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January 09, 2023

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Subject: Public Comment for Stibnite Gold Project EIS #50516

Mrs. Jackson,

I am writing to offer general support for the Stibnite Gold Project and specific comments on the adequacy and thoroughness of the geochemical characterization and predictive water quality modeling. Hydrogeochemical modeling for mine environments is a critical aspect of modern mine development and permitting. The work completed for the Stibnite project is comprehensive and consistent with best practices. I compliment the USFS for leading such a s complete assessment of the impacts.

I am a practicing subject matter expert in geochemistry and an affiliate research professor of environmental studies with extensive experience in industrial and mining-related groundwater assessment, water resources management and site assessment and remediation. I have spent my career assessing the fate and transport mechanisms for constituents in the mine-water environment as they pertain to environmental risk assessment, I have co-authored chapters in two books on the characterization, modelling and management of mine-impacted water, and am first author of several peer-reviewed manuscripts published in upper tier journal publications on the topic.

I have followed Pereptua's project for many years as it offers the potential for cutting edge, privately funded large scale mine site remediation and restoration. I have reviewed the Supplemental Draft EIS document, supporting documents and specialist reports pertinent to my area of expertise, including:

1. Stibnite Gold Project Comprehensive Baseline Geochemical Characterization Report, SRK, Nov 2021 (SRK 2021a)
2. Stibnite Gold Project ModPRO2 Site-Wide Water Chemistry (SWWC) Modeling Report, SRK, Oct 2021 (SRK 2021b)
3. Stibnite Gold Project ModPRO2 Site-Wide Water Chemsitry (SWWC) Model Sensitivity Analysis Report, SRK Nov 2021
4. Water Resources Monitoring Plan, Brown and Caldwell, March 2022

I wish to offer the following commentary in support of the project and adequacy of the SDEIS document and supporting geochemical characterization and hydrogeochemical modeling.

The SDEIS Presents an unbiased review of general findings

The overall affected environment section of the SDEIS presents a concise and accurate summary of important and relevant criteria against which to assess potential project impacts. The SDEIS does a good job of documenting extensive legacy mining disturbances and summarizing results of geochemical characterization of in-situ rock and historical mining wastes, as well as existing environmental conditions.

The document attributes existing water quality issues on site to a combination of natural background mineralization and historical mining activities. Specifically, elevated concentrations of arsenic and antimony in discharging groundwater are tied to the Bradley tailings, northwest Bradley waste rock dump and Yellow Pine pit (3.9.4.3). Clearly, a mining scale solution is required to fully address water quality issues associated with historical mining wastes. Perpetua's plan to relocate the millions of tons of mining wastes on site into engineered storage locations is the only viable plan to clean up the area in absence of significant federal funding and investment.

Reclamation of historical mining facilities is a key aspect of the SGP mine plan, with the intention to improve surface and groundwater quality from existing conditions. This includes the removal of the 10 MT of spent ore, the 5MT of Bradley Tailings and removal of the Hecla Heap Leach pad and relocation of some portions of the Bradley waste rock dumps. Placement of much of this material in the TSF starter dam or in engineered and covered waste rock dumps (development rock storage facilities), will effectively reduce metal loading from these materials into Meadow Creek and the East Fork Salmon River. The SDEIS appropriately concludes that these actions are likely to result in improved water quality on the site, however, the document goes on to state that new mine-wastes placed in Meadow Creek may result in further degradation of water resources (i.e. Executive Summary). These statements appear un-substantiated based on analysis presented in section 4.9 of the document, as will be detailed below.

Furthermore, the document appears to overpromise on the benefits of on-going work at the site. Ongoing surface water diversions and limited material removal relocation taking place on-site under CERCLA cleanup actions, are unlikely to effectively address elevated metal concentrations in groundwater and surface water due to the small volume of materials being removed and it is surprising that this action is described as leading to a reasonably foreseeable future improvement in analyte concentrations under the "no-action" alternative. Future mining-scale cleanup under this program could conceivably result in demonstrable improvements to water quality but this is not forthcoming without permitting of the mining action.

The SDEIS appropriately concludes that site material geochemical characteristics are not conducive to acid rock drainage conditions and that acidic conditions are not known to occur in groundwater monitoring wells. Presence of significant volumes of legacy mining wastes on the project site and absence of acid rock drainage conditions are an excellent justification for this statement. The lack of ARD is also well supported by the extensive paste pH, net acid/neutralization potential and HCT testing conducted for characterization work.

The conclusion that geological materials at Stibnite have potential to release metals under neutral conditions is appropriate and consistent with site characterization information documenting elevated arsenic and antimony at circum-neutral drainage conditions. This is an important conclusion in design of the overall characterization work and predictive geochemical models and warrants application of principals and methods outlined in the MEND guidelines pertinent to neutral metal leaching processes and prediction.

The SDEIS also finds that geological materials on the Stibnite site are not a significant source of mercury. Plots of mean and total mercury concentrations in Section 3.9, Figure 10, show that Hg concentrations in the EFSF above meadow Creek are higher than those in Meadow Creek. While seeps in Meadow Creek may exceed regulatory criteria for Hg, mining materials occurring on site are not a significant source of mercury, as the majority of mercury occurring in streams is sourced from the mercury mining district upgradient of the Stibnite minesite drained by the upper EFSF and Sugar Creek, as shown on the figure. This is an important fact to recognize in assessment of impacts from the project. It appears that elevated mercury, and other metals are a consideration of impacted water quality and associated aquatic habitat quality; the executive summary notes “exceedances… are likely to occur for antimony, arsenic, copper and mercury” and that impacts may be minimal to fish species from mercury but “uncertainties in predicting future conditions exist.” While this is technical accurate, without mentioning that the water above site is already degraded from up-stream mercury sources, it leads the reader to believe that mine-impacts would result in mercury exceedances.

Characterization is extensive, representative, comprehensive, and follows best-practices guidelines

The hundreds of samples collected for the program are consistent with the MEND Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials best practice guidelines. Geochemical characterization sample selection considered spatial, lithological and alteration/chemical variability to ensure robust sample representativity. The multiple phases of testing and sampling conducted were designed to address gaps identified in earlier phases, consistent with best practices outlined in MEND. The guidelines allow for sample frequency variability based on chemical and lithological heterogeneity of different mine-units. Consideration of the extensive ICP multielement datasets as well as geological and geostatistical deposit models for sample selection, as documented in SRK 2021a, is consistent with best practices and ensures adequate sample representativity.

Statistical analysis and comparison of the 46000 sample multielement ICP data to geochemical samples selected for static and kinetic geochemical testwork, as documented in SRK 2021a, is important to ensure broad representativity of the sample suite based on chemistry in addition to lithology. Because alteration and secondary mineralization is an important factor influencing concentrations of arsenic, antimony and other COIs in the rock mass, use of chemistry to augment and validate lithology based sample selection provides an important cross check that characterization samples are representative

The SGP geochemical characterization program utilized appropriate test procedures including use of static test results to inform selection of samples for kinetic humidity cell testing. The various levels of static testing applied; multi-element, paste pH and NAG testing, MWMP and finally HCTs, are a comprehensive approach to build knowledge and inform selection of samples for more advanced and time consuming procedures, ensuring results are comprehensive and representative.

Application of HCT results is appropriate

Use of stable, long term reaction rates for prediction of weathering rates in the predictive models is appropriate as these rates reflect primary weathering rather than secondary dissolution processes. Accumulation and flushing of secondary minerals may occur at a different rate, and would not be representative of primary weathering, nor appropriate to apply for long term predictions. Even when assessed in kinetic testing, "reaction product retention and associated drainage chemistry cannot always be reliably identified, even after decades of monitoring and testing (MEND Section 19.1; pg 495). Critique of the program due to use of steady state rates is unfounded given extensive uncertainties associated with modeling and prediction of secondary retention and dissolution processes. Furthermore, slow facility wet-up time frames relative to cover placement time-frames are predicted to reduce dump percolation and toe seepage to a limited period during mine years SRK 2021b

Site-specific NPR ratio, PAG threshold and HCT representativity

SRK has applied a site specific NPR Ratio for identification of potentially acid generating (PAG) materials. This approach follows commonly applied methodologies for sites with potential for ARD development, but is also appropriate for stibnite where neutral metal leaching processes are principal factors effecting surface and groundwater quality. While none of the HCT samples resulted in acidic leachates, use of a PAG designation for rocks with a higher potential for neutral leaching of arsenic and other COIs is appropriate because of the geological association of these constituents with sulfide minerals and gold, principally pyrite, arsenopyrite and stibnite.

Samples with elevated gold concentrations generally demonstrate the highest arsenic and antimony concentrations (as in SDEIS Section 3.9, Table 4), lowest NPR values (Table 3-9, SRK 2021a), and arsenic leaching rates/release (SRK Table 3-22), The ore grade samples all plot above the 1:1 line on the neutralizing potential to acid generating potential plots (i.e. figure 3-8) in SRK 2021a further supporting the association and use of the PAG approach even if no acidic conditions are generated.

Most of the projects PAG materials will be processed as they are also ore-grade, but application of the elevated leachate results to remaining waste material tonnages designated as PAG is validated through sensitivities assessing alternative approaches based on constituent concentration distributions from the geological and mineral resource block models, including sulfur and arsenic concentrations, and yielded similar tonnages of rock with elevated metal leaching potential as the PAG approach. These sensitivities, documented in SRK 2021c, validate the overall modeling approach and selection of the NPR = 1.5 PAG designation.

The sensitivity results, demonstrating little effect of selection of the PAG threshold, are not surprising if one looks closely at the metal release tables in SRK 2021a, Table 3-22. These tables show that all of the intrusive Idaho Batholith affinity rocks and fault rocks have elevated arsenic concentrations generally 500-5000 ppm, and all had similar metal release of 1-2% over the duration of the HCT tests. Appendix B.1, *Box and whisker plots showing HCT Sample Representativity*, of the Characterization report (pdf page 1879), graphically shows Hangar Flats and Yellow Pine HCT samples selected from intrusive phases and granite as falling within or above the mid-to upper quartile ranges of the arsenic and antimony distributions. Assuming a reasonable association between concentrations of deleterious metals and their release, as shown in the release tables, this data demonstrates overall general representativity of the HCT samples.

Development Rock Management Plan

The data presented above, detailing consistent metal release and elevated metals concentrations throughout much of the projects development rock, coupled with sensitivity results showing that changing the PAG threshold doesn't appreciably impact the leachate chemistry, is important in determining adequacy of the project's development rock management plan and overall closure strategy.

The Forest is likely to receive criticism of this Development Rock Management Plan from project opponents for its lack of segregation strategies or inappropriate selection of the PAG NPR threshold. These types of critique are not justified by the geochemical data, which shows that most of the project development rock has elevated metals concentrations and can leach arsenic, antimony, aluminum, and other metals of concern. Perpetua recognizes this and has appropriately proposed to cover the entirety of the dumps at closure rather than attempt to segregate, special handle and "burrito" certain materials. This common-sense closure design is not only more effective than special handling as it covers more materials, but is operationally more straightforward, increasing likelihood that it will be effectively implemented by the mining operations.

Geochemical Modeling

The general geochemical predictive modeling approach, combining reactive facility equilibration models with flow-balanced surface water and groundwater inputs to determine water quality is an appropriate approach allowing prediction of project impacts across the mine-site at pertinent time periods.

The geochemical modeling sensitivity analysis demonstrates that surface water quality predictions are robust and are generally insensitive to modeling assumptions regarding factors effecting metal release rates. While assumptions regarding the reactive mass of rock within the dumps (i.e. proportion of fine particles) result in changes to seepage chemistry predictions, the volume of seepage is relatively small compared to stream discharge, and effects on downstream water quality are small. Similarly, sensitivity analysis for the NPR ratio to define PAG in water chemistry models did not yield significantly different water quality prediction results. Use of more conservative modeling assumptions does not result in prediction of new constituent exceedances and the same parameters are elevated above potentially applicable water quality guidelines as in the base case predictive model.

The geochemical models apply a number conservative assumptions, which collectively could result in model results being highly conservative and underestimating total restoration benefits from the Stibnite project. The elimination of ferrihydrite, Mn and Sb compounds in PHREEQC do not promote precipitation of arsenic with ferrihydrite in the models, as well as direct Mn and Sb precipitation. The input chemistry for bedrock groundwater inflows to the Yellow Pine backfilled pit is highly elevated in arsenic (0.32mg/L), based on nearby wells. These wells are located within the general altered zone associated with the ore-body and removing this material through mining could improve local water quality and promote inflows of cleaner, more distal groundwater.

Furthermore, SRK applied load reduction factors to the Yellow Pine Pit source term to account for loading associated with the ore body, pit lake and with the Northwest Bradley dumps, reported as 0.24 for both arsenic and antimony:

“To include a degree of conservatism in the model, the maximum factor (i.e. the factor that results in the minimum amount of load being removed in the model) from the five sampling events was carried forward into the SWWC model” (SRK 2021b, 10.1.2).

The SDEIS describes model calibration to address discrepancies in loading “*likely originating from several sources, including mineralized bedrock outcrops and subsurface groundwater load inputs. To improve the model calibration, additional loading was added or subtracted… to achieve calibration for the existing condition were carried forward to the simulation of the 2021 MMP to generate future water quality predictions*. (SDEIS section 4.9.2.4)”

SRK’s load reduction factors are likely to underestimate actual constituent loading associated with the Yellow Pine pit lake, ore body and Bradley Dumps. This load is described by the USGS as follows “on average, the Glory Hole reach contributed only 10 percent of the streamflow, but contributed 52 percent of total arsenic, 53 percent of total antimony, and 43 percent of dissolved manganese loads…” (Etheridge, 2015). If the load is reduced in the model by only 24%, but constitutes over 52% of the total load in the river, not considering seasonality, then as much as 76% of the remaining load occurring in the reach (40% of total in the river), could potentially be addressed by mining out the ore body, pumping and treating impacted groundwater, or additional mine waste cleanups associated with the project.

These comments are only meant to emphasize that the predictive water quality results presented in the SDEIS are plausibly highly conservative. The Forest is likely to receive comments from project opponents claiming otherwise and second-guessing model assumptions. I encourage you to bear in mind that models inherently require simplifying assumptions and omission of many details and that overall, the level of analysis so far completed for the Stibnite Gold Project is exemplary and more than sufficient to meet the needs for comprehensive environmental effects analysis under the National Environmental Policy Act.

Results indicate overall improvements on the site

Despite the use of conservative modeling assumptions, as discussed above, this project is projected to improve surface water quality and have only limited impacts on groundwater. Figure 4.9-21 in the SDEIS summarizes the predictive model results showing significant decreases in concentrations of antimony, arsenic and mercury in streams across most of the site during operations and closure. If modeling assumptions are indeed conservative, and mining out the ore deposits or additional cleanup actions under the CERCLA work result in further improvements to water quality, then this project may achieve results better than those currently predicted.

Model predictions for groundwater quality beneath the waste rock dumps indicate some degradation from existing conditions in upper Meadow Creek and in limited areas downgradient of the Yellow Pine Pit backfill where the existing aquifer is not effected by historical mine dumps. but do not predict impacts anywhere near as significant as have resulted from legacy mining activities. As described in the water resources monitoring plan, Perpetua will implement monitoring to ensure compliance with IDEQ IPDES permits and establish a Point of Compliance. The POC is consistent with IDAPA 58.01.11 to allow beneficial use (including mining) and limited on-site impacts to groundwater from mining activities while ensuring no down gradient impacts occur. The overall improvement in surface water on site is a notable net-environmental benefit of this project.

Conclusions

The geochemical characterization and predictive modeling completed for the project is more than sufficient for assessment of environmental impacts from the project. The use of scaled HCT results is standard practice and meets industry best-practices and guidance documentation for mine-site modeling. The modeling predicts overall net-environmental improvements to the site resulting from removal of legacy mine wastes and Perpetua's Development Rock Management and Closure plans. These results may be conservative based on modeling assumptions and application of adjustment factors, but are sufficient for NEPA environmental assessment purposes. The SDEIS document adequately presents this information but could be improved through minor editing, specifically the effects stated in the document's executive summary. I support permitting of this project and advocate for prompt finalization of the EIS and issuance of a ROD authorizing construction and operations of the Stibnite Gold Project.

Thank you for considering my comments,

Sincerely,

Nick Tucci, CEM
Subject Matter Expert, Geochemist

References

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SRK 2021b, Stibnite Gold Project ModPRO2 Site-Wide Water Chemistry (SWWC) Modeling Report – DRAFT; July 2021

SRK 2021bc Stibnite Gold Project ModPRO2 Site-Wide Water Chemistry (SWWC) Model Sensitivity Analysis Report; November 12, 2021