

Technical Memorandum

To:	Glen Van Treek	Date:	December 7, 2021
Company:	Calico Resources USA Corp.	From:	Rob Bowell
Copy to:	Tom Patterson, SLR International Corporation	Reviewed by:	Amy Prestia
Subject:	Ecological Risk Assessment: Numerical Prediction of Tailings, Supernatant Pond and Reclaim Pond Chemistry for the Grassy Mountain Project	Project #:	506800.040

1. Introduction

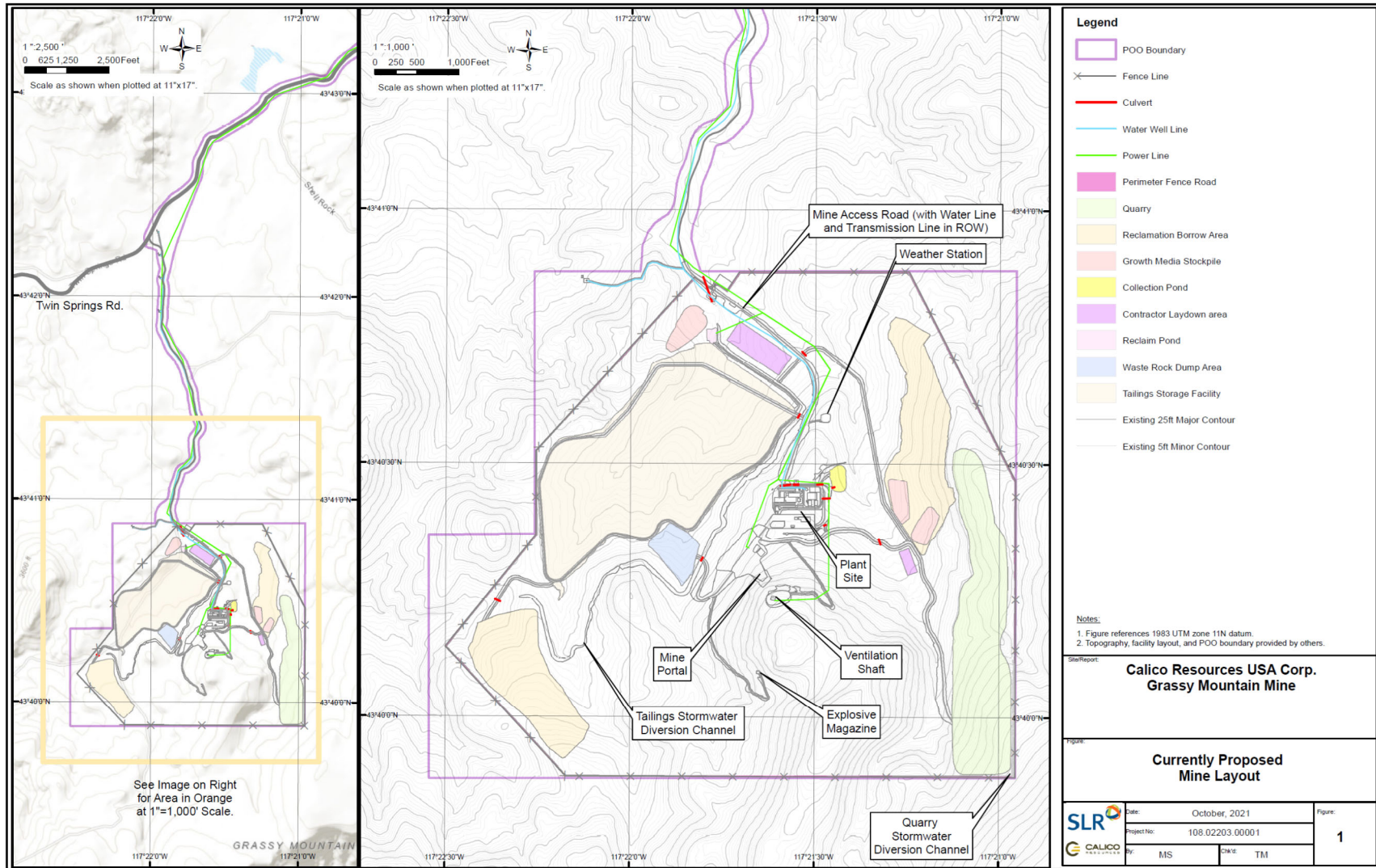
On behalf of Calico Resources USA Corp. (Calico), SRK Consulting U.S., Inc. (SRK) has developed a geochemical model that predicts the operational tailings supernatant pond chemistry for the Grassy Mountain Gold Project (Project) in Oregon. The purpose of the predictive calculations is to determine if the water exposed within the tailings impoundment during operations poses an ecological risk to wildlife. This technical memorandum has been prepared to describe the model approach, inputs and present the model results. The results presented herein are an update to the 2019 study that address comments from Geomega received during the December 4, 2020 conference call.

2. Background

2.1 Project Description

The Project is located in Malheur County, Oregon, approximately 22 miles south-southwest of Vale and will include construction, operation, reclamation, and closure of the underground and precious metal milling operation. The proposed mining and precious metal processing operations will consist of underground mine and ore processing facilities, including a conventional mill and tailings storage facility, and waste rock storage areas, as well as other support facilities (Figure 2-1).

Calico proposes to mine approximately 3 million tons of mill-grade ore and 0.2 million tons of waste rock (total of 3.2 million tons). The material (both ore and waste) will be extracted from the underground mine using conventional underground mining techniques of drilling, blasting, mucking, loading, and hauling. Calico will use hydraulic loaders to load the ore and waste into the haul trucks. The haul trucks will transport the waste rock to the waste rock disposal areas near the tailings facility and transport the ore to the ROM stockpile adjacent to the crushing and milling facilities. The ore will be leached in a carbon-in-leach processing plant to recover the precious metals into a “pregnant” leach solution. The pregnant solution will then be processed for metal recovery and further off-site refining.



Source: SLR (2021)

Figure 2-1: Grassy Mountain Site Layout

2.2 Topographic Setting and Climate

The Grassy Mountain property is located in the semi-arid plateau region of eastern Oregon. The local landscape is typical of a high mountain desert environment and range land. Terrain is gentle to moderate throughout the majority of the project study area, with elevations ranging from 3,330 to 4,300 feet above mean sea level (amsl).

Local weather data indicate a mean annual temperature of 52°F for the Project site, with daily temperatures ranging from an extreme low of -20°F in the winter to extreme highs of +100°F in the summer. Annual precipitation is approximately 9.8 inches, roughly half of which falls as snow between November and March. Winter and wet weather occasionally limit access to the Project site, but operations can typically be carried out year-round.

The data presented below in Table 2-1 are sourced from Golder (2019), where average monthly precipitation data for the Project area were compiled based on regression analysis of daily data from three nearby weather stations obtained from the Western Regional Climate Center (WRCC). Lake evaporation using the Combination Method of Penman was calculated using daily temperature, humidity, and wind speed from the Owyhee Ridge RAWS weather station (Golder, 2019). To obtain the one in one hundred (1:100) wet and dry year average monthly precipitation and lake evaporation values, Golder (2019) conducted a frequency analysis on the annual precipitation and lake evaporation data from 1999 through 2017 and from 1999 through 2018, respectively. A three-parameter log-normal distribution was used to generate the extreme annual rates (Golder, 2019)

Table 2-1: Grassy Mountain Site Precipitation and Lake Evaporation Data (Golder, 2019)

Month	Average Annual Precipitation	Average Annual Lake Evaporation	1:100 Wet Year Precipitation	1:100 Wet Year Lake Evaporation	1:100 Dry Year Precipitation	1:100 Dry Year Lake Evaporation
	in	in	in	in	in	in
January	0.93	0.85	1.50	0.79	0.27	1.07
February	0.62	1.31	1.00	1.21	0.18	1.65
March	0.97	2.69	1.56	2.49	0.29	3.39
April	1.14	3.81	1.83	3.52	0.34	4.8
May	1.49	5.28	2.40	4.88	0.44	6.65
June	0.89	6.37	1.43	5.89	0.26	8.02
July	0.51	8.16	0.82	7.54	0.15	10.27
August	0.31	7.04	0.50	6.51	0.09	8.86
September	0.46	4.39	0.74	4.06	0.14	5.53
October	0.83	2.95	1.33	2.73	0.24	3.71
November	0.73	1.31	1.17	1.21	0.22	1.65
December	0.89	0.79	1.43	0.73	0.26	0.99
Total	9.77	44.97	15.71	41.55	2.88	56.59

2.3 Tailings Geochemical Characterization

Geochemical characterization of material representative of tailings from the Grassy Mountain project has been completed and is described in the Baseline Geochemical Characterization Report for the Grassy Mountain Project (SRK, 2019). As part of this program, one sample of tailings material was collected from the metallurgical testing program conducted in 2015 at Resource Development Inc. The metallurgical test was conducted on a sample collected from core that consisted of a range of lithologies and gold grades (i.e., average ore grade and composition). The tailings sample was collected after Inco cyanide destruction using sodium bisulfite as a SO₂ source. Due to the consistent nature of the geology of the deposit and the fact that the deposit has been oxidized, major shifts in the ore (and tailings) geochemistry are not anticipated. Therefore, this sample is considered representative of unamended tailings material that will be generated as part of operations.

In 2018, three additional test residues were generated from metallurgical testing representative of the tailings material. These samples consist of a mixture of the primary lithologies that comprise the bulk of the ore and underwent cyanide destruction prior to geochemical testing to be consistent with OAR 340-043-0130 (1). Two buckets of tailings slurry per sample were submitted to McClelland Laboratories (MLI) for sample preparation and testing. The samples were allowed to settle and a sample of decant solution, representative of supernatant solution, was collected from each of the six buckets for analysis. Following collection of the decant solution sample, the material from the first bucket (1 of 2) for each sample was air dried and each sample was individually blended and split to obtain samples.

The tailings geochemical characterization results indicate that despite low sulfide sulfur, the tailings material has a potential to generate acid due to the low neutralization potential (NP) of the material. The potential for tailings material to generate acid and leach metals was confirmed by the HCT results for the unamended tailings sample from the 2015 metallurgical test program. Under low pH conditions, iron, manganese and copper were mobile at concentrations greater than the Oregon Groundwater Quality Guidelines (OGWQG, OAR 340-40-020). 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. Decant solution samples had slightly alkaline pH and exceeded the OGWQG for arsenic, selenium, sulfate, and TDS.

ABA test results from the 2018 metallurgical samples were used to determine the amount of lime required to neutralize the tailings to meet the regulatory requirement of an NPR > 3 and an NNP > 20 kg CaCO₃/t. The ABA results for the tailings material demonstrate that there is some inherent variation in the sulfide sulfur and NP content of the tailings materials that is likely to occur during mining operations. In order to take into account the slight variation in NP and sulfide sulfur in the tailings material, the amount of lime amendment needs to exceed the minimum amount required to ensure that the neutralization criteria specified in the OAR 340-043-0130 (2) is met. Based on the testing conducted to date, the lime amendment rate needs to include the amount of lime required to neutralize the tailings to meet the regulatory guideline plus an additional 20%.

The amended tailings samples were submitted for the Modified Synthetic Precipitation Leaching Procedure (SPLP) modified to use a water to solid ratio of 1:1 and distilled water for the lixiviant. The test results indicate that selenium is leached under alkaline conditions at concentrations above the OGWQG. Sulfate and chromium were also slightly elevated above the OGWQG for one sample and all other parameters were below the OGWQG.

3. Geochemical Model

3.1 General Approach

A predictive geochemical model has been developed to predict the Grassy Mountain tailings supernatant pond chemistry. The model assumes that tailings seepage flowing into the reclaim pond will consist of underdrain solution that is represented by SPLP data from the amended tailings samples that has been scaled to the tonnage of tailings material in the tailings impoundment, which varies over time. The water input to the mill consists of a blend of supernatant water, reclaim pond water and freshwater make-up water according to the water balance. Supernatant pond water chemistry that feeds the mill is assumed to be similar to the predicted mill water chemistry. Evapoconcentration or dilution is applied as a function of the balance of evaporation and precipitation occurring in the tailings storage facility. Modeling was completed for three phases of the mining operations under dry, wet and average precipitation conditions. The geochemical model has been developed from site-specific hydrological, geochemical and hydrochemical data. A description of the model inputs and assumptions are provided below.

3.2 Water Balance

A deterministic water balance model has been developed by Golder (2019) to evaluate water management of the proposed Grassy Mountain TSF including:

- Predicting the volume of the supernatant pool located at the southern boundary of the facility
- Sizing the Reclaim Pond at the base of the facility
- Estimating make-up water requirements
- Estimating return water flow rates from the supernatant pool to the mill
- Estimating return water flow rates from the underdrain pond to the mill

The water balance accounts for inflows and outflows to the process and tailings disposal system as shown in Figure 3-1. Inflows to the system include precipitation falling on lined facilities, runoff from an upstream basin reporting to the TSF and fresh make-up water. Outflows include evaporation from the tailings surface, supernatant pool and reclaim pond plus water lost in the void spaces of the stored tailings.

The Golder (2019) water balance is based on (1) tailings testing results provided by Golder's Denver, Colorado Geotechnical Laboratory; (2) Data provided by Ausenco in the Grassy Mountain Prefeasibility Study Mass Balance report updated on March 29, 2018 (Doc. No. 101768-MB-0001); and (3) assumptions based on climatically and operationally similar mine sites in Nevada.

The starting values that Golder used in their water balance include the following:

- Tailings are deposited in the TSF at a rate of 680 tons per day
- Tailings settled dry density of 80 lb/ft³ at a saturation of 90 percent
- Tailings have a specific gravity of 2.65
- Tailings slurry contains 46 percent solids
- The dry beach area will make up 84% of the total exposed tailings area
- The wet beach area will make up 16% of the total exposed tailings area
- Evaporation rates from wet and dry tailings beach areas (presented in Table 3-1) were developed using the tailings testing data performed in the Denver, Colorado Golder geotechnical laboratory
- Underdrain rates are constant and vary by stage

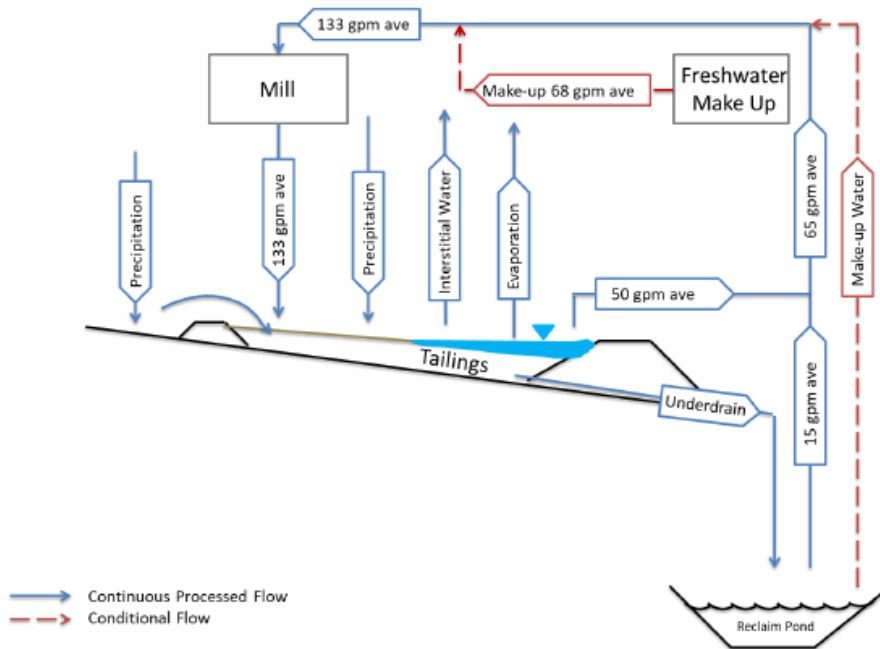


Figure 3-1: Process Flow Diagram (Golder, 2019)

Table 3-1: Tailings Beach Evaporation Rates

Stage	Wet Beach Evaporation Coefficient	Dry Beach Evaporation Coefficient
	% of ET	% of ET
1	92	48
2	93	38
3	94	33

The assumptions that Golder included in their water balance are:

- Pool evaporation is 75 percent of the evapotranspiration rate
- Tailings have a runoff coefficient of 100 percent
- Upstream basins reporting to the TSF have a runoff coefficient of 40 percent
- No seepage through the underlying geomembrane liner
- The surface area of the supernatant pool corresponds to a minimum pool depth of 5-feet required for normal reclaim pump operations
- The area of the supernatant pool for each stage was held constant assuming that all solution above the 5-foot operating pool would be removed monthly
- Water losses in the mill are negligible and are not considered in this analysis

Golder determined the reclaim rate after calculating the losses and gains to the tailings impoundment. If in a given month there was excess water in the supernatant pool, then the reclaim rate to the mill would be equal to the rate at which water is reporting to the TSF in the tailings slurry. Conversely, if there was a monthly deficit of water in the TSF, only the minimum amount of water necessary to maintain the 5-ft minimum supernatant pool depth would be removed from the supernatant pool. The remaining water demand of the mill to be satisfied by make-up water.

Given that the water demands of the Grassy Mountain TSF Mill are unknown, the make-up water required for mill operations was defined as the rate of evaporation from the tailings beach and supernatant pool plus interstitial water loss minus precipitation. The make-up water rate is less than or equal to rate that water is reporting to the TSF in the tailings slurry. The results of the Golder (2019) water balance are shown in Table 3-2 for the average, wet year and dry year and indicate that the average reclaim rate from the supernatant pool is about 54 gallons per minute (gpm) for Stages 1 through 3. The calculations used to produce these values are provided in Golder (2019).

Table 3-2: Reclaim Rates to Mill (gpm)

Month	Stage 1			Stage 2			Stage 3		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
January	71	106	117	69	111	118	67	118	119
February	54	84	117	49	84	118	42	85	119
March	32	77	117	19	73	118	5	71	119
April	8	65	117	0	58	118	0	51	119
May	0	57	110	0	46	118	0	35	119
June	0	8	43	0	0	39	0	0	72
July	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0	0
September	0	21	41	0	5	29	0	0	16
October	24	65	93	10	60	93	0	54	95
November	57	89	113	52	90	118	47	92	119
December	71	105	117	70	110	118	69	117	119
Minimum	0	0	0	0	0	0	0	0	0
Maximum	71	106	117	70	111	118	69	118	119
Average	27	56	82	22	53	82	19	52	85

3.3 Tailings Tonnages

The lined tailings areas and tailings capacity used in the Golder (2019) water balance and the geochemical modeling are summarized in Table 3-3 for each phase of mining.

Table 3-3: Total Lined Areas

Stage	Lined Area	Minimum Tailings Capacity
	ft ²	Million Tons
1	1,949,200	0.9
2	2,983,900	1.8
3	4,011,100	3.2

3.4 Solution Inputs

3.4.1 Rainwater chemistry

The rainwater chemistry used in the numerical predictions were mean rainwater chemistry data for Oregon, taken from Bormann et al. (1989). The rainwater chemistry was used to represent the make-up water added to the mill process as defined by the water balance. The average values used are shown below in Table 3-4.

Table 3-4: Average Rainwater Chemistry in Oregon

Parameter	Value
Temp (°C)	5
pH (s.u.)	4.88
pe (mV)	2
Alkalinity as HCO ₃	0.05
Calcium	0.095
Chloride	2.34
Potassium	0.17
Magnesium	0.16
Nitrite	0.05
Nitrate	0.18
Sodium	1.33
Sulfate	0.64

Units in mg/L unless otherwise noted.

3.4.2 Tailings Supernatant Chemistry

For the purposes of this study, the initial tailings supernatant water was assumed to be similar to average SPLP results from the lime amended tailings samples at a liquid:solid ratio of 1:1 (Table 3-5). To estimate the tailings supernatant pond chemistry that is returned to the mill, evapoconcentration or dilution was applied to the SPLP chemistry as a function of the balance of evaporation and precipitation occurring in the tailings storage facility.

3.4.3 Tailings Underdrain Chemistry

Based on the water balance, tailings underdrain solution is the primary solution reporting to the reclaim pond. In order to simulate the underdrain chemistry, the average SPLP data from the amended tailings samples were scaled to the tonnage of tailings material in the tailing's impoundment for each phase of mining and under minimum, maximum, and average precipitation conditions.

Only a portion of the total mass of tailings within the facility will be effectively leached due to factors such as preferential fluid flow pathways and also due to reactive mass effects in which mass within larger particles is effectively encapsulated and therefore resistant to weathering. Based on supporting literature, the reactive fine content of the tailings has been estimated to 60% (e.g., Benzaazoua et al., 2004; Erguler and Erguler, 2015). Although flow within the facility will be restricted to movement along preferential flow paths, 60% of the tailings mass was allowed to contact tailings seepage and provides a conservative estimate. Using these assumptions, the average SPLP data were scaled to the mass of tailings and volume of mixed water to generate chemistry representative of underdrain water that reports to the reclaim pond. The results of these calculations are summarized in Table 3-5.

Table 3-5: Tailings Underdrain/Reclaim Pond Water Chemistry

Parameter	Average SPLP Chemistry	Tailings Underdrain/Reclaim Pond Water Chemistry								
		Phase 1			Phase 2			Phase 3		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Alkalinity	96.7	94.9	134	112	93	141	115	93.9	155	117
Aluminum	0.043	0.042	0.060	0.050	0.041	0.063	0.051	0.042	0.069	0.052
Antimony	0.101	0.099	0.140	0.117	0.097	0.148	0.121	0.098	0.162	0.122
Arsenic	0.427	0.419	0.593	0.494	0.410	0.625	0.510	0.415	0.684	0.516
Barium	0.057	0.056	0.079	0.066	0.055	0.083	0.068	0.055	0.091	0.069
Beryllium	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001
Boron	0.028	0.027	0.039	0.032	0.027	0.041	0.033	0.027	0.045	0.034
Cadmium	0.0002	0.0002	0.0003	0.0002	0.0002	0.0003	0.0002	0.0002	0.0003	0.0002
Calcium	231	227	321	267	222	338	276	224	370	279
Chloride	12.3	12.1	17.1	14.2	11.8	18.0	14.7	11.9	19.7	14.9
Chromium	0.118	0.116	0.164	0.137	0.113	0.173	0.141	0.115	0.189	0.143
Cobalt	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001
Copper	0.02	0.020	0.029	0.024	0.020	0.030	0.025	0.020	0.033	0.025
Cyanide	0.028	0.027	0.039	0.032	0.027	0.041	0.033	0.027	0.045	0.034
Fluoride	0.28	0.275	0.389	0.324	0.269	0.410	0.334	0.272	0.449	0.338
Iron	0.028	0.028	0.039	0.033	0.027	0.041	0.034	0.028	0.045	0.034
Lead	0.0006	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Lithium	0.094	0.092	0.130	0.109	0.090	0.138	0.112	0.091	0.151	0.114
Magnesium	3.45	3.38	4.79	3.99	3.31	5.05	4.12	3.35	5.53	4.17
Manganese	0.036	0.035	0.050	0.042	0.035	0.053	0.043	0.035	0.058	0.044
Mercury	0.013	0.013	0.018	0.015	0.012	0.019	0.016	0.013	0.021	0.016
Molybdenum	0.085	0.083	0.118	0.098	0.082	0.124	0.101	0.083	0.136	0.103
Nickel	0.0035	0.003	0.005	0.004	0.003	0.005	0.004	0.003	0.006	0.004
Nitrate	0.215	0.211	0.298	0.249	0.207	0.315	0.257	0.209	0.345	0.260
pH (s.u.)	8.23	8.23	8.26	8.24	8.22	8.27	8.25	8.22	8.28	8.25
Phosphorous	0.011	0.011	0.015	0.013	0.011	0.016	0.013	0.011	0.018	0.013
Potassium	40.4	39.6	56.0	46.7	38.8	59.1	48.2	39.2	64.7	48.8
Selenium	0.045	0.044	0.062	0.052	0.043	0.066	0.054	0.044	0.072	0.054
Silver	0.00035	0.0003	0.0005	0.0004	0.0003	0.001	0.0004	0.0003	0.001	0.0004
Sodium	461	452	640	534	443	674	550	448	739	557
Strontium	0.65	0.642	0.908	0.757	0.628	0.957	0.781	0.635	1.048	0.790
Sulfate	1463	1435	2030	1693	1405	2140	1746	1420	2345	1768
Thallium	0.0018	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.003	0.002
Tin	0.04	0.039	0.056	0.046	0.038	0.059	0.048	0.039	0.064	0.048
Titanium	0.007	0.007	0.010	0.008	0.007	0.010	0.008	0.007	0.011	0.008
Uranium	0.014	0.014	0.019	0.016	0.013	0.020	0.017	0.014	0.022	0.017
Vanadium	0.0007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.02	0.020	0.028	0.023	0.019	0.029	0.024	0.019	0.032	0.024

Units in mg/L unless otherwise noted.

3.5 Solubility Controls and Trace Element Adsorption

The models assume that water within the system will mix evenly and completely under equilibrium conditions. Under these conditions, the solutes in solution will react with each other and may form chemical precipitates if the concentrations and geochemical conditions (Eh, pH, pCO₂, pO₂, and ionic strength) allow minerals to become oversaturated. The geochemical model requires the specification of a number of equilibrium phases that are allowed to precipitate if they become oversaturated. The suite of minerals chosen for the geochemical model was based on the geology and mineralogy of the deposit and an assessment of mineral phases that are close to saturation based on the initial model iterations. The mineral phases allowed to form in the geochemical model are listed in Table 3-6. An equilibrium with atmospheric partial pressure of CO₂ (pCO₂) and O₂ (pO₂) was maintained throughout the model. Although it is likely it will be lower than this, insufficient site information exists to propose a lower value.

Table 3-6: Mineral Phases Included in the Geochemical Models

Equilibrium Phase	Ideal Formula
Calcite	CaCO ₃
Ferrihydrite	Fe ³⁺ ₁₀ O ₁₄ (OH) ₂
Gypsum	CaSO ₄ ·2H ₂ O
Quartz	SiO ₂

Once mineral precipitates are formed, the models assume they are no longer available for geochemical reactions. This is a reasonable assumption unless the pH or redox conditions change substantially. Such significant changes in pH are considered unlikely based on the alkaline effluent chemistry observed from the lime amended tailings. The uncertainties related to the assumptions regarding mineral precipitation are addressed through sensitivity analysis described in Section 4.2.

In solution, trace element concentrations are mostly controlled by adsorption onto common mineral phases or are removed from solution through a process of co-precipitation. The models assume that trace metals may be removed from solution via sorption onto freshly generated mineral precipitates such as iron oxides. Ferrihydrite (5Fe₂O₃·9H₂O) represents the primary sorption surface. Ferrihydrite (5Fe₂O₃·9H₂O) was selected as a sorption surface because it is a common sorption substrate in oxygenated natural waters and because the trace element sorption thermodynamic properties of these reactions are well defined by numerous empirical studies. Adsorption of soluble phases to hydrous ferric oxides (HFO) is highly pH dependent as is the solubility of HFO itself. Below a pH of around 4.5 s.u., only minimal sorption of most dissolved metal species is observed (Stumm and Morgan, 1996). The mass of ferrihydrite used in the models is assumed to be identical to the mass of the mineral phase ferrihydrite precipitated in the previous model reaction step and is controlled by the chemistry of the system.

The models assume that the ferrihydrite is characterized by both strong (HFO_s) and weak (HFO_w) surface adsorption sites. In order to be consistent with the properties of ferrihydrite published by Dzombak and Morel (1990) the geochemical models assume a surface site density of 0.2 moles of weak sites and 0.005 moles of strong sites per mole of ferrihydrite. Any HFO/ferrihydrite will therefore originate from the precipitation of oversaturated mineral phases that develop upon solution mixing.

As with mineral phase precipitation, the mass of trace elements removed through adsorption is assumed to be permanently removed from the system following incorporation and co-precipitation with the HFO phase, because it is unlikely that desorption due a major shift in pH or redox conditions will

occur. The models rely on an external database of thermodynamic constants for mineral phase precipitates and sorbed surface complexes that are valid at 25°C and 1 atmosphere of pressure.

3.6 Model Code

Numerical predictive calculations were developed using the USGS thermodynamic code PHREEQC and the Minteq.v4 thermodynamic database supplied with the v3.5.0-14000 version of PHREEQC (released November 9, 2017). This thermodynamic database is widely used for geochemical modeling and was selected for this study because it is publicly and freely available and includes the full range of elements for consideration in this water quality prediction as well as key sorption reactions for iron oxyhydroxides.

The PHREEQC models consist of several components including the input data file, the thermodynamic database, the executable code, and the output file. The input file consists of a series of logic statements and commands that define each of the components of the system and explains how these components interact. The input file is read by the executable code and commands are executed in a stepwise manner. Influent component waters are speciated and mixed to generate a series of intermediate waters, solid phases, and adsorbed phases. Selected outputs are specified and organized in various output files for analysis of results. PHREEQC operates on the basis of one kilogram (kg), which is equivalent to one liter of solution (in dilute systems).

4. Geochemical Model Results

4.1 Base Case

The predicted water chemistry for the supernatant pond under dry, average, and wet conditions are summarized in Table 4-1 for each phase of mining. The supernatant pond chemistry is predicted to have an alkaline pH due to the addition of lime to the tailings. Under these high pH conditions, metals content is generally low with the exception of arsenic. Although some arsenic is adsorbed, no arsenic phases were predicted to be saturated in the model. Wet years tend to yield higher concentrations of sulfate and metals presumably due to flushing of the tailings by rainwater and less make-up water being added to the mill process. As shown in Table 4-1, the predicted supernatant pond chemistry is comparable for the three phases of mining.

Table 4-1: Predicted Supernatant Pond Chemistry

Parameter	Phase 1			Phase 2			Phase 3		
	DRY	AVG	WET	DRY	AVG	WET	DRY	AVG	WET
Alkalinity	17.6	28.8	42.1	10.8	26.5	41.7	9.2	25.6	42.5
Aluminum	0.142	0.232	0.340	0.087	0.214	0.337	0.074	0.207	0.344
Antimony	0.022	0.037	0.054	0.014	0.034	0.053	0.012	0.033	0.054
Arsenic	0.090	0.147	0.215	0.055	0.135	0.213	0.047	0.131	0.217
Barium	0.016	0.026	0.037	0.010	0.024	0.037	0.008	0.023	0.038
Beryllium	0.0002	0.0003	0.0005	0.0001	0.0003	0.0004	0.0001	0.0003	0.0005
Boron	0.008	0.012	0.018	0.005	0.011	0.018	0.004	0.011	0.018
Cadmium	0.0002	0.0004	0.0006	0.0001	0.0004	0.0006	0.0001	0.0004	0.0006
Calcium	62.9	103	151	38.6	95.2	150	33.1	91.9	153
Chloride	4.51	5.89	7.53	3.67	5.61	7.49	3.48	5.50	7.59
Chromium	0.001	0.001	0.002	0.001	0.001	0.002	0.0005	0.001	0.002
Cobalt	0.041	0.067	0.098	0.025	0.062	0.097	0.021	0.059	0.099
Copper	0.989	1.62	2.37	0.606	1.50	2.35	0.519	1.44	2.40
Cyanide	0.010	0.016	0.023	0.006	0.015	0.023	0.005	0.014	0.024
Fluoride	0.122	0.199	0.292	0.075	0.184	0.289	0.064	0.178	0.295
Iron	0.0004	0.0002	0.0002	0.0007	0.0003	0.0002	0.0008	0.0003	0.0002
Lead	0.0003	0.0005	0.0007	0.0002	0.0005	0.0007	0.0002	0.0004	0.0007
Lithium	0.026	0.042	0.061	0.016	0.039	0.061	0.013	0.037	0.062
Magnesium	1.33	2.08	2.98	0.88	1.94	2.95	0.777	1.88	3.01
Manganese	0.378	0.620	0.907	0.232	0.572	0.900	0.199	0.552	0.918
Mercury	0.003	0.005	0.007	0.002	0.004	0.007	0.002	0.004	0.007
Molybdenum	0.020	0.033	0.048	0.012	0.030	0.048	0.011	0.029	0.049
Nickel	0.001	0.001	0.002	0.0005	0.001	0.002	0.0004	0.001	0.002
Nitrate	0.99	0.97	0.94	1.00	0.97	0.94	1.00	0.97	0.94
pH (s.u.)	7.84	7.64	7.84	8.00	7.45	7.81	7.99	7.38	7.79
Phosphorous	0.003	0.005	0.007	0.002	0.005	0.007	0.002	0.005	0.008
Potassium	9.07	14.8	21.5	5.6	13.6	21.4	4.84	13.2	21.8
Selenium	0.011	0.018	0.026	0.007	0.016	0.026	0.006	0.016	0.026
Silver	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003
Sodium	106	173	253	66	160	251	56	154	256
Strontium	0.159	0.261	0.382	0.098	0.241	0.379	0.084	0.233	0.386
Sulfate	364	597	873	224	551	866	192	532	883
Thallium	0.001	0.002	0.002	0.001	0.001	0.002	0.0005	0.001	0.002
Tin	0.012	0.019	0.028	0.007	0.017	0.027	0.006	0.017	0.028
Uranium	0.003	0.005	0.008	0.002	0.005	0.008	0.002	0.005	0.008
Vanadium	0.0005	0.001	0.001	0.0003	0.001	0.001	0.0003	0.001	0.001
Zinc	0.041	0.067	0.098	0.025	0.062	0.097	0.021	0.060	0.099

Units in mg/L unless otherwise noted.

4.2 Sensitivity Analysis

The base case model assumes that certain mineral phases will form (i.e., precipitate) if the concentrations and geochemical conditions (Eh, pH, pCO₂, pO₂, and ionic strength) allow these minerals to become oversaturated. An additional model scenario was run whereby mineral precipitation and surface complexation is suppressed (i.e., no thermodynamic equilibrium and adsorption calculation) in the model in order to test the effect of surface complexation and secondary precipitation (i.e., how much solutes are taken out from secondary precipitation). This sensitivity analysis was conducted to address comments from Geomega received during the December 4, 2020 conference call.

The results of the sensitivity analysis are provided in Table 4-2. All the parameters remain the same as the base case model except for an increase in arsenic, copper, and iron concentrations. This is related to the absence of mineral precipitation.

Table 4-2: Predicted Supernatant Pond Mineral Precipitation Sensitivity Chemistry

Parameter	Phase 1			Phase 2			Phase 3		
	DRY	AVG	WET	DRY	AVG	WET	DRY	AVG	WET
Alkalinity	17.7	28.9	42.3	10.8	26.7	42.0	9.3	25.8	42.8
Aluminum	0.142	0.232	0.340	0.087	0.214	0.337	0.074	0.207	0.344
Antimony	0.022	0.037	0.054	0.014	0.034	0.053	0.012	0.033	0.054
Arsenic	0.095	0.156	0.228	0.058	0.144	0.226	0.050	0.139	0.230
Barium	0.016	0.026	0.037	0.010	0.024	0.037	0.008	0.023	0.038
Beryllium	0.0002	0.0004	0.0005	0.0001	0.0003	0.0005	0.0001	0.0003	0.0005
Boron	0.008	0.012	0.018	0.005	0.011	0.018	0.004	0.011	0.018
Cadmium	0.0002	0.0004	0.0006	0.0001	0.0004	0.0006	0.0001	0.0004	0.0006
Calcium	62.9	103	151	38.6	95.2	150	33.1	91.9	153
Chloride	4.51	5.89	7.53	3.67	5.61	7.49	3.48	5.50	7.59
Chromium	0.001	0.001	0.002	0.001	0.001	0.002	0.0005	0.001	0.002
Cobalt	0.041	0.067	0.098	0.025	0.062	0.097	0.021	0.059	0.099
Copper	1.00	1.64	2.41	0.615	1.52	2.39	0.527	1.46	2.43
Cyanide	0.016	0.026	0.038	0.010	0.024	0.038	0.008	0.023	0.039
Fluoride	0.122	0.199	0.292	0.075	0.184	0.289	0.064	0.178	0.295
Iron	0.0820	0.134	0.197	0.0502	0.124	0.195	0.0430	0.120	0.199
Lead	0.0003	0.0005	0.0008	0.0002	0.0005	0.0008	0.0002	0.0005	0.0008
Lithium	0.026	0.042	0.061	0.016	0.039	0.061	0.013	0.037	0.062
Magnesium	1.33	2.08	2.98	0.88	1.94	2.95	0.78	1.88	3.01
Manganese	0.378	0.620	0.907	0.232	0.572	0.900	0.199	0.552	0.918
Mercury	0.003	0.005	0.007	0.002	0.004	0.007	0.002	0.004	0.007
Molybdenum	0.020	0.033	0.048	0.012	0.030	0.048	0.011	0.029	0.049
Nickel	0.001	0.001	0.002	0.0005	0.001	0.002	0.0004	0.001	0.002
Nitrate	0.99	0.97	0.94	1.00	0.97	0.94	1.00	0.97	0.94
pH (s.u.)	7.64	7.84	8.00	7.45	7.81	7.99	7.39	7.80	8.00
Phosphorous	0.003	0.005	0.007	0.002	0.005	0.007	0.002	0.005	0.008
Potassium	9.07	14.8	21.5	5.63	13.6	21.4	4.84	13.2	21.8
Selenium	0.011	0.018	0.026	0.007	0.016	0.026	0.006	0.016	0.026
Silver	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003
Sodium	106	173	253	65.6	160	251	56.4	154	256
Strontium	0.159	0.261	0.382	0.098	0.241	0.379	0.084	0.233	0.386
Sulfate	364	597	873	224	551	866	192	532	883
Thallium	0.001	0.002	0.002	0.001	0.001	0.002	0.0005	0.001	0.002
Tin	0.012	0.019	0.028	0.007	0.017	0.027	0.006	0.017	0.028
Uranium	0.003	0.005	0.008	0.002	0.005	0.008	0.002	0.005	0.008
Vanadium	0.0005	0.001	0.001	0.0003	0.001	0.001	0.0003	0.001	0.001
Zinc	0.041	0.067	0.098	0.025	0.062	0.097	0.021	0.060	0.099

Units in mg/L unless otherwise noted.

5. Ecological Risk

The estimated reclaim pond and supernatant pond water qualities (including the Mineral Precipitation Sensitivity Chemistry for the tailings supernatant water) summarized in Table 3-5, Table 4-1 and Table 4-2, were screened against site-specific mammalian and avian wildlife ecological risk benchmark criteria following guidance provided in the *Guidelines for Ecological Risk Assessment* (EPA, 1998) and the *Guide for Performing Screening Ecological Risk Assessments at DOE Facilities* (Suter, 1995). Information regarding wildlife receptors that could potentially be exposed to the water in these sources was obtained from the *Calico Resources USA Corp Grassy Mountain Mine Project Malheur County, Oregon Wildlife Resources Baseline Report* (EM Strategies, 2020), and are summarized in Table 5-1.

Table 5-1: Potential Wildlife Receptors for the Grassy Mountain Project

Mammalian Species	Avian Species
Mountain Cottontail	Golden Eagle
Porcupine	Common Raven
Coyote	Horned Lark
California myotis	Burrowing Owl
Bobcat	Chukar
Mule Deer	Red-tailed Hawk
Deer Mouse	Mallard
Ord's kangaroo rat	

An analysis of consumption of pond waters by selected site fauna using conservative exposure assumptions (i.e., 100% of the ecological receptor's water needs obtained from each source) against no-observed-adverse-effect level (NOAEL) toxicological dose information, indicates that harmful effects from the Supernatant Pond and Reclaim Pond water are not likely (Hazard Quotients < 1.0) for all of the receptors. This conclusion also applies to the sensitivity analysis.

The conservative NOAEL denotes the level of exposure of an organism, found by experiment or observation, at which there is no biologically or statistically significant increase in the frequency or severity of any adverse effects of the tested protocol. Combined with conservative exposure assumptions for the wildlife receptors yields confidence in this conclusion.

Closing

SRK has developed predictions of water chemistry for the proposed reclaim pond supernatant pond under dry, average, and wet conditions. An additional model scenario was run where mineral precipitation and surface complexation is suppressed in the model in order to test the effect of these assumptions on the model results. A comparison of the model results to the NOAEL toxicological dose information indicates that harmful effects to ecological receptors are unlikely at the predicted concentration. During operations, samples will be collected from the supernatant pond to confirm the water quality predictions presented herein.

6. References

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