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First name: Christopher
Last name: Jones
Organization:
Title:
Comments: Payette Forest Service
Forest Supervisor Jackson

Subject: Support of the Stibnite Gold Project

Dear Supervisor Jackson:

I am writing to submit comments on the Stibnite Gold Project Supplemental Draft EIS (SDEIS). I wish to provide comments specifically pertaining the predictive hydrogeologic/hydrologic modeling completed for the project. I have reviewed the SDEIS sections and supporting documents pertinent to the hydrological model and Perpetua's water management Plans, and also spoken to Perpetua representatives at industry conferences and events regarding progression of the project and the permitting process.

The SDEIS documents include an extensive body of scientific and technical analysis and represent best-practices modeling and design principals. I commend the USFS for preparing such a comprehensive report and am grateful for the opportunity to provide comments on this project and the important economic stimulus and restoration benefits it offers.
My review was focused on the following documents with particular attention to the adequacy of the existing condition model and its use for assessment of future mine-related impacts in the ModPRO2 predictive model:
*Supplemental Draft EIS, particularly Sections 2, Section 3.8 and 4.8
*SGP Water Quantity Specialist Report, USDA 2022b (WQSR)
*Hydrologic Site Model Refined Proposed Action (ModPRO2) Report, Brown and Caldwell, 2021 (BC, 2021a)
*Hydrogeologic Data Adequacy Review Technical Memorandum (BC, 2021b)

I am a hydrogeologist with 15 years experience in mine-site hydrological modeling and hydrogeologic modeling. I have worked on mining sites across the United States and several of them have been in Idaho. I have worked to support water management designs and groundwater control features at mining sites in ID and I am familiar with the geology and hydrogeologic conditions. This experience makes me well qualified to provide comments on the modeling completed for mine planning purposes and environmental impact assessment for the Stibnite Gold Project.

I remember the first mine I had visited outside of Soda Springs, ID. I was in awe of the beauty and grandeur of my surroundings and the mine itself. It was at that time that I understood the delicate balance we must achieve when mining to provide invaluable economic resources, while completing the work in a responsible manner that is protective of worker safety and the environment, while maximizing production to the extent practicable. At times, these can be competing interests, but I believe this team is striking the proper balance from the onset. My comments primarily focus on the approaches of this team pertaining to hydrogeology and hydrologic modeling that impact the environmentally responsible mining of this resource.

The hydrologic model prepared for the DEIS was adequate, but Perpetua and its consultants collected additional information and extensively revised the site hydrological and water balance models for the Supplemental DEIS at the direction of the USFS to make further improvements. The Stibnite Hydrologic Site Model (SHSM) Existing conditions report describes the updates as completed in response to agency comments received during review of the modeling reports for the DEIS alternatives, additional data analysis and the 2019 aquifer test (BC 2021a,

Appendix A, Section 1.2). This update is not only responsive to public comments but also improves calibration, includes additional site detail and provides increased precision into the modeling process with use of updated code.

The meteoric water balance supporting surface and groundwater modeling was updated to account for spatial variability in precipitation and climate across the study area. Perpetua installed an additional pumping well and performed additional hydraulic aquifer testing to ensure hydraulic properties of the aquifer were well understood. Perpetua's consultants and geologists worked to refine the hydrologic conceptual model and numerical model setup to better represent site-specific geological structures and formations. The updated numerical model employed a different MODFLOW code that is better suited to model unsaturated flow conditions and model input parameters were refined in the calibration process. The calibration to baseline streamflow data at numerous gages, basin yield comparisons, and other observations by the team based on experience, demonstrate that the model performance is overall a good predictor of existing conditions and is acceptable for impact assessment purposes.

Public comments on the site hydrological model, particularly those from Integrated Hydro Systems (R Prucha), included critique of the DEIS model based on insufficient baseline data and application of site geological and 3D information; comments pertaining to the model, lack of precision in the water balance model; and comments pertaining to the modeling inputs/setup including storativity, ET values and model timestep.

The model updates included in the SDEIS are highly responsive to these criticisms and have resulted in a more accurate representation of groundwater flow and effects of the mining project on water quantity. The complete revision of the hydrogeologic model, including use of updated solver, is also responsive to public comments.

Given the high-profile nature of this project from national NGO organizations, it is likely that additional consultants will submit extensive comment letters criticizing all aspects of the current hydrological model. Models can be picked apart for anything, there are often several acceptable approaches to modeling the same system that can provide acceptable results. This should not be cause for additional delay of the permitting process; there is always room for criticism of models and there are always opportunities to increase complexity, but these are often unwarranted and do not produce improved results. The current SDEIS hydrological modeling is comprehensive and is more than adequate for environmental assessment of the proposed Stibnite Mining Project. The adaptive approach outlined in several documents highlights the commitment from the team to consistently evaluate the situation based on new technology and observations in the system.

The US EPA guidance on environmental model development outlines four primary aspects to assess in evaluation of model adequacy (EPA 2009):
1)How have the principles of sound science been addressed during model development,
2)How is the choice of model supported by the quantity and quality of the available data,
3)How closely does the model approximate the real system of interest, and
4)How well does the model perform the specified tasks?

The current groundwater model checks all of these boxes and is well suited to modeling of future conditions to assess mine-related impacts. The following sections of this comment letter support the adequacy of the model on the basis of:
*Use of scientifically and data supported conceptual models integrating hydrologic, meteoric and geologic information,
*Extensive supporting baseline data and knowledge of existing site conditions,
*Use of appropriate model inputs and codes, including PRISM data, MODFLOW 6, and site specific data supported model parameters,
*Model calibration against multiple stream gauges and a suite of groundwater wells, and
*Appropriate prediction of mine-related impacts with model-steps tailored to the updated SGP mine-plan.

Baseline characterization data is sufficient for site characterization

The existing baseline data set supporting the hydrogeological conceptual and numerical models is comprehensive and sufficient for modeling of future scenarios in support of the SDEIS. Not only has Perpetua installed a monitoring well network on site, and funded operation of multiple USGS gauging stations, but the conceptual model is also supported by an extensive exploration data set and detailed localized geological models for ore-reserve assessments.

The groundwater monitoring well network is sufficient for understanding variations in the water table across the site and within different hydrologic units and model domains, as described in SDEIS section 3.8. The network consists of a sufficient number of wells which are screened in both bedrock and alluvium. Alluvial wells are completed in alluvial and glacial deposits. Bedrock wells are completed within key lithotypes including intrusive and metasedimentary formations. The spatial distribution of wells allows for monitoring and model calibration of groundwater levels within upland and valley bottom regions.

The USGS gauging stations, installed at the expense of Perpetua and operated since 2012, provide a decade's worth of continuous discharge monitoring data which is key for accurate calibration of the SHSM. These gauge stations are situated at above confluences of the principal drainages on the site and support sub-basin calibration of the site meteoric water balance.

Perpetua's extensive exploration data set and geological models were also applied in development of the hydrological model. The Hydrogeologic Data Adequacy Review Technical Memorandum (BC, 2021b), outlines the use of exploration borehole data in construction of the conceptual site model, specifically the rock quality fracture data to inform the depth of the bedrock fractured layer, an important zone of increased conductivity in the numerical model. Integration of this data provides a level of detail not typically available or utilized in hydrologic models.

The extensive mining history of the Stibnite district is another important data set applied to development of site conceptual models. Extensive data exists from prior mining companies and operations including estimates of dewatering rates and adit and tunnel seepage rates which were qualitatively incorporated into development of conceptual models.

The meteoric water balance based on scaled PRISM data is appropriate and accounts for spatial variability in the watershed

The meteoric water balance supporting surface and groundwater modeling was updated for the SDEIS to account for spatial variability in precipitation and climate across the study area and allow for more accurate calibration of the water balance and supported hydrological model. The water balance was discretized into four sub-basins to address variability occurring due to elevation, distribution of snowfall and other processes effecting surface and groundwater. The sub basin selection is appropriate as USGS gauges are available at sub-basin outlet locations to allow for accurate calibration of precipitation and runoff against gauge data.

The water balance is based on scaled PRISM dataset for estimation of precipitation across the study area. This methodology is appropriate and commonly applied to regional watershed scale water balance projects as it accounts for large scale physiographic variability and allows for local calibration. The existing conditions report notes that the Salmon River Mountains and Stibnite watershed show variability in precipitation and snowfall dependent on elevation, aspect and other factors, as is common in mountainous areas subject to significant snowfall. PRISM is especially appropriate where site-specific data cannot reasonably be collected across large study areas with significant variation in elevation aspect and subject to wind driven snow loading creating spatial heterogeneity. In the Stibnite watersheds, construction of weather stations to provide local data across the area would be unreasonable due to cost, logistics and administrative challenges, and use of scaled PRISM data is therefore optimal for this purpose.

The PRISM datasets account for large scale physiographic variability based on effective elevation of interpolation grid cells and scaling factors were applied in the calibration process to adjust the inputs to the watershed specific USGS gauge data. This is a commonly applied methodology and is overall appropriate for construction of a regional groundwater model. The availability of multiple USGS gauges on the Stibnite site and a sufficient long-term record (8 years) is notable and unusual in that if provides an excellent baseline data set for calibration of supported predictive models and confidence that the MWB inputs are accurate. The overall scaling factor of 1.19 (BC Appendix A, Section 2) indicates that precipitation was scaled up to reproduce streamflow statistics. Upscaling of the precipitation indicates a conservative assumption for a project with technical water management challenges due to high discharge seasonal snowmelt runoff events and associated mine contact water management challenges.

The updated MWB also appropriately accounts for geology driven physiographic variability effecting runoff and recharge. Throughout the area, higher elevation upland areas are dominated by exposed and shallow bedrock, typically of the Idaho Batholith, with valley bottoms characterized by occurrence of thick accumulations of glacial till, fluvioglacial and alluvial sediments. This is supported by quadrangle scale geological mapping (I.e. BC 2021b, Appendix A ,Figure 2.2). Incorporation of these regions into the MWB is an important factor to allow application of different parameters to account for differences in recharge, runoff potential and storage within these rock or sediment dominated areas, ultimately improving the accuracy of the MWB. This is an important factor improving calibration of the hydrological model.

The conceptual site model is an adequate representation of site geology for regional modeling purposes

The generalized hydrogeological units in the model, including the ID batholith, metasedimentary formations, the Meadow Creek Fault Zone, and alluvial materials, are an appropriate generalization of key geological formations in the Stibnite Area. These are the principal formations mapped by the IGS on the Stibnite Quadrangle Geological Map and are also the principal bedrock units described in the SDEIS, section 3.1, and in Perpetua's 2020 Feasibility Study.

Available estimates of hydraulic conductivity show higher values in alluvial and metasedimentary units, and lower values in Cretaceous intrusive rocks of the Idaho batholith, supporting differentiation of these units within the model. The Meadow Creek Fault zone is sufficiently well understood and of sufficient scale (100's of feet wide), based on exploration data and shown on Perpetua's Feasibility Study geology cross sections (M3 2020), to support its inclusion in the model with reasonable expectation of spatial accuracy.

There is insufficient data to support incorporation of additional detail on a regional scale regarding sub-divisions of the metasediments, modeling of discrete zones or structures within the batholith, or alluvial lenses within the till and valley fill materials. A generalized model with assignment of bulk K values to homogenous units within the model is therefore warranted.

In my experience, attempting to represent too much complexity in groundwater flow models typically results in a model that does not function well. Typically, in complex geologic settings it is highly unlikely that everything in the natural environment will be understood. It is more important to represent the major features and calibrate the system to observed hydrogeologic conditions. This team has done just that.

In a geologically complex region covering tens of square kilometers, where substantial heterogeneity occurs due to differing geological units and complex structural geology, development of an accurate detailed model of the subsurface is impossible without extensive, invasive, cost-prohibitive and un-permittable drilling activities. Trying to incorporate all of that detail and complexity into the model may make the model unusable. In this situation, a regional model assessing bulk hydrologic properties of major rock units is appropriate and adequate for predictive modeling purposes. This is especially true for the unconsolidated alluvial and glacial valley fill materials, in which channel deposits are complexly interbedded within till and floodplain overbank deposits (Stewart, D.E. et al, 2016) making direct 3D representation near-impossible. The USFS should not consider or require additional subsurface characterization, as it will only provide local information and not be applicable to refinement of the regional model. Models like this are tools to help us better understand the hydrogeologic system and as such should be a "living" tool that is updated throughout the mining process as more information and data is collected.

Input parameters to the model are supported by field data
Accurate estimates of hydraulic conductivity can be of the most important factors effecting the overall accuracy of the model for prediction of project impacts associated with surface water use, stream baseflow conditions, dewatering activities and treatment requirements. The bedrock hydraulic conductivity values applied in the hydro model are supported by field data, geological observations and anecdotal information from the site. The wide range of hydraulic conductivities measured in pumping tests, packer injection tests, and slug tests, suggest a high degree of local heterogeneity in hydrologic formations, however, assignment of bulk conductivity values and treatment of units as homogeneous is warranted for the purposes of regional groundwater modeling. Use of geometric mean values for generalized formations is appropriate to accurately represent heterogeneous zones of low and high conductivity.

The overall low conductivity assigned to rocks of the Idaho Batholith is consistent with pumping tests and injection tests in this formation, including 2019 bedrock pumping well driven into a known fault zone which failed to produce sufficient water for a pumping test (Hydrogeologic Data Adequacy Review Technical Memorandum (BC, 2021b)). Clay gouge development along fault structures is well documented in the district and is factored into gold recovery estimates (i.e. M3, 2020), and would reduce hydraulic conductivity both along structures and between structures due to structural compartmentalization. The low bulk K values are also consistent with occurrence of widespread hydrothermal alteration in the district which resulted in hydration of feldspar minerals to clays (low K), increasing likelihood of post-faulting structural annealing (i.e. Gillerman et al., 2019). Historical accounts from the Bradley Mining Company also support low K values and record low dewatering rates of 300 gpm during mining operations in the Yellow Pine Pit (Bradley et al., 1943). Additional support is based on overall low flows from excavations and adits driven into the batholith, such as the DMEA adit and Monday Tunnel. Use of higher K values for metasedimentary formations is consistent with overall steeply dipping bedding introducing anisotropy, and rheology of widespread siliciclastic formations, such as the quartzite and quartz-pebble conglomerate, which is conducive to brittle deformation and fracturing.

Application of MODFLOW 6 is appropriate
The updated hydrologic model uses MODFLOW 6, which is an improvement on the prior MODFLOW code used in the DEIS. The model applies an unstructured grid model and therefore offers improved local accuracy and better calibration to well data in areas with high topographic relief. MODFLOW 6 is also able to handle unsaturated flow conditions, and its use in the updated model addressed one of the issues identified in the DEIS public comment period for the hydrological model.

Model Calibration
The hydrologic model is well calibrated to both surface water flows and groundwater elevations across the site. The surface water model calibration graphs and statistics in BC 2021a, Appendix A Section 4, demonstrate robust model performance in prediction of streamflows. Time series plots show accurate prediction of peak flows, low flows, and onset and waning of peak discharge on the hydrographs for the five gaging stations on site. Model calibration statistics for baseflow periods (table 4-6) show overall accuracy of the model with residuals closely reproducing gage data (within a couple CFS) and overall low RMSE, even for higher discharge gauge locations. These results demonstrate that the model performance is acceptable for assessing relative changes for for impact assessment purposes.
Groundwater elevation calibration statistics are similarly good, demonstrating overall accuracy of the hydrologic model in predicting the regional water surface. The scatter plot shows a tight distribution around the 1:1 line.. While predicted groundwater elevations in some wells are low biased by 3.6 ft on average relative to observations, the bias is small compared to the large elevation differences observed across the site where wellhead elevations range from 6300-7300 feet elevation and groundwater elevations range from 5900-6700 feet (SDEIS Table 3.8-9) and can be readily accounted for by large size of the MODFLOW grid cells relative to local topographic effects. These calibration measures demonstrate that the hydrological model is well calibrated and is

acceptable for assessing relative changes for impact assessment purposes.

Selection of calibration parameters using Monte Carlo simulation methods is a good way to eliminate potential bias on behalf of the modelers in construction and calibration of the groundwater model. This method reduces the possibility that modeling was tweaked to achieve a specific goal (i.e. less treatment volume or greater water supply).

Time steps are appropriate for the SGP mine plan
The mining and reclamation sequence are accurately accounted for in setup of the groundwater flow model. Splitting the model to correlate with Yellow Pine and Hangar pit excavation, and subsequent backfilling activities is an elegant solution to handle complex landform modifications associated with the Stibnite Project. The monthly model time-step is adequate for calibration to hydrographs and peak runoff events, which typically occur over the course of multiple months, as shown on calibration time-series plots. The monthly model time step is also appropriate for the mining rate proposed in the Stibnite Gold Project in which mine pit phases are modeled quarterly or annually (SGP Feasibly Study, M3, 2020). Use of a shorter time step is unwarranted for this type of long-term groundwater model and associated slow mining rate and would only have introduced unnecessary detail and require overly sophisticated computer processing capabilities.

Design criteria for water management plans is appropriate
Shorter time steps were applied in the site-wide water balance and water management design for simulation of storm related runoff events and infrastructure sizing. Critique that the time step for the hydrological model is too short to assess the magnitude of these events misses the fact that separate models and tools (i.e. Goldsim, HEC-HMS) were developed and applied for these purposes, as described in other engineering reports.

The event-based modeling methods and precipitation analysis, as described in the technical memorandum appended to the water management plan, are sufficient for development of runoff volumes and peak discharges for use in planning and design. Incorporation of snowmelt and modeling of extreme rain-on-snow events appropriately quantifies potential peak discharges on the site. Use of US ACOE Hydraulic Engineering Center Hydrologic Modeling System software (HEC-HMS) for design of diversions, ponds and other water management features is a standard and acceptable practice for model development.

Scenarios analyzed in water management plans are within potential climate change projections
NOAA climate change projections, prepared as state summaries, predict only modest (>10%) changes to spring precipitation coupled with earlier melting (Runkle et al. 2022) under "business as usual" climate projections for central Idaho and the Stibnite area. These scenarios are not anticipated to result in increases in flood frequency, therefore design factors cover an appropriate range of uncertainty, including climate change driven variability. While it is important to consider climate change effects in design and flood control measures, incorporation of climate change effects into predictive models for comparison against baseline conditions is difficult. In my experience I have found it best to analyze the event(s) with the know information and apply a factor of safety or additional freeboard to the storm or the results to be sure that the system can handle an upset condition. In this case the effects of climate change would be that "upset" condition.

Water management plans are robust and adaptive
The water management plan incorporates numerous redundant systems and measures to prevent release of contact water to the environment. In addition to redundant systems, the adaptive approach will afford the team the opportunity to achieve the water management objectives while making changes to the system based on technology, observed conditions, and changes in the environment over time. Routing of excess water to pits and/or the tailings storage facility allows for flexibility in handling storm events exceeding the conservative design capacities. As Modeled, the tailings facility will have sufficient freeboard for water storage throughout the operational period to handle unforeseen or anomalous operational or climatic events (upset conditions). Pits offer additional excess storage capacity. Contingency water management in the event of an emergency entails

shutdown of mining and ore processing operations as required and pumping water to the TSF for storage. Contingency plans which prioritize environment protection demonstrate sound engineering and design and the company's commitment to safe operations.

Conclusions

In summary, the hydrological modeling completed for the Stibnite Gold Project is adequate and appropriate for prediction of environmental impacts associated with the mine. Models are meant to be simplified representations of natural systems constructed for a particular purpose, as such, there is always room to criticize the practitioner's selection of input parameters or assumptions, but this does not make them invalid. There is no one right answer to problems like this in complex situations and environments, there are often multiple solutions of which several of them could be considered "correct". The extensive hydrological modeling work completed for the project represents a significant body of analysis, more than meeting the requirements for impact assessment under NEPA.

Thank you for considering my comments,

Christopher K. Jones, P.G. (ID-1509)

References

Supplemental Draft EIS, particularly Sections 2, Section 3.8 and 4.8

SGP Water Quality Specialist Report, USDA 2022b (WQSR)

Hydrologic Site Model Refined Proposed Action (ModPRO2) Report, Brown and Caldwell, 2021 (BC, 2021a)

Hydrogeologic Data Adequacy Review Technical Memorandum (BC, 2021b)

Site wide water balance model refined proposed action (ModPRO2) Report (BC, 2021c)

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