geotechnical Mine Solutions 2023). The potential for mine collapse due to an earthquake is considered in the design of underground features, and underground structures are generally earthquake resistant (Aydan et al. 2010). In general, acceleration motions from earthquakes experienced on the ground surface are twice, or greater than twice, the motions observed underground. Damage to underground structures is typically from shaking, portal damage, and permanent ground deformations, which are often caused by faulting, slope failure/movement, and liquefaction (Aydan et al. 2010).

In the unlikely event of a mine collapse, workers may be injured or killed by falling debris and may be trapped underground, equipment may be damaged or destroyed, hazardous materials may be spilled, and fire may occur from damaged equipment and spills. The Applicant’s design of underground workings includes the installation of ventilation shafts, emergency refuge stations, and escape routes to be used in the event of an emergency such as mine collapse. See Section B-5 for further information on Project-specific accident prevention measures.

Considering that the proposed Project facilities have been designed to account for a maximum credible earthquake, the likelihood of a catastrophic event such as a full or partial TSF embankment failure or mine collapse is low. However, if such an event occurred, it would be important to have measures already in place to respond quickly and effectively. See Section B-5 for further information on emergency response measures.

Wildfires

Wildfires are a common and widespread natural hazard in eastern Oregon. Wildfires can destroy mining infrastructure, disrupt supply of power and operations, and put employee safety at risk. Reducing wildfire risk in mine operations requires developing operational tools to identify wildfire threats, planning appropriately for potential wildfires, and using the latest wildfire science and analysis methods to inform decision-making (Wand 2023).

According to FEMA, the risk of wildfire in Malheur County is “relatively moderate” (FEMA 2024). The Applicant’s approach to mitigate wildland fire risk within the Project area is to reduce the likelihood of wildland fire by having an adaptive management style and a proactive fuels monitoring and reductions strategy. The Applicant’s Wildfire Mitigation Plan (SLR International Corporation 2024) identifies actions that can be taken to mitigate risk of wildfire to Project operations, use and occupancy, and the environment within the Project area. This includes access roads, pipelines, extractive equipment, water management systems, and processing facilities, among others. For example, the access road would be maintained free of vegetation, including the road shoulders and ditches on both sides; no fuels would be allowed to directly contact a facility to minimize ignition risk; and the fuel break around certain facilities may be expanded to reduce the risk of facility ignition from adjacent vegetation. The Applicant intends to collaborate with the Bureau of Land Management (BLM) to ensure a natural fire regime in the Project area because this plays an important role in creating suitable habitat for the greater sage-grouse’s adult and nest survival (SLR International Corporation 2024).

To also minimize risks associated with wildfires, the Applicant would work with firefighting organizations to establish emergency firefighting, evacuation, and rescue procedures as described in the Emergency Response Plan (Calico Resources USA Corp. 2023a). See Section B-5 for further information on emergency response measures.

Severe Weather and Flooding

Severe weather and changing climatic conditions can affect mining operations such as disrupting operations and reducing the stability and effectiveness of infrastructure. Heavy rainfall can lead to localized flooding, which can degrade roads and disrupt deliveries of needed equipment and materials. Heavy rainfall may also require additional pumping in dewatered areas to expel excess water. Underground mining operations are inherently susceptible to flooding from high rainfall, surface waterways, and underground aquifers, which can all contribute to flooding. The potential for flooding depends on the mine location, mine type, and ingress routes for water. For underground mines, uncontrolled flooding is often attributed to an increased mine water inrush from an aquifer or from a surface-related event.

Heavy rainfall can also overflow containments and/or result in surface water flooding that affects the overall facilities. The TSF embankment has been designed to withstand a 500-year, 24-hour severe weather event, which exceeds the regulatory standards at OAR 690-020-0037 and OAR 340-043-0090 (Golder Associates 2021), so the likelihood of embankment failure due to flooding is low. Nevertheless, regular inspections of the TSF embankments, containments, stormwater controls, and other areas are required, particularly during or after heavy rainfall, to ensure that facilities function as planned and to perform any maintenance needed to meet performance requirements. Potential consequences of a TSF dam breach are described in the discussion of earthquakes above.

Heavy rainfall and flooding have the potential to overflow other containments not associated with the TSF (e.g., fuel areas), damage facilities, damage roadways, and present other physical risks to human health and safety (e.g., erosional gullies, flooded road conditions). Stormwater diversions have been included in the Project to protect facilities and roadways from runoff events, and most areas are within the stormwater protections for the TSF described above. Access roads are also operated per American Association of State Highway and Transportation Officials and Malheur County standards. Nevertheless, inspections of facilities and roadways following periods of heavy rainfall and flooding for the effects of uncontrolled runoff and erosion are required to check for and address risks to health and safety.

According to FEMA, the risk of flooding in Malheur County is “very low” (FEMA 2024). Furthermore, the proposed Project facilities have been designed to account for the 500-year, 24-hour severe weather event, so the likelihood that severe weather and flooding would cause a catastrophic event such as a TSF embankment failure or mine collapse is low. However, if such an event occurred, it would be important to have measures already in place to respond quickly and effectively. See Section B-5 for further information on emergency response measures.

Wildlife Encounters

Mines can be an attractive location to many animal species, including bears, cougars, snakes, and bats. Both wild and domestic animals can inflict life-threatening injuries and diseases on humans, and such encounters cannot be totally discounted as a possibility. Some recent wildlife encounters are noted below:

- In 2017, two mine workers were attacked by a black bear on mine property in Alaska, resulting in one worker being fatally injured and another being hospitalized (Alaska Department of Fish and Game 2017);
- In 2021, a consultant working at a remote mine site in Canada was stalked and charged by a large adult mountain lion (cougar)—the worker was able to repel the attack by using bear spray (Stantec 2021); and
- Although not at mine sites, a hiker at Mt Hood, Oregon, found dead in 2018 was determined to have been killed by a cougar attack, and a mountain biker was killed by a cougar while biking on a trail northeast of North Bend, Washington (Flaccus 2018).

No data has been located documenting animal attacks at an Oregon mine site, although cougar sightings are relatively common in Oregon, particularly in more rural areas (Flaccus 2018). A western rattlesnake was observed on or in proximity to the Permit Area during wildlife surveys conducted for the Wildlife Resources Baseline Report (EM Strategies 2020). A potential method to prevent rattlesnakes from entering the Project area would be to install snake fencing along the perimeter fence. Snake fencing consists of metal mesh with spacing gaps no greater than 0.25 inch to prevent the smallest rattlesnake species, as well as young individuals, from entering an area (Rattlesnake Solutions LLC 2023). The fencing should be installed to a height of 36 inches from the ground surface to prevent the largest snakes from climbing over, and the bottom portion of the fence should be buried in the ground to prevent the formation of gaps by erosion or rodents (Rattlesnake Solutions LLC 2023). If installed correctly, this mesh would also help keep out other small mammals such as rodents and prey that attract rattlesnakes. Keeping the Project area clear of trash and food would also control rodents, and regular maintenance of grass trimming along the fence line would aid in preventing snakes from climbing over. Other potentially dangerous wildlife that may be found around the Project area include black bears, cougars, bobcats, wolves, coyotes, and other predatory mammals (Oregon Department of Fish and Wildlife 2024).

It is unlikely that a wildlife attack would occur at the Project site because the Permit Area would be fenced. However, preventative measures can be taken to minimize the potential of human–wildlife interactions. Waste being properly disposed of and secured decreases attractiveness to the site. Staff who are alert and aware of their surroundings when walking around the site, especially at dusk and dawn when wildlife activity may be increased, are more likely to detect and avoid potential interactions. A snake bite kit and bear spray can be made available to staff, so they are prepared for wildlife interactions.

B-3.2 Human-Induced Events

Equipment Failure

Equipment failure can occur from inadequate maintenance, use of equipment that is past its safe and useful life, outdated technology, harsh environments, or poor operation. For example, on December 14, 2023, a contractor died while delivering parts to a mine when an all-terrain telehandler pulling cable tipped over, striking him (MSHA 2023b). In another example, on February 14, 2022, a maintenance technician with 10 years of mining experience was fatally injured when the lube truck she was driving went over the edge of an open stope and fell approximately 60 feet. The accident occurred because the mine operator did not maintain the backup camera on the Getman A64 Lube/Fuel truck and did not place a berm in front of the open stope (MSHA 2022a).

These incidents may have been prevented by conducting regular maintenance of vehicles and equipment and making repairs, checking safety systems on all equipment to ensure they are in good working order, proper training and use of equipment, ensuring visitors entering the mines received site-specific hazard awareness training, and maintaining good communication between staff.

Many different types of equipment would be used at the proposed mine, including haul trucks, dozers, conveyors, and rock crushers, among others. All of these require frequent maintenance and inspections to avoid accidents due to faulty equipment use.

Frequent machine failures can expedite an asset's natural breakdown and significantly reduce its useful life, resulting in higher costs and inconveniences. Conducting effective maintenance is important to prevent equipment failure from both cost and safety perspectives. There are five common approaches for maintaining mining equipment in working order:

- **Reactive**: Maintenance is performed once an asset has broken down.
- **Preventative**: Maintenance is conducted on a regularly scheduled basis (either based on calendar time or usage time) to help prevent unexpected failures in the future.
- **Condition-based**: Assets or equipment are monitored to determine when maintenance work is necessary using sensors and other monitoring equipment to collect data on the performance of equipment.

- **Predictive**: Data analysis is used to identify operational anomalies and potential equipment defects, enabling timely repairs before failures occur in order to minimize maintenance frequency and avoid unplanned outages and unnecessary preventive maintenance costs.
- **Prescriptive**: Data analytics, condition monitoring sensors, and artificial intelligence are used to predict equipment failures and recommend specific actions to prevent them.

Reactive maintenance is the most costly and inefficient since it results in unplanned outages and unnecessary maintenance costs that may not have been required otherwise. Conversely, excessive maintenance can be harmful too—when equipment is serviced too frequently or with unnecessary tasks, it causes wear and tear that can lead to equipment failure rather than preventing it. Calendar-based preventative maintenance often proves to be inefficient because 82 percent of machine failures occur at random patterns (Provencher 2020). Condition-based, predictive, and prescriptive maintenance strategies all use sensors and other monitoring equipment to collect data on the performance of equipment to identify issues and enable repairs before equipment fails. The most recent advances in mine maintenance technology are prescriptive methods, which involve the integration of big data, analytics, machine learning, and artificial intelligence to implement an action to solve an impending issue, rather than simply recommending an action.

Predictive maintenance is being used at the Barrick Cortez Mine in Nevada because the machinery involved in the gold refining process at that location is expensive and downtime caused by mechanical failure is costly. Sensors and machine learning are being used at the mine to detect potential equipment problems before the equipment fails. The machine learning algorithms use frequently collected sensor data to generate an equipment health score, which can be tracked for declines that might indicate a potential problem. Since its inception in 2018, more than half a dozen major equipment failures have been avoided, and a single early fault detection for one piece of equipment alone may save the company $600,000 (Provencher 2020).

While not required, installing predictive maintenance for mine equipment may result in cost-savings by identifying and conducting maintenance actions on equipment to avoid a major equipment failure and costly downtimes.

Human Error

There are many examples of injuries and fatalities reported by MSHA each year resulting from human error, including not providing proper training for equipment use, not adhering to equipment safety practices, improper use of equipment, not using appropriate PPE, and failing to conduct adequate workplace examinations before beginning tasks. For example, on January 23, 2023, a technician with over 19 years of experience was killed when standing on a mobile work platform (scissor lift) while removing a chiller pipe suspended from a mine roof when the pipe forcefully came apart and a rush of water pushed the technician off the scissor lift. The accident occurred because the mine operator did not ensure that the miner used fall protection while working where there was a danger of falling and did not conduct an adequate workplace examination, which would have included ensuring that all systems and equipment were checked for stored energy and made safe prior to beginning any work (MSHA 2023c). In another example, a mine owner and operator with over 14 years of mining experience died when he was struck by a bulldozer while performing maintenance at the mine's maintenance shop. The accident occurred because the mine operator did not block the bulldozer against hazardous motion before performing maintenance (MSHA 2022b). These incidents may have been prevented by using appropriate

PPE for specific tasks and conditions (including fall hazards), adhering to equipment safety practices, and conducting adequate workplace examinations before beginning tasks.

The top three types of operator errors in mining are (Hazbic 2020):

- **Routine errors**, which occur without significant conscious thought. These usually occur due to loss of attention, lack of situational awareness, and memory lapses, such as omitting a critical step in a procedure, not responding to a signal or a stop sign, daydreaming, or operating a machine/vehicle on automaticity and not mindfully;
- **Decision errors**, which can be rule-based or knowledge-based or require problem solving, such as the use of incorrect equipment, misdiagnosing or misapplying a procedure that is further exacerbated by pressure and stress, and ignoring a warning/caution; and
- **Perceptual errors,** which occur due to degraded sensory inputs such as misjudging time, distance, and environmental conditions, or failing to hear signals and alarms.

To combat these operator errors, the workplace can include adequate breaks for staff, regular training, enforcement of PPE compliance, provision of correct safety apparatuses, and promotion of a culture of safety first.

Fire and Explosion Hazards

Fires and explosions in underground mines and processing facilities can result from equipment malfunction or failure; human error or fatigue; sparks associated with the buildup of static electricity, lightning, open flames, improper hot-work practices, or smoking outside of approved areas; unplanned detonation of explosives; terrorism, sabotage, or vandalism; and powerful natural forces (e.g., landslides, ground settlement).

Fire is a major concern for those who work in underground mines. It can occur at any time, often results in a partial or total evacuation of mine personnel, and can result in injuries and loss of lives. Having the appropriate tools and equipment to detect and combat fires and explosions is essential. Technologies identified to assist in emergency evacuation operations include strobe lights to mark underground areas and map out escapeways, light vests to identify team members, laser pointers to negotiate travel through smoke, thermal imaging systems, which allow rescue personnel to see in darkness and heated areas, and lifelines (Conti 2001a). Lifelines consist of rope or other material secured to the rib of the mine leading to the exit portal that miners physically hold and follow to escape. Cones that point in the direction of the exit and reflective strips can be added to the lifeline to assist in finding the correct exit route.

Alerting workers of the presence of a fire quickly is essential in allowing for rapid escape of all personnel working underground. Wireless signaling systems can be used to transmit an emergency warning to quickly reach every underground miner using a transmitter loop antenna on the surface and a receiver/transmitter loop antenna underground with small wearable receivers incorporated into miners' cap lamp assemblies. Upon receiving an emergency or paging signal, the cap lamp begins to flash, which in turn alerts the miner to evacuate the mine or call the surface for a message, depending on which signal is received. The system can also activate devices such as strobe lights, turning them on or off to identify escape routes (Conti 2001b). A similar system, the Personal Emergency Device, was used effectively during an underground mine fire in Helper, Utah, on November 25, 1998. In this instance, the paging system (which displayed a message on an LCD display after the cap lamp flashed) was activated when one miner saw flames and telephoned the dispatcher to evacuate the mine; all 46 underground miners escaped in approximately 45 minutes (Conti 2001b).

The remote nature of underground mining requires workers, at all positions within the organization, to maintain higher skill levels in emergency response compared with workers in many other industries (Conti 2001a). It is paramount for miners to maintain and know their escape routes. Poor preparedness is a major challenge that could significantly impact a safe and timely evacuation from an underground fire. Findings from one study indicate that over 80percent of miners who lost their lives in a mine disaster survived the initial incident but perished while trying to escape because they were not aware of the self-escape route and instead used familiar but unsafe exits during a fire (Brnich and Kowalski-Trakofler 2010). Regularly scheduled (every 6 months) realistic fire simulation escapes and training of miners on fire rescue skills would better prepare miners for such events and could improve mine rescue missions. It is also important that miners be properly trained in the use of fire extinguishers, water hoses, and firefighting procedures. Preparing an emergency evacuation plan before an incident occurs is crucial to a successful evacuation mission and disaster prevention (Salami et al. 2023).

The Applicant has developed an Emergency Response Plan (Calico Resources USA Corp. 2023a), which identifies evacuation procedures and training requirements for workers. A full evacuation drill would take place every 60 days, emergency firefighting drills would be held at least once every 6 months for persons assigned surface firefighting responsibilities, and mine evacuation drills would be held once every 6 months following MSHA regulations to assess the ability of all persons underground to reach the surface or designated safety point within a time limit. In addition, all personnel who work underground would be instructed in the escape and evacuations plans, procedures, and warning signals for an emergency on an annual basis.

A fire underground can lead to entrapment, smoke inhalation, serious or fatal burns, and asphyxiation for workers. An aboveground fire may lead to equipment and property damage and worker injuries. A fire could also lead to explosions in the event that unprotected explosives are located near the fire. Explosives storage facilities would be constructed at the southwest side of the Project area, which has a hill that would serve as a natural barrier between the explosives storage facility and other mine infrastructure. Explosive agents would be stored within a secure powder magazine, and detonators would be stored in separate storage magazines, with earthen berms for additional protection.

There is a possibility of a fire or explosion at the Project site since the Project involves the use of flammable materials and equipment. However, by following current regulations, adhering to industry best practices, and following operational procedures and safety protocols developed in the Project-specific plans, the likelihood of a fire in underground areas or the mill is expected to be low. Installing effective notification technology and escape equipment, conducting adequate training for employees, including escape simulations, and creating emergency plans would reduce the effects of an underground fire incident.

Releases of Contaminants

Hazardous materials releases can result from equipment malfunction or failure, human error, and powerful natural forces, which can cause a pipeline or containment rupture or leak. These factors may act singly or in combination to create a condition that leads to a hazardous material release that may represent risk to one or more elements of the Project, workers, and the environment.

One of the most common causes of accidental releases of contaminants is failure of mine retention basins. A recent example of this is the Gold King Mine spill in Silverton, Colorado, in 2015, which spilled 3 million gallons of contaminated water into the surrounding watershed, affecting fish, wildlife, and communities across the southwest. This accidental release was attributed to human error when contractors accidentally destroyed a plug holding water trapped inside the mine while attempting to drain ponded water near the entrance of the mine, which caused an overflow (Harder et al. 2015).

For this Project, management of process solution within the process plant, TSF, and reclaimed process solutions requires operations to use pumping equipment and pipelines along with the primary and secondary containment provided by lined ponds, sumps, and ditches. Operation of pumping equipment requires an understanding of pipeline and containment capacities plus changing meteoric precipitation, snowmelt, and freeboard requirements to prevent overflows from containment. In addition, operators need to conduct their duties in a manner that does not result in punctures, tears, or wear of primary or secondary containments and liners that would allow process solution to infiltrate through containment into underlying materials. Appropriate operator actions include the use of standard operating procedures for inspecting current meteorological, flow, pressure, and freeboard conditions, starting and stopping pumping equipment, securing tools and equipment to prevent liner tears and punctures from moving or falling items, scheduled inspections and preventative maintenance, and removal of sediment and debris from containments if necessary.

Properly preparing the subgrade is crucial for avoiding tension or stretching of a liner, which may alter proper liner function (Tuomela et al. 2021). Appropriate preparation of the ground surface prior to liner installation in the TSF is one way to reduce the risk of leaks or rupture of the liner over time. A smooth surface with a subgrade free of rocks greater than 1-inch diameter is required for the placement of geosynthetic lining systems. Therefore, prior to installation of the liner at the TSF, the subgrade in the area would be prepared appropriately. Some areas where the native material already meets required subgrade specifications would only require surface preparation, which includes compacting, grading, and removing oversized rocks and projections from the surface. Other areas may require fill with prepared subgrade to either meet design grades or to be placed where the native materials do not meet subgrade specifications. Quality control inspections and testing of the subgrade prior to liner installation would be completed using standardized testing procedures (i.e., ASTM methods) for particle size, density, moisture content, and plasticity to ensure the subgrade surface is suitable (Golder Associates 2021).

Construction quality assurance and control (QA/QC) would be undertaken by contracted construction personnel. The Construction Quality Assurance Plan (Golder 2021: Appendix J) describes the program used to verify and document that earthwork construction, geomembrane installation, gravity pipe installation, and structural concrete installation for the TSF and TWRSF have been conducted in accordance with the technical specifications and drawings for the Project. As described in the Project Quality Plan (Ausenco Engineering Canada Inc. [Ausenco] 2019), the contractor would be responsible for the quality of the work to ensure that quality standards are met, including quality control testing (materials, soil compaction, concrete strength, welds, protective coating, pipeline leakage), inspections, and reporting. The contractor would be required to develop a quality control plan, construction procedures, and an inspection and testing plan as part of quality assurances for construction of Project features.

A rupture of TSF liner could potentially cause process leachate to be released into the environment. The TSF has been designed to be continuously geomembrane-lined, with primary and secondary lining systems to provide dual containment of process solution (Golder Associates 2021). However, if these liners were to rupture, process solution would collect through the underdrain collection piping and leakage collection recovery system. The leakage collection recovery system would be placed where concentrated flows are expected and immediately below the primary collection pipes, and it would convey underdrain flows to the reclaim pond (Golder Associates 2021).

The largest potential source of a release of contaminants for the Project would be failure of the TSF embankments holding the tailings and contaminated wastewater. The TSF has been designed to withstand a maximum credible earthquake, so the likelihood of an embankment failure is low. Nevertheless, planning for unforeseen events, including embankment failure as well as spills from storage areas, equipment, and vehicles is important. See Section B-4.3 for a list of plans the Applicant has created to identify potential hazards and provide best management practices (BMPs) and response measures for the proposed mine operation. Another potential source of a release of contaminants for the Project would be from a pipeline leak or rupture. Pipelines used to convey water or tailings slurry are subject to weather and temperature conditions that can cause wear due to expansion and contraction of the pipeline material. Additionally, pipeline operation per standard procedures needs to account for acceptable flows and pressures consistent with the pipeline design and materials. Leaks and failures due to pipeline wear or over-pressurization have the potential to introduce water or tailings slurry into the environment in the event that the leak or failure results in a volume and/or direction of discharge that eludes secondary containment.

Similar to equipment failures, pipeline failures can be prevented by scheduled inspections, predictive maintenance, and adherence to standard operating procedures for starting and stopping flows in pipelines. These measures include QA/QC of pipeline installations to ensure compliance with design specifications; flow and pressure monitoring; visual inspection for expansion, contraction, and signs of wear; and operating procedures that prevent rapid changes in pipeline operating pressures (e.g., “water hammer,” a condition when water flow in a pipeline is brought to a sudden halt). Since the tailings pipeline would be installed within a lined channel, in the event of a rupture or leak, tailings would flow down the channel to the TSF, preventing the material from escaping into the environment. In addition, the Applicant’s Emergency Response Plan (Calico Resources USA Corp. 2023a) addresses emergency situations including spill prevention methods that would be adhered to.

In addition to designing facilities to withstand natural events and planning for emergency situations, the chemicals and processes used in mining can avoid the potential for an accidental release of liquids or gases from mine facilities. Traditional end-of-pipe technologies used to treat wastes remediate pollution problems after they have occurred, rather than tackling them before they develop. A more effective approach to waste management is pollution prevention and cleaner production, which aims at reducing levels of pollutants in waste streams prior to their release. Cleaner production includes the integration of cleaner technologies and strategies, including highly efficient environmental equipment, heavily retrofitted control systems, and comprehensive environmental management plans. Each system works to minimize pollution to air, water, and land, rather than treating it once it has manifested into an environmental crisis (Hilson 2000). The adoption of such cleaner production strategies has reduced environmental stresses and saved firms large amounts of money that would have otherwise been spent on environmental cleanup. Examples of clean production technologies include the use of wet scrubbers to minimize releases of hazardous gases into the atmosphere and advanced wastewater treatment technologies such as electrochemical methods, membrane filtration, and chemical precipitators, which more effectively mitigate water pollution problems (Hilson 2000). For the Project, the Applicant proposes to use a number of clean technologies to manage cyanide, including treatment using hydrogen peroxide, sulfur dioxide/air detoxification, and biological oxidation. These cleaner technologies would assist in avoiding a potentially costly accidental release of contaminants.

Accidental spills from handling of materials or leaking equipment are other potential sources of releases of hazardous substances into the environment. The Applicant's Emergency Response Plan (Calico Resources USA Corp. 2023a) outlines specific procedures to address an accidental spill or discharge of hazardous material and the responsibilities and guidelines for actions to be taken by mine personnel in such circumstances. Hazardous materials would be stored at the most efficient location according to their place of use and would be stored appropriately based on the chemical in question. Some chemicals would be stored within secondary containments (e.g., diesel stored in double-walled tanks), and some chemicals would be stored in secure, fire-proof cabinets. Storage areas would be designed appropriately based on specific characteristics of the chemicals to be stored; for example, in areas where corrosive materials are stored or used, the concrete floor would be covered with an impermeable compound that would be resistant to corrosive chemicals in the event of a spill. Containers for all chemicals would be labeled appropriately, and Safety Data Sheets (SDS) made available to provide information about safety precautions, first aid, and medical treatment (Calico Resources USA Corp. 2023a).

Spill containment and cleanup equipment would be located at strategic locations throughout the facility and include spill kits, absorbent materials such as pads, rolls, and pillows, and machinery equipment such as backhoe or excavator and bulldozers. Cyanide spill response would follow the plan in the Emergency Response Plan, while spill response for oil and other chemicals would follow the SDS available onsite and typically include controlling the source, containing the fluid, and cleaning up using sorbent materials. Solid chemicals would be swept up and placed in containers. If the spill were large in size or duration, spill response contractors would be used (Calico Resources USA Corp. 2023a).

The Applicant's Waste Management Plan (Calico Resources USA Corp. 2023b) describes the disposal of contaminated spill response materials and other chemical and hazardous substances. Hazardous materials would be shipped to a licensed hazardous waste treatment, storage, and disposal facility. Materials used to clean up a spill would be disposed of appropriately based on the type of material cleaned (Calico Resources USA Corp. 2023b).

The potential for very small spills of chemicals and other materials may occur based on the high volume of chemical substances expected to be used throughout operation of the mine. However, such accidental spills would be contained in specific use areas and cleaned up efficiently per the hazardous materials handling and spill response plans developed for the Project.

Transportation Accidents

Accidents can be caused by vehicles transporting personnel, equipment, and materials to, from, and around a site and can involve collisions with wildlife (e.g., deer). Vehicle accidents can result in serious injury or death. When vehicles transport hazardous materials, such as petroleum products or chemicals, this can be another source of accidental releases of contaminants.

In the US during 2021, 5,700 large trucks (with a gross vehicle weight rating of greater than 10,000 pounds) were involved in fatal crashes, and 176,843 trucks were involved in non-fatal crashes. Of those crashes, there were 3,311 incidents (both fatal and non-fatal) involving large trucks carrying hazardous material cargo, and 17 percent of those crashes involved the release of hazardous materials from the cargo compartments (Federal Motor Carrier Safety Administration 2023).

Fatal crashes in the US in 2021 involving large trucks were predominantly due to another vehicle, person, animal, or object in the truck's lane or encroaching into it, accounting for 63 percent of large truck fatal crashes. Loss of control or driver movement was the cause for 24 percent of these large truck fatal crashes, and vehicle-related factors were recorded for 4 percent of these crashes, with the most common factors being issues with tires and brake systems (Federal Motor Carrier Safety Administration 2023).

According to the same Federal Motor Carrier Safety Administration 2021 dataset, flammable liquids were the number one hazardous material cargo released during these accidents. An example is an accident that occurred in 2016 when a semitrailer loaded with noncorrosive liquified petroleum gas separated from its truck, traveled into a ditch, struck a rock, and ruptured the cargo tank releasing its contents, which then caught fire. The truck driver was severely injured as a result of the crash and fire (National Transportation Safety Board 2016).

The Applicant's Toxic and Hazardous Substances Transportation and Storage Plan (Calico Resources 2021a) describes transporter and owner requirements for toxic or hazardous substances proposed for shipment to the Project. It includes the federal and state requirements and provides reporting procedures in the event of an incident during the transportation of hazardous or toxic materials.

B-3.3 Post-closure Events

Mine closure activities are intended to physically and chemically stabilize and revegetate closed mine sites in order to return them to post-mining use, in this case for livestock grazing, wildlife habitat, and potentially dispersed recreation. Closure activities are described in the Applicant's Reclamation Plan (Calico Resources USA Corp. 2023c) and include long-term stormwater management, placement of growth media over mine facilities, passive treatment of small volumes of mine drainage,[2] and re-establishment of native vegetation. For arid site conditions, revegetated covers are key to the chemical stabilization of mine facilities because they constrain the infiltration of precipitation, which reduces the potential for leaching constituents from mined materials that could impact surface water and groundwater quality. While proposed closure activities are anticipated to achieve success in stabilizing and revegetating the mine site, credible accidents could occur that reduce the effectiveness and durability of mine closure during the post-closure period. Such accidents may include erosion and slope failures that lead to failures of surface water and underdrain water controls, liners, and revegetated covers.

Erosion and Slope Failures

A sudden event such as an earthquake or severe storm, or long-term weathering, may also cause erosion and slope failures. The Applicant has designed slopes for closed facilities to be geotechnically stable and to preclude slope failures under static conditions and seismic conditions involving credible magnitudes for earthquake events. Nevertheless, over time, the physical stability of closed facilities can be affected by local-scale water erosion associated with precipitation and/or wind erosion, particularly in unvegetated or poorly vegetated areas. If not addressed, local-scale erosion can diminish overall slope stability over time, increasing the potential for larger slope failure accidents. Wide-scale erosion and slope failures would be particularly damaging to permanent liners and covers. Post-closure monitoring inspections for local-scale

[2] The Reclamation Plan assumes 28 gallons per minute during stage 1 (closure year 1) and 51 gallons per minute during stage 2 (closure year 2) of TSF closure. In closure year 3, the reclaim pond would be converted to an evaporation cell for the management of tailings underflow from the reclaimed TSF, although the timing of decommissioning would be contingent on the evaporative potential of the evaporation cell (Calico Resources USA Corp. 2023b).

erosion and repair/maintenance actions would help prevent the potential for wider erosion and slope failure.

Cover and Liner System Failures

Liner systems beneath closed facilities are typically durable unless subjected to slope failures where materials migrate off the lined area. Geosynthetic liners buried under covers that prevent their exposure to sunlight and weather remain competent over their history of use. Similarly, cover systems are typically durable unless subjected to erosion (water or wind) and slope failures that diminish the cover functionality of inhibiting oxygen and water from contacting the materials in closed mine facilities (e.g., TSF). Construction QA/QC would be undertaken by contracted construction personnel, who would be responsible for the quality of the work to ensure that quality standards are met. As part of these quality control assurances, the contractor would be required to develop a quality control plan, construction procedures, and an inspection and testing plan.

Post-closure inspections for erosion, and monitoring of liners and subsequent repair and revegetation actions, would aid in maintaining the physical and chemical stability of closed facilities and liners.

Water Control Failures

Stormwater diversions and drainage swales may experience diminished functionality due to a sudden event such as an earthquake or severe storm, or long-term weathering of materials, sedimentation, debris, or anthropogenic blockage. If functionality is impaired, uncontrolled runoff would have the potential to erode reclamation cover materials and/or infiltrate into covered areas with contaminants. The physical and chemical stability of such closed facilities may be affected, and infiltrated contaminated waters could leak into the environment. The long-term integrity of surface water controls can be ensured via post-closure site monitoring and repair when functionality risks are detected (e.g., debris/blockage removal). The Applicant’s Reclamation Plan (Calico Resources USA Corp. 2023c) includes inspections of stormwater diversion channels during the reclamation monitoring period (of 15 years) to ensure that sediment has not accumulated and that the lining in the channels (riprap, concrete) has not been compromised. In addition, stormwater samples from outfalls would be collected, tested, and reported to the relevant regulatory agencies to demonstrate reclamation compliance where necessary.

The TSF design uses active evaporation during early closure to manage discharge of leached constituents as tailings dry sufficiently to allow for installation of the closure cover system consisting of a geosynthetic liner overlain by revegetated growth media. Due to the fine-grained nature of the tailings, the TSF would continue to drain at a low flow rate for an extended period of time into the post-closure period. This low flow discharge would contain leached constituents from the tailings that could impact surface water and groundwater quality if it were to contact the environment. The long-term discharge would be managed by converting the lined TSF reclaim pond into an evaporation cell (e-cell) where discharge collects and evaporates without contacting the environment. Such lined e-cells are effective means to passively treat low volumes of TSF drainage in arid environments where the evaporation rate is higher than annual precipitation.

The effectiveness of e-cells in preventing drainage from contacting the environment depends on sizing the e-cell to achieve evaporation greater than the TSF discharge flow rate and installation of a liner system that prevents TSF discharge from infiltrating into the subsurface toward groundwater. An event leading to liner malfunction such as a slope failure may reduce the effectiveness of this closure system.

The liner system below an e-cell is typically durable when covered and protected from sunlight and precipitation, whereas exposed areas are subject to wear over time with increased potential for leakage. The Applicant's post-closure monitoring inspections of the TSF e-cell, and subsequent maintenance actions to repair liners and revegetate areas, would protect the TSF e-cell and prevent accidental release of contaminants into the environment. In addition, groundwater quality would be routinely collected, tested, and reported to the relevant regulatory agencies to demonstrate reclamation compliance (Calico Resources USA Corp. 2023c).

Additional monitoring actions include measuring TSF discharge flow rates via totalizer flow meter readings to confirm that they are stable or decreasing and installation of leak detection for the e-cell liner to confirm liner functionality and trigger liner maintenance if needed.

Revegetation Failure

Revegetation contributes to the effectiveness and durability of reclaimed facilities by reducing the effects of water and wind erosion that could diminish cover system effectiveness. Even after successful initial revegetation efforts, long-term post-closure vegetation durability could be affected by a number of natural and/or anthropogenic factors including over-grazing, drought, infestation, and wildfires. Post-closure vegetation monitoring would assess whether sufficient vegetation is present to maintain cover systems, provide for post-mining land uses, and ensure achievement of ecological reference site conditions.

In the event of revegetation failure, slopes would not be protected and may experience erosion from wind and water. Revegetation failure could lead to additional spread of invasive species. Revegetation failure would extend the period of time needed for restoration of the site and require additional seeding and watering.

The Applicant's Reclamation Plan (Calico Resources USA Corp. 2023c) includes revegetating disturbed areas with a seed mix that would provide erosion protection, have the ability to grow within the constraints of the low annual precipitation experienced in the region, and be suitable for the site aspect and the elevation and soil type. Vegetation monitoring of reclaimed facilities would be conducted 5 years after revegetation activities have been completed and reclaimed areas not meeting regulatory standards would be evaluated and corrective actions implemented. Such measures could include, if necessary, additional soil amendments, reseeding, installation of erosion control measures, irrigation systems, and continued monitoring. In addition, to prevent infestations, noxious weed monitoring and control would be implemented for a minimum period of 5 years following the cessation of operations (Calico Resources USA Corp. 2023c).

B-4 ACCIDENT PREVENTION

While the mine site is active, the MSHA would be the regulating agency. Once mining activities ceases, the Occupational Safety and Health Administration (OSHA) would be the regulatory agency for the site.

B-4.1 Identifying and Assessing Hazards

A primary root cause of workplace injuries, illnesses, and incidents is failure to identify or recognize hazards that are present or that could have been anticipated. A critical element of any effective safety and health program is a proactive, ongoing process to identify and assess such hazards. To identify and assess hazards, employers and workers should (OSHA 2024):

- Collect and review information about the hazards present or likely to be present in the workplace and create plans to address these;
- Conduct initial and periodic workplace inspections to identify new or recurring hazards;
- Investigate injuries, illnesses, incidents, and close calls/near misses to determine underlying hazards, their causes, and safety and health program shortcomings;
- Group similar incidents and identify trends in injuries, illnesses, and hazards reported;
- Consider hazards associated with emergency or nonroutine situations; and
- Determine the severity and likelihood of incidents that could result for each hazard identified and use this information to prioritize corrective actions.

Physical safety hazards can increase over time as workstations and processes change, equipment or tools become worn, maintenance is neglected, or housekeeping practices decline. Setting aside time to regularly inspect the workplace for physical hazards can help identify shortcomings so that they can be addressed before an incident occurs. Documenting inspections and repairs allows for verification that hazardous conditions have been corrected, which may include taking photos or videos of problem areas to facilitate later discussion and brainstorming about how to address hazards. All facility areas and activities should be included in these inspections, such as storage and warehousing, facility and equipment maintenance, purchasing and office functions, and the activities of onsite contractors, subcontractors, and temporary employees. The use of checklists can assist in highlighting hazards to look for (OSHA 2024).

Health hazards are potential sources of danger to a person’s health. They can be obvious, such as a faulty electrical wire, or less obvious, such as gases and vapors that may be invisible, often have no odor, and may not have an immediately noticeable harmful health effect. Health hazards may include chemical hazards (e.g., gases, solvents, adhesives, paints, toxic dusts); physical hazards (e.g., broken equipment, excessive noise or heat); biological hazards (e.g., infectious diseases, molds, toxic or poisonous plants, or animal materials); and ergonomic risk factors (e.g., heavy lifting, repetitive motions, vibration) (OSHA 2024). Hazard assessment should include consideration of all of these types of health hazards.

Workplace incidents provide a clear indication of where hazards exist and may include injuries, illnesses, close calls/near misses, and reports of other concerns. Clear plans and procedures for conducting incident investigations should be developed so that an investigation can begin immediately after an incident. Thoroughly investigating incidents and reports is important in identifying the root causes of the incident or concern in order to prevent future occurrences (OSHA 2024).

Emergencies and nonroutine or infrequent tasks, including maintenance and startup/shutdown activities, present potential hazards. Plans and procedures should be developed for responding appropriately to emergency scenarios and nonroutine situations.

After identifying all workplace hazards, plans should be created to minimize the hazards and workers’ exposures to these hazards, and these should be used to train workers in identifying and avoiding physical safety and health hazards. After an incident occurs, these plans should be updated and include lessons learned.

B-4.2 Accident Prevention Measures

Accident prevention begins with controlling exposure to hazards in the workplace. The hierarchy of controls is a way of determining which actions best control exposure to hazards, beginning with the most effective (Figure B-2). The hierarchy of controls has five levels of actions to reduce or remove hazards. The preferred order of action based on general effectiveness is:

1. **Elimination**: Removing the hazard entirely.
2. **Substitution**: Replacing a severe hazard with a less severe one.
3. **Engineering Controls**: Replacing equipment or changing the work environment to separate workers from a hazard.
4. **Administrative Controls**: Developing formal procedures and processes for working safely under anticipated conditions.
5. **PPE**: Equipping workers with clothing and equipment designed to reduce risk and limit the severity of injuries.

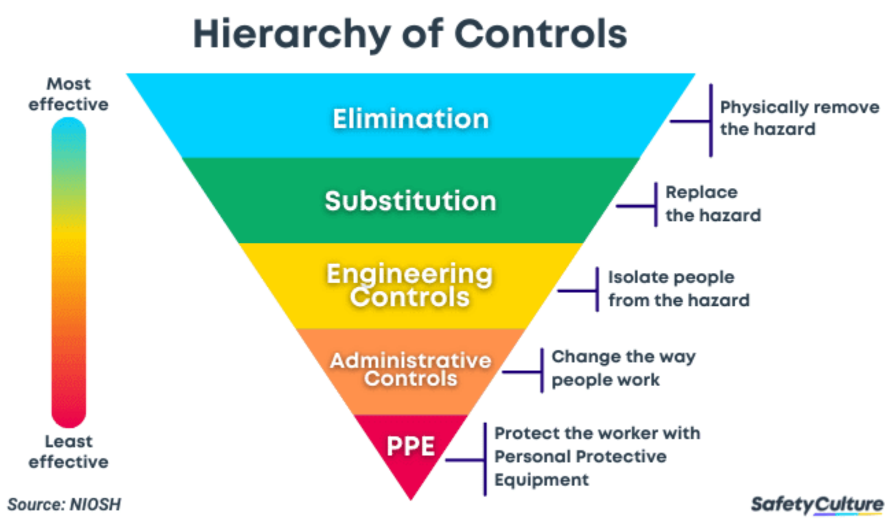

Figure B-2 Hierarchy of Controls

Source: Centers for Disease Control 2023.

Elimination removes the hazard at the source and is the preferred solution to protect workers because no exposure can occur. This could include changing the work process to stop using a toxic chemical, heavy object, or sharp tool.

Substitution is using a safer alternative to the source of the hazard that reduces the potential for harmful effects and does not create new risks. An example is using plant-based printing inks as a substitute for solvent-based inks. When considering a substitute, it is important to compare the potential new risks of the substitute to the original risks. This review should consider how the substitute would combine with other agents in the workplace.

Elimination and substitution can be the most difficult actions to adopt into an existing process. These methods are best used at the design or development stage of a work process, place, or tool. At the development stage, elimination and substitution may be the simplest and cheapest option. Another opportunity to use elimination and substitution is when selecting new equipment or procedures. “Prevention Through Design” is an approach to proactively include risk prevention through elimination and substitution when designing work equipment, tools, operations, and spaces.

Engineering controls reduce or prevent hazards from coming into contact with workers. Such controls can include modifying equipment or the workspace, using protective barriers, ventilation, and more. The most effective engineering controls:

- Are part of the original equipment design;
- Remove or block the hazard at the source before it comes into contact with the worker;
- Prevent users from modifying or interfering with the control;
- Need minimal user input for the controls to work; and
- Operate correctly without interfering with the work process or making the work process more difficult.

Engineering controls can cost more upfront than administrative controls or PPE. However, long-term operating costs tend to be lower, especially when protecting multiple workers. In addition, engineering controls can save money in other areas of the work process or facility operation.

Administrative controls establish work practices that reduce the duration, frequency, or intensity of exposure to hazards. They may include:

- Work process training;
- Job rotation;
- Ensuring adequate rest breaks;
- Limiting access to hazardous areas or machinery; and
- Adjusting line speeds.

Administrative controls require significant and ongoing effort by workers and their supervisors. They are useful when employers are in the process of implementing other control methods from the hierarchy. Additionally, administrative controls and PPE are often applied to existing processes where hazards are not well controlled.

PPE is equipment worn to minimize exposure to hazards. Examples of PPE include gloves, safety glasses, hearing protection, hard hats, and respirators. When employees use PPE, employers should implement a PPE program. While elements of the PPE program depend on the work process and the identified PPE, the program should address:

- Workplace hazards assessment;
- PPE selection and use;
- Inspection and replacement of damaged or worn-out PPE;

- Employee training; and
- Program monitoring for continued effectiveness.

Employers should not rely on PPE alone to control hazards when other effective control options are available. PPE can be effective, but only when workers use it correctly and consistently. When other control methods are unable to reduce the hazardous exposure to safe levels, employers must provide PPE. PPE might seem less expensive than other controls but can be costly over time, especially when used by multiple workers on a daily basis.

For mining and hauling material, typical PPE for workers includes mining boots, gloves, helmet, high-visibility gear, and protective padding. Miners work on wet and oily surfaces in underground mines, so mining boots with a traction outsole assist in preventing slips and falls. Gloves prevent scrapes and abrasions and reduce exposure to cold and heat. Helmets provide vital protection against falling objects, head injuries, confined space hazards, and electrical shocks. Helmets can have different colors and stickers for identification purposes, lights, and emergency communication or warning devices such as wearable wireless receivers and LCD displays (see Section B-3.2 for more information on emergency communication devices). The use of high-visibility clothing ensures that miners are always visible, which is especially important where vehicles are operating and in conditions of low light. Other PPE for miners may include padding for protection of joints, ear plugs to reduce exposure to noise, and masks to reduce exposure to particulate matter.

For a process plant (including laboratory and gold room), PPE may include closed-toed shoes, ear plugs to reduce noise exposure, eye protection, gloves, and a gas mask among others. Different tasks and areas of the mine require different PPE. Every piece of PPE is designed to prevent injury and protect employees and should be worn at all times. Regular inspections, maintenance, and replacement of PPE should occur to prevent injury.

In addition to the use of PPE, examples of key precautions, procedures, and methods that are effective in preventing accidents include:

- Training employees in safe operational procedures for all equipment and vehicles that would be used onsite and the proper use of all PPE;
- Creating and adhering to a site health and safety plan that accurately identifies all known hazards and their controls and establishing policies to ensure safe work practices are stringently adhered to;
- Regularly testing equipment and reviewing operational practices;
- Maintaining proper equipment and procedures during storage/transport (e.g., stable oil temperature and pressure);
- Conducting regular safety inspections and performing routine equipment maintenance, such as making sure that connections remain leak-proof and that automatic shutoff mechanisms function properly;
- Installing and maintaining automatic leak detection, emergency shutdown systems, and manual emergency shutdown capabilities;

- Training employees in the use of fire extinguishers, spill equipment, and manual emergency shutdown procedures;
- Installing and maintaining secondary containment systems, such as containment berms around storage facilities, to capture accidental spills or leaks;
- Assigning hazardous materials handling, monitoring, and operational management to qualified and trained personnel;
- Developing, updating, and adhering to regulated spill prevention, control, and countermeasure plans and emergency response plans;
- Educating and training staff in spill prevention, control, and countermeasures and ensuring proper certifications are in place;
- Training employees to recognize potential ignition sources, to use fire alarms, and to quickly notify emergency responders; and
- Conducting emergency response simulations to prepare staff for potential accidents.

B-4.3 Project-specific Accident Prevention Measures

Project-specific accident prevention measures and incorporating the hierarchy of controls into the Project include designing Project features to withstand natural hazards and to exclude wildlife; providing appropriate PPE; providing adequate training for equipment use and operational procedures; conducting regular equipment and vehicle maintenance, inspections, and replacements; and adherence to all safety protocols.

The Project TSF has been designed to withstand a maximum credible earthquake, and the underground mine has been designed with structural supports and a set sequence for ore extraction. Nevertheless, frequent inspections should be conducted of structural supports and underground mine roofs, particularly during changing conditions such as heavy rainfall or drought.

For emergency situations, a series of steel-lined vent raises would connect each underground mine level to a ventilation shaft that exits at the surface to provide ventilation for underground mine areas. These vent raises would have an escape ladder to provide a secondary means of egress in an emergency. Two emergency refuge stations would be installed in case of fire or rockfalls that block access and prevent full evacuation of personnel. These protected mobile refuge stations would be located no more than 1,000 feet from mine operation personnel and would allow 20 staff to remain safe in the underground mine for 48 hours.

The proposed Project facilities, including the TSF, have been designed to account for the 500-year, 24-hour severe weather event. Project facilities would be monitored on a regular basis to detect and repair identified failures. This includes leak detection for the TSF and TWRSF and groundwater monitoring.

To avoid conflicts between workers and wildlife, Project features include fencing, wildlife exclusion devices, and garbage management to prevent wildlife from inhabiting or damaging Project facilities.

PPE for the proposed Project includes hardhats, steel-toed and steel-shanked boots, leather gloves, eye protection, safety vests, and hearing protection where necessary, as required by MSHA and described in the Emergency Response Plan (Calico Resources USA Corp. 2023a).

The Applicant has created a number of plans to identify potential hazards and provide BMPs and response measures for the proposed mine operation. These include:

- Cyanide Management Plan (Ausenco 2023);
- Emergency Response Plan (Calico Resources USA Corp. 2023a);
- Petroleum-Contaminated Soil Management Plan (Calico Resources USA Corp. 2022);
- Safety Training Plan (Calico Resources USA Corp. 2021b);
- Tailings Chemical Monitoring Plan (Calico Resources USA Corp. 2023d);
- Toxic and Hazardous Substances Transportation and Storage Plan (Calico Resources USA Corp. 2021a);
- Waste Management Plan (Calico Resources USA Corp. 2023b); and
- Wildlife Protection Plan (Mason, Bruce & Girard, Inc. 2023).

The Emergency Response Plan identifies evacuation procedures and training requirements for workers. The Safety Training Plan identifies the training requirements for employees. The Applicant would also develop an MSHA safety training program for new miners and an MSHA safety training refresher program for experienced miners in collaboration with the State of Oregon MSHA program coordinator at Eastern Oregon University in LaGrande, Oregon.

B-5 EMERGENCY RESPONSE MEASURES

B-5.1 Malheur County

Malheur County developed an Emergency Operations Plan (Malheur County 2022) that describes how the county organizes and responds to emergencies and disasters in the community. The Emergency Operations Plan provides a framework for coordinated response and recovery activities during a large-scale emergency and describes how various agencies and organizations in the county coordinate resources and activities with other federal, state, local, tribal, and private-sector partners.

Local government has the primary responsibility for emergency management functions and for protecting life and property from the effects of hazardous events. Primary roles in initial emergency response are undertaken by first responders such as fire and police departments and may involve hospitals, local health departments, regional HAZMAT teams, and Oregon Department of Forestry Incident Management Teams. The Emergency Operations Plan is used in the event that county municipalities or emergency response agencies are reaching, or have exceeded, their abilities to respond to an emergency incident (Malheur County 2022). The emergency communications system is organized and coordinated within the Sheriff's Office Emergency Management Division, located in Vale.

In addition, the Federal Mine Health and Safety Act of 1977 requires that every operator of an underground mine ensure the availability of mine rescue teams for purposes of emergency rescue and recovery of trapped or injured miners. Rescue teams must receive adequate training in accordance with MSHA regulations at 30 CFR Part 49, and mine rescue contests and simulations are an essential part of the training process to ensure that teams receive hands-on exposure to a range of potential hazards and mine emergency scenarios.

B-5.2 Project-specific Emergency Response Measures

The Applicant's design of underground workings includes the installation of ventilation shafts, emergency refuge stations, and escape routes to be used in the event of an emergency such as mine collapse. The protected mobile refuge stations would be located no more than 1,000 feet from mine operation personnel and would allow 20 staff to remain safe in the underground mine for 48 hours.

The Applicant has developed an overall Emergency Response Plan (Calico Resources USA Corp. 2023a), an Emergency Action Plan for emergencies that require evacuation, and a Safety Training Plan (Calico Resources USA Corp. 2021b) for mine workers.

The Emergency Response Plan was developed in accordance with applicable federal, state, and local provisions and incudes a description of general response procedures to emergencies that could potentially occur at the facility, specific procedures to address a spill/discharge of hazardous material, and responsibilities and guidelines for actions to be taken by mine personnel in the event of a credible accident. The Emergency Response Plan would be reviewed and updated on a regular basis during operations to ensure it remains applicable to the hazards associated with the operation and the responsible parties assigned to respond to a spill.

The Safety Training Plan provides a description of health and safety training requirements for mine employees through identification of the occupational safety and health training requirements for employees at the mine site and addressing known occupational safety and health risks for the planned activities onsite. Safety training would include review of the Emergency Action Plan. In addition, the Applicant would conduct regular mine evacuation drills and emergency firefighting drills for mine workers to provide more robust safety training than classroom-only exercises and discussions.

The Applicant would work with firefighting organizations to establish emergency firefighting, evacuation, and rescue procedures as described in the Emergency Response Plan (Calico Resources USA Corp. 2023a).

In addition to Project design features and mine rescue operations, MSHA (CFR 30 Part 57 Subpart U) requires mine operators requires operators to develop, implement, and update a written safety program for surface mobile equipment to reduce the number and rates of accidents, injuries, and fatalities and promote and support a positive safety culture. The safety program includes actions the operator would take to:

- Identify and analyze hazards and reduce the resulting risks related to the movement and the operation of surface mobile equipment;
- Develop and maintain procedures and schedules for routine maintenance and nonroutine repairs for surface mobile equipment;

- Identify currently available and newly emerging feasible technologies that can enhance safety at the mine and evaluate whether to adopt them; and
- Train miners and other persons at the mine necessary to perform work to identify and address or avoid hazards related to surface mobile equipment.

The Applicant would develop an MSHA safety training program for new and experienced miners that incorporates these actions.

The Applicant's Emergency Response Plan (Calico Resources USA Corp. 2023a) addresses emergency situations including earthquakes, wildland fires, torrential rain/flooding, high winds/windstorms, landslides, mine infrastructure instability, transportation incidents, explosives incidents, operational failures, process failures, equipment failures, human-started fires, worker injury/illnesses, power outages, a TSF dam breach, overtopping of the reclaim pond, overtopping of the dam crest, and impoundment or reclaim pond leakage. The plan includes reporting and notification procedures, emergency response procedures, emergency preparedness information (such as PPE, first aid, fire protection, and spill response), spill prevention methods, and information regarding the training and exercise program. Employees would receive CPR and first aid training annually. Oil-handling personnel would receive annual spill prevention training including operation and maintenance of equipment to prevent discharges, spill response procedures, pollution control regulations, and general facility operations. Emergency response team members would receive enhanced training on spill response equipment and tactics and MSHA and Hazardous Waste Operations and Emergency Response (HAZWOPER) standards for emergency response.

B-6 LIABILITY AND COMPENSATION FOR ACCIDENTS

There are a number of federal regulations that may apply to a mining accident, including the Safe Water Drinking Act, Comprehensive Environmental Response, Compensation, and Liability Act, Resource Conservation and Recovery Act, and Executive Order 12580. The decision to use the procedures and processes outlined in these acts depends on mine ownership and the location and extent of contamination. The BLM, as the lead federal permitting agency for the Project, would be responsible for coordinating cleanup with federal and state regulators, including DOGAMI and the Oregon Department of Environmental Quality (DEQ).

DEQ's Environmental Cleanup Program protects human health and the environment by identifying, investigating, and remediating sites contaminated with hazardous substances. There is also an Emergency Response Program to oversee short-term cleanups of chemical spills resulting from accidents or natural disasters. In the event of an emergency situation that caused a spill of contaminated material (e.g., wastewater from the TSF is accidentally released into the environment), DEQ would assess the site and make recommendations for cleanup in collaboration with federal entities.

With regard to cleanup funding, contingency costs are the funds required to achieve a stable site in the event of unplanned closure or outcome (e.g., an accident that affects proposed facilities or the environment). The consideration of financial assurances considers these contingency costs for cleanup in the event of an emergency. The process for estimating the total financial assurances required, including contingency costs, is a serious, complex, and lengthy process that is being undertaken by DOGAMI and the BLM via a joint reclamation bond process. The total quantity of financial assurances required would be determined at the time permits are issued prior to any surface disturbance and assessed annually. See Section 5.6 for further information on financial assurance considerations for the proposed Project.

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APPENDIX C

CYANIDE CHEMISTRY

APPENDIX C CYANIDE CHEMISTRY

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C-1 INTRODUCTION

The purpose of this appendix on cyanide chemistry is to provide background information supporting the analysis of anticipated Grassy Mountain Gold Project (Project) effects associated with cyanide use on water quality, the environment, and wildlife resources.

Cyanide is a chemical compound comprising the anionic cyano group. The cyano group contains a carbon atom triple-bonded with a nitrogen atom, resulting in a molecule with a negative charge. Cyanide is one of the rare ions that, in the presence of oxygen, dissolves gold, a generally non-reactive metal. The dissolved gold is transported in solution as a complex: dicyanoaurate. The gold is typically recovered from the complex by adsorption onto activated carbon.

The US Bureau of Mines published Information Circular 9429, Cyanide Chemistry – Precious Metals Processing and Waste Management (Flynn and Haslem 1994) to provide regulatory agencies with technical information regarding cyanide. This appendix uses that technical information, along with more recent literature, plus best practices for cyanide handling, transportation, and management developed by the International Council on Mining and Metals for its International Cyanide Management Code (ICMC; International Cyanide Management Institute 2023).

Key terminology for describing cyanidation processes include (Flynn and Haslam 1994):

- Free Cyanide – the uncomplexed cyanide ion (CN^-) and molecular hydrogen cyanide (HCN). In an aqueous solution with pH greater than 9.2, the cyanide ion is the predominant cyanide form, while HCN becomes the predominant form in solutions where the pH is below 9.2. The cyanide ion is reactive with metals in ore, necessitating pH control above 9.2 for process solutions.
- Complexed Cyanide – a cyanide ion bound to a metal ion. While cyanide ions may bond with many elements, the most common complexes are with cadmium, chromium, cobalt, copper, gold, iron, lead, manganese, mercury, nickel, silver, and thallium.
- Weak Acid Dissociable (WAD) Cyanide – cyanide complexes that are decomposed by acids. Common WAD cyanide complexes include cyanide ions complexed with cadmium, nickel, and zinc.
- Non-WAD Cyanide – cyanide complexes that are resistant to acids. Common non-WAD cyanide complexes include cyanide ions complexed with cobalt and iron.
- Cyanide-Derived Species – molecules derived from the cyanide ion through addition of hydrogen, oxygen, and sulfur such as cyanate and thiocyanate.

The remainder of this appendix describes cyanide chemistry and the reactions that occur between molecules; cyanide solution management; cyanide use, handling, and transportation; cyanide in the environment; cyanide use specific to the Project; and regulations that address cyanide use.

C-2 CYANIDE CHEMISTRY

The concentration of cyanide required to optimize a metal-recovering cyanidation process depends on the amount of cyanide-complexing metals available in the crushed ore.

The metal reaction for metal-cyanide complexes typically follows (Medina and Anderson 2020):

$$4Metal + 8NaCN + 2H_2O + O_2 \rightarrow 4NaMetal(CN)_2 + 4NaOH$$

Through this reaction, the metal-complexed cyanide ion is present in a dissolved form in process solutions, facilitating the movement and handling of a metal-rich aqueous solution for subsequent steps in metal production and refining, free of the solid rock mass from which the metal was extracted.

Based on this reaction, two cyanide molecules are required for each metal molecule extracted from the ore. Hence, an ore with abundant concentrations of cyanide-complexing metals (e.g., gold, silver, copper) will need a higher concentration of cyanide to beneficiate those metals than an ore with lower concentrations of metals (e.g., a gold ore with no copper present). Typical concentrations of cyanide in a metal-leaching solution range from 300 to 500 milligrams per liter (mg/L). Use of lower concentrations of cyanide in process solution than the ore-dictated concentrations will result in lower metal production. Use of higher concentrations of cyanide than the ore-dictated concentrations will result in no material increase in metal production.

C-2.1 Dissociation in Water

Cyanide occurs in water as hydrocyanic acid (HCN) and the cyanide anion (CN-), simple cyanides, and metallocyanide complexes (US Environmental Protection Agency [EPA] 1994). The relative proportions of the two forms of free cyanide (HCN and CN-) depend mainly on pH and temperature, which can vary depending on the abiotic environment. Metallocyanide complexes have a range of stabilities for dissociation hydrolyzation to form free cyanide, but some complexes can dissociate via other mechanisms such as photo-decomposition after exposure to natural light (e.g., iron cyanides). The proportion of cyanide within metallocyanide complexes that are more likely to dissociate are measured using the WAD analytical method. This helps estimate the amount that may readily dissociate to free cyanide under natural conditions. WAD metals include silver, cadmium, copper, nickel, zinc, and mercury. However, total cyanide measurements are needed to quantify all the forms of cyanide complexes that may dissociate in the environment. The relative proportions of free cyanide and metallocyanides vary based on the mining solution of slurry which in turn depends on site-specific ore processing and environmental conditions. As described above, the cyanide species present are determined by the pH and the temperature of the process solution and slurry but are also dependent on the composition of the ore.

C-2.2 Cyanide Degradation

One of the primary fractions of cyanide species subject to “cyanide loss” in the environment involves the volatilization of HCN to the atmosphere, photolysis of iron cyanides in environments with high natural light, and oxidation.

Volatilization of HCN is dependent on how much of the cyanide mass is in the form of HCN. The proportion of free cyanide as HCN depends on environmental conditions such as pH and temperature. At a pH of 9.24 (the acid dissociation constant for cyanide), half of the concentration of free cyanide will be present as HCN and half as CN-. The lower the pH the greater the fraction of free cyanide that will be present as HCN and available for volatilization.

Lower temperature decreases dissociation and volatilization, while higher temperatures and lower pH values increase loss via volatilization. For example, when pH is below 8 and temperature is below 77 degrees Fahrenheit (°F), at least 94 percent of the free cyanide exists as HCN. When pH or temperature or both are higher, a greater percentage of free cyanide exists as CN- (e.g., at pH 9 and temperature of 86°F, about 55 percent of the free cyanide is HCN). High temperature and alkaline conditions would decrease the removal of cyanide via volatilization in a tailings storage facility (TSF) pond.

Photolysis occurs in ponds such as leach solution storage ponds, TSF supernatant ponds, and reclaim ponds where the solution is exposed to direct sunlight. Biological degradation occurs due to natural microbes in leach solutions. Oxidation of cyanide involves reaction with oxygen or other oxidants (e.g., hypochlorite or sulfur dioxide). Photolysis, biodegradation, and oxidation all result in the formation of other chemicals such as cyanate and thiocyanate which are typically further degraded to nitrate, bicarbonate/carbonate, and ammonia.

Since the goal of Project operation is to maintain an alkaline pH to maximize the use of cyanide as a lixiviant, the fraction of the WAD cyanide that is released or "degraded" would be more limited than it would be in acidic or neutral pH conditions where higher proportions of HCN are expected.

Iron-cyanide complexes (ferro- and ferricyanide) and some other metal-cyanide complexes will degrade when exposed to light. Metal-cyanide complexes are also biodegraded and/or oxidized. However, the degradation rates of metal-cyanide complexes are typically much slower than for free cyanide ions, so in an open pool such as the Project's TSF supernatant pond, where cyanide has been degraded first by chemical means prior to discharge in the pond and then is exposed to sunlight and microbes within the TSF, cyanide concentrations will be very low and the dominant forms will be metal-cyanide complexes and typically non-WAD cyanide complexes.

C-2.3 Cyanide Complexes

In solution, metal complexes of cyanide are formed by association of free metal ions with free cyanide ions according to the equilibrium association constants of the various metals and cyanide. Cyanide can form both weak and stronger metal complexes. Weakly bonded cyanide complexes (WAD cyanides) dissociate under weakly acidic pH conditions (4<pH<6). WAD cyanide complexes can be liberated under acidic conditions and converted to HCN in the environment or in the stomach when consumed by biota (the stomach is acidic, with a pH of approximately 3).

The cyanide ion can form strong complexes with a number of heavy metals such as barium, calcium, iron, potassium, lithium, magnesium, ammonium, sodium, strontium, thallium, cobalt, platinum, gold, and palladium. Iron is the most abundant of these elements in the environment and in process slurry and waters and is therefore of greatest interest for the Project. Such metal-cyanide complexes dissociate under strongly acidic pH conditions (pH<2), but while iron-cyanide complexes (ferro- and ferricyanide) are quite stable when covered, they can dissociate rapidly when exposed to light. Iron-cyanide complexes may potentially account for a large portion of the cyanide present and dissociate primarily with exposure to natural light. Neutral or alkaline conditions would increase the proportion of free cyanide occurring as CN-. The predicted conditions in the TSF are alkaline, which would mobilize iron cyanides and slow the formation and release to the atmosphere of HCN. However, as lime additions to the tailings are not continued into closure, lower pH conditions would be realized over a period of years to decades as oxygen rate-limited oxidation reactions consume the lime's neutralizing capacity. The loss of cyanide in the environment is most prominent at a pH less than 9.2, where the HCN- species is dominant.

C-3 CYANIDE MANAGEMENT

The precious metals industry has used the cyanidation process since the late 1880s to extract gold, silver, and other metals from ores. Cyanidation has been the dominant gold extraction technology since the 1970s (Society for Mining, Metallurgy & Exploration [SME] 2021). The cyanidation process has greater than 90 percent efficiency in most applications in removing precious metals, even from very low-grade ores (Medina and Anderson 2020; Verbrugge et al. 2021). Cyanidation is the leading industrial process for extracting gold because it provides high selectivity for gold over other elements. No other chemical reagents have been found to be nearly as effective as cyanide (SME 2021). With proper management and control of its use, cyanide has been used safely within the mining industry since becoming the dominant extraction technology (SME 2021).

Best practices for cyanide handling and transportation have been incorporated into the ICMC. Cyanide users, manufacturers, and transporters may opt to be certified as compliant with the ICMC. The objective of the ICMC is to improve the management of cyanide used in gold mining and to assist in the protection of human health and reduction of environmental impacts. Companies that adopt the ICMC are audited by an independent third party to determine the status of ICMC implementation. Audit results are made public to inform stakeholders of the status of cyanide management practices at the certified operation. While regulatory agencies typically do not require certification for their permitting and compliance requirements, they have recognized many elements of the ICMC as best practices.

The ICMC is organized into principles associated with mining use of cyanide (nine principles), cyanide manufacture (five principles), and cyanide transport (three principles). The mining use and transportation principles are most applicable to the Project because cyanide would not be manufactured as part of the Project.

The mining principles and their associated standards of practice are (International Cyanide Management Institute 2023):

1. Production and Purchasing: Encourage responsible cyanide manufacturing by purchasing from manufacturers who operate in a safe and environmentally protective manner.
    a. Purchase cyanide from certified manufacturers employing appropriate practices and procedures to limit exposure of their workforce to cyanide and prevent releases of cyanide to the environment.
2. Transportation: Protect communities and the environment during cyanide transport.
    a. Require that cyanide is safely managed through the entire transportation and delivery process from the production facility to the mine by use of certified transport with clear lines of responsibility for safety, security, release prevention, training, and emergency response.
3. Handling and Storage: Protect workers and the environment during cyanide handling and storage.
    a. Design and construct unloading, storage, and mixing facilities consistent with sound, accepted engineering practices, quality control and quality assurance procedures, and spill prevention and spill containment measures.

   b. Operate unloading, storage, and mixing facilities using inspections, preventative maintenance, and contingency plans to prevent or contain releases and control and respond to worker exposures.

4. Operations: Manage cyanide process solutions and waste streams to protect human health and the environment.

   a. Implement management and operating systems designed to protect human health and the environment including contingency planning and inspection and preventative maintenance procedures.

   b. Introduce management and operating systems to minimize cyanide use, thereby limiting concentrations of cyanide in mill tailings.

   c. Implement a comprehensive water management program to protect against unintentional releases.

   d. Implement measures to protect birds, other wildlife, and livestock from adverse effects of cyanide process solutions.

   e. Implement measures to protect fish and wildlife from direct and indirect discharges of cyanide process solutions to surface water.

   f. Implement measures designed to manage seepage from cyanide facilities to protect the beneficial use of groundwater.

   g. Provide spill prevention or containment measures for process tanks and pipelines.

   h. Implement quality control/quality assurance procedures to confirm that cyanide facilities are constructed according to accepted engineering standards and specifications.

   i. Implement monitoring programs to evaluate the effects of cyanide use on wildlife, and surface and groundwater quality.

5. Decommissioning: Protect communities and the environment from cyanide through development and implementation of decommissioning plans for cyanide facilities.

   a. Plan and implement procedures for effective decommissioning of cyanide facilities to protect human health, wildlife, livestock, and the environment.

   b. Establish a financial assurance mechanism for fully funding cyanide-related decommissioning activities.

6. Worker Safety: Protect workers' health and safety from exposure to cyanide.

   a. Identify potential cyanide exposure scenarios and take measures as necessary to eliminate, reduce, and control them.

   b. Operate and monitor cyanide facilities to protect worker health and safety and periodically evaluate the effectiveness of health and safety measures.

   c. Develop and implement emergency response plans and procedures to respond to worker exposure to cyanide.

7. Emergency Response: Protect communities and the environment through the development of emergency response strategies and capabilities.
    a. Prepare detailed emergency response plans for potential cyanide releases.
    b. Involve site personnel and stakeholders in the planning process.
    c. Designate appropriate personnel and commit necessary equipment and resources for emergency response.
    d. Develop procedures for internal and external emergency notification and reporting.
    e. Incorporate remediation measures and monitoring elements into response plans and account for the additional hazards of using cyanide treatment chemicals.
    f. Periodically evaluate response procedures and capabilities and revise them as needed.
8. Training: Train workers and emergency response personnel to manage cyanide in a safe and environmentally protective manner.
    a. Train workers to understand the hazards associated with cyanide use.
    b. Train appropriate personnel to operate the facility according to systems and procedures that protect human health, the community, and the environment.
    c. Train appropriate workers and personnel to respond to worker exposures and environmental releases of cyanide.
9. Dialogue and Disclosure: Engage in public consultation and disclosure.
    a. Promote dialogue with stakeholders regarding cyanide management and responsibly address identified concerns.
    b. Make appropriate operational and environmental information regarding cyanide available to stakeholders.

The transportation principles and their associated standards of practice are (International Cyanide Management Institute 2023):

1. Transport: Transport cyanide in a manner that minimizes the potential for accidents and releases.
    a. Select cyanide transport routes to minimize the potential for accidents and releases.
    b. Ensure that personnel operating cyanide handling and transport equipment can perform their jobs with minimum risk to communities and the environment.
    c. Ensure that transport equipment is suitable for transport of cyanide.
    d. Develop and implement a safety program for transport of cyanide.
    e. Follow international standards for transportation of cyanide by sea.
    f. Track cyanide shipments to prevent losses during transport.

2. Interim Storage: Design, construct, and operate cyanide interim storage sites to prevent releases and exposures.

    a. Store cyanide in a manner that minimizes the potential for accidental releases.

3. Emergency Response: Protect communities and the environment through the development of emergency response strategies and capabilities.

    a. Prepare detailed emergency response plans for potential cyanide releases.

    b. Designate appropriate response personnel and commit necessary resources for emergency response.

    c. Develop procedures for internal and external emergency notification and reporting.

    d. Develop procedures for remediation of releases that recognize the additional hazards of cyanide treatment chemicals.

    e. Periodically evaluate response procedures and capabilities and revise them as needed.

The Applicant has developed a Cyanide Management Plan (Ausenco Engineering Canada Inc. [Ausenco] 2023) that uses the ICMC guidelines for the management of cyanide, including the design of facilities. It is recognized that many specific compliance actions, including Project-specific cyanide handling and storage design criteria, and specific operating procedures, require further definition in subsequent development phases of the Project.

The Applicant has stated that the Project would follow the ICMC guidelines during detailed design and construction and aim toward certification during operations (Ausenco 2023).

C-4 CYANIDE IN THE ENVIRONMENT

Cyanide may be present at the Project site in the following forms:

- **Free cyanide** consists of HCN and CN-. HCN is bioavailable and toxic. Dissociation depends on environmental conditions (pH, temperature, light) and the presence of source material that may release HCN (e.g., WAD metal cyanides).

- **WAD cyanide** includes metal-cyanide compounds that dissociate in neutral and acidic conditions, making them bioavailable and toxic when ingested.

- **Strong cyanide complexes** include metal-cyanide compounds that dissociate only under acidic conditions. Note that iron cyanides are strong complexes that do dissociate in the aquatic environment in the presence of natural light.

Cyanide toxicity is related to the types of cyanide complexes that are present (Donato et al. 2007). Measuring of free, total, and WAD cyanide is recommended to quantify the total mass of cyanide present and to evaluate potential dissociation routes, exposure scenarios, and environmental effects. Intake of cyanide via ingestion, dermal contact, or inhalation results in rapid absorption into the bloodstream. However, cyanide can take time to dissociate in the digestive tract, which can lead to delayed effects. Cyanide can react with iron in blood and/or inhibit critical oxidative enzymes, which may lead to cardiac or respiratory arrest (Towill et al. 1978). If a lethal dose is not absorbed, cyanide is metabolized and excreted from the body without lasting toxicity. Since cyanide is quickly metabolized, it is unlikely to bioaccumulate in the food chain (Eisler 1991), and effects (e.g., lethargy, gasping) are temporary (Henny et al. 1994).

The Project-specific ecological risk assessment (SLR International Corporation 2023) was reviewed along with guidelines from the ICMC, EPA, and state regulations regarding cyanide concentrations that would be protective of wildlife exposed to tailings solutions. The ICMC requires a concentration of less than 50 mg/L WAD cyanide in TSF water to protect exposure of wildlife that use the water to drink and forage. According to the ICMC, "Ingestion of WAD cyanide solutions by birds may cause delayed mortality. It appears that birds may drink water containing WAD cyanide that is not immediately fatal, but which breaks down in the acidic conditions in the stomach and produces sufficiently high cyanide concentrations to be toxic." Additionally, this cyanide concentration may not protect against incidental ingestion of beach soils/sediments that may be contacted in the TSF. Oregon Administrative Rule (OAR) 340-043-0130 provides a more conservative limit on WAD cyanide in water at 30 mg/L. The Oregon Department of Environmental Quality believes monitoring and control of total cyanide should also be implemented to protect accumulation in mining waste within the TSF that may represent future risk to wildlife.

C-5 CYANIDE USE IN THE GRASSY MOUNTAIN GOLD PROJECT

The geology of the gold deposit and the mineralogy of the ore generally determine the selection of the best gold extraction method for a particular ore. Cyanidation works well at recovering gold in low-grade sulfide ores similar to ore present at the Project. Cyanide would be used in tanks within the mill in a closed system, which would prevent cyanide escape into the environment. The waste tailings would undergo cyanide destruction using addition of copper sulfate and sodium metabisulfite to achieve the lowest practical levels of cyanide prior to discharging into the TSF (see Section 2.1.6, which describes the cyanide destruction process). This results in the reduction of cyanide concentrations in tailings solution to a level below target toxicity thresholds. The tailings slurry would then be pumped into a lined TSF facility for containment, which could be accessed by wildlife. Large mammals would be prevented from entering the TSF through the use of fencing 8 feet in height, and armoring extending 30 inches above and 18 inches below the ground surface would exclude burrowing mammals including porcupines. However, small mammals and amphibians or reptiles could climb the fence to enter the TSF, and birds and bats could fly into the area.

The goal is to reduce the total and WAD cyanide entering the TSF in order to ensure the accumulation of cyanides in soils and sediments does not reach levels of concern that could generate current and future leachate and direct contact risk of wildlife to soils and sediments. The Applicant has: (1) proven feasible the discharge of WAD cyanide concentrations in the tailings slurry of 1.0 mg/L or less (Ausenco 2020; Mine Development Associates 2018) and (2) proposed discharging WAD cyanide levels in tailings slurry initially to less than 15 mg/L (and not to exceed the 30 mg/L maximum). Tailings slurry from the carbon-in-leach process plant would be treated for cyanide destruction prior to being pumped to the TSF (Ausenco 2020; Mine Development Associates 2018; SLR International Corporation 2023) as described in Section 2.1.6 of the environmental evaluation.

The concentration of 15 mg/L WAD cyanide would be further reduced after release into the TSF via natural processes such as photodegradation by ultraviolet light and biodegradation (see Section C-2). A target level of 1 mg/L WAD cyanide is proposed for supernatant water in the TSF, which is well below the

EPA and Oregon state cyanide limits and is considered to be protective of water concentrations for wildlife ingestion. To ensure water concentrations are protective, concentrations of total and WAD cyanides in tailings solution and deposited tailings would be monitored. If the cyanide concentration in the TSF pond exceeds 1 mg/L and/or metals concentrations exceed regulatory limits, the Applicant would immediately implement a number of contingency actions including lowering the target WAD cyanide concentration for the cyanide detoxification circuit to a level less than 15 mg/L to reduce the cyanide level in the supernatant pond, treating the supernatant pond (e.g., with hydrogen peroxide) to destroy cyanide, and evaluating water management systems to reduce the load of cyanide and/or metals or volume of water in the supernatant pond (Calico Resources USA Corp. 2023).

The Applicant proposes to monitor chemicals in the TSF pond solids and water regularly and immediately report results gathered by the Project's environmental and safety superintendent to the Oregon Department of Fish and Wildlife (EM Strategies and Mason, Bruce & Girard 2023). This would ensure that cyanide and metal concentrations are closely monitored and actions can be taken quickly to address exceedances in established thresholds. In addition, the TSF pond and enclosed contact water tanks would be monitored daily to detect any wildlife mortalities, and employees would be required to report any wildlife fatalities (EM Strategies and Mason, Bruce & Girard 2023).

After mining is complete, the TSF supernatant pond water would be drained and the tailing surface would evaporate and progressively dry, which would facilitate the breakdown of the cyanide remaining in the TSF over time as the tailings assume a more neutral pH without continued additions of lime. Accumulated metals and total cyanide in the dried pond (current or future) could pose a risk to wildlife through incidental soil ingestion. Therefore, concentrations in the solid phase would be monitored throughout the Project to ensure the solids are at acceptable levels for direct contact/ingestion for wildlife exposure. The TSF would be capped to prevent exposure and then reclaimed by covering and vegetating.

C-6 CYANIDE REGULATORY PROGRAMS

Federal and state requirements specific to waste management at cyanide leach operations include programs related to cyanide tailings impoundments, spent heaps and pads, and solution wastewater (EPA 1994). Federal regulations at 40 Code of Federal Regulations (CFR) Part 440 Subpart J for mills that beneficiate gold or silver by cyanidation establish zero discharge for process wastewaters except in the case where net precipitation exceeds net evaporation creating a potential need for water treatment and discharge to maintain the facility water balance.

The Bureau of Land Management (BLM) issued a *Policy for Surface Management of Operations Utilizing Cyanide or Other Leaching Techniques* in August 1990 to address prevention of unnecessary and undue degradation of public lands under 43 CFR Part 3809. The policy covers multiple aspects of cyanide operations, including acceptable operational monitoring and data requirements; wildlife mortality reporting; discharge reporting; quarterly inspection requirements; use of best practicable technologies; fencing requirements; berm requirements; leak detection and solution recovery; containment requirements; reclamation and closure requirements; environmental monitoring requirements; and financial surety for closure. The Project is undergoing federal environmental review by the BLM, which will consider the prevention of unnecessary and undue degradation of public lands from the proposed mining operation.

In Oregon, concentrations of cyanide in mine tailings are regulated under *Guidelines for the Design, Construction, Operation and Closure of Chemical Mining Operations: Guidelines for Disposal of Mill Tailings* (OAR 340-043-0130). Regulations state “mill tailings shall be treated by cyanide removal, reuse, or destruction prior to disposal to reduce the amount of cyanide introduced into the tailings pond to the lowest practicable level. The permittee shall conduct laboratory column tests on mill tailings to determine the lowest practicable concentration to which the WAD cyanide (WAD cyanide as measured by ASTM Method D2036-82 C) can be reduced. In no event, shall the permitted WAD cyanide concentration in the liquid fraction of the tailings be greater than 30 ppm [parts per million].” The WAD cyanide species is available to ecological receptors through digestion. Other cyanide species that are components of total cyanide are bound to metals (e.g., iron) and are stable under weakly acidic conditions.

California, Colorado, Idaho, Montana, Nevada, South Carolina, and South Dakota have implemented additional requirements primarily related to standards and monitoring metrics for the detoxification, chemical stabilization, reclamation, and closure of cyanide-processing facilities, heap leach pads, and tailings impoundments. While requirements vary from state to state, typical requirements for monitoring cyanide process facilities include:

- Onsite meteorological conditions,
- Ore acid-base accounting and leachability,
- Process make-up water supply quantity and quality,
- Process and emergency pond solution volumes and depths,
- Depth and acreage of supernatant ponds,
- Process water analyte concentrations including WAD cyanide,
- Water pressures in impoundments,
- Leak detection flows,
- Local seep, spring, and streamflow and water quality, and
- Local groundwater levels and water quality.

Monitoring results that deviate from facility designs, operating plans, and/or permit requirements are subject to corrective action requirements as described in Project management plans and permits.

Reclamation and closure requirements in other US states include managing the residual process solution in facilities so that there is no release of the solution to the environment. Following operations, process water management by active and/or passive treatment is required for decades, albeit at low flow volumes for facilities in arid climates (e.g., less than a few gallons per minute). Beyond the water management requirements, extended monitoring of reclaimed process facilities into the post-closure (e.g., 25 years) is a typical requirement. Most US states also require financial sureties for the reclamation and closure of these facilities.

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APPENDIX D

ACID ROCK DRAINAGE ASSESSMENT AND ANALYSIS

APPENDIX D ACID ROCK DRAINAGE

Table of Contents

D-1 INTRODUCTION

Underground mining exposes sulfides present on mine walls or blast fractures to atmospheric oxygen that enters the underground workings through shafts and other openings that intersect the land surface. The underground workings, as well as the ore, tailings, and waste piles generated by mining, are a potential source of acid rock drainage (ARD).

The purpose of this ARD assessment is to evaluate the potential geochemical reactivity and chemical stability of mine waste, borrow material, ore, access road cuts, and tailings that would be produced by the proposed Grassy Mountain Gold Project (Project).

The results of the Baseline Geochemical Characterization Report (SRK Consulting 2022a) and Cemented Rock Fill Characterization Report (SRK Consulting 2022b) were used in this ARD assessment.

D-2 REGULATORY CONTEXT

The Oregon Department of Environmental Quality (DEQ) manages a water quality program designed to protect and improve Oregon's water quality by protecting rivers, lakes, streams, and groundwater for beneficial uses such as drinking water, irrigation, recreation, industrial and commercial uses, and fish habitat. The DEQ has regulatory authority and works with other local and state agencies and tribal governments to protect groundwater in Oregon (DEQ 2024). Once polluted, groundwater is difficult and sometimes impossible to clean up. Therefore, the State of Oregon has established mandatory minimum groundwater quality protection requirements (Oregon Administrative Rule [OAR] 340-040-0001 through 340-040-0210) to control waste discharges to groundwater so that groundwater pollution is prevented and the highest possible water quality is maintained.

The Oregon Groundwater Quality Guidelines (OGWQG) per OAR 340-40-020 are provided in Table D-1 and are referenced several times during this assessment. All reference levels and guideline levels shown in Table D-1 indicate when groundwater may not be suitable for human consumption, or when its aesthetic quality may be impaired, and are used by DEQ in determining the level of remedial action necessary to restore contaminated groundwater for human consumption. These levels are not to be construed as acceptable groundwater quality management goals (OAR 340-040-0080).

Table D-1 Oregon Groundwater Quality Guidelines (OAR 340-40-020)

Parameter	Units	Reference Level[1]	Guidance Level[1]
Arsenic	mg/L	0.05	-
Barium	mg/L	1	-
Cadmium	mg/L	0.01	-
Chloride	mg/L	-	250
Chromium	mg/L	0.05	-
Copper	mg/L	-	1
Fluoride	mg/L	4	-
Iron	mg/L	-	0.3

Parameter	Units	Reference Level[1]	Guidance Level[1]
Lead	mg/L	0.05	-
Manganese	mg/L	-	0.05
Mercury	mg/L	0.002	-
Nitrate	mg/L as N	10	-
pH	s.u.	-	6.5–8.5
Selenium	mg/L	0.01	-
Silver	mg/L	0.05	-
Sulfate	mg/L	-	250
Total Dissolved Solids (TDS)	mg/L	-	500
Zinc	mg/L	-	5

Source: Baseline Geochemical Characterization Report Grassy Mountain Project (SRK Consulting 2022a)
mg/L – milligrams per liter; N – nitrogen
[1] All reference and guideline levels are for total (unfiltered) concentrations.

D-3 GEOCHEMICAL CHARACTERIZATION METHODS

The Applicant's geochemical characterization program for the Project was designed to follow guidelines set forth in the Bureau of Land Management's (BLM's) Instruction Memorandum NV-2010-014, *Nevada Bureau of Land Management Rock Characterization and Water Resources Analysis Guidance for Mining Activities* (BLM 2013). In addition, the program followed the guidance provided in the *Global Acid Rock Drainage Guide* (International Network for Acid Prevention 2014), which describes the industry best practices for characterization to support evaluation of potential future impacts to water resources and design of appropriate mitigation strategies. Leachate chemistry was compared to the OGWQG (OAR 340-40-020) to provide a context in which to understand and interpret the data. The average groundwater pH observations during baseline data collection were between 6.6 and 9.2 (except when newly installed wells were experiencing well development issues) with an average and median value of pH 8.3 (SRK Consulting 2022a).

The design of the Applicant's geochemical characterization program was developed based on the geology of the site and the mine plan information. The program described herein characterized seven potential sources of ARD: (1) waste rock storage areas, (2) ore stockpiles, (3) underground workings, (4) tailings impoundment, (5) borrow material, (6) access road cuts, and (7) cemented rock fill (CRF).

Waste rock and ore samples were collected to examine the range of conditions that could occur within the Grassy Mountain Gold ore deposit. Tested ore and waste materials include exploration core (as available) and samples of test residues from metallurgical testing conducted in 2015 and 2018. The metallurgical test residues underwent cyanide destruction and are representative of the tailings material that would be generated as part of the milling process. The 2018 test residues were amended with lime and are considered representative of tailings material that would be placed in the proposed tailings storage facility (TSF).

Access road construction involves widening an existing road that is mostly alluvium, with some areas of exposed bedrock. This bedrock at the road surface is not directly comparable to the underground waste rock collected and sampled. Therefore, rock samples representative of bedrock that could be intersected during road construction were collected from outcrops for geochemical characterization.

Core samples from the proposed basalt quarry were also collected as part of the geochemical characterization program. The quarry would be a source of aggregate for general construction use and for CRF, which would be placed as backfill in the underground workings.

In addition to geochemical testing of rock samples, a CRF characterization program (SRK Consulting 2022b) was implemented to determine the acid-generation and metal-leaching characteristics of the CRF that would be used as backfill in the underground workings.

The geochemical characterization program and CRF characterization program used a number of techniques to test the sampled materials. The appropriate combination of whole rock, static, and kinetic testing was conducted to assess the potential for acid-generation and solute leaching from mined materials and tailings, and the program was designed to test and confirm results via multiple methodologies, as described below. The reactivity observed with the static and kinetic testing is supported by examination of the mineralogy present in the rock materials via the multi-element, XRD, SEM, and petrography analyses. The techniques to test the sampled materials are briefly described below:

- **Synthetic Precipitation Leaching Procedure (SPLP):** This procedure uses a water-to-solid ratio of 1:1 and uses distilled water to extract elements from the sample. It simulates the leaching of mine waste material.
- **Meteoric Water Mobility Procedure (MWMP):** This procedure involves a 24-hour, single-pass column leach using a 1:1 distilled water to rock ratio. It was developed to simulate the leaching of mine waste materials by meteoric water under typical low-precipitation environmental field conditions. The results can be used to identify the presence of leachable metals and readily soluble salts stored in the waste material, to provide an indication of their availability for dissolution and mobility, and to assess the potential for acid release during dissolution of soluble acid salts.
- **Humidity Cell Test (HCT):** This procedure is designed to simulate water-rock to evaluate the rate of sulfide mineral oxidation and predict acid generation and metals mobility. The test typically runs for 20 weeks, using a 7-day cycle, during which humidified air is introduced to the bottom of the sample column for 3 days, followed by 3 days of dry air. On the seventh day, the sample is rinsed with distilled water and the extracted solution is collected for analysis.
- **X-Ray Diffraction (XRD**): Under this technique, an x-ray is used to investigate the crystalline structure of materials found in soil samples. It is commonly used to identify minerals in soil samples.
- **Scanning Electron Microscopy (SEM) Analysis:** SEM is used to examine the size and shape of crystals within a sample in order to determine if certain minerals are present.
- **Petrography:** Under this method, an optical minerologist uses a microscope to observe the properties of minerals found in soil samples to aid in their identification.

- **Thin Section Technique:** Under this technique, a thin section of a rock or mineral sample is observed using a microscope in order to classify the minerals found in the sample.
- **Acid Base Accounting (ABA):** This procedure provides an assessment of the acid-generation or acid-neutralization potential of rock materials. It includes both laboratory analysis and empirical calculations based on acid-generating potential and neutralizing potential. An estimate of acid generation is made by assuming complete reaction between all minerals with acid-generating potential and all of the minerals with neutralizing potential.
- **Net Acid Generation (NAG) Test:** This test is used to determine the maximum potential for acid generation from the samples. The method involves intensive oxidation of the sample using hydrogen peroxide, which accelerates the dissolution of sulfide minerals and has the net result that acid production and neutralization can be measured directly.
- **Multi-Element Analysis:** This is a technique used to characterize minerals and rocks and to understand their formation and transformation during geological processes. It is used for determination of major elements and trace elements.

Table D-2 provides a list of the mine facilities included in the geochemical characterization, location and duration of the facilities, and the types of geochemical data required.

The Applicant’s characterization performed is consistent with published BLM and Nevada Division of Environmental Protection guidelines for characterization of mined materials and as such conforms with industry standards for characterizing mined materials. The characterization identifies the acid-generating potential of Grassy Mountain lithologies and the analyte leaching characteristics of those lithologies and is suitable for understanding the potential environmental effects of the Project.

Table D-2 Sample Collection and Testing Matrix

Source	Description	Location	Duration	Composition	Sample Types	Geochemical Data Needs				
						Static	Mineralogy	SPLP	MWMP	HCT
Waste rock	Waste rock in TWRSF	Mine area (surface)	Life of mine	Non-PAG and PAG waste rock	Core	X	X	--	X	X
Ore stockpile	ROM ore stockpile	Plant site	Life of mine	Underground ore	Core	X	X	--	X	--
Underground workings	Exposed rock in underground workings	Mine area (underground)	Permanent	Waste rock and ore	Core	X	X	--	X	X
Tailings Impoundment	Tailings	Plant site	Permanent	Tailings with and without lime amendment	Metallurgical test work	X	X	X	X	X
Borrow material	Borrow materials for construction	Quarry and Other	Permanent	Basalt	Core	X	X	--	X	--
Access and haul roads	Surface development (cut/fill)	Various	Permanent	Alluvium/bedrock	Surface samples	X	X	--	X	--
Underground backfill	Rock fill	Mine area (underground)	Permanent	Basalt	Core	X	X	--	X	X

Source: SRK Consulting 2022a

HCT = Humidity Cell Test; MWMP = Meteoric Water Mobility Procedure; PAG = Potentially acid generating; ROM = run-of-mine; SPLP = Synthetic Precipitation Leaching Procedure, TWRSF = Temporary Waste Rock Storage Facility

D-4 GEOCHEMICAL CHARACTERIZATION RESULTS

A summary of the geochemical characterization program results is presented in the following sections. For more details refer to the Baseline Geochemical Characterization Report (SRK Consulting 2022a), Ecological Risk Assessment (SRK Consulting 2021), and Cemented Rock Fill Characterization Report (SRK Consulting 2022b).

D-4.1 Waste Rock and Ore

The results of the Project geochemical characterization program indicate that the majority of the waste rock and unprocessed ore material would generate acid and leach metals under long-term weathering conditions. The exceptions to this include sinter material within the waste rock and ore, which shows a low potential for acid generation due to its lower sulfide sulfur content. The acid-generating potential of the materials is directly related to the sulfide content.

Based on the MWMP test, under low pH conditions, constituents above OGWQG levels include sulfate, arsenic, cadmium, chromium, copper, fluoride, iron, manganese, selenium, and zinc. For samples with neutral pH (i.e., pH >6.5), all constituents were less than the OGWQG reportable limits.

Most HCTs that developed acidic conditions leached copper, iron, manganese, arsenic, and sulfate at concentrations greater than the OGWQG levels, indicating these elements can be mobilized under acidic pH conditions. Other constituents that were leached above OGWQG levels in HCTs include cadmium, chromium, copper, fluoride, lead, selenium, silver, and zinc.

Analysis for the presence of erionite (a fibrous carcinogenic mineral) was conducted using XRD and SEM analysis and petrography as part of the program. Two standard samples from Rome, Oregon, containing erionite were also submitted and used as controls. The results of the analyses show that erionite was not detected in any of the waste rock/ore samples. The only samples that contained detectable levels of erionite were the two standards that contained erionite.

D-4.2 Borrow Material

Basalt would be used as construction material and is the main source of aggregate for the CRF backfill that would be placed in the underground mine. The results of geochemical testing are that borrow material from the proposed basalt quarry has no potential for acid generation, with total sulfur values below the detection limit of 0.01 percent for all samples. Thus, basalt borrow material is considered benign and does not present a risk to groundwater if used as backfill in the underground workings.

Analysis for the presence of erionite was included in the XRD and SEM analysis and petrography for all eight samples. Results of the analyses indicated erionite was not detected in any of the borrow materials except for one sample of andesitic basalt (Basalt B3 48–53 feet). Erionite was tentatively identified at trace amounts in this sample from the XRD analysis. The optical mineralogist was not able to confirm the presence of erionite using SEM or thin section techniques.

D-4.3 Access Road Cuts

The results for the access road cut materials testing show that total sulfur values were below the detection limit of 0.01 percent, indicating that bedrock encountered during access road development has no potential for acid generation. All access road cut samples exhibited circumneutral pH, with low concentrations of metal in the MWMP tests and all parameters below OGWQG levels.

Testing for the presence of erionite was included in the XRD and SEM analysis and petrography for all seven access road cut samples. One standard containing erionite was also analyzed. Results of the XRD analysis indicated that trace amounts of erionite were present in one of the access road cut material samples. However, upon further investigation, the optical mineralogist was not able to confirm the presence of erionite using SEM or thin section techniques.

D-4.4 Tailings Material

Tailings material from the 2015 metallurgical test program (one sample, unamended) and the 2018 metallurgical test program (three samples) were tested. The results indicate that despite low sulfide sulfur, the tailings material has the potential to generate acid due to its low neutralization potential. The potential for tailings material to generate acid and leach metals was confirmed by the HCT results for the unamended tailings sample. Under low pH conditions, iron, manganese, and copper were mobile at concentrations greater than the OGWQG levels. In addition, there was an initial flush of several other constituents, including sulfate, aluminum, cadmium, fluoride, nickel, selenium, sulfate and zinc, which likely reflects the removal of soluble oxidation products from the tailings material surfaces.

D-4.5 Lime-Amended Tailings Material

Testing of tailings amended with lime is representative of water chemistry that would be entrained in the tailings. Short-term leach test results from three tailings samples amended with lime indicate that selenium is leached under alkaline conditions at concentrations above the OGWQG levels. Sulfate and chromium were also slightly elevated above the OGWQG levels for one sample, and all other parameters were below the OGWQG levels.

The tailings material requires lime amendment to achieve non-acid-generating characteristics. ABA test results were used to determine the amount of lime required to neutralize the tailings to meet the neutralization criteria specified in OAR 340-043-0130 (2). The results demonstrate that there is some inherent variation in the sulfide sulfur and neutralization potential content of the tailings material that is likely to occur during mining operations. The amount of lime amendment needs to exceed the minimum amount required by the regulations to ensure that the neutralization criteria are met.

Analysis for the presence of erionite was included in the XRD analysis. One sample of amended tailings considered representative of the final tailings product was analyzed along with the two standard samples from Rome, Oregon. Results of the XRD analysis indicate erionite is not present in the tailings material. The only samples that contained detectable levels of erionite were the two standards that contained erionite. Therefore, no optical or SEM analysis was completed for the amended tailings sample.

D-4.6 Cemented Rock Fill

A CRF characterization program was undertaken to determine the acid-generation and metal-leaching characteristics of CRF. A total of 14 cylinders representative of CRF were generated using borrow material (basalt) and waste rock along with binder material composed of various percentages of cement and/or fly ash. See the Cemented Rock Fill Characterization Report (SRK Consulting 2022b) for more detail.

Results from the CRF characterization program show that all CRF cylinders had significant acid-buffering capacity due to the addition of binders and CRF is not expected to generate acid. Fly ash is comparable to cement, with no appreciable differences in the results for the binder types or percentages used to generate the cylinders. Additional binder does not change the results in terms of potential for acid generation and/or metal leaching.

Cementation of the waste rock results in overall lower metal releases under higher pH conditions in comparison to uncemented material. The concentrations of several constituents (i.e., arsenic, chloride, fluoride, mercury, and sulfate) are lower in the leachate (test samples) than in the lixiviant (site groundwater), indicating the potential for attenuation within the CRF.

Metal release in the diffusion test were generally below the OGWQG levels. The exception to this is a single measurement of iron from the binder-only cylinders at the beginning of the test.

Some constituents in the leachate were above the OGWQG levels in the liquid-to-solid ratio leach test. However, this test is done on a disaggregated sample and concentrations that may occur in groundwater flowing through the monolithic blocks of CRF would likely be much lower and more comparable to concentrations observed in the diffusion tests.

Based on the results of the CRF characterization program, the CRF containing basalt or waste rock does not show a significant potential to degrade groundwater, with most constituents leached at very low levels for all tests.

D-5 ACID ROCK DRAINAGE ASSESSMENT

The proposed Project includes five areas where aggregate, waste rock, and ore would be extracted, temporarily stored, or processed:

1. Underground mine
2. TWRSF
3. Run-of-mine (ROM) ore stockpile
4. TSF
5. Access and haul road material

Assessments of the potential for these areas to generate ARD are provided below along with measures to reduce the potential for ARD generation and ARD monitoring measures.

D-5.1 Underground Mine

The underground mine would be developed through excavation, backfilling, and dewatering the mine area. Dewatering activities during operations would alter groundwater flow paths near the underground workings. The quality of groundwater inflow is a function of the composition and reactivity of the rock it encounters and the contact time. Oxidation of exposed sulfides in underground workings (mine walls or blast fractures) results in the accumulation of sulfide oxidation products also known as ARD. During mining, a constant supply of oxygen is maintained through the ventilation system, mine shafts, and adits that intersect the land surface. The accumulated sulfide oxidation products are flushed by inflowing groundwater, reducing groundwater quality.

Underground mine water quality may also be affected by chemicals introduced during mining activities (e.g., diesel leaks or spills, nitrogen from blasting residuals) or by materials backfilled into the mine during operations or at closure (e.g., CRF, waste rock). Groundwater removed as part of dewatering activities would be pumped to the raw water tank for use in the mill. Although the underground mine is typically a groundwater sink during operations, release of impacted mine water to the environment may occur by infiltration to groundwater if it is not cleaned up.

Groundwater is found within permeable sediments and fractured rock in the Project area. Groundwater flow is generally to the northwest, from areas of higher to lower ground surface elevation, although the pattern of groundwater flow shows local variations attributed to the presence of faults, fractures, lithologic facies changes, vertical gradients, or some combination of these influences. Aquifer hydraulic conductivity is low within the immediate vicinity of the Grassy Mountain ore body, attributed to low-permeability materials (i.e., clay and siltstone, competent bedrock, and silicified deposits), and is anticipated to significantly restrict groundwater flows into underground mine workings (SPF Water Engineering [SPF] 2021a).

After excavation, material used for CRF would be mostly basalt borrow material from the quarry with some (approximately 10–15 percent) waste rock. The basalt material from the quarry has neutralization potential, is low in metals content, and does not have a potential to generate acid. However, the 10 to 15 percent of waste rock may have the potential to generate ARD. However, as described in Section D-4.6, based on the CRF characterization program, the CRF containing basalt or waste rock does not show a significant potential to degrade groundwater, with most constituents leached at very low levels in all tests. The use of cement in the CRF mixture would eliminate the potential for acidic drainage in the CRF-backfilled portions of the underground workings because sulfide minerals in the rock fill would be neutralized by the cement. In addition to adding neutralizing potential, the cement reduces the air and water permeability of the backfill material (compared to un-cemented material). Because the sulfide oxidation reaction that generates acidity requires both atmospheric oxygen and water, the reduced air and water permeability of the CRF rate limits the sulfide oxidation reaction by limiting the availability of oxygen and water to the sulfide minerals. Further, most of the rock fill and CRF would be formulated from inert basalt with no acid-generating potential.

Excavated areas with exposed rock that are not covered with CRF such as mine access drifts have the potential to generate acid and contain metals that could leach into the environment. However, when the access drifts are excavated, exposed rock would be covered with a cement ground support that would limit exposure of sulfides in the exposed rock to oxygen and would provide neutralization for any acid drainage that occurs up until the neutralization component of the cement were exhausted. Additional cement may need to be added in areas of high sulfide concentrations. Once placed in the underground workings, the backfilled materials are physically and geochemically stable. However, additional monitoring and testing can be conducted to confirm expectations and refine operations. See Section A-3.5 in Appendix A for information on additional monitoring and testing for ARD in mined rock and groundwater.

During closure, the mine portal would be plugged with rock and the ventilation shaft sealed with a concrete plug, which would prevent surface waters from entering the underground mined areas.

In closure and post-closure, when mining has ceased and dewatering is stopped, the underground workings would fill with water. This initial groundwater flush has the potential to generate ARD if the neutralizing potential of cement ground support and backfill were to be exhausted, but the oxidation reaction would only continue until the remnant oxygen at the time of closure were consumed. In the presence of sulfide minerals, this reaction would occur in a short time span (i.e., weeks, as occurs in laboratory kinetic testing). After the groundwater has returned, any further oxidation of sulfide minerals becomes inhibited by the groundwater's displacement of atmospheric oxygen, which is a necessary component of the oxidation reaction.

The geochemical characterization results show that the CRF has the potential to release metals at concentrations greater than the lixiviant (groundwater) during the initial flush and the last flash, but below the OGWQG levels. Therefore, post-closure, the Applicant proposes to conduct quarterly groundwater monitoring for 5 years, followed by semi-annual monitoring for 10 years, and then annual monitoring for 15 years. It should be noted that the groundwater that was used as a lixiviant in the CRF test exceeded the OGWQG level for arsenic under neutral pH.

The following additional measures are proposed to reduce or mitigate ARD formation in underground mine workings:

- Spray a 2-inch layer of cement on the walls and ceiling of access routes to prevent ARD in these exposed areas.
- Conduct quarterly geochemical characterization of the material excavated during mining to flag waste rock with elevated sulfide content including pH sampling at all Level Stations. By characterizing mined materials at the time they are produced, potential acid-generating conditions can be observed and addressed during active operations ahead of mine closure. The amount of cement added can be adjusted depending on the sampling results. After any preventive measure has been implemented, monthly monitoring should be conducted until the potential for ARD has been characterized and addressed and then quarterly monitoring resumed.

D-5.2 Temporary Waste Rock Storage Facility

Waste rock generated from underground mining operations would be temporarily stored at the TWRSF before being mixed with cement and basalt and used as backfill in the underground mine.

The TWRSF is a geomembrane-lined storage area with both primary and secondary lining systems to provide dual containment of process solution and an underflow collection system, which would prevent leakage of potentially contaminated water into the environment. The collected underdrain flows would be routed to the TSF reclaim pond through a solid wall pipe for independent monitoring and sampling. Water collected at the reclaim pond would be pumped back to the process plant for reuse. An independent leak detection and leakage collection and recovery system would be installed to monitor and manage potential leakage between primary and secondary containment layers within the TWRSF.

The Applicant proposes to test waste rock stored at the TWRSF for acid-generating potential weekly for the first 6 months of mine operations, at which time sampling frequency would be re-evaluated to account for variations (or lack thereof) in the mineralogy and the physical and chemical composition of the waste rock (Calico Resources USA Corp. 2023a).

At closure, no waste rock is planned to be present in the TWRSF, but if any remains it would be removed and placed in the zero-discharge TSF and amended with lime to address any pH issues. Therefore, there would be no potential for ARD to be released into the environment from the TWRSF during post-closure.

D-5.3 Run-of-Mine Ore Stockpile

Gold-bearing ore would be transported directly to the ROM hopper or stockpiled temporarily in the outdoor ROM ore stockpile adjacent to the mill. Material in the ROM ore stockpile would be typically stored for a short time, less than 1 week, and for a maximum of less than 1 month. During this time, ROM material that has been classified as potentially acid generating has the potential to generate ARD. However, the contact time is limited and the climate is semi-arid; therefore, the quantity of ARD is likely to be limited provided that ores are processed within weeks or months of stockpiling and do not remain in stockpiles for longer durations.

The ROM ore stockpile would have a lined base pad (geosynthetic clay plus 2-millimeter [mm] high-density polyethylene [HDPE] liner), with containment lined berms along each edge of the stockpile and a sump to collect the contact runoff. In the event that ARD occurs at the ROM ore stockpile, the lined pad with containment berms and a sump to collect the contact runoff would prevent any ARD from being released into the environment. The sump level would be monitored, and any seepage would be emptied into the process water tank (Ausenco 2021).

In addition to these plans, in the event of a temporary or unexpected shut down of the process plant for an extended period of time, accommodations can be made to relocate stockpiled ores to the TWRSF or other facility with the capacity for permanent containment of acid-generating rock to prevent potential release of contaminants from the ROM ore stockpile.

D-5.4 Tailings Material in the Tailings Storage Facility

The TSF would be constructed of material from grading operations and the quarry. Based on the geochemical characterization results, the basalt borrow source material from the quarry is considered benign and is not potentially acid generating. Therefore, the TSF embankments do not have the potential to generate acid rock drainage.

The tailings characterization results indicate that despite low sulfide sulfur, the unamended tailings material has a potential to generate ARD due to its low neutralization potential. This was confirmed by the HCT result for the unamended tailings sample from the 2015 metallurgical test program. The tailings material requires lime amendment to achieve non-acid-generating characteristics, although there remains the potential for amended tailings to leach selenium, chromium, and sulfate under alkaline conditions (SRK Consulting 2021). During testing, these parameters were leached by only one sample; the other two samples were below the OGWQ levels. The TSF is designed as a “zero discharge” facility and would be 100 percent geomembrane-lined with continuous primary and secondary leakage collection and leak detection systems, which would contain and monitor the material within the TSF system.

The Applicant has developed a Tailings Chemical Monitoring Plan (Calico Resources USA Corp. 2023a), which provides a basis to demonstrate compliance with applicable Oregon regulations pertaining to management and monitoring of chemical aspects of stored tailings. Tailings would be sampled on a routine basis (e.g., continuously, daily, weekly, quarterly) for geochemical testing to monitor total cyanide, pH, and metals concentrations.

Sampling of tailings using ABA analyses would be conducted weekly for the first 6 months of mine operations, at which time sampling frequency would be re-evaluated to account for variations (or lack thereof) in the mineralogy and the physical and chemical composition of the tailings (Calico Resources USA Corp. 2023a). ABA results from unamended tailings would be used to determine if the ABA properties of the tailings are changing to determine if process adjustments may be necessary, such as adjusting the amount of lime added to the tailings being discharged from the plant if the target neutralization potential or neutralization potential ratios do not meet requirements. ABA results from tailings after lime addition would be used to verify that net neutralization potential and neutralization potential ratio properties of outgoing tailings are compliant with the neutralization criteria.

When mining operation ceases, active deposition of tailings into the TSF would stop. Tailings underflow would be managed by passive evaporation at the supernatant pond and reclaim pond. Approximately 1 year post-closure, tailings are expected to consolidate sufficiently to allow for the tailings impoundment surface to be regraded, covered, and vegetated. The cover would consist of a geomembrane, drainage layer, non-woven textile, and growth media, which would prevent infiltration of air and water, thus preventing acid generation over the long term. Long-term tailings underflow would be collected in the reclaim pond for storage and evaporation. The reclaim pond would be converted to an evaporation cell, which would be maintained and monitored until the TSF is fully drained with no tailings underflow, estimated at 20 years. The release of any tailings is unlikely following successful stabilization.

D-5.5 Access and Haul Road Material

The access road for the mine would use an existing road, improved by widening, realignments, and culvert installations. Some access road development would expose bedrock. The access road cut material sampled reported total sulfur below the detection limit, indicating bedrock encountered during access road development has no potential for acid generation.

The aggregate material from the quarry that would be used to develop the access road and onsite haul roads is similar to the aggregate cuts; the total sulfur values for this material were also below the detection limits, and it therefore has no potential to generate ARD.

D-6 ACID ROCK DRAINAGE ASSESSMENT CONCLUSIONS

The *Global Acid Rock Drainage Guide* (International Network for Acid Prevention 2014) informed the characterization of the mined materials and the assessment of their acid-generating potential. The conclusions are drawn based on that assessment of acid-generating potential and mining practices employed to address potential and actual acidic drainage. The ARD assessment results in the following conclusions.

D-6.1 Underground Mine

Filling the underground mine workings with cemented basalt and waste rock would prevent ARD formation. However, during testing, some metals were released in the initial flush and some during the last flush that were above groundwater metals concentration, but below OGWQG levels (SRK Consulting 2022b). A monitoring program is required to assess ARD generation during operation and post-closure. During operations, the Applicant proposes to monitor groundwater at various locations on a quarterly basis throughout the Project operations phase, with the first event conducted shortly after well construction and development (SPF 2021b). Post-closure, the Applicant proposes quarterly groundwater monitoring for 5 years, followed by semi-annual monitoring for 10 years, and then annual monitoring for 15 years (Calico Resources USA Corp. 2023b).

The following additional measures are proposed to reduce or mitigate ARD formation in underground mine workings:

- Spray a 2-inch layer of cement on the walls and ceilings of access routes to prevent ARD in these exposed areas.
- Conducted quarterly geochemical characterization of the material excavated during mining to flag waste rock with elevated sulfide content. By characterizing mined materials at the time they are produced, potential acid-generating conditions can be observed and addressed during active operations ahead of mine closure. The amount of cement added can be adjusted depending on the sampling results. After any preventive measure has been implemented, monthly monitoring should be conducted until the potential for ARD has been characterized and addressed and then quarterly monitoring resumed.
- In the event that ARD is detected post-closure, ARD could be treated outside the underground workings using an appropriately sized wetland[1]. An example is the Sleeper Mine in northern Nevada which developed wetlands as part of its closure plan to address acid-generation from an open pit mine.

D-6.2 Temporary Waste Rock Storage Facility

The waste rock does not show a significant potential to degrade the environment during operations. Any seepage through the liner will be collected in the underdrain and the flow would be routed to the TSF reclaim pond through a solid wall pipe for independent monitoring and sampling.

At closure, no waste rock is planned to be present in the TWRSF, but if any remains it would be removed and placed in the TSF and amended with lime to address any pH issues. Therefore, there is no potential for ARD to be released into the environment from the TWRSF.

D-6.3 Run-of-Mine Ore Stockpile

While the ore is stored in the ROM stockpile, it has a limited potential to generate ARD due to the short storage duration (less than a week to less than a month) and semi-arid climate. In addition, the ROM ore stockpile would have a lined base pad (geosynthetic clay plus 2-mm HDPE liner), with containment berms along each edge of the stockpile and a sump to collect the contact runoff to prevent any releases to the environment.

However, to confirm the actual ARD generation from the ROM stockpile, and in the event that ore is stored in the ROM stockpile for a longer period, quarterly geochemical characterization of leachate collected at the ROM stockpile drainage sump for its acid-generating potential and leaching potential should be conducted. In the event of a temporary or unexpected shutdown, a plan should be put into place to either completely process the entire stockpile or relocate it to the TWRSF. In addition, spill

[1] While there has been no specific design developed for this unlikely contingency, wetlands would need to be supported by a supplemental water supply, likely derived from a groundwater well, and the location of the wetlands would be as near as practicable to the source of any acidic drainage (i.e., the portal location).

response procedures in the Emergency Response Plan (Calico Resources USA Corp. 2023c) should be expanded to include potential stockpile drainage release during emergency situations.

In addition to these plans, in the event of a temporary or unexpected shutdown of the process plant for an extended period of time, accommodations can be made to relocate stockpiled ores to the TWRSF or other facility with the capacity for permanent containment of acid-generating rock to prevent potential release of contaminants from the ROM ore stockpile.

D-6.4 Tailings Material in the Tailings Storage Facility

The tailings material requires lime amendment to achieve non-acid-generating characteristics. The TSF is designed as a “zero discharge” facility and would be 100 percent geomembrane-lined with continuous primary and secondary leakage collection and leak detection systems, which would contain and monitor the material within the TSF system during operations.

The Applicant has developed a Tailings Chemical Monitoring Plan (Calico Resources USA Corp. 2023a), which provides a basis to demonstrate compliance with applicable Oregon regulations pertaining to management and monitoring of chemical aspects of stored tailings. Tailings would be sampled on a routine basis (e.g., continuously, daily, weekly, quarterly) for geochemical testing to monitor total cyanide, pH, and metals concentrations. Post-closure, the release of any tailings is unlikely following successful stabilization of the closed TSF since the cover system would isolate the tailings from air and water, thereby preventing formation of acid.

D-6.5 Access and Haul Road Material

The access road cut material sampled reported total sulfur was below the detection limit, indicating bedrock that could be encountered during the access road development has no potential for acid generation. No ARD mitigation measures are necessary for the haul road since the material does not have the potential to generate acid.

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