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

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Economically Feasible	Total Score	Notes and Examples
Mine Construction Methods								
Extracting Ore	2.1.3, 2.2.3.2, A-3.1	**Underground Mining**	Yes	Yes	Yes	Yes	9	Underground production of comparable ores is currently active at the Turquoise Ridge and Rodeo mines in Nevada.
	2.2.3.2, A-3.1	Open-Pit Mining	Yes	Yes	No	-	-	The size and geometry of the Grassy Mountain orebody make it amenable to underground mining and open pit mining infeasible.
	2.1.3, A-3.1	**Mechanized Cut-and-Fill with CRF**	Yes	Yes	Yes	Yes	9	Cut-and-fill mining with cemented rock fill is currently employed at the Turquoise Ridge and Jerritt Canyon Mines in Nevada.
	A-3.1	Longhole Open Stoping	No	-	-	-	-	Bulk mining methods are employed at the Meike, Rodeo, and Cortez Hills Mines in Nevada. These methods are usable when geotechnical rock strength characteristics allow for excavation of larger volumes of material before backfilling to support ground conditions in the mine. This mining method is not necessary and is typically employed to reduce per ton mining costs where it can be safely implemented. Geotechnical conditions in the Grassy Mountain orebody may not have sufficient rock strength characteristics to employ a bulk mining method.
	A-3.1	Blind Bench Stoping	No	-	-	-	-	Bulk mining methods are employed at the Meike, Rodeo, and Cortez Hills Mines in Nevada. These methods are usable when geotechnical rock strength characteristics allow for excavation of larger volumes of material before backfilling to support ground conditions in the mine. This mining method is not necessary and is typically employed to reduce per ton mining costs where it can be safely implemented. Geotechnical conditions in the Grassy Mountain orebody may not have sufficient rock strength characteristics to employ a bulk mining method.
Backfilling	A-3.1	Dry Fill	No	-	-	-	-	Dry fill of underground mine excavations is generally not used in other regional underground mines because it does not supply the desired ground strength for mining below the backfilled area. This backfill method is not necessary and typically employed to reduce cement costs where it can be safely implemented. The underhand cut-and-fill mining method for the Grassy Mountain orebody would require backfill to have sufficient strength to allow mining underneath backfill areas.
	A-3.1	Hydraulic Fill	No	-	-	-	-	Hydraulic fill of underground mine excavations is generally not used in other regional underground mines because it does not supply the desired ground strength for mining below the backfilled area and does not align with groundwater protection regulations. This backfill method is not necessary.
	2.1.3, A-3.1	**Cemented Fill**	Yes	Yes	Yes	Yes	9	Cemented fill is currently employed at the Turquoise Ridge, Jerritt Canyon, Cortez Hills, and Goldrush mines in Nevada.
	2.2.3.5, A-3.3	Paste Fill	Yes	Yes	No	-	-	Paste fill is currently employed at the Rodeo, Meikle, and Leeville mines in Nevada where ground tailings are sufficiently coarse to achieve the target geotechnical strength for ground support. The tailings generated from the Grassy Mountain ore are expected to not meet the geotechnical strength requirements for use as backfill.
Transporting Mined Materials	2.1.15, A-3.1	**Diesel Fuel (Trucks and Loaders)**	Yes	Yes	Yes	Yes	5	Diesel equipment is used at all the regional underground mining operations because of the power requirements for the equipment and the need to avoid carbon monoxide emissions underground.
	2.2.3.13, 2.2.5, 5.4, A-3.1	Biodiesel Fuel (Trucks and Loaders)	Yes	Yes	Yes	Yes	7	Bio-diesel equipment is used at all the regional underground mining operations to control the levels of diesel particulate matter in the air within the underground workings.
	2.2.3.10, 2.2.5, 5.4, A-3.1	Operational Improvement Technologies (e.g., Short Interval Control)	No	-	-	-	-	Operational improvement technologies such as short interval control are not necessary for the mining and are typically employed to reduce per ton mining costs (by defining detailed operating metrics and targets in the case of short interval control).
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	Yes	5	Cyanide processing and gold recovery by CIL, elution, and electrowinning are currently employed at the Twin Creeks, Goldstrike, Carlin, Cortez, and Jerritt Canyon processing plants in Nevada.

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	2.2.3.6, A-3.2	Gold Roasting	No	-	-	-	-	Gold roasting is currently employed at the Goldstrike, Carlin, and Jerritt Canyon processing plants in Nevada. Roasting removed organic carbon from ore to allow for gold extraction by cyanide. This process is not necessary for ores that do contain elevated concentrations of organic carbon.
	A-3.2	Mercury Amalgamation	No	-	-	-	-	Because of environmental concerns regarding the release of mercury into the environment, mercury amalgamation is not utilized regionally for gold production. This process is not necessary for extraction of gold from ore.
	2.2.3.9, 2.2.5, 2.2.6.3, A-3.2	Thiosulfate Leach	Yes	Yes	No	-	-	Thiosulfate leaching was employed at the Goldstrike process plant in the late 2010s. The process plant was converted back to a cyanide process – see the recent Calico submission on this topic. There are no current production-scale processes utilizing thiosulfate leach in the region.
	2.2.3.6, A-3.2	Alternative Mill Processing (gravity concentration, hydrometallurgical, pyrometallurgical, flotation, pressure oxidation)	Yes	Yes	No	-	-	The feasibility of alternative milling processes depends on specific gold mineralization characteristics within the orebody such as visible elemental gold or gold association with sulfide minerals. In the region, gold mineralization is generally microscopic and flotation of sulfide mineralization results in loss of gold to tailings. Therefore, these techniques are not in use regionally. Pressure oxidation is in use at the Twin Creeks and Goldstrike processing plants as a pre-cursor to cyanide leaching. In these applications, pressure oxidation is employed to remove sulfides from ores to allow effective gold removal by cyanide. This pre-cursor step is not necessary for the removal of gold from the Grassy Mountain ore.
	2.2.3.6, A-3.2	Heap Leaching	Yes	Yes	Yes	No[2]	-	Heap leaching is used to produce gold at the Round Mountain, Bald Mountain, Twin Creeks, Cortez, Carlin, Long Canyon, and Ruby Hill mines in Nevada. The recovery of gold by heap leaching is less efficient than mill process for most ores.
	2.2.3.6, A-3.2	Offsite Ore Processing	Yes	Yes	Yes[1]	No[2]	-	Off-site shipment of ore for processing is a common practice regionally. The Twin Creeks, Goldstrike, and Carlin processing plants currently receive ore from off-site locations. Orebody characteristics for effective gold commonly align with the capabilities of a processing plant off-site. However, off-site processing plants may or may not have the capacity to receive and process additional ore, and ore shipment incurs transportation costs and other effects to resources (air, noise, traffic) resulting from increased over-the-road truck usage.
	2.2.3.9, A-3.2	Non-cyanide Gold Extraction Processes (gravity separation, microbial leaching, biological, leaching agents)	Yes	Yes	No	-	-	The feasibility of alternative milling processes depends on specific gold mineralization characteristics within the orebody such as visible elemental gold or gold association with sulfide minerals. Biological leaching of gold was attempted at the Carlin processing plant in the 1990s but discontinued due to poor gold recovery. There are no current biological or other non-cyanide processes employed in regional full-scale gold production.
Cyanide Management	2.1.7, 2.2.3.7, A-3.2	**Detoxification and Neutralization of Cyanide**	Yes	Yes	Yes	Yes	7	Detoxification and neutralization of cyanide below a permit-proscribed threshold concentration is required practice regionally.
	2.2.3.8, A-3.2	Cyanide Reduction	No	-	-	-	-	Cyanide destruction renders cyanide reduction unnecessary.
	2.1.6, A-3.2	**Cyanide Destruction Circuit**	Yes	Yes	Yes	Yes	7	Detoxification and neutralization of cyanide below a permit-proscribed threshold concentration is required practice regionally.
Cyanide Monitoring	2.2.3.8, A-3.2	**Certified Laboratory Testing**	Yes	Yes	Yes	Yes	8	Certified laboratory testing is a permit-proscribed requirement for compliance monitoring regionally.
	2.1.7, 2.2.3.8, A-3.2	**In-Line Device (e.g., Cynoprobe)**	Yes	Yes	Yes	Yes	7	The Cynoprobe has gained world-wide commercial acceptance and has been installed on more than 30 plants in 14 countries since 2004.
Air Quality Controls	2.1.6.4, A-3.2	**Mercury Retort Oven**	Yes	Yes	Yes	Yes	4	Mercury retorts are utilized regionally to condense gaseous mercury generated by thermal processes such as gold refining. The refineries at the Cortez, Goldstrike, Carlin, and Twin Creeks processing plants are equipped with mercury retorts.
	A-3.2	**Wet Scrubber**	Yes	Yes	Yes	Yes	6	Processing plants regionally are equipped with wet scrubbers to condense gases prior to release into the environment. The Cortez, Goldstrike, Carlin, and Twin Creeks processing plants are equipped with scrubbers in their gas handling systems.

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	A-3.2	Electrostatic Precipitator	No	-	-	-	-	Electrostatic precipitators are not necessary for gas emissions when more effective technology (i.e., scrubbers) is employed and for dust when water sprays are employed.
	A-3.2	Baghouse Filter	No	-	-	-	-	Baghouse filters are not necessary for gas emissions when more effective technology (i.e., scrubbers) is employed and for dust when water sprays are employed.
Process Solution Containments	A-3.2	**Concrete Secondary Containments**	Yes	Yes	Yes	Yes	5	Concrete containments for process plant components are utilized in all regional processing plants due to their durability around operating equipment.
	A-3.2	Water Stops and Concrete Coatings	Yes	Yes	Yes	Yes	6	Water stops and concrete coatings to prevent seepage of process solutions through concrete seams are permit-proscribed in Nevada.
Wildlife Exclusion from Mill	3.5.4.2, 5.3, A-3.2	**Perimeter Fencing and Monitoring**	Yes	Yes	Yes	Yes	6	Perimeter fencing and wildlife monitoring are permit-proscribed regionally.
	3.5.4.2, 5.3, A-3.2	**Covers, Mesh, or Netting to Reduce Bird and Bat Nesting**	Yes	Yes	Yes[1]	Yes	6	Measures to inhibit wildlife access to process ponds are permit-proscribed regionally. While some netting is currently still in use at the Cortez Mine, most locations utilize bird balls for the surface of process ponds.
	5.3, A-3.2	**Covering Waste Bins**	Yes	Yes	Yes	Yes	7	Covers on a waste bins are required nationally by Mine Safety and Health Administration regulations. Nevada regulations require covering of waste bins, so they do not attract wildlife.
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	Yes	7	Removal of mill infrastructure as part of mine closure is permit-proscribed regionally.
	2.1.17, 2.2.3.14, A-3.2	**Breaking, Burying, and Recontouring Foundations**	Yes	Yes	Yes	Yes	7	Breaking, burying, and recontouring of foundations is the standardized practice for mine closure in Nevada.
	A-3.2	Removal of Foundation Materials	Yes	Yes	Yes	Yes	3	Off-site removal of foundation materials is not a requirement regionally.
	A-3.2	Retaining Power Lines Post-Closure	No	-	-	-	-	Retention of power lines post-closure is not necessary because mine closure removes their function. Removal of power lines during closure is required regionally except in cases where the powerlines also service a continuing function.
	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	Yes	6	Sagebrush, perennial grasses, and forbs are permit-specified components of revegetation following mine closure in Nevada. Revegetation monitoring programs are permit requirements regionally.
	2.1.17, A-3.2	Closure-Period Inspections	Yes	Yes	Yes	Yes	9	Closure-period inspections are monitoring requirements for mine closure regionally.
Tailings Management								
Tailings Disposal	2.1.8, A-3.3	**Permanent Storage of Tailings in Lined TSF**	Yes	Yes	Yes	Yes	5	Permanent tailings storage in lined facilities is practiced regionally with active tailings storage facilities at the Twin Creeks, Goldstrike, Carlin, Cortez, and Jerritt Canyon processing plants. There are no current operations that dispose of tailings via sub-aqueous or riverine discharge methods. Backfill of underground workings with a mixture of cement and tailings is employed at the Rodeo, Meikle, and Leeville Mines in addition to tailings storage in lined facilities. Since the early 1990s, gold processing facilities are required to be equipped with geosynthetic liner systems because they utilize cyanide.
	2.1, 2.1.5.2, 2.1.6, A-3.2	**TSF Lime Addition**	Yes	Yes	Yes	Yes	7	No current regional TSF's utilize lime addition to neutralize acid-generating potential in tailings material. Lime addition is commonly used to maintain a pH above 9.2 in process solution. While not directly intended to neutralize tailings, the lime addition to control process solution pH adds neutralization potential to the overall tailings. Management of any acid-generation by tailings material relies on the TSF liner system and reclamation cover that inhibit the sulfide oxidation reaction in the tailings and release of any seepage to the environment. Lime additional specifically to counteract acid generation within tailings further reduces the potential for acid-generation.
	2.2.3.5, A-3.3	Mix with Cement and Use as Backfill in Underground Mine	Yes	Yes	No	-	-	Cemented tailings are currently employed at the Rodeo, Meikle, and Leeville mines in Nevada where ground tailings are sufficiently coarse to achieve the target geotechnical strength for

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								ground support. The tailings generated from the Grassy Mountain ore are expected to not meet the geotechnical strength requirements for use as backfill.
	A-3.3	**TSF pH Monitoring**	Yes	Yes	Yes	Yes	7	Monitoring of the pH (and other water quality parameters) in regional TSF's is a requirement of permit conditions.
Tailings Water Content	2.2.2.2, A-3.3	**Conventional Tailings Slurry**	Yes	Yes	Yes	Yes	5	Conventional tailings storage via a slurry from a mill process to the TSF is employed at the Twin Creeks, Cortez, Carlin, and Jerritt Canyon mines.
	2.2.2.2, A-3.3	Filtered Tailings	No	-	-	-	-	Filtration of tailings is not employed within the region because of technical issues associated with tailings filtration under variable climatic conditions and the amount of water storage required once water is removed from tailings. Additional challenges with filtered tailings are associated with controlling fugitive dust emissions from dry tailings. Because there are preferred options available tailings, filtration is not necessary.
	2.2.2.2, A-3.3	High-density Thickened Tailings	No	-	-	-	-	Tailings thickened to densities greater than conventional slurries are not employed within the region. Because there are preferred options available tailings, filtration is not necessary.
	A-3.3	Water Balance Accounting (including probabilistic and deterministic meteorological water projections)	Yes	Yes	Yes	Yes	7	Water balance accounting is an industry standard included in the ICMM's global standard for tailings management.
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	Yes	6	Since the 1990's, regional TSFs have been designed as zero discharge facilities where process solutions are contained within the facility and evaporated during the closure period. Liner design requirements vary by state and the proximity of tailings to groundwater, but double lining is the most protective liner system adopted regionally.
	2.2.3.4, A-3.3	Alternative Liners	Yes	Yes	Yes	No[2]	-	Regionally, liners are constructed from HDPE or LDPE materials above a prepared substrate. There are variations in design of the leak detection layer installed between liner layers but the utilization of alternative materials for the liner layers has not been adopted for the large area TSF facilities based on economics.
	A-3.3	Reparable Liner	Yes	No	-	-	-	Following installation, liners are repairable up until the point that they are covered with tailings. Following coverage, technologies that can access liner flaws for repair are not available.
	A-3.3	Alternative Embankment Designs (using different materials)	No	-	-	-	-	Regional TSFs utilize earthen embankments constructed from native or mined materials. Utilization of different construction materials is not necessary based on the performance of the native and mined materials.
	A-3.3	LiDAR Slope Monitoring	No	-	-	-	-	LIDAR slope monitoring is utilized in mining for slopes that are dynamically changing such as open pit walls, where conditions are changing on intervals as short as a few hours. Once constructed, TSF embankments are maintained per design and monitored using conventional surveys and hydrostatic pressure measurements. Therefore, the short interval measurements of LIDAR are not necessary.
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	Yes	6	Liner leak detection and collection of seepage are permit-specified requirements for TSF's regionally.
	2.1.19.1, A-3.3	**Groundwater Monitoring for Leaks**	Yes	Yes	Yes	Yes	6	Groundwater monitoring for seepage from TSF's is a permit-specified requirements for TSF's regionally.
	2.2.3.4, A-3.3	Electromagnetic Leak Detection	No	-	-	-	-	Electromagnetic leak detection method that infers potential leakage. Because leak detection, seepage collection, and groundwater monitoring directly inspect for leakage, the electromagnetic leak detection is not necessary.
	A-3.3	Geophysical Leak Detection	No	-	-	-	-	Geophysical leak detection method that infers potential leakage. Because leak detection, seepage collection, and groundwater monitoring directly inspect for leakage, the Geophysical leak detection is not necessary.
Long-Term Pollution Prevention Controls and Monitoring	2.1.19.3, A-3.3	**Backfilling using CRF**	Yes	Yes	Yes	Yes	6	Backfilling with CRF is employed regionally at the Turquoise Ridge, Cortez, Carlin, and Jerritt Canyon mines.
	2.1.17, A-3.3	**Plugging the Mine Portal**	Yes	Yes	Yes	Yes	6	Plugging mine portals is a closure permit requirement for all regional mine operations.

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	2.1.17, A-3.3	**Retaining Liners in Perpetuity**	Yes	Yes	Yes	Yes	7	Retaining liners into the closure and post-closure periods is a component of closure plans at the Turquoise Ridge, Cortez, Goldstrike, Carlin, and Jerritt Canyon mines. In closure, the liners remain environmentally protective, and removal of the liners incurs cost without environmental benefit.
	2.1.17, A-3.3	**Reclaiming Mine Areas**	Yes	Yes	Yes	Yes	9	Reclaiming mine areas is a closure permit requirement for all regional mine operations.
	2.1.17, A-3.3	**Converting the Reclaim Pond to an Evaporation Cell**	Yes	Yes	Yes	Yes	8	Conversion of process ponds to evaporation cells has been utilized at the Turquoise Ridge, Cortez, and Goldstrike Mines. Monitoring of evaporation cell performance has determined that these facilities are effective in disposing of long-term drainage from process facilities.
	2.1.17, A-3.3	**Retaining Stormwater Infrastructure**	Yes	Yes	Yes	Yes	8	Retaining stormwater infrastructure is a component of closure plans at the Turquoise Ridge, Cortez, Goldstrike, and Carlin mines. Implementation of closure adds further stormwater diversions and controls to the stormwater infrastructure developed during operations.
	D-5.1, A-3.3	Monitoring Mined Materials Quarterly During Operations	Yes	Yes	Yes	Yes	9	Monitoring of mined materials via static and kinetic testing by a certified analytical laboratory is a permit requirement for mines in Nevada. The monitoring frequency is typically quarterly in these permits unless the frequency is increased to address variability in monitoring results.
Long-Term Monitoring	2.1.19.2, A-3.3	**Monitoring Groundwater**	Yes	Yes	Yes	Yes	7	Monitoring groundwater levels and water chemistry is an operating and closure permit requirement for all regional mine operations.
	2.1.19.2, A-3.3	**Monitoring Noxious Weeds**	Yes	Yes	Yes	Yes	7	Monitoring for noxious weeds is an operating and closure permit requirement for all regional mine operations.
	A-3.3	Noxious Weed Mapping via UAV or Satellite Imagery	No	-	-	-	-	Ground monitoring for noxious weeds on mine properties precludes the need for weed mapping by UAV or satellite imagery.
	2.1.19.2, A-3.3	**Facility Inspections, Maintenance, and Repairs**	Yes	Yes	Yes	Yes	8	Facility inspections, maintenance, and repairs are an operating and closure permit requirement for all regional mine operations. MSHA regulations also impose these requirements on a national basis.
	2.1.19.2, A-3.3	**Inspections and Sampling of Stormwater Facilities and Discharges**	Yes	Yes	Yes	Yes	7	Stormwater facility inspections and sampling are an operating permit requirement for all regional mine operations. These requirements are implemented via a required Stormwater Pollution Prevention Plan.
	A-3.3	Spring and Seep Monitoring	Yes	Yes	Yes	Yes	7	Seep and spring monitoring is a permit requirement at the Turquoise Ridge, Cortez, Goldstrike, and Carlin Mines. This monitoring is required regionally for mines with dewatering systems that drawdown groundwater levels.
	2.1.19.2, A-3.3	Biomonitoring	No	-	-	-	-	Monitoring for revegetation success meeting regulatory reclamation standards precludes the need for biomonitoring.
	2.1.19.2, A-3.3	Vegetation Cover Indexes	No	-	-	-	-	Monitoring for revegetation success meeting regulatory reclamation standards precludes the need for vegetation cover indexes.
TSF Wildlife Exclusion	3.5.4.2, 5.3, A-3.3	**Perimeter Fence and TSF Fences and Barriers**	Yes	Yes	Yes	Yes	6	Perimeter fencing and TSF fencing are permit requirements for process components for all regional mine operations.
	3.5.4.2, 5.3, A-3.3	**Bird Deterrent Balls on TSF Pond**	Yes	Yes	Yes	Yes	6	Bird balls are utilized on process ponds at the Cortez, Goldstrike, and Carlin mines.
	3.5.4.2, 5.4, A-3.3	Visual Deterrents: Effigies, Predator Models	Yes	Yes	Yes[1]	Yes	6	Studies conducted with effigies in natural and artificial ponds in the boreal forest of Alberta, Canada, and at the University of Kentucky; experiments with mylar flags in northern Ohio.
	3.5.4.2, A-3.3	Radar-activated Propane Cannons	Yes	Yes	Yes[1]	Yes	5	Experiments with propane cannons at John F Kennedy Airport, oil sand mine tailings in Canada, and contaminated ponds at a power plant.
	3.5.4.2, 5.4, A-3.3	Laser Bird Deterrents	Yes	Yes	Yes[1]	Yes	6	Experiments at Wageningen University, Netherlands, in use at Oswestry Water Treatment Works in the UK, used on various buildings in Australia and the US and in agricultural fields and at airports.
	3.5.4.2, A-3.3	Emergency Hazing	Yes	Yes	Yes	Yes	6	The USACE has used pyrotechnics to haze piscivorous birds at The Dalles Lock and Dam for over 30 years.
	3.5.4.2, 5.4, A-3.3	Bio-exclusion Zones	Yes	Yes	Yes[1]	Yes	6	Vegetation clearing used in agricultural drainage basins the San Joaquin Valley, California.

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	3.5.4.2, A-3.3	Decoy Ponds	No	-	-		-	Decoy ponds would require additional ground disturbance and water usage that is rendered unnecessary by other controls on wildlife exposure.
	3.5.4.2, A-3.3	Hyper-salinization	Yes	Yes	Yes	No2		Hyper-salinization is utilized at Australian mines where natural brine solutions are available locally to provide dissolved solids in process solutions. Generating brines for hyper-salinization usage incurs costs and has not been shown to out-perform other controls on wildlife exposure.
	3.5.4.2, 5.3, A-3.3	**Monitoring Perimeter for Signs of Wildlife**	Yes	Yes	Yes	Yes	6	Joint inspections of process areas and their perimeters are conducted quarterly by regulatory agency and mine personnel for Nevada mines.
	3.5.4.2, 5.3, A-3.3	Netting and Wires on TSF	No	-	-	-	-	Netting and wires would require additional installations and maintenance of equipment in a TSF environment that poses human safety risks. Further, these measure would be rendered unnecessary by other controls on wildlife exposure.
	5.3, A-3.3	**Monitoring and Removal of Aquatic Species in TSF Pond**	Yes	Yes	Yes	Yes	6	In Nevada, monitoring and removal of wildlife from process ponds is a requirement of industrial pond permits issued by the Nevada Division of Wildlife.
Closure of the TSF	A-3.3	**Dry Closure**	Yes	Yes	Yes	Yes	7	Dry closure is a component of the closure plans at the Turquoise Ridge, Cortez, Goldstrike, Carlin, and Jerritt Canyon mines.
	2.1.16, A-3.3	**Conversion of Process Pond to Evapotranspiration Cell**	Yes	Yes	Yes	Yes	8	Conversion of process ponds to evaporation cells has been utilized at the Turquoise Ridge, Cortez, and Goldstrike Mines. Monitoring of evaporation cell performance has determined that these facilities are effective in disposing of long-term drainage from process facilities.
	A-3.3	Wet Closure	No	-	-	-	-	Wet closure is rendered unnecessary by the established effectiveness of dry closure. Further, under arid site conditions, maintaining a wet tailings facility post-closure would require perpetual pumping of groundwater to add water to the facility.
	A-3.3	Wetland Establishment Closure	No	-	-	-	-	Wetland establishment is rendered unnecessary by the established effectiveness of dry closure. Further, under arid site conditions, maintaining a wet tailings facility post-closure would require perpetual pumping of groundwater to add water to the facility.
	A-3.3	Alternative TSF Cover Design	No	-	-	-	-	Oregon regulations for TSF closure require installation of a geosynthetic cover and a revegetated soil cover. These requirements are more rigorous that other jurisdictions that require a revegetated soil cover but do not require a geosynthetic cover. The rigorous design requirement precludes the need to consider other, less rigorous designs.
	A-3.3	Hydroseeding	Yes	Yes	Yes	Yes	5	Hydroseeding of reclaimed mine slopes has been effective in revegetating facilities at the Cortez mine. However, other methods of seeding such as broadcast seeding and harrowing have resulted in revegetation consistent with reclamation objectives and regulatory requirements.
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	Yes	5	Monitoring groundwater levels and water chemistry is an operating and closure permit requirement for all regional mine operations.
	2.2.2.5, A-3.4	Pipeline from Municipal Supply	No	-	-	-	-	The availability of water rights for use on site precludes the need to import water from distal off-site sources. Further, the installation of pipelines to distal municipal water supplies results in additional ground disturbance, energy, and reclamation requirements.
	A-3.4	Perimeter Well Dewatering	Yes	Yes	No	-	-	Perimeter well dewatering is feasible when the hydraulic conductivity of the aquifer materials around an orebody is sufficiently high to allow pumping at the orebody perimeter to draw water from the orebody into the pumping well. Perimeter well dewatering is employed at the Cortez, Goldstrike, Leeville, and Carlin mines. However, site date for Grassy Mountain show that the hydraulic conductivity near the orebody is too low to allow pumping from wells for orebody dewatering.
	A-3.4	Groundwater Production Sumps for Dewatering	Yes	Yes	Yes[1]	Yes	3	Groundwater production from underground sumps for dewatering is conducted at the Turquoise Ridge and Jerritt Canyon mines.
	A-3.4	Closure Reclamation of Water Supply Piping	Yes	Yes	Yes	Yes	5	Reclamation of water supply piping is a requirement of the closure permit for the Cortez mine. Pipeline removal is primarily a requirement for pipelines installed on public lands.
Air Quality Control Measures	A-3.4	Monitor TSF for Dust after Operations Cease and Prior to Cover	Yes	Yes	Yes	Yes	6	Dust monitoring is required regionally by active air quality permits.

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	5.3, A-3.4	**Dust Suppression Water Spray**	Yes	Yes	Yes	Yes	4	Dust suppression sprays are in use at the Twin Creeks, Cortez, Goldstrike, and Carlin processing plants.
	5.3, A-3.4	**Equipment Hoods, Curtains, Chutes**	Yes	Yes	Yes	Yes	6	Equipment to capture dust are in use at the Twin Creeks, Cortez, Goldstrike, and Carlin processing plants.
	A-3.4	**Cover/Enclose Material Piles**	Yes	Yes	Yes	Yes	5	The ore stockpile is located in an enclosed facility at the Goldstrike processing plant.
	5.3, A-3.4	**Air Permit BMPs**	Yes	Yes	Yes	Yes	5	Best management practices for air emissions and fugitive dust are required regionally by active air quality permits.
	A-3.4	**Dust Control Staff Training**	Yes	Yes	Yes	Yes	6	Mining operations in Nevada are required to have personnel trained in dust control monitoring (i.e., opacity monitoring) on-site to conduct required compliance monitoring for air quality permits.
Equipment Maintenance	A-3.4	Reactive Maintenance	Yes	Yes	Yes	Yes	3	Reactive maintenance involves responding to inoperative or poorly operating equipment upon observation of the operating condition.
	A-3.4	**Preventative Maintenance**	Yes	Yes	Yes	Yes	5	Regional mines utilize preventative maintenance programs for their operating equipment. These include but are not limited to lubricant change, coolant change, tire changes, planned replacement of wear parts, filter changes, and cleaning.
	A-3.4	Predictive Maintenance	No	-	-	-	-	Predictive maintenance programs are utilized at the Cortez and Goldstrike mines for select equipment with long lead-times for replacement. However, preventative maintenance renders the predictive maintenance unnecessary.
Operations Monitoring	2.1.19.1, 5.3, A-3.4	**Resource-Specific Monitoring Plans**	Yes	Yes	Yes	Yes	9	Resource monitoring is a requirement of resource permits regionally.
	A-3.4	**Permit Monitoring Requirements**	Yes	Yes	Yes	Yes	10	Resource monitoring is a requirement of resource permits regionally.
Acid Rock Drainage Management	D-3, D-4.6, A-3,5	**CRF**	Yes	Yes	Yes	Yes	5	Cement in rock fill at the Turquoise Ridge and Meikle mines is utilized to manage sulfide oxidation and leaching of constituents from underground workings.
	A-3.5	Additional Monitoring and Testing (by mine level)	Yes	Yes	Yes	Yes	6	Monitoring and testing of mined materials is required quarterly as part of operating permits in Nevada. Testing is performed on composite samples of material mined over the quarter. Monitoring by mine level may increase the frequency of monitoring and testing compared to the quarterly requirement.
	A-3.5	Additional Water Quality Monitoring	Yes	Yes	Yes	Yes	6	Groundwater water quality monitoring in the vicinity of mine operations is required quarterly. Additional monitoring of sump locations near mined materials is a component of permit requirements at the Twin Creeks, Cortez, and Goldstrike mines.
	A-3.5, D-6.1	**Groundwater Monitoring for Acid Rock Drainage**	Yes	Yes	Yes	Yes	6	Groundwater water quality monitoring in the vicinity of mine operations is required quarterly in the region.
	A-3.5	Passive or Active Treatment of Acid Rock Drainage	Yes	Yes	Yes	Yes	6	Passive treatments for neutralization of acid rock drainage are employed at the Turquoise Ridge, Twin Creeks, and Meikle operating mines. Passive treatment for acid drainage is employed at the post-closure Sleeper mine. Active treatment for acid drainage is employed at the closed Lone Tree and McAlister mines.
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	Yes	9	Plans for the transportation of hazardous materials are required to comply with U.S. Department of Transportation regulations. Storage and transportation plans are required for U.S. EPA waste permits nationally.
	5.3, A-3.6, B-3.2	**Waste Management Plan**	Yes	Yes	Yes	Yes	9	Waste management plans are required for U.S. EPA waste permits nationally.
	2.1.5, 2.1.10.3, A-3.6	**Offsite Hazardous Materials Disposal**	Yes	Yes	Yes	Yes	8	Offsite hazardous material disposal is used by the Turquoise Ridge, Twin Creeks, Cortez, Goldstrike, Carlin, and Jerritt Canyon mines. Stantec is not aware of any U.S. mine site that disposes of hazardous materials on-site.
	A-3.6	**Toxic and Hazardous Substances Transportation and Storage Plan**	Yes	Yes	Yes	Yes	8	Plans for the transportation of toxic and hazardous materials are required to comply with U.S. Department of Transportation regulations. Storage and transportation plans are required for water quality permitting in regional jurisdictions.
	3.1.4, 5.3, A-3.6	**Stormwater Pollution Control Plan**	Yes	Yes	Yes	Yes	7	Stormwater Pollution Prevention Plans are required by regional jurisdictions.

Project Component	EE Section	Name of Technology	Necessary	Available	Technically Feasible	Economically Feasible	Total Score	Notes and Examples
	A-3.6	**Regular Inspections of Hazardous Materials Storage Areas and Updates to Management Plans**	Yes	Yes	Yes	Yes	9	Joint inspections of hazardous material storage areas are conducted quarterly by regulatory agency and mine personnel for Nevada mines. Any new material used on site is required to be disclosed to the Nevada State Fire Marshall for compliance with the state fire marshall permit.
Spill and Emergency Response	A-3.7, B-3.2	**Spill Prevention, Control, and Countermeasures Plan**	Yes	Yes	Yes	Yes	7	Spill Prevention Control and Countermeasure Plans (referred to as Emergency Response Plans in some jurisdictions) are required by regional jurisdictions.
	A-3.2	Water Stops and Concrete Coatings	Yes	Yes	Yes	Yes	6	Water stops and concrete coatings to prevent seepage of process solutions through concrete seams are permit-proscribed in Nevada.
	A-3.7, B-3.2	**Emergency Response Plan**	Yes	Yes	Yes	Yes	9	Spill Prevention Control and Countermeasure Plans (referred to as Emergency Response Plans in some jurisdictions) are required by regional jurisdictions.
	A-3.7, B-4.3, B-5.1	**Mobile Emergency Refuge Stations**	Yes	Yes	Yes	Yes	5	Mobile refuge stations are employed at the Turquoise Ridge, Cortez Hills, Meikle, and Rodeo mines.
	A-3.7, B-3.2	Strobe Lights, Light Vests, Laser Pointers, Lifelines, Cones, and Reflective Strips	Yes	Yes	Yes	Yes	5	Strobe lights and reflective clothing are general requirements of MSHA regulations nation-wide.
	A-3.7, B-4.2	**Fire Alarm System**	Yes	Yes	Yes	Yes	5	Fire alarm systems are requirements for county occupancy permits.
	A-3.7, B-3.2	Wireless Signaling System	No	-	-	-	-	Permit compliant fire alarm systems render wireless signaling systems unnecessary.

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).