State of New Mexico
Energy, Minerals and Natural Resources Department

Susana Martinez
Governor

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Fernando Martinez, Director
Mining and Minerals Division

March 22, 2018

Ms. Katie Emmer
New Mexico Copper Corporation
4253 Montgomery Blvd NE, Suite 130
Albuquerque, NM 87109

RE: Technical Comments on Baseline Data Reports for Copper Flat Mine, Sierra County, New Mexico, Permit Tracking Number SI027RN:

- ***Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project*, December 2017;**
- ***Probable Hydrologic Consequences of the Copper Flat Project*, December 12, 2017.**

The Mining and Minerals Division ("MMD") has received and reviewed two baseline data reports submitted as part of the Permit Application Package for the Copper Flat Mine. The two reports submitted on behalf of New Mexico Copper Corporation ("NMCC") are: *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico*, prepared by SRK Consulting, December 2017; and *Probable Hydrologic Consequences of the Copper Flat Project, Sierra County, New Mexico*, prepared by John Shomaker & Associates ("JSAI"), December 12, 2017.

In accordance with 19.10.6.605 NMAC, MMD provided these documents to, and requested comments from, the New Mexico Environment Department, New Mexico Office of the State Engineer, Bureau of Land Management, and New Mexico Department of Game and Fish. After review, MMD has the following comments to be addressed in writing:

General Comments:

1. The two reports *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project* and *Probable Hydrologic Consequences of the Copper Flat Project* provide good, technical analyses of what may happen to water quality and quantity during and after mining on the permit and affected areas. The operational and reclamation plans will need to incorporate surface and groundwater monitoring to verify the predicted direction of the models. Monitoring will be a future permit condition.

2. Please provide a detailed executive summary using these two reports addressing the probable hydrologic consequences of the operation on both the permit and affected areas. Specifically, please explain how the performance and reclamation standard, addressed in 19.10.6.603.C(4) NMAC (Hydrologic Balance), is achieved. Please explain how the reclamation shall result in a hydrologic balance similar to pre-mining conditions and how this will be verified at the end of reclamation.

Technical Comments on *Probable Hydrologic Consequences of the Copper Flat Project, JSAI, December 12, 2017*

3. Figure 3.1: The 1 foot contour in this figure shows an abrupt turn to the east on the north side of Percha Creek. This figure is similar to Figure 3-19b in the Draft Environmental Impact Statement ("DEIS"; November 2015), which appears to show that this portion of the contour is controlled by negligible predicted drawdown in well LRG-10948, as shown in Figure A14 of the JSAI Report. However, LRG-10948 is listed in the Baseline Data Report ("BDR"; June 2012 by Intera) as a Percha Creek alluvial well (see Section 8.2.4.3.3 of the BDR) whereas Figure 3.1 represents projected groundwater drawdown in the Santa Fe Group ("SFG") aquifer. If LRG-10948 is an alluvial creek well, the predicted 1 foot contour would likely continue in the SFG south across Percha Creek. Please comment on whether LRG-10948 is modeled as an alluvial creek well or as a SFG well and any changes this may make on the predicted drawdown within the SFG at the end-of-mining.

4. The drawdown contour intervals of Figure 3.12 versus Figure A1 are different. Please include an approximate 1 foot drawdown contour on Figure A1 to allow for comparison of the end-of-mining drawdown versus the anticipated effects 100-years after mining.

5. Figure A1 appears to show propagation of the pit cone of depression within the crystalline aquifer post-mining. At about 40 to 50 years post-mining, the propagation of the cone of depression seems to diminish (i.e. see Figure A23, projected water levels at Ready Pay well). Please comment on this apparent propagation including how the water levels are projected to stabilize over time.

6. There appears to be an area of groundwater drawdown overlap in Grayback/Greenhorn arroyos between the crystalline aquifer and the SFG aquifer immediately east of the permit area (e.g. between the eastern edge of the permit area and monitoring well MW-8). Figure 3.1 shows approximately 10 feet of drawdown in the SFG in this area at the end-of-mining and Figure A1 shows up to 20 feet of drawdown in the crystalline aquifer 100-years after mining. Please comment on whether there are any anticipated cumulative effects of groundwater drawdown in this area.

7. Figure 3.14 of the report indicates that the pit lake surface will stabilize at the ~4,897 foot elevation and remain there for a number of years. What is the probability that it will remain at this level; either drop below or go above? What are the environmental circumstances that would allow the level to decrease or increase beyond the ~4,897 foot level? What might be the impacts on water quality or quantity?

Technical Comments on *Predictive Geochemical Modeling of Pit Lake Water Quality at the Copper Flat Project, New Mexico, SRK Consulting, December 2017*

8. Section 3.1.8 and Figure 3-1 indicate that the pit bottom will be covered with a suitable reclamation material before pit flooding occurs, however the October 13, 2017, amendment to the Mining Operation and Reclamation Plan ("MORP") submitted by NMCC does not propose to place reclamation materials below the waterline of the future pit lake. As stated in Section 6.2, the covered and submerged portions of pit reclamation are excluded from the surface area available (Table 6-1) for leaching, and therefore the pit lake modeling results presented in Section 6.6. It is MMD's opinion that any pit surface area exposed before submerging will likely be available to leaching. NMCC should plan to cover as much of the pit surface area as possible after mining to limit the amount of leaching, even those areas to be submerged. This would assist with reclamation prior to inundation of the pit using the rapid refill proposal. Please address.

9. Please utilize the calibrated PHREEQC model to predict the pit lake chemistry for the small pit lake that currently exists at the Copper Flat site. The model for the existing pit lake should utilize the same time steps used in the future pit lake model. Please provide comments/discussion on the results and compare them to the model results for the future pit lake.

10. Figures 5-1 and 6-1 show different rates of evaporation, direct precipitation, pit wall run-on etc., and a different final pit lake elevation. Please explain the differences between the values presented in these two figures.

11. Agency comments are attached and shall be addressed in writing.

Please provide responses to these comments within 60-days of receipt of this letter. If you have any questions or wish to discuss any of these comments, please contact me at (505) 476-3434 or by email at david.ennis@state.nm.us.

Sincerely,

David J. ("DJ") Ennis, P.G.
Reclamation Specialist/Permit Lead

Attached: Agency comments

cc: Holland Shepherd, Mining Act Program Manager
Brad Reid, NMED Permit Lead

STATE OF NEW MEXICO
OFFICE OF THE STATE ENGINEER

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Mailing Address:
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Santa Fe, NM 87504-5102

January 12, 2018

David J. Ennis, P.G.
Permit Lead
Mining Act Reclamation Program
1220 South St. Francis Drive
Santa Fe, NM 87505

Re: Response on probable hydrologic consequences, Copper Flat Mine, Sierra County, New Mexico, Permit Tracking No. SI027RN

Dear Mr. Ennis,

I have reviewed the December 12, 2017 report "Probable Hydrologic Consequences of the Copper Flat Project Sierra County New Mexico," authored by John Shomaker & Associates (JSAI). I do not have any objections to the report technical content.

The report addresses and adheres to a concern made by myself for the Hydrology bureau at the Office of the State Engineer (OSE) when reviewing the EIS model. I agree with JSAI on the methodology on the treatment of mine pumping impacts on the general head boundary on the northern portion of the Palomas Graben and how those impacts relate to impacts on the Rio Grande.

Other calculations in the JSAI report that are outside of the numerical model such as potential tailings liner leakage and the estimation of potential land subsidence look reasonable.

In any kind of modeling as new information becomes available, the modeling can change. At present, this is the best available tool in the determination of mine impacts.

Sincerely,

Eric Keyes
Hydrologist
NMOSE Hydrology Bureau
505-476-0322

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Alexandra Sandoval

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17 January 2018

David J. (DJ) Ennis, P.G., Permit Lead
Mining Act Reclamation Program
Mining and Minerals Division (MMD)
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Predictive Geochemical Modeling of Pit Lake Water Quality, Copper Flat Mine, Permit No. SI027RN; NMDGF No. 18208

Dear Mr. Ennis,

The New Mexico Department of Game and Fish (Department) has reviewed the document referenced above. New Mexico Copper Corporation (NMCC) submitted a report, prepared by SRK Consulting, which provides a predictive geochemical model that assesses future water quality in the Copper Flat Mine project pit lake, and compares the projections to the water quality in the existing pit lake. The work was undertaken to demonstrate compliance with New Mexico Mining Act regulations.

The modeling report concludes that "…changes to the hydrologic balance of the future pit water body that will form post-mining will be nil or minimal and the water quality will be very similar to that of the existing pit lake." The Department believes that the geological and hydrological complexities and inherent uncertainties make accurately predicting future pit lake water quality difficult. We believe that some type of mitigation strategy should be in place and implemented if pit lake water quality degrades to the point where it becomes hazardous to wildlife. The modeling effort was limited to projecting pit lake water quality for 100 years. However, the pit lake will persist "in perpetuity", and the time span over which the water quality can deviate from pre-mining conditions can be on the order of hundreds to thousands of years.

The Department also questions the predicted rate of evaporation that will concentrate chloride, sulfate, total dissolved solids (TDS) and trace elements in the pit lake over time, and may eventually lead to water quality conditions that are deleterious to wildlife. The current model appears to rely on historic climate data to predict the rate of evapoconcentration. The modeling should consider projected future climate regimes that would provide a plausible range of possible pit lake water quality outcomes. A hotter and drier climate for this region could result in substantially higher rates of evapoconcentration.

The proposed rapid fill reclamation scenario uses clean water from the production wells to achieve higher initial water quality of the pit lake. This approach informed the Department's previous comments to MMD regarding pit reclamation in the Mining Operations and Reclamation Plan to improve the value of the pit lake area for wildlife habitat. These recommendations involved modifications to the high wall to create ledges and cavities, and modifications to the Expanded 4900 Catch Bench to create a shallow

littoral zone for aquatic plants. Because the pit lake is anticipated to exist in perpetuity and accurately predicting water quality and associated hazards to wildlife for that duration is questionable, the Department no longer supports creating features that may attract wildlife to the pit lake. Alternatively, we suggest installing clean water sources, such as impermeable rainwater catchment drinkers, that would attract wildlife away from the pit lake area. The Department also recommends additional modifications to the pit shell area that are designed to mitigate the impacts of periodic acid wall seep events on the pit lake.

Thank you for the opportunity to review and comment on the proposed project. If you have any questions, please contact Ron Kellermueller Mining and Energy Habitat Specialist, at (505) 476-8159 or ronald.kellermueller@state.nm.us.

Sincerely,

Matt Wunder, Ph.D.
Chief, Ecological and Environmental Planning Division

cc: USFWS NMES Field Office

GOVERNOR
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19 January 2018

David J. (DJ) Ennis, P.G., Permit Lead
Mining Act Reclamation Program
Mining and Minerals Division (MMD)
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Probable Hydrologic Consequences of the Copper Flat Project, Sierra County, New Mexico, Permit No. SI027RN; NMDGF No. 18207

Dear Mr. Ennis,

The New Mexico Department of Game and Fish (Department) has reviewed the report referenced above. New Mexico Copper Corporation submitted a report prepared by John Shomaker & Associates, Inc. (JSAI) that presents the probable hydrologic consequences for the Copper Flat Mine project.

The Department's primary concern remains the reaches of perennial flow and riparian habitat along Las Animas and Percha Creeks. These areas may be affected by the cone of depression caused by the pumping of production wells in the Santa Fe Group (SFG) aquifer.

The Department is particularly concerned about the riparian habitat along Las Animas Creek. This habitat is located less than one mile north of the production wells and supports the northernmost riparian forest dominated by Arizona sycamore (*Platanus wrightii*) trees. The JSAI report states on page 20 that:

> the increased transmissivity of the SFG results in water levels dropping below the bottom of the alluvium, forming a hydraulic disconnection between the SFG aquifer and the alluvial groundwater system. As a result, water flows from the alluvium to the SFG, through low-permeability clay beds, only by gravity; pumping from the SFG does not increase the flow or change water levels in the alluvium."

The JSAI report projects "non-measureable small changes in surface flow and riparian evapotranspiration" based on the presence of the low-permeability clay beds that minimize effects to shallow groundwater. It is unclear to the Department whether these changes are considered to be non-measureable relative to a range of normal or average flows, or whether withdrawals would create disproportionately greater reductions in surface water levels during low-flow periods.

The Department remains dubious that the report's findings of limited hydraulic connection between the SFG and the alluvial groundwater system provide sufficient security and mitigation to preclude impacts to wildlife and wildlife habitats from drawdown of groundwater levels. The Department requests clarification of what contingencies, if any, would be in place if the hydraulic connectivity between the SFG and the alluvial groundwater system proves to be greater than predicted, and results in adverse impacts to perennial flow and riparian habitat along lower Animas Creek.

Thank you for the opportunity to review and comment on the proposed project. If you have any questions, please contact Ron Kellermueller, Mining and Energy Habitat Specialist, at (505) 476-8159 or ronald.kellermueller@state.nm.us.

Sincerely,

Matt Wunder, Ph.D.
Chief, Ecological and Environmental Planning Division

cc: USFWS NMES Field Office

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BUTCH TONGATE
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J.C. BORREGO
Deputy Secretary

MEMORANDUM

DATE: March 16, 2018

TO**:** Holland Shepherd, Program Manager, Mining Act Reclamation Program

FROM: Brad Reid, Mining Environmental Compliance Section
Bryan Dail, Ph.D., Surface Water Quality Bureau
Patrick Longmire, Ph.D., Principal Aqueous Geochemist, Ground Water Quality Bureau
Joe Marcoline, PhD., Mining Environmental Compliance Section, Ground Water Quality Bureau

THROUGH: Jeff Lewellin, Mining Act Team Leader, Mining Environmental Compliance Section

RE: NMED Comments for the Copper Flat Mine Permit Application, Applicant Submission of Two Technical Reports for NMED Review, Sierra County, MMD Permit No. SI027RN

The New Mexico Environment Department (NMED) received correspondence from the Mining and Minerals Division (MMD) on December 14, 2017 requesting that NMED review and provide comments on the above referenced MMD reports associated with the permitting action. In accordance with § 19.10.6.605.C NMAC NMED has 30 days to provide comment. Subsequent to the original deadline to provide comments, NMED requested and was granted an extension from MMD until March 19, 2018. NMED comments are set forth below.

Background

On December 13, 2017, New Mexico Copper Corporation (Applicant) for the Copper Flat Mine submitted two documents as addendum to MMD Permit No. SI027RN. The titles of the two documents submitted are as follows: *Probable Hydrologic Consequences of the Copper Flat Project, Sierra County, New Mexico* by John Shoemaker & Associates, Inc., December 2017; and, *Predictive Geochemical Modeling of Pit Lake Water Quality, Copper Flat Project, New Mexico* by SRK Consulting, December 11, 2017.

NMED Recommendations to MMD Associated with Review of the Predictive Geochemical Modeling and Hydrologic Consequence Models

NMED reviewed the report *Predictive Geochemical Modeling of Pit Lake Water Quality* prepared by SRK Consulting (U.S.), Inc. for THEMAC Resources Group Ltd. SRK Consulting Inc., utilized the computer program PHREEQC developed by the US Geological Survey (USGS) to model different water-rock interactions. These interactions include groundwater and pit lake/wall rock mixing, precipitation/dissolution and adsorption desorption processes expected to occur at Copper Flat. Overall, the PHREEQC simulations are reasonable and applicable to post-mining, aqueous geochemical conditions expected to be encountered after cessation of mining operations at the Copper Flat site. A significant amount of site-specific water chemistry and mineralogical data and experimental results obtained from leachate testing have been conducted that are used as inputs to PHREEQC simulations for Copper Flat. These data and information provide relevance and meaningful input parameters for modeling complex geochemical interactions currently taking place at the site and those that are hypothesized or predicted to take place in the future.

NMED independently ran all PHREEQC simulations using input files provided in the report by SRK Consulting Inc., and evaluated and verified different output files serving as the primary source of material described in the text and shown in various figures in the SRK report.

NMED has the following comments and recommendations regarding PHREEQC modeling performed by SRK Inc. for the Copper Flat site. The comments are not specific action items, whereas the recommendations require additional geochemical modeling, investigation, and analysis.

Surface Water Quality Bureau Comments

Probable Hydrologic Consequences of the Copper Flat Project, New Mexico evaluated the hydrologic consequences related to the development of the Copper Flat Project, including reduced flows to artesian wells and springs, and reduced discharge to shallow aquifers along Animas Creek and Percha Creek. The consequences were evaluated using a numerical model developed from the United States Geological Survey (USGS) groundwater-flow modeling code MODFLOW. The model is well calibrated, reproduces measured data, and demonstrates an evaporative sink for the open pit lake, such that the pit lake waters are not mixing with subsurface waters. However, the SWQB has the following comments and concerns:

The SWQB urges demonstration that sufficient and robust monitoring plans are in place that assure the pit lake remains an evaporative sink under future climatic conditions to confirm model predictions and ultimately protect surface and ground waters.

The SWQB has concerns regarding the potential hydrologic consequences to perennial flows in Las Animas Creek and Percha Creek. Surface water in the Chihuahuan Desert, and the semi-arid southwestern United States in general, is a vital resource for numerous species including humans. The report indicates that, “effects on shallow groundwater (riparian) systems along Las Animas

Creek and Percha Creek are projected to be minimal, with a maximum of less than 2 ft of groundwater-level change on Percha Creek, less than 1 ft of groundwater-level change on Animas, and non-measurable small changes in surface flow and riparian evapotranspiration." The SWQB is concerned with the "non-measurable small changes in surface flow." Non-measurable can be significant when one is talking about creeks that are less than a foot deep. Given the current low baseflow conditions in Las Animas Creek and Percha Creek, any reduction or drawdown in the shallow groundwater that feeds them would likely reduce surface flows and potentially eliminate surface waters and aquatic habitat in certain reaches that are currently wet, which would cause additional stress and impairment to the aquatic community.

Mining Environmental Compliance Section Comments

1. During the review, an emphasis was placed on the end of mining drawdown in the bedrock aquifer around the open pit, i.e., the cone of depression, the evaluation of the extent to which the open pit will form an evaporative sink in the future, and on the potential for discharges from the tailing and waste rock stockpiles.

2. MECS concurs with conclusion by Copper Flat that the post-mining open pit will result in a perpetual evaporative sink and has confidence in the prediction. MECS will require monitoring of water levels in wells surrounding the open pit during and following mining to ensure that the predictions are correct.

3. MECS concurs with Copper Flat that the impact to groundwater chemistry should be minimal, and that net-percolation from the tailing areas is not expected, however, questions the interpretations of infiltration into the cover system, the properties of the cover materials and waste rock and ultimately the net-percolation from the waste rock storage areas. A detailed comment is included in the Specific Comments.

4. MECS also reviewed the modeling and predictions regarding the water-level drawdown in the SFG aquifer as well as the evaluation of the discharge to the Rio Grande. Considering the overall conceptual model, the conventional mathematic modeling approach, the ability to re-calibrate the model following the initiation of mining, and the long-term nature of the predictions, MECS concurs with the model and predictions to date. Since the predictions are extended out to a date exceeding the capability of our current understanding of the system, and past the capabilities of a predictive model, it is recommended that a re-calibration and evaluation of the system occur at a regular interval as impacts in wells are observed following the initiation of mining.

Specific Comments:

1. Copper Flat should revise the documents with the correct spelling of the word "tailing". The words tailing and tailings are often misused, even within the industry. For example, a facility has tailings in their ponds if the milled ore was from multiple sources, facilities, ore types or operations. A facility has tailing in their impoundments if the source was from one operation, unit or era of mining. In New Mexico examples would be the Deming Tailings Facility which had multiple sources or ore and the Molycorp Tailing Facility which only received tailing from the Questa Mine. While this comment has no effect on the modeling or operation, for the sake

of being correct, Copper Flat should refer to the proposed facility as a tailing facility that contains tailing from the new mining operation.

2. MECS requests that Copper Flat clarify the language regarding the water balance to differentiate between surface infiltration and net-percolation. Water that infiltrates into the cover or waste material has the potential to evaporate, be transpired, remain in storage or percolate down past the influence of evaporation and transpiration (net-percolation). To predict the water and gas flux to and from the atmosphere, this distinction in both a conceptual and a physical model must be considered.

3. MECS agrees that the impact to groundwater chemistry is likely to be minimal in part due to precipitation patterns, the low permeability of the underlying andesite, and the geochemical characteristics of the waste rock. MECS disagrees with the conclusion that net-percolation to groundwater from the waste rock storage areas is not expected. The evaluation presented is rudimentary at best and not appropriate for an evaluation of water and evaporative flux within a waste rock cover system and waste rock stockpile. In addition, the numbers are inconsistent with predictions from other mine sites with similar rainfall and evaporative regimes.

Specifically, the evaluation results in precise numbers without an error evaluation and without any supporting science. The evaluation does not include waste or cover material property information other than a number for the field capacity of the waste rock and an associated reference. The referenced document (JSAI, 2011) does not discuss or present the field capacity or have a discussion of the material properties of the waste rock. The evaluation does not rely on an industry standard Richards Equation based approach, nor does it account for redistribution or preferential flow and is not able to describe water or gas flow in an unsaturated material. The evaluation does not couple gas and water flux and has no mechanism to evaluate actual evaporation based on the soil potential and humidity of the pore gas. While potentially insignificant in this semi-arid climate, the evaluation does not have a realistic mechanism of representing transpiration from plants.

The draft DP-1840 requires groundwater monitoring, implementation of a material handling plan to limit production of acid rock drainage, construction of seepage interceptor systems at the toe of the waste rock stockpile, and development of soil water characteristic curves for reclamation cover material. If necessary, based on the information acquired during initial phases of mining MECS may require a more rigorous quantitative evaluation of the potential for impacts to groundwater from the waste rock.

NMED Comments and Recommendations for Additional PHREEQC Modeling and Report Revision

1. The updated model runs now assume two possible scenarios to pit infilling after mine closure. Scenario 1 is the unreclaimed fill scenario wherein the pit mine is allowed to re-fill naturally from area ground water seeps exposed during mining. Scenario 2 is amending the natural infilling with “good quality” ground water from supply wells used during mining. The latter scenario is predicted to reduce groundwater contact with oxidizable pit wall minerals, thus reducing mobilization of metals and acid generating reactions. However, during a presentation of the updated and refined pit lake model, it appeared that part of the improvement to water

quality under the reclaimed “rapid fill” scenario might be allotted to vegetative (or other) reclamation techniques to the pit void and haul road that would be under water in the refilled pit. It is unclear to the SWQB whether these terrestrial reclamation practices would enhance pit water if inundated by pit infilling, whether natural or rapid. A model run that only allows for terrestrial reclamation practices that improve water quality (above the predicted water line of the future pit lake) for both scenario 1 and 2 closure plans would be appropriate to make a valid comparison of the two possible closure plans.

2. Groundwater chemistry and hydrologic monitoring of the aquifer after open-pit mining has been terminated should be conducted to confirm the geochemical simulations quantified by PHREEQC. Groundwater monitoring at Copper Flat, however, is essential under current and future conditions. Additional simulations using PHREEQC are warranted in the future during mining operations, especially if site-specific changes in water chemistry, mineralogy, groundwater flow regime, and climatic conditions take place and vary from predicted conditions. No geochemical model or simulations are entirely perfect and uncertainties exist, especially for predicting future aqueous compositions, mineralogical assemblages, and other water-rock interactions occurring at mine sites.

3. Weaknesses or experimental gaps in thermodynamic data (MINTEQV4), serving as the basis for calculating aqueous speciation, mineral-solution equilibrium, and adsorption, are adequately presented in the SRK Inc. report. This discussion is important to provide to the reader because geochemical modeling contains varying uncertainties and multiple hypotheses can be tested by performing numerous simulations with different constraints placed on the "modeled system".

4. The post mining, rapid-pit fill is an optimal remediation strategy to significantly decrease acid rock processes by neutralizing acidic conditions in the pit lake during filling and steady-state conditions anticipated to occur in the long-term (100 years after post-mining operations). Groundwater pumped from two water supply wells has a sufficiently high total carbonate alkalinity (average value of 111 mgCaCO3/L, Appendix E) to maintain circumneutral pH conditions in the future pit lake at Copper Flat. The average pH of the two groundwater samples is 8.03. Higher bicarbonate alkalinity values (259 mgCaCO3/L, 316 mg/L of HCO3) are reported for the other water supply wells.

5. NMED agrees with the previous revisions to the water balance calculations provided by John Shoemaker & Associates, Inc. (JSAI), as evapo-concentration is the primary process controlling solute concentrations that influence mineral equilibrium and adsorption processes at the site. The new water balance calculations provided by JSAI improved model calibration for PHREEQC simulations under existing pit-lake conditions.

6. Figure 6-18 presents a trilinear or Piper diagram for both existing measured pit lake chemistry and future chemistry of the larger pit lake, suggesting that the future pit lake will be more uniform in major ion composition. This figure most likely assumes that the future pit lake is homogeneous in chemical composition in lateral and vertical dimensions, but it may change as a function of evapo-concentration of solutes under heterogeneous conditions. Monitoring of the future pit lake should confirm its major ion and trace metal composition as functions of depth and surface location.

7. Table 4-3. shows that mean concentrations of numerous measured solutes differ from those determined from PHREEQC simulations, however, they are generally within the range of measured solute concentrations. This suggests that the PHREEQC simulations are approximate for existing pit lake chemistry and model calibration is not perfect for antimony, arsenic, barium, boron, cadmium, chloride, fluoride, iron, lead, and molybdenum. A more detailed discussion needs to be provided in the text explaining discrepancies in solute concentrations that are controlled by a combination of adsorption/desorption and mineral precipitation/dissolution processes.

8. Average solute concentrations obtained from humidity cell tests (HCT) were used as input to the PHREEQC simulations. Use of maximum values of solute concentrations, however, would provide the most conservative or worst-case scenarios of the modeled geochemical processes quantified by PHREEQC and would capture or reduce uncertainty in the simulations. Additional PHREEQC simulations using maximum solute concentrations obtained from HCT should be performed by SRK Inc to more accurately bound model uncertainties in the future (100 years post-mining activities).

9. Suggested revision 2 also has relevance to Figures 5-6 through 5-16. These figures should be separated apart from each other, one set showing existing (measured) concentrations versus modeled concentrations and another set for post-closure conditions of the larger pit lake that will be present at Copper Flat. This is a scaling issue with the smaller existing pit lake and the much larger future pit lake that is part of the PHREEQC simulations. A more detailed geochemical discussion is warranted for Figures 5-6 through 5-16 evaluating mineral precipitation/dissolution (major cations and bicarbonate) and solute adsorption/desorption (arsenic and other oxyanions and cations). Time series plots for the existing pit lake show large variations in total dissolved solids (TDS) and major cations and anions, which support further refinement or calibration of existing and future conditions using PHREEQC.

10. Charge balance errors of zero were achieved for the different simulated aqueous solutions by stipulating that sodium was added to achieve perfect electroneutrality (zero percent charge balance error) by presence of excess anions such as chloride, sulfate, and total carbonate alkalinity. A discussion on this stipulation should be added to the report. Addition of sodium will influence mineral saturation index calculations by causing a positive bias in saturation indices values for sodium-rich silicates, carbonates, and sulfates.

11. Surface complexation modeling using PHREEQC was performed by SRK, Inc., including the adsorbent, ferrihydrite (general formula of FeOOH) to quantify removal of major cations and anions and trace elements from solution. What specific surface area value of ferrihydrite was used during the PHREEQC simulations? The default surface area for ferrihydrite is 600 m^2/g. If this surface area value was not used in the PHREEQC simulations, justification for the alternate value should be provided.

12. Table 3-2 in the report provides a list of equilibrated phases included in the pit lake geochemical simulations. Observed phases include alunite, barite, brochantite, calcite, ferrihydrite, fluorite, gypsum, mirabilite, and NiCO3. Numerous other minerals were included in the PHREEQC simulations that did not reach equilibrium conditions because different

solutions are undersaturated with respect to the phases. Additional PHREEQC simulations should be performed only using the observed phases. Many of the phases hypothesized to occur at Copper Flat have no influence on water chemistry because there is no mass of these minerals precipitated from solution, as shown in PHREEQC output. Precipitation of the additional minerals is negligible at Copper Flat. The additional minerals that are not observed at the site should to be removed from input files and new PHREEQC simulations should to be conducted by SRK, Inc.

13. Phosphorus-bearing and silica phases were included in the PHREEQC simulations. However, PO4 and silica were not analyzed in the water samples. Phosphorus-bearing and silica phases should not be included in the PHREEQC simulations.

14. A discussion on the geochemical evolution of observed and modeled compositions of the present and future pit lakes, shown in Figure 6-17 in terms of pH and Cu + Cd + Co + Pb + Ni + Zn, would be useful to the reader.

NMED Summary Comment

NMED has no additional comments at this time.

If you have any questions regarding the above comments, please contact Jeff Lewellin at (505) 827-1049.

cc: Bruce Yurdin, Division Director, NMED-WPD
Shelly Lemon, Bureau Chief, SWQB
Liz Bisbey-Kuehn, Bureau Chief, AQB
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