DATE December 22, 2022

TO Save the South Fork Salmon

FROM Betsy Semmens, RG **EMAIL betsy@basgc.com**

EXECUTIVE SUMMARY

The modeling effort undertaken to estimate the impacts of proposed mining on the groundwater and surface water system near Stibnite, Idaho has been improved for the MODPRO2 evaluation compared to the MODPRO evaluation in 2019 and 2020. The sensitivity and uncertainty testing appear to have been expanded with the modeling done for the MODPRO2 and better support was provided in the modeling report for the model input parameters chosen for the MODPRO2 model.

There remain unaddressed comments from the MODPRO modeling that apply to the MODPRO2 modeling, as well as new comments on the MODPRO2 groundwater modeling effort. The MODPRO2 model needs additional clarification, testing, and potential improvement before predictions of groundwater and streamflow impacts can be made and conclusions can be formed. These concerns include spatial calibration bias, a model domain that is too close to areas of impacts, model layering that may be inadequate to estimate vertical hydraulic gradients, model layer geometry that may adversely affect model results, and a lack of testing major geologic structures in the area, to name a few. These concerns should be addressed and potentially corrected to improve upon the model's ability to predict impacts.

One of the largest concerns of the MODPRO2 modeling is the lack of correlation of what the model results mean in terms of potential impacts to sensitive ecosystems. The modeling results are presented in terms of a) drawdown of the water table during and after mining at discrete times, b) modeled predictions of the recovery of streamflow after mining, and c) percentage of abundance of particles (flow paths) from the three pits (two backfilled and one pit lake) that will report to various stretches of different streams, creeks, and rivers. Furthermore, drawdown impacts are only shown for a minimum evaluation of the 10-foot drawdown contour, and sensitive ecosystems may be impacted at levels below this threshold. The model predicted impacts should be equated to volumes of impacted groundwater and rates of impacted groundwater movement to sensitive downstream ecosystems, rather than only in the context of groundwater and surface water drawdown and recovery.

The general impact of modifying the model to address the comments in this letter could potentially change model predictions such as:

- groundwater flow directions and interaction with surface water during and after mining,
- estimated depth to groundwater and impacts of groundwater mounding beneath or within facilities and generated geochemistry, and
- estimates of groundwater discharge to the open pits which could, in turn, influence estimates of ultimate pit lake level, the amount of and impacts from groundwater pumping for makeup water, and the geochemistry of seepage during and after mining.

TECHNICAL REVIEW OF MODPRO2 MODFLOW 6 MODEL

I am a hydrogeologist with over 25 years of experience in consulting with an emphasis in numerical groundwater modeling. I have a Bachelor of Science in Geology from the University of Minnesota and a Master of Science in Geology from Northern Arizona University. I am the owner of BAS Groundwater Consulting, Inc., located in Colorado, and am a Past-President of the Colorado Groundwater Association. I am a Registered Geologist in Idaho (PGL-1656), Arizona (40167), Utah (11242390-2250), and Wyoming (PG-4118). I have personally constructed and calibrated dozens of numerical groundwater flow models, including for the mining industry, and used those models for predictions of impacts from mining activities and system recovery post-closure. I also have experience providing third-party reviews of groundwater models including as a contracted reviewer by state agencies in Arizona and Kansas.

I was involved with the initial review of the groundwater modeling conducted in support of the original modified proposed action (MODPRO) report. For that effort, I reviewed the following:

- Draft Environmental Impact Statement (*Stibnite Gold Project, Draft Environmental Impact Statement*, United States Department of Agriculture, August 2020 (DEIS, 2020),
- *Final Stibnite Gold Project, Hydrologic Model Existing Conditions*, *April 27, 2018* (BC 2018a),
- *Revised Final Stibnite Gold Project, Hydrologic Model Proposed Action, October 5, 2018* (BC 2018b),
- *Stibnite Gold Project, Hydrologic Model Sensitivity Analysis, December 2019* (BC 2019a),
- *Final Stibnite Gold Project Modified PRO Alternative Modeling Report, September 2019* (BC 2019b),
- *Golden Meadows Project Overburden Geotechnical Investigation, June 2012* (SRK 2012),
- *Stibnite Gold Project Water Resources Summary Report, June 30, 2017* (BC 2017),
- *Groundwater Hydrology Baseline Study, Stibnite Gold Project, Final. June 2017 (*SPF 2017),
- *Final Workplan: Hydrologic Model of the Upper Watershed of the East Fork of the South Fork of the Salmon River, Stibnite, Idaho. October 23, 2017* (JSAI 2017),
- Existing Conditions model – file name: *Midas_ExistingCond.gwv,* and associated MODFLOW-NWT input files,
- Life of Mine model without mining – file name: *Midas_NoAction_AvgPrecip.gwv* and associated MODFLOW-NWT input files,
- Life of Mine model with mining – file name: *Midas_MineOps_AvgPrecip.gwv* and associated MODFLOW-NWT input files, and
- Instructions provided with the model files – file name: *Midas MODFLOW Hydro Model Readme.doc*

I have reviewed documents that have been submitted since 2020 in support of the modified refined proposed action (MODPRO2). The following is a list of the documents that I have reviewed for the MODPRO2 modeling:

- *Draft Stibnite Hydrologic Site Model Particle Tracking Technical Memo*, *to Alan Hasiam, VP Permitting, Perpetua Resources, from Mark Porter, Principal Hydrogeologist, Brown and Caldwell, dated July 12, 2020 (BC 2020),*
- *Hydrologic Site Model Refined Proposed Action (MODPRO2) Report, August 2021 (BC 2021a),*
- *Draft Stibnite Hydrologic Site Model (SHSM) Sensitivity Analysis, September 2021 (BC 2021b)*
- *Draft Aquifer Test Report RTC SGP Hydrogeologic Data Adequacy Review Technical Memorandum to Alan Haslam, VP Permitting, Perpetua Resources Idaho Inc., from Brad Hart, Brown and Caldwell, dated September 1, 2021 (BC 2021c),* and
- *Final 2022 Drilling and Aquifer Testing Work Plan, June 2022 (BC 2022)*

Two additional references are cited in this technical memorandum:

- Naylor, P. 2012, *Review of Known Hydrogeologic Conditions at the Midas Gold – Golden Meadows Project Area. Technical Memorandum, MWH Global*
- Rygh, J., 2015*, Analysis of the Potential Effects to Groundwater Resources from the Proposed Golden Meadows Exploration Project. 2015 Revision*

Many of the comments that I provided in 2020 on the original MODPRO modeling appear to have been addressed by Brown & Caldwell, Stantec, and/or the U.S. Forest Service in the modeling conducted for the MODPRO2. An overarching comment that I had on the original MODPRO modeling was the lack of sensitivity and uncertainty analysis testing and documentation on the modeled parameters and assumptions. The sensitivity and uncertainty testing appear to have been expanded with the modeling done for the MODPRO2 (BC 2021b) and better support was provided in the modeling report for the model input parameters chosen for the MODPRO2 model (BC 2021c). Unaddressed comments from the MODPRO modeling that apply to the MODPRO2 modeling, or new comments on the MODPRO2 groundwater modeling effort are provided below.

1. Model Domain

The modeled contours of drawdown for MODPRO2 reach the model boundary downgradient of the Yellow Pine pit, as shown on Figures 4-4 and 4-5 (BC 2021a). This indicates that the model boundary is too close to the pits to allow proper testing of the impacts of dewatering the pit. Exterior model boundaries should be located far enough from the features of interest, so they do not impact the predictive results. The radial nature of groundwater discharge to these open pits cannot properly be simulated if the model boundary encroaches upon the pit. The model-predicted results of pit dewatering, namely the amount of groundwater capture in the Yellow Jacket and potentially West End pits, the extent of drawdown of the groundwater table, and the impacts to streamflow may all be affected by the model boundary influencing the model's results.

2. Model Grid

The MODFLOW 6 model grid has a quadtree refinement around major washes and the Meadow Creek Fault Zone (MCFZ), but the modeling report (BC 2021a) has no discussion of grid refinement around the pits. Stage-Area and Stage-Volume curves (collectively referred to here as SAS curves) are provided on Figures 3-7 and 3-8 (BC 2021a). It is assumed that this figure shows the SAS curves for pit shell topography based on the mine plans and not the modeled SAS curves that represent the geometry of the planned pits in the model grid. Regardless, a comparison of the topographic-based SAS curves to the modeled SAS curves should be provided to show how the planned pit geometries are represented with the model grid. The uses of the MODFLOW Lake (LAK) package to represent the pit lake in the West End pit and the MODFLOW Drain (DRN) package to represent dewatering in the Yellow Pine, West End, and Hangar Flats pits rely on the model grid to represent the pit geometries.

For the calculations of pit dewatering the drain elevation representing the pit depth is applied to the entire model cell and in this way the pit geometry and subsequent groundwater discharge to the pit can be over- or underestimated by the model. The post-mining simulations in the Yellow Pine and Hangar Flats pits apply hydraulic conductivity and specific yield values to represent backfill materials in model cells within the pits and these adjusted property values are applied to the entire volume of the model cell. In this way, the pit backfill materials also can be over- or underestimated by the model. For the calculations of pit lake development in the West End pit, the MODFLOW LAK package performs a water balance between the infill rates (groundwater, runoff, and precipitation) and the outflow rates (evaporation and groundwater flow-through (if applicable)) to estimate the pit lake level at defined time intervals. The pit lake level grows until the combined inflow rates are balanced by the combined outflow rates and the equilibrated, ultimate pit lake level is determined. The entire model cell (area and layer thickness) assigned with a LAK boundary condition contributes to the calculation of volume and area, and therefore the model grid (cell dimensions and layer thickness) have a significant impact on the resulting modeled estimate of pit lake filling.

The modeling report (BC 2021a) notes that the bottom of model layer 4 was adjusted in model cells representing the pit bottoms, but this does not guarantee that the volumes and areas of the pits are represented closely in the model grid. If the modeled volume is significantly different than the pit topographic designs, the modeled flux of groundwater to the pits during dewatering and the filling rate of the pit lakes can be in error. If the modeled area of the pit at various elevations is significantly different than the pit topographic designs, the modeled evaporation will be in error. These inconsistencies will lead to errors in estimating the volume of groundwater discharge to the open pits and the rate of pit lake formation and ultimate pit lake levels.

3. Model Layering

The model is described in the modeling report (BC 2021a) as having five layers. Model layers 1 and 2 represent alluvial and overburden materials and have a combined thickness to represent mapped alluvial thickness in the mine area and a combined thickness of 15 feet outside of these areas. The area and thickness of alluvial and overburden materials is not shown in the modeling report and should be shown on figures to clearly communicate the modeled thickness of this important lithological unit that yields most of the groundwater to the Hangar Flats pit and the water to planned groundwater extraction wells.

Model layer 3 is described in the modeling report as being 20 feet thick, model layer 4 is 120 feet thick, and model layer 5 is 980 feet thick (BC 2021a). The deeper model layers (layers 4 and 5) are significantly thicker than the upper model layers and were set as thickness from the top of model layer 1 which was defined with a topographic digital elevation model (DEM) surface. From this process it follows that there may be vertical discontinuity between model cells. Vertical discontinuity occurs when there is a steep change in layer elevations and relatively thin model layers resulting in a model cell from a deeper model layer laying vertically adjacent to a model cell from a shallower model layer. This can result in errors during particle tracking with particles becoming “stuck” in the vertically displaced cell.

The model layering should be shown in cross sections on figures to allow the reader to understand the geometry of the modeled system. The cross sections should show the ultimate pit bottoms to communicate the relationship between the layering and the mine pits.

Showing the model layers in cross section with the pit bottoms is important because the model was simulated, for the most part, with one value of hydraulic conductivity for each model layer, and with decreasing bedrock hydraulic conductivity with deeper model layers. Descriptions of the model particle tracking results of post-mining conditions in the West End pit lake (BC 2020) report that water losses from the pit lake to groundwater occur first in model layer 5. Model layer 5 was simulated with a significantly lower value of hydraulic conductivity throughout most of the model domain (0.03 feet per day (ft/d)) than in the upper model layers and if the model cells in the bottom elevations of the West End pit (model layer 4) were in adjacent communication with model cells in model layer 5, this might affect the model-estimated groundwater flow paths and ultimate discharge to rivers. In other words, water from the West End pit may be forced to move through the lower hydraulic conductivity materials of model layer 5, not because this represents the true nature of the potential groundwater flow paths but because of an artifact of the model layer geometry. Furthermore, if the area of the West End pit has a combined thickness of 15 feet for the alluvial and overburden materials (model layers 1 and 2), the overall thickness of model layers 1 through 4 in the pit area is approximately 155 feet (15 feet (model layers 1 and 2) plus 20 feet (model layer 3) plus 120 feet (model layer 4)). Of the nine reported values of hydraulic conductivity in the area of the West End pit that measured at depths greater than 155 feet, five have values greater than 0.03 ft/d (the value of hydraulic conductivity modeled in model layer 5), (Table 3-2, BC 2021a).

Additionally, the model layering may be too coarse/thick to adequately simulate vertical hydraulic gradients that may be important for model predictions of water exchange between groundwater and the streams or infiltration of seepage from mining activities. There was discussion in the original MODPRO modeling report that the model did not calibrate well to a pump test in the Gestrin well because the model layering is a “poor analog of the test conditions” because the pumping well and observation wells have well screens that are only about 10 feet long and model layer 1 is “approximately 190 feet thick near the pumping well” (BC 2018a). Appendix A of SPF, 2017 provides monitor well construction information and most monitor wells have screen lengths of approximately 10 feet. Model layers 1 and 2 in the modified MODPRO2 model vary in thickness between 15 and greater than 250 feet and model layer 5 (the layer beneath the pit bottoms) is 980 feet thick. The model-calculated groundwater elevation is averaged vertically over the thickness of each layer, and it has not been shown that the model layering is sufficiently discretized to represent the vertical movement of groundwater typically found near open pits nor the hydraulic gradients needed to properly model the exchange of groundwater with surface water.

A sensitivity analysis and a predictive uncertainty analysis should be conducted specifically of the area of the West End pit to demonstrate the sensitivity of the model calibration in this local area and pit lake estimates and subsequent flow paths from the West End pit to the assumption of lower hydraulic conductivity with depth below the pit bottom. Furthermore, a discussion and cross sections of the model layering with pit bottoms should be included in the modeling report clarifying that vertically disconnected cells do not occur from the model layering (if applicable) or have not impacted particle tracking results (if applicable and if this is true). If particles appear to be “stuck” in vertically disconnected cells the model layering should be adjusted to alleviate this condition. A discussion should be added to the modeling report of modeled vertical hydraulic gradients beneath the pit bottoms along with a justification that the layer thicknesses are appropriate to simulate these gradients.

4. Simulation of the Rivers

The model simulates streamflow using MODFLOW’s Streamflow Routing (SFR) package. A constant depth was assumed for the streams (ICALC = 0), and the modeling report indicates that the depth was assumed to equal 2 feet in all streams (Section 4.3.2, BC, 2018a). This depth may be too small to property represent the actual stream depth for some portions of the streams and portions of the year, such as early summer when snowmelt runoff is high, and this overall assumption may be too restrictive to allow for appropriate representation of the stream geometry because the model will hold the depth constant while exchanging streamflow with the underlying aquifer. Stream geometry is important because the stream stage is used to calculate the hydraulic gradient with the underlying aquifer and thus impacts the exchange of water between the aquifer and the stream, a major component of the model calibration and an important predictive result of the future models. At the very least the assumption of stream depth should have been tested in the model sensitivity analysis along with other options for defining stream characteristics, such as defining a Manning’s coefficient from literature values for comparable settings or conducting stream bathymetry surveys (ICALC = 1 or 4). Given that two main conclusions made from modeling of the mining and post-mining periods is the impact of mining on the amount of streamflow and the time, post-closure, until streamflow is restored, the stream characteristics should have been thoroughly tested in the sensitivity analysis.

5. Modeled Geologic Structures

The modified MODPRO2 model included two geologic structures: the MCFZ which was modeled as an aquitard with low hydraulic conductivity, and the Gestrin Feature, which was modeled with locally high hydraulic conductivity. The presence of the MCFZ was tested with model runs where this feature was removed, and the conclusion was that the presence of the MCFZ as an aquitard in the model domain did not influence the model-estimated pit dewatering volumes. However, the uncertainty of the model predicted post-mining flow paths on the inclusion of this aquitard was not discussed in the modeling report. Such uncertainty analyses should be conducted to demonstrate if the model estimated of post-mining flow paths from the pits are influenced by this regional barrier to groundwater flow. The MCFZ as a low permeability feature could impact the timing and location of groundwater discharge to various reaches of the river, which is one of the major conclusions of the post-mining modeling effort.

The Gestrin feature was calibrated in a separate effort through manual calibration techniques. Presumably this resulted in an understanding of the sensitivity of the model calibration to the manner in which this feature is represented in the model (higher permeability). This understanding should form the basis of testing the Gestrin feature in an uncertainty analysis for mining impacts, and this should be included in the modeling report. Furthermore, it is mentioned in several documents (BC 2021a, 2022) that aquifer testing within the bedrock is impractical in the low permeability bedrock setting because of unsustainable flows and that packer testing is a more reliable method of obtaining estimates of hydraulic conductivity. However, this argument should not apply to the alluvial materials and it appears that limited successful aquifer testing has been conducted in the alluvial materials (limited to the Gestrin pumping well test in 2013 and inconsistent testing in 2019). Given that the alluvial unit yields almost all of the water to the Hangar Flats pit, and will supply water to extraction wells for mine operations, this alluvial unit should have further hydraulic testing conducted to support modeling of the Gestrin feature and modeled permeability in general.

Lastly, it does not appear that other structural features were included or tested in the model. A discussion and justification should be added to the modeling report to explain why other structural features (e.g. faults and fractures) were deemed unnecessary for representation in the model domain. An example is the West End Fault Zone (WEFZ) around which wells have shown artesian conditions and a well drilled into the fault zone produced high yield (approximately 50 gallons per minute (gpm)) (Naylor 2012 *in* Rygh, 2015). The WEFZ may be a barrier to flow across the fault trace but permeable along it or show different conditions in different areas of the fault, and this may be an important control for estimates of pit dewatering and pit lake development. If the areas of higher suspected permeability along the WEFZ are included in the area of higher hydraulic conductivity modeled in the Midnight Basin (see next bullet), then this should be explained in the modeling report along with an explanation of how these higher permeabilities can represent the artesian conditions observed in the area. Additionally, it does not appear that a blast zone was included in the model to represent the locally increased permeability around the pits from blasting of the native rocks. This area can be important to appropriately estimate pit dewatering with the model.

6. Midnight Basin

The area of Midnight Basin was modeled with a generally higher value of hydraulic conductivity (relative to adjacent bedrock) to represent vertical bedding and fracturing observed in the area. The modeled hydraulic conductivity ranges from 0.15 to 0.5 ft/d in model layers 4 and 5, yet field data in the area (Table 3-2, BC 2021a) show hydraulic conductivity values higher than this (0.12 to 5.9 ft/d). Therefore, the sensitivity analyses conducted for the model in general do not test a high enough range of values of hydraulic conductivity for this area. Additionally, the higher values of hydraulic conductivity in the Midnight Basin area alone should be tested in a separated sensitivity and uncertainty analysis given the potential for this permeable area to impact pit dewatering estimates in both the West End and Yellow Pine pits and the predicted flow through groundwater fluxes and flow paths.

7. Model Calibration

The modeling report states that there is no bias to the model calibration, and that the model showing both over and underestimated water levels and a balance of calibration residuals (BC 2021a). However, review of the provided spatial plots of calibration residuals (Figure 4-15, BC 2021a) shows that there is a spatial bias in the calibration, with water levels near the Yellow Pine pit consistently underestimated in the model (modeled water level is too low). This underprediction of water levels at the downgradient end of the model domain (Yellow Pine pit area) could influence ultimate, predicted flowpaths of impacted groundwater from the pits (BC, 2020) as well as rates of pit dewatering and streamflow impacts. This area of spatial bias in the model calibration residuals should be corrected.

Additionally, the transient hydrographs of measured and modeled water levels in bedrock wells (Figures 4-16 through 4-21, BC 2021a) show that the model underpredicts seasonal fluctuations in the bedrock monitoring wells, potentially implying that the modeled hydraulic conductivity is too low, disallowing enough connection of those model layers with the shallow groundwater and streamflow systems, the modeled storage is too high, or other mechanisms of the bedrock groundwater system are inappropriately simulated.

There is also a general bias in the model calibration that the modeled streamflow is typically higher than the measured streamflow, particularly at lower stream flows. This is shown on the graphs of modeled and measured streamflows at individual gage locations (Figures 4-4 through 4-8, BC 2021a) with the blue (modeled) line above the black (measured) line in the low flow months. If the model consistently overestimates streamflow, this may impact estimates of available surface water to satisfy mill demand and underestimate the amount of groundwater required as pumped make up water. This in turn could impact the predictions of drawdown in certain areas.

The discussion of model calibration does not include an evaluation of the calibrated model's replication of the measured vertical hydraulic gradients at the site. The modeling report provides cross sections of the alluvial and bedrock groundwater systems and the vertical hydraulic gradients between the two (Figure 1-2, BC 2021a), and mentions that two new pairs of paired alluvial/bedrock monitoring wells were installed at the site (MGI-19-OW1A and 1B, and 2A and 2B) (BC 2021a,c) yet the model's reproduction of vertical gradients is not provided. Appropriately representing downward hydraulic gradients in areas of recharge and upward hydraulic gradients in areas of discharge (such as beneath gaining reaches of the rivers and beneath the open pits during dewatering) is important to show that overall flow paths are appropriate (one of the predictive modeling results presented in BC 2020) and that the modeled discharge fluxes are appropriate (a major result of the predictive modeling results of pit dewatering and streamflows in BC 2021a). The modeling report should be amended to present the modeled vertical hydraulic gradients, and to show that these are appropriate to represent the conceptualized groundwater system.

Lastly, the calibrated modeled water budget is not presented in the modeling report, as discussed in the next bullet.

8. Modeled Water Budgets

A calibrated water budget was not provided for the model calibration. Components of the conceptual water budget, derived from the meteoric water balance were provided in the modeling report (BC 2021a) but the resulting calibrated water budget was not provided to allow confirmation that the model adequately represents the total expected amount of water and its movement between the various components of the model. Providing a calibrated water budget and presenting it in the context of how well, or not well, it represents the conceptual water budget is a basic standard of groundwater modeling (American Society for Testing and Materials (ASTM) D5490).

Similarly, while a large amount of modeled flow information is provided for various components of the Proposed Action predictive model (simulated streamflows, groundwater discharges to open pits by geologic unit, etc) (BC 2021a), a summarized water budget that can be easily compared to the calibrated model water budget and the conceptual model water budget was not provided. Additionally, the pit filling curve for the West End pit is provided (Figure 5-1, BC 2021a) but not the modeled fluxes for each component of the pit lake simulation (runoff, evaporation, and precipitation over time), hindering review and understanding of the modeled predictions. Providing these components of the pit lake water balance allows for review that the evaporation is consistent with the pit geometry, and that mass balance errors are not present in the pit lake (may be indicated by oscillating values).

9. Modeled Impacts from Mining

The MODPRO2 modeling only presents impacts to groundwater from mining as the modeled change to water levels (represented as drawdown) and modeled change to baseflow (BC 2021a), and the modeled percentage of particles that report to each downgradient stream reach post mining (BC 2021b). Comments on the post-mining modeling conducted for the MODPRO2 model are as follows:

- The volume of impacted water from the backfilled pits and the West End pit lake that blends with groundwater was not quantified and the volumes of impacted groundwater that reach downgradient stream reaches was not estimated.
- Particle tracks were not shown to illustrate the groundwater flow paths of impacted mine water and timing was not presented to show how long it will take for impacted groundwater to reach sensitive downstream ecosystems.
- Only the model-predicted 10-year drawdown contours of the water table, calculated as the difference between the modeled groundwater elevations determined from a no-action model scenario and the proposed action model scenario, is shown in the modeling report (BC 2021a), because it is noted that the absolute average model calibration error is 9 feet and model predicted drawdown impacts less than 10 feet are "highly uncertain". Drawdown of the water table less than 10 feet may be critical impacts to sensitive ecosystems that rely upon spring discharges and/or baseflow. It is recommended that the 1-foot drawdown contour be included in modeling figures of impacts with an assessment of the uncertainty of those estimates, and spatial calibration bias at the downgradient end of the model domain (at Yellow Pine pit) be corrected for improved estimates of impacts.
- Model-predicted drawdown of the water table is presented as contours at specific post-mining timeframes that coincide with mining milestones (years 5 and 12 when "significant changes in dewatering occur", year 70 when West End pit lake reaches maximum stage, and year 112 at the end of the predictive modeling). However, drawdown impacts in groundwater can propagate through low permeability bedrock systems, beyond when pit dewatering reaches a maximum. The maximum extent of the 1-foot and 10-foot drawdown contours should be blended for various mining times to show the maximum extent of drawdown impacts regardless of mining year. The downgradient boundary of the model domain may need to be adjusted to incorporate the entire area of potential impacts from mining.
- Model estimated contours of groundwater elevations should be shown for key times to allow the reader to understand the model-predicted groundwater flow paths. Only showing contours of the relative drawdown of the water table does not allow the reader to understand where flow-through conditions at the pits occur.

10. Information to Include in the Modeling Report

The modeling report should be edited to include key information to help the reviewer understand the modeling approach and results. Specifically, the modeling report figures should have common features shown on each to orient the reviewer and allow for understanding of spatial relationships. These common features should include, at a minimum:

- Outlines of the proposed open pits,
- Major washes and tributaries labeled (to ease the location of Midnight Basin, for example),

- The MCFZ, and
- The outer perimeter of the model domain

The general impact of modifying the model to address the comments in this letter could potentially change model predictions such as:

- groundwater flow directions and interaction with surface water during and after mining,
- estimated depth to groundwater and impacts of groundwater mounding beneath or within facilities and generated geochemistry, and
- estimates of groundwater discharge to the open pits which could, in turn, influence estimates of ultimate pit lake level, the amount of and impacts from groundwater pumping for makeup water, and the geochemistry of seepage during and after mining.

1.0 CONCLUSIONS

The modeling effort undertaken to estimate the impacts of proposed mining on the groundwater and surface water system near Stibnite, Idaho has been improved for the MODPRO2 evaluation compared to the MODPRO evaluation in 2019 and 2020. The MODPRO2 model needs additional clarification, testing, and potential improvement before predictions of groundwater and streamflow impacts can be made and conclusions can be formed. Spatial calibration bias, a model domain that is too close to areas of impacts, model layering that may be inadequate to estimate vertical hydraulic gradients, model layer geometry that may adversely affect model results, and a lack of testing major geologic structures in the area, to name a few, should be addressed and potentially corrected to improve upon the model's ability to predict impacts. The model predicted impacts should be equated to volumes of impacted groundwater and rates of impacted groundwater movement to sensitive downstream ecosystems, rather than only in the context of groundwater and surface water drawdown and recovery. Groundwater impacts less than the currently delineated minimum of 10-feet of drawdown should be assessed to properly evaluate the potential impacts to sensitive downstream ecosystems.

Sincerely,

Betsy Semmens

Betsy Semmens, R.G.