

Nez Perce Tribe Hydrology Expert Report Rebuttal for Perpetua Resources Water Right Application

Prepared for
Perpetua Resources Idaho, Inc.
Valley County, Idaho
November 6, 2023



1290 West Myrtle Street, Suite 340
Boise, ID 83702

Table of Contents

List of Tables	ii
List of Abbreviations	iii
1. Expert Qualifications	1-1
2. Introduction	2-1
2.1 Rebuttal of Kaiser (2023) Summary Conclusions	2-1
3. Background	3-1
3.1 NPT Misrepresentation of Perpetua Resources Water Right Application	3-1
4. Technical Assessment of Perpetua Models	4-1
4.1 Perpetua Resources' Use of Historical Data (2004 – 2017), Limits the Statistical Validity of the Model's Predicted Streamflows	4-1
4.2 Various Structural Components of Perpetua Resources' MODPRO2 Groundwater Model Should Be Improved to Assess Effects on Streamflow and Groundwater	4-3
4.3 Perpetua's SHSM "No Action" Scenario Predicts Higher Low Flows Than Currently Observed at Multiple Locations	4-6
5. Projected Effects of Perpetua's Proposed Water Rights and Conditions on EFSFSR Streamflow and Groundwater.....	5-1
5.1 Analysis of Perpetua Resources' Modeled Streamflow Statistics and Potential Effects of Proposed Water Withdrawals on Surface Water.....	5-1
5.2 Summary of the Predicted Groundwater Effects of Perpetua's Water Rights	5-3
6. Summary.....	6-1
7. References	7-1

List of Tables

Table 1. Existing Water Rights, Transfers and Exchanges	3-1
---	-----

List of Abbreviations

7Q10	lowest 7-day average flow that occurs once every 10 years
CSM	Conceptual Site Model
EC	Existing Conditions
EFSFSR	East Fork South Fork Salmon River
IDFG	Idaho Department of Fish and Game
MCFZ	Meadow Creek fault zone
ModPRO2	Site Wide Water Balance Refined Modified Proposal Action
MWB	Meteoric Water Balance
NPT	Nez Perce Tribe
OSC	Office of Species Conservation
Perpetua Resources	Perpetua Resources Idaho, Inc.
POD	point of diversion
POQ	point of quantification
RMSE	Root Mean Square Error
SFR	Streamflow Routing Package
SGP	Stibnite Gold Project
SHSM	Stibnite Hydrologic Site Model
SWWB	site wide water balance
TSF	tailings storage facility
USGS	United States Geological Survey

Section 1

Expert Qualifications

Steve Young

Steve Young is a managing principal hydrogeologist with over 40 years of experience in quantitative hydrogeology and groundwater modeling. He currently serves as the national specialty leader for hydrogeology and groundwater modeling and is senior technical director to the Brown and Caldwell modeling team. He holds an MAS in Water Resources and a BS in Earth Science and is a registered professional geologist in Wyoming and Pennsylvania. Steve has extensive experience in developing hydrogeologic conceptual site models and numerical or analytical models in complex geologic settings throughout the US. This varied experience includes many types of project sites including coal, mineral, and aggregate mine sites in every region of the country including work as expert witness in water allocation related disputes at mineral mines in Idaho. Steve has been the senior technical member of the modeling team on the Stibnite Gold Project (SGP) for over 2 years and has supported other aspects of the SGP project in the role of senior quality assurance for hydrogeology.

Brad Hart

Brad Hart is a senior principal hydrogeologist with Brown and Caldwell with over 35 years of experience in hydrogeologic characterization, groundwater modeling, aquifer testing, and groundwater supply evaluation. Brad has a BA in geology and an MS in Hydrogeology and is a registered Professional Geologist in Idaho and California. Brad's work experience includes development of hydrogeologic conceptual site models and implementation of those models in numerical hydrogeologic models for multiple mining projects. Brad has evaluated interactions of surface and groundwater for multiple sites in Idaho and other western states, including the SGP. Specific to the SGP, Brad has been a senior technical advisor and reviewer for multiple evaluations at the SGP including the development of the Stibnite Hydrologic Site Model (SHSM). He has designed, led and evaluated aquifer testing at the site that informs the SHSM. His involvement with the SGP began in 2017.

Dan Stanaway

Dan Stanaway is a principal scientist with Brown and Caldwell focusing on water supply, groundwater management, water rights, and permitting projects. He has 13 years of professional experience including 10 years of working on water resource issues in Idaho. Dan has a BS in environmental studies and an MS in Hydrologic Sciences. Dan's work experience includes working in the private and public sectors where he has filled technical and management roles in water right modeling and administration, developing and executing complex groundwater programs, managing hydrologic modeling tasks, and leading state and federal environmental permitting projects. Specific to the SGP, Dan leads a team of technical hydrogeologists to conduct groundwater studies, leads the hydrologic modeling, stream temperature modeling and water chemistry modeling teams, and is a technical resource and team leader for water rights permitting. Dan has been involved in the Perpetua Resources water rights process for five years and has drafted or reviewed all reports delivered as a part of this process. Further, Dan has been involved with, oversaw, drafted or reviewed all Perpetua Resources water modeling related reports and other water modeling deliverables for the past five years.

Section 2

Introduction

By request of Perpetua Resources Idaho, Inc. (Perpetua Resources), this expert report rebuttal raises concerns with the analysis and refutes conclusions of the Nez Perce Tribe (NPT; Kaiser 2023) expert report on Perpetua Resources water right applications for permit nos. 77-14377, 77-1437, and 77-14379, applications for transfer nos. 85396, 85397, 85398, and 85399, and application for exchange no. 85538 for the Stibnite Gold Project (SGP).

The NPT expert report does not fully consider all project documentation and evaluations that have described the environmental effects of the SGP on water resources, the water right application for permit, applications for transfers, and simulated diversion demand. Analyses described in Kaiser 2023 are, in some instances, lacking sufficient documentation to fully understand methods, approaches and implications to the SGP, or proffer inappropriate interpretations of existing data used to generate a biased discussion. This expert report rebuttal is organized in the same format as, and addresses the arguments in, Kaiser (2023) to correct misinterpretations of existing information to present a more balanced assessment of the Perpetua Resources application for permit for industrial uses.

2.1 Rebuttal of Kaiser (2023) Summary Conclusions

Kaiser (2023) opens with a bullet list of conclusions based on the water right and water modeling documentation that has been reviewed in her role as the NPT expert witness in the Idaho Department of Water Resources administrative procedures. The summary bullets are copied here in bold with Perpetua Resources brief response below each bullet in normal font. Perpetua Resources responses here are elaborated and supported in Section 3, Section 4, and Section 5 of this Rebuttal.

- **Perpetua's assessment of the effect of their proposed water rights on surface water and groundwater does not sufficiently evaluate or take into account future climate change conditions.**

Perpetua Resources acknowledges that climate change conditions may affect the EFSFSR drainage and has undertaken efforts to evaluate the potential effects. The discussion provided in Kaiser (2023) is largely speculative without quantification of streamflow trends or impacts to the EFSFSR within the duration of the mining period that is approximately 14.25 years.

- **Perpetua's SWWB Model does not reflect the full potential effects of their water right because they do not model the scenario under which they divert the maximum amount of water sought under their water right applications.**

A fundamental principle of a site wide water balance (SWWB) is that the water supply, demand, and storage must be balanced. The expected monthly industrial diversion rate is based on operational parameters including ore processing rate, water needed for drilling and dust control, tailings consolidation that produces water for reclaim, climatic conditions, and dewatering timing and rate. Constraining the SWWB model to a monthly 9.6 cfs diversion rate would result in runaway storage and excessive water treatment (i.e., an unbalanced water balance model), a scenario that would never occur in practice as it would require the mine operator to willfully divert additional stream water or groundwater beyond what was needed for ore processing and other mine uses. That water

would then either occupy expensively constructed storage capacity intended for storing tailings or contact water or, to prevent runaway water storage, be treated at considerable expense and discharged back to the stream system from which it was diverted without being put to beneficial use. Note that the expected industrial makeup water diversion demand from the SWWB does not include excess dewatering water that is treated and discharged back to surface water that is included in the water right application.

- **If Perpetua's total water rights (10.43 cfs) were used (assuming a 1:1 groundwater to surface water connection, as Perpetua assumes in the June 27, 2022, technical memorandum appended to the August 2, 2022, letter to James Cefalo, Regional Manager, Idaho Department of Water Resources), the EFSFSR would go dry during low flow conditions in the months August through March.**

It is incorrect to assess a 10.43 cfs depletion in the months August through March because this does not recognize the low flow water right condition Perpetua Resources agreed to with the Idaho Department of Fish and Game and the Office of Species Conservation that limits diversion rate during this period; nor does it recognize that a component of the 10.43 cfs is for peak dust control (superimposed on other peak demands) which would not occur in most or all of the cited months, and that the transfer components of the water right application are volume-limited. But again, and perhaps most importantly, Perpetua would not divert and consume 10.43 cfs on a continuous basis because they do not need or have a beneficial use for that quantity of water on a continuous basis.

- **Perpetua's analysis and figures provided in their SWWB Model Revised Proposed Action ModPRO2 Report (10/2021) obscure the true effect of water diversions on EFSFSR streamflow.**

The Site Wide Water Balance Refined Modified Proposal Action (ModPRO2) Report (PRII 2021) does not simulate streamflow effects; it balances water supply, demand, determines the need for, and magnitude of additional stream or groundwater withdrawals (beyond those incidental to dewatering and contact water collection) needed to satisfy calculated demands. Streamflow effects of all withdrawals and hydrologic modifications (dewatering, contact water collection and storage, liners, water supply wells, and EFSFSR intake pumping) are simulated in the Stibnite Hydrologic Site Model (SHSM) and documented in the SHSM Refined Modified Proposed (ModPRO2) Report (BC 2021).

The SHSM simulates streamflow impacts in recognition of the magnitude, location, timing of expected diversions from the various sources, and recognizes the water management practices and design features included in the mine plan to limit environmental impacts (BC 2023). The Idaho Department of Fish and Game (IDFG) and Office of Species Conservation (OSC) low flow water right condition was not agreed to when the SHSM Refined Modified Proposed (ModPRO2) Report was published and therefore streamflow impacts do not represent a diversion limitation during low flow periods. That is, rather than the SWWB "obscure[ing] the true effect" of diversions, it is the SHSM that presents a conservative (greater than anticipated) estimate of the effect of diversions.

- **Perpetua's "no action" SWWB Model output predicts higher low flow statistics than those calculated from historic observations.**

The SWWB model does not have a no action scenario and does not predict streamflows, low flow or otherwise. The SHSM simulated a no action scenario and does simulate streamflow and is calibrated to monthly streamflows within the calibration period of November through January 2011 to 2019. The low flow statistic used in assessment of model performance is the 95 percent exceedance, a very rare occurrence with the vast majority of flows exceeding this value. The modeling objective of the SHSM was not to simulate rare occurrences, but rather the expected condition. Further, it is unclear how the low flow statistics are calculated by Kaiser for the SHSM and the historical record because of the model's monthly timestep and the daily timestep of historical data.

- **Due to Perpetua's failure to account for climate change there could be less water in the EFSFSR during low flows and less groundwater than Perpetua has predicted, and they could have underpredicted the amount of time it will take for groundwater levels to rise.**

The lack of clarity and lack of empirical evidence on the impacts of climate change in the headwaters of the EFSFSR within the next 15 years renders this conclusion speculative.

- **Perpetua's Proposed Conditions would result in the EFSFSR dropping below 7 cfs from August through March each year, based on historical data. This conclusion does not take into account changing conditions due to climate change effects.**

This conclusion cannot be verified with the information presented in the Kaiser (2023) report. It should be noted however that hydraulic modeling of the tunnel and the downstream reach between the tunnel outlet and Sugar Creek are shown to maintain fish passage functionality when flows are below 7 cfs (McMillen 2022, Rio 2023a, Rio 2023b).

- **Perpetua's Proposed Conditions place the proposed point of quantification for the water right condition below the confluence of Sugar Creek. This location makes it difficult to accurately determine the effect of Perpetua's proposed water rights on flows in the EFSFSR.**

This claim is unsubstantiated. Under the proposed low flow water right condition, the maximum allowable diversion rate from all sources, less water treated and discharged, is 20 percent of streamflow in the EFSFSR below Sugar Creek. The maximum allowable diversion rate can be calculated and applied to the EFSFSR at the tunnel inlet that is downstream of all diversions except for Yellow Pine pit and West End pit dewatering, which is a marginal contribution to overall water supply.

- **In order to accurately and reliably monitor flows in the EFSFSR, I recommend that a monitoring location be sited directly below the point of diversion on the EFSFSR (above Perpetua's proposed fish passage tunnel) so that the effect of diversions upstream of this point and at that point on streamflow can be directly quantified. I also recommend that current streamflow monitoring locations should remain in place where possible to maintain a consistent hydrologic record.**

Perpetua Resources largely agrees with this recommendation and anticipates that streamflow monitoring at multiple locations throughout the site will be required as a condition in the United States Forest Service Record of Decision and that diversion rates at the points of diversion will be measured. However, as Yellow Pine and West End pit dewatering and contact water management may affect streamflows between the tunnel inlet and the point of quantification (POQ), the proposed POQ below Sugar Creek provides the most comprehensive measurement point.

Section 3

Background

3.1 NPT Misrepresentation of Perpetua Resources Water Right Application

Kaiser (2023) identifies the total diversion rate, inclusive of groundwater and surface water, to be 11.39 cfs that is divided into 10.43 cfs from surface water and 0.96 cfs from groundwater (Kaiser 2023, Appendix A). This is a misinterpretation of Perpetua Resources on-site applications for permit, transfers, and exchanges. The correct total diversion rate from all sources for industrial and domestic use is 10.94 cfs. In review of Appendix A (Kaiser 2023), the transfer 85399 for existing water 77-7141 for a domestic use of 0.2 cfs and permit 77-14377 for 0.2 cfs of domestic use at the same points of diversion is summed for a total of 0.4 cfs, as well, exchange 85398 and transfer 85538 are summed for a total 0.5 cfs. This is a double counting of these permits, transfers, and exchanges that results in an exaggerated total diversion rate; whereas, the domestic water right application for transfer and permit seek a total of 0.2 cfs and the industrial exchange and transfer seek a total of 0.25. The exaggerated rate in Kaiser (2023) is utilized throughout the NPT expert report to assess project impacts.

Further, Kaiser (2023) does not recognize the limited volume of the existing water rights that are included in the applications for transfer and assumes that 10.43 cfs is continuously diverted. This is incorrect because of a misinterpretation of the water right application package and because annual volume limits are not considered. Table 1 shows the volume limitations associated with the existing water rights and other details. Total diversion rate of existing water rights for industrial/mining use is 1.08 cfs and 0.2 cfs for domestic use with limited annual volumes. These water rights are active until the authorized annual volume is met and, at that point, water may not be diverted under these water rights. While the existing water rights contribute to the domestic and industrial water right application, the total authorized industrial use is 10.68 cfs and domestic use is 0.26 cfs; the full rate of the existing water rights will be available for a limited duration because of the annual volume limit. For example, water right 77-7285 has a diversion rate of 0.50 cfs and an annual volume of 30.2 acre-feet. At the maximum diversion rate for this water right, the annual volume permitted would be diverted in just 30.5 days.

Table 1. Existing Water Rights, Transfers and Exchanges

Water Right Number; Transfer/Exchange Number	Current Owner	Source	Beneficial Use(s)	Transfer Application	Diversion Rate (cfs)	Annual Volume (acre-feet)
77-7122; 85396	Idaho Gold Resources Company	East Fork South Fork Salmon River	Diversion to Storage Mining Storage Mining from Storage	Transfer POD to surface water intake at tunnel	0.33	7.1
77-7141; 85399	Idaho Gold Resources Company	Groundwater	Domestic	Transfer POD to worker housing facility	0.20	11.4

Water Right Number; Transfer/Exchange Number	Current Owner	Source	Beneficial Use(s)	Transfer Application	Diversion Rate (cfs)	Annual Volume (acre-feet)
77-7285; 85397	Stibnite Gold Company	Groundwater	Mining Diversion to Storage Mining Storage Mining from Storage	Transfer POU to proposed mine and mill area	0.50	30.2
77-7293; 85398/85538	Stibnite Gold Company	Unnamed Stream (Hennessy Creek)	Mining	Transfer POD to surface water intake at tunnel	0.25	20

Abbreviations:

cfs = cubic feet per second

POD = point of diversion

POU = place of use

Lastly, Kaiser claims that that application for permit 77-14378, which is the application for permit for industrial uses seeking 9.6 cfs, does not cover the dewatering well networks that will be required for mining. This is not true. Permit 77-14378 is for all water diversions from groundwater and surface water. The inclusion of dewatering in the permit 78-14378 is described in the SGP Water Right Diversion Rate and Storage Volume memo delivered to the Idaho Department of Water Resources with Perpetua Resources' water right application for permit and provided to the NPT during Discovery (BC 2021a). As stated in BC (2021a), *The industrial water demand will be met by groundwater from pit dewatering wells and/or water supply wells, surface water from the East Fork of the South Fork of the Salmon River (EFSFSR), direct diversion of contact water (stormwater runoff or groundwater that has contacted mining features), and detained contact water.* A discussion of excess dewatering water being included in permit 77-14378 follows the description of dewatering water/wells being included in the permit as points of diversion (POD) to meet industrial demand.

Kaiser's statement that, *Application for permit 77-14378 does not cover the dewatering well networks that will be required for mining the pits, although this dewatering will also affect surface water and groundwater conditions*, is incorrect, misleading, and implies greater impacts to surface waters than those evaluated in the suite of water management and environmental impact assessment reports, particularly the Site Wide Water Balance Refined Modified Proposed Action (ModPRO2) Report (PRII 2021a) and the Stibnite Hydrologic Site Model Refined Modified Proposed Action (ModPRO2) Report (BC 2021b). On a related note, streamflow (BC 202b) and groundwater chemistry benefits (SRK 2021) resulting from the pumping, treating, and discharging of excess dewatering water are not accounted for nor discussed in Kaiser (2023).

Section 4

Technical Assessment of Perpetua Models

The following sections present a technical assessment of the NPT expert witness report and the contained claims that climate change was not adequately addressed in Perpetua's modeling of predicted streamflow and groundwater levels at the SGP, that the Stibnite Hydrologic Site Model (SHSM) has limitations that render model predictions inadequate for predicting groundwater and surface water flows, and that low flow conditions are not adequately characterized by the SHSM.

4.1 Perpetua Resources' Use of Historical Data (2004 – 2017), Limits the Statistical Validity of the Model's Predicted Streamflows

The NPT expert witness report makes the claim that Perpetua's Site Wide Water Balance (SWWB) Sensitivity Analysis (Perpetua 2021) scaling of total precipitation at the Stibnite Gold Project (SGP) based on historical conditions as a proxy for streamflow changes due to climate change is incorrect. As support, the author states that the scaling of precipitation does not account for the ways in which climate change will affect the type and timing of precipitation in Idaho and how those changes will affect flow regimes. The NPT expert report goes on to present an interpretation of projected stream flows for Johnson Creek, a separate, much larger, and physically different watershed, based on 10 unspecified global climate change models downscaled to the watershed; it does not present any information to demonstrate that the selected climate models or the comparison of separate watersheds produce valid assessments, or how short-term seasonal variations would be of particular consequence to a water balance that is dominated by annual yield, much of it from factors other than climate (i.e., tailings consolidation and water reclaim). Streamflow probability distribution plots for the Johnson Creek watershed are presented with no discussion of relevance to the East Fork South Fork Salmon River (EFSFSR) at the SGP, leaving the reader with an unstated assumption that these projections are valid for the EFSFSR. The following discussions illustrate that the author's findings are highly uncertain and inappropriate for the EFSFSR at the SGP.

The NPT expert witness report contends that Perpetua's Meteoric Water Balance (MWB) is flawed by the assumptions about the percentage of precipitation that falls as snow versus rain in the months of April and October and that this lessens the validity of predictions of groundwater and surface water flows from the Stibnite Hydrologic Site Model (SHSM). The author states that the percentages of precipitation phase (rain versus snow) are projected to change and *there is data that can be used to quantify the actual precipitation phase statistics*, suggesting that such a change in rain/snow percentages in these shoulder season months would somehow meaningfully impact the SHSM predictions. The author offers no quantification of potential changes in SHSM predictions, leaving this up to speculation by the reader. The MWB is very robust and accounts for all available water as input to the SHSM, whether directly from rain or indirectly from snowmelt. The percentage of rain versus snow in the shoulder months of October and November is an assumed average and in reality, is expected to vary on an interannual basis. The author does not identify where the alternative "data" would be sourced from and how application of them would improve the SHSM's ability to predict

groundwater and surface water flow. Rather, the NPT expert witness report implies that the MWB is in error without adding any meaningful quantification of a specific error or to demonstrate an impact to SHSM predictions.

Related to the NPT expert witness report critique of the MWB and SHSM based on rain/snow percentages in the months of October and April, the author states that *Total annual precipitation is not predicted to change significantly in the Pacific Northwest due to climate change, but the seasonality of this precipitation is expected to change (Klos et al., 2015)* and goes on to cite a reduction in April 1st snowpack at the Secesh Summit SNOTEL site over two intersecting 30-year periods (1981 to 2010 and 1991 to 2020) as support that this change is ongoing at the SGP. No statistics are provided to demonstrate that the selected 30-year periods provide a statistically valid comparison of data. Rather, this incomplete analysis is apparently included to leave the reader with an unstated assumption that the comparison is statistically valid and represents direct evidence of a rate of change in April 1st snowpack depth for the SGP and a consequent invalidation of predictive modeling of surface water and groundwater.

Focus on potential shifts in snowmelt timing and the potential resulting streamflow reductions by the NPT expert witness report fails to characterize the breadth of science on this issue. Through path analyses of historical streamflow data from the Pacific Northwest, Kormos et al (2016) found that the precipitation amount has been the dominant control on the magnitude of low streamflow extremes compared to the air temperature-affected timing of snowmelt runoff. The NPT report author acknowledges that precipitation is not predicted to change significantly in the Pacific Northwest and the high warming climate change scenario referred to by the NPT author includes a 10 percent increase in annual precipitation by the end of the century, yet the snowmelt timing is pointed to in the NPT expert witness report as leading to lower streamflows. This is obviously not settled science, should not be treated as such, and does not diminish the validity of SHSM predictions of groundwater and surface water flows.

The NPT expert witness report includes figures that show two projected probability distributions of daily streamflow for Johnson Creek over the next 20 years under two climate scenarios. Although there is not a legend provided for the reader to interpret the figures, the author asserts that the figures generated for Johnson Creek are applicable to streamflow conditions on the EFSFSR at the SGP and show that extreme low flow streamflow conditions will become more common on the EFSFSR over the next 20 years (*those below 10 cfs (cubic feet per second) in particular*). This assertion is made without any attempt to demonstrate that hydrogeologic and other physical conditions of these two watersheds are similar enough to make this comparison. It is also notable that the 10 cfs flow is not provided on the x-axis of the graph figures, making it difficult to interpret, and that the changes in probability are notably small (generally less than 5 percent). While climate models have improved, they are still unable to resolve fine spatial features and processes that characterize the climate of mountainous regions like Idaho (Abatzoglou 2021). Further, one can expect some spatial variability as spatially variable subsurface (groundwater) drainage processes influence the translation of water inputs into streamflow (Kormos 2016, after Tague and Grant 2009). The EFSFSR and Johnson Creek watersheds are significantly different hydrologically and the findings of Abatzoglou (2021) and Tague and Grant (2009) cast significant doubt on the validity of applying an analysis of Johnson Creek to the upper EFSFSR basin.

The assertion by the author of the NPT expert witness report that the analyses of low flow characterization in the report are valid is also troublesome. Global circulation models produce relatively consistent temperature change estimates across models but the same models produce relatively inconsistent results in projected precipitation amounts due to an incomplete understanding of the complex precipitation drivers (Kormos, et al., 2016). Uncertainty in future precipitation is important because mean annual streamflow has been shown to be more sensitive to precipitation

than temperature, and streamflow projections become more uncertain when moving from mean values to extreme values (Bloschl and Montanari, 2010; Bloschl et al., 2007; IPCC, 2007; Seneviratne et al., 2012, *after Korma, et al., 2016*). The NPT expert witness report focuses on the extreme low end of streamflow values where uncertainty is high and asserts that these events (*those below 10 cfs in particular*) will become more common in the next 20 years. The well-recognized uncertainties render this conclusion unwarranted.

4.2 Various Structural Components of Perpetua Resources' MODPRO2 Groundwater Model Should Be Improved to Assess Effects on Streamflow and Groundwater

The NPT author is basing this comment regarding the SHSM on her opinion that the review of the SHSM provided by BAS Groundwater Consulting (BAS) provides an “excellent job of outlining the multiple structural components of Perpetua’s groundwater model and its associated sensitivity or uncertainty analysis that should be improved.” The substance of the NPT author’s summary of the BAS critique is provided in a series of bulleted statements that are addressed individually in the following paragraphs.

One element of the reworked BAS comments that gets repeated in several of the bulleted comments is the concept of a sensitivity analysis. As explained in the NPT comment letter, a sensitivity analysis is an organized evaluation of model predictions that “examines how model results change when model parameters change.” This is a useful exercise in that it helps test the calibration and helps to frame the uncertainty surrounding the model predictions provided by the calibrated model. Contrary to the NPT reviewer statements, Perpetua did perform a detailed sensitivity analysis on the SHSM. and unfortunately the NPT author was unable to include it in the review and critique of the SHSM (BC 2021c). In summary, the sensitivity analysis does provide some information that is valuable in understanding the suitability of the SHSM. The sensitivity analysis varied hydraulic conductivity and specific yield using multipliers ranging from 0.02 to 50. The results show that pit dewatering rates for the Yellow Pine pit are sensitive to changes in bedrock hydraulic conductivity and more importantly that changes in hydraulic conductivity (either increase or decrease) rapidly degrade the calibration of the model. This means that there is confidence (i.e. lower uncertainty) that the estimates of the pit dewatering withdrawals as simulated are reasonable estimates. The same analysis for the Hangar Flats pit shows that rates are relatively insensitive to changes in bedrock hydraulic conductivity. Most changes in hydraulic conductivity produced insignificant change in dewatering rates and the very high change in input parameters produced larger response while degrading calibration quality. In this case, less is learned about the quality of the calibration but the insensitive response to change in hydraulic conductivity increases confidence in the rate estimates for Hangar Flats. This pattern is generally the same with respect to stream flow and groundwater elevations. Large increases (10 to 50 times the calibrated value) in hydraulic conductivity produced the most response in both groundwater elevation and stream flow. Stream flow impacts from bedrock hydraulic conductivity changes moderate with distance down the EFSFSR valley indicating the hydrologic setting is increasingly dominated by the alluvial groundwater system as elevation decreases. In all cases forcing large change in either groundwater elevation or stream flow markedly degrades the quality of the model calibration. In summary, the sensitivity analysis illustrates that the calibrated existing conditions (EC) SHSM represents the minimum head and stream flow error achievable within the expected range of both hydraulic conductivity and specific yield.

The first bullet asserts that there is an issue with the model domain size in that predicted drawdown appears to be impinging on the edge boundary of the SHSM. While BAS is correct in observing that this condition is predicted to occur, it is incorrect to imply that the figures show impacts beyond the

model boundary as stated. The contours stop at the model boundary because the model has no ability to predict head values beyond that boundary. In addition, the statement “model cannot capture full impacts of dewatering as those impacts are cut off at the model boundary” is misleading. Boundary interference in a numerical groundwater model is an important consideration in model design and application; it can be of concern when a boundary is a temporally variable boundary type or when the actual hydrogeologic boundary is poorly understood. In this case, neither of those conditions are present. The outer boundary of the SHSM is a no flow condition that represents the mountain ridge that surrounds the Stibnite valley. This is, in physical fact, a no flow boundary for groundwater at that location. The primary source of water in this valley is recharge that occurs predominantly in the lower portions of the valley because of the extreme mountainous conditions where precipitation runs down the high angle slopes (i.e cannot easily infiltrate the poorly permeable rock, steep slope, ground surface). This means that there is very little recharge to groundwater occurring in the higher elevation portions of the valley which equates to the portions of the SHSM along the model boundary. This physical condition means that there is very little to no groundwater available to flow across this topographic boundary; hence, in reality, it is effectively a “no flow” boundary. This condition is intentionally built into the SHSM and is observed in model results by the fact that the only layer at the high elevation model boundaries that remains active during simulations is layer 5. All of the layers above layer 5, along the topographically high areas of the model, are dry and inactive and layer 5 has an extremely low capacity to transmit groundwater, which accurately reproduces the mountainous valleys’ dependence on precipitation for groundwater and stream base flow. For all these reasons the NPT authors assertion that the model domain is not large enough is unsupported and reflects a misunderstanding of the hydrogeologic setting at the SGP site and conceptual site model (CSM) that form the basis of the SHSM design. In fact, the model domain was carefully designed to mimic the behavior of the actual physical valley boundary.

Bullet number 2 claims that the model layering is too thick to adequately capture vertical movement of groundwater. The comment provides no specific reasoning to support this claim, however, review of the supporting BAS summary report suggests that the concern is focused primarily on the potential for vertical gradients around the mine features. While it is true that more refined vertical discretization can improve understanding of vertical gradients in a numerical groundwater model, the goal of the model and overall approach to layering must be balanced against such secondary goals. In this case the primary goal based on the CSM of the overall hydrogeologic setting is to simulate the groundwater to surface water interactions, the potential impacts to each from mine activities, and to estimate water management rates and quantities to facilitate site wide water balance calculations. In this context, the thickness values of model layers 1, 2, and 3 were selected and adjusted during model construction to provide sufficient detail in model simulations while not creating an unwieldy model or one that would provide spatially detailed predictions that could not be verified or calibrated.

Bullet number 3 suggests that a sensitivity analysis of the stream stage value in the MODFLOW streamflow-routing (SFR) package would be helpful in understanding the effects of this parameter on surface water to groundwater interaction. Perpetua agrees that this parameter could be varied in a sensitivity evaluation however because of the localized nature of the SFR nodes in comparison with the model parameters such as hydraulic conductivity the stream stage is not likely to have a significant impact on the calibration fit of a regional scale model. This fact, combined with the uncertainty surrounding the lack of actual values of stream depth during extreme conditions such as suggested by the NPT author, mean that little could be inferred from an evaluation of model response to variations in stream stage in a relatively small portion of the model domain. In addition, the possible range of variation in stream depth is very small when compared to the surrounding topographic relief and associated shallow groundwater head change from valley bottom to mid-slope. Any error induced by stream depth assumptions would quickly be overwhelmed by the groundwater

gradient into the stream channel. In summary, all of these conditions indicate that the SFR stage value assumptions would have little effect on model performance and would not alter the model parameterization. Furthermore, learning that there is even a moderate impact realized by changes to SFR stage would not translate into a meaningful change in SFR stage assignment. This is because the range of actual values once averaged over the monthly time step required by the SHSM would not be expected to vary to a significant degree from the assumed value.

Bullet number 4 questions the level of detail included in the SHSM with respect to structural features such as faults and fractures. Simulating bedrock fracture fabric explicitly would require a level of data collection that is rarely available or feasible to gather. Representing bedrock fracture conditions as a bulk effect is sufficient for groundwater flow modeling at the scale of the SHSM. The bulk hydraulic conductivity of the bedrock layer can be adjusted to reflect the observed effects of the overall fracture fabric of the subject bedrock unit without representing individual features. This approach is applied as a higher hydraulic conductivity in layers 4 and 5 located in an area trending southeast roughly in the center of the model domain which represents increased fracture occurrence within the metasedimentary bedrock present in this area (see Figures 3-8 and 3-9 in the SHSM model report). Also, the sensitivity analysis described at the beginning of this section did vary the value of the bulk hydraulic conductivity for the bedrock layers and in doing so, effectively evaluated the impact of lesser or greater fracture density. As explained above the result of significant changes to bulk hydraulic conductivity was unacceptable degradation of model calibration.

With respect to simulation of fault planes and associated damage zone in a regional scale model (such as the SHSM), there is a similar consideration applied to selecting the fault structure that is predominant in the model domain, which will generally have more data available for reasonable parameter selection and evaluation of fault impacts on background groundwater flow behavior. This logic was applied when developing the SHSM and the Meadow Creek Fault Zone was identified as having the highest likelihood of influencing groundwater movement. The leading factor in this evaluation is the Meadow Creek fault zone (MCFZ) passes through both Hangar Flats pit and the Yellow Pine pit. Because of the understanding that faults can play significant roles in the flow of groundwater in a bedrock setting, a sensitivity test was performed on the SHSM behavior by removing the MCFZ (setting hydraulic conductivity equal to the surrounding bedrock) in layers 4 and 5 to investigate the effect on pit dewatering. As explained in the SHSM report Section 4.1, page 4-3 removal of the MCFZ had negligible effect on the dewatering rate predictions for both Hangar Flats pit and the Yellow pine pit. The conclusion from this test is that although the presence of the fault improves calibration and the overall reproduction of head and gradient simulation, the model results are not sensitive to the presence of the fault. By extension, it is then expected that if the largest most proximal fault to the area of interest does not impact application of the SHSM, any of the smaller or more distant faults would be expected to have less influence and therefore less value to the overall model design. This evaluation of the sensitivity of the SHSM to the presence of the MCFZ is appropriate in scope and sufficient in detail to address the question raised by the NPT author regarding effect of bedrock structure on pit dewatering estimates. Since the pit dewatering represents a greater stress to the groundwater system than drainage to or from the stream channels would present, it is reasonable to also conclude from this sensitivity evaluation that the MCFZ and by extension any of the lesser faults would not significantly affect stream flow. Additional sensitivity evaluation could be performed as the NPT author suggests however it is unlikely that the results would provide any valuable change in the model predictions of future conditions.

Bullet number 5 questions the performance of the model in the vicinity of Yellow Pine pit and further speculates as to the reasons for this presumption of poor performance. There are unfortunately several misunderstandings evident in the NPT author's statements. Firstly, the magnitude of the difference between modeled and measured heads in wells surrounding the Yellow Pine pit are in fact

shown on Appendix A, Figure 4-15. In addition, the model results illustrated in Appendix A, Figure 4-15 show that heads in wells downstream of the pit area are underestimated by the SHSM and in wells upstream of the pit area, the SHSM predicts heads greater than the measured values. The NPT reviewer unfortunately did not recognize this condition and focused instead on a partial interpretation of model results. Further examination of the overall results presented in the preceding figure (Appendix A, Figure 4-14) illustrates the overall fit of SHSM groundwater head predictions in the context of the overall model scale. Given the regional nature of this model and the goals for which the model was designed, the fit illustrated in Appendix A, Figure 4-14, represents a successful calibration of the SHSM. And in summary, the NPT speculation regarding potential reasons for the observed differences are neither substantiated nor unique. In fact, there are many, perhaps unknowable, combinations of input parameter variations that could, in theory result in lower residual values in this specific area of the SHSM. The implication that the specific changes to hydraulic conductivity (suggested by the NPT reviewer) are known to produce a lower localized residual is unsubstantiated. Bullet number 6 is an assertion that the lack of a comparison of the overall water budget for the SHSM somehow represents a breach of standard protocol that is a requirement of an ASTM standard. Specifically, ASTM standard 5490 Standard Guide for Comparing Groundwater Flow Model Simulations to site specific information is referenced. Unfortunately, there is some confusion over what ASTM standard guidelines are and whether the referenced ASTM standard applies in the case of the SHSM report. The scope statement in ASTM D5490 states, among other caveats, that *“Not all aspects of this guide may be applicable in all circumstances”*. The ASTM standard explains that professional judgment is an important factor in determining the appropriate approach to comparison of model results to site specific data. And the final misunderstanding is that this particular ASTM standard (ASTM, 5490) has been withdrawn by the ASTM and no replacement has been developed. This suggests that the requirement for professional judgment in the evaluation of model performance has been judged to be of greater importance than the provision of standard processes.

The summary paragraph for this section of the NPT comments returns to the issues identified in each of the preceding bullets and continues to indicate the perceived model domain issue and allegedly missing evaluation of model sensitivity are limiting factors in the reviewer’s ability to judge the suitability of the SHSM. Perpetua suggests that the NPT authors allegations are based on incomplete understanding of the information provided and/or misunderstandings of that information. Our explanation of these misunderstandings is described for each bulleted item in the paragraphs above and together provide clarification that serves to address the issues reiterated in the NPT author’s closing paragraph.

4.3 Perpetua’s SHSM “No Action” Scenario Predicts Higher Low Flows Than Currently Observed at Multiple Locations

The NPT author begins this comment section with an unexplained statement that the SHSM predictions of “low flows” are higher than those observed. This is presumably a reference to stream flow data provided the SHSM SFR data as compared to United States Geological Survey (USGS) gage data from locations throughout the project site. The reference to an included figure unfortunately does not clarify this statement since the figure has not been explained and appears to be a comparison of some statical evaluation of both SHSM output data and USGS gage data. At this point in the comment presentation this statement appears unsubstantiated and may be a typographical error or editing error.

The next paragraph provides some small detail regarding the calibration metrics used in the SHSM as related to the streamflow from the SFR package. The reviewer states that there are many ways to measure how well a model represents a natural system. And then provides a reference for an

academic paper that compares various methods (Pfannerstill et al, 2014). The author then states “The model evaluation criteria Perpetua uses, the Root Mean Square Error (“RMSE”), is known to overemphasize how well models predict flood peaks, which masks poor model performance in low streamflow periods.” Although it isn’t clear, this statement is apparently based on Pfannerstill, 2014. Upon reviewing this reference (Pfannerstill,2014) it is immediately clear that the author has misunderstood the origin of the streamflow data used in the SHSM report. These data are the result of a module or element of a groundwater flow model. The Pfannertsill comparison is specifically focused on the application of calibration metrics as applied to surface water models. This distinction is critical because the groundwater flow model is not developed to simulate the detailed and complex nature of the many types and conditions of surface water movement that occur in nature and which are explicitly handled in surface water modeling tools. Nor does a surface water model have the capacity to evaluate the subsurface complexities inherent in estimating the interaction between groundwater and surface water. These model types, the physical systems and behaviors they are designed to simulate, and the mathematics behind approximating these different and equally complex systems, make their ability to simulate low flow in a stream drastically different. It seems clear then that while the statistical methods for measuring model performance against measured data have some inherent bias, the study of the characteristics of those methods when applied to surface water modeling has no direct relevance to groundwater modeling results.

The NPT author then states that the SHSM has not been calibrated to low conditions in August and September “...when stream flows are low and evapotranspiration is high.” Again, there seems to be some misunderstanding of the information provided in the SHSM report. For the very reason that (as explained above) a groundwater flow model is not capable of accurately modeling all the complex elements of surface movement, the model calibration is focused on times when surface water flow is observed to be low because this condition most accurately represents surface water that originates as groundwater. Review of Figures 4-4 through 4-11 of Appendix A of the SHSM report clearly show that the low condition for the streams at the site (as represented by the USGS gages present with the site) occurs between November and February consistently. These are the same months for which model residual statistics are provided. It is unclear then why the NPT author asserts that calibration does “...not provide complete information on model performance at low flows”. In fact the SHSM is specifically and deliberately calibrated to exactly that low flow condition. It is worth noting that the NPT author implied special importance around identifying the point in time when evapotranspiration is high. However, the direct observation of streams on site at their lowest annual flow rate would be the absolute indication of when low flows would occur, regardless of the relative contribution to that condition from any individual factor, including evapotranspiration.

The comment then attempts to provide a description of the author’s application of the duration curve technique to the model generated stream flow data. This is a unique application of a statistical method that is most often used to evaluate the risk of a daily low flow condition occurring during any given month. And it is typically applied to gauge data in order to base the estimate on actual stream basin behavior. In this case, it appears that the author has assumed that the stream flow estimates from a groundwater flow model, with a monthly time step, are sufficient to evaluate using this method. No justification or clear explanation of the method is offered therefore it isn’t clear what value this evaluation may have as it relates to the ability of the SHSM to simulate low stream flow conditions.

The duration curve method uses a ranking procedure to calculate a flow value that represents the flow value that will be exceeded 95 percent of the time for the period evaluated. The usual application uses daily flow data to calculate a daily flow exceedance value for the month from which the daily data were taken. Since the SHSM only provides monthly predictions of stream flow, the

application to the SHSM model would seem to provide a monthly value that would be exceeded 95 percent of the months for the year from which the monthly data was taken. Given this understanding of the duration curve method, the apparent application to the SHSM output stream flow data, and in the absence of a clear explanation, it seems that the assertion of a 95 percent exceedance value for a specific month is an incorrect application of this method. Further, comparing a monthly flow 95 percent exceedance value to a single monthly prediction seems somewhat circular; the monthly value being compared was in fact used to calculate the statistical measure (95 percent exceedance) used in the comparison. The NPT author would need to provide a more complete explanation of this method and its application as a measure of model performance in order to establish any value in the aspect of the comment. Also, the specific reference to predicted stream low flows being “...up to 305% higher than they actually are.” is not supported with any details and not explained by the application of the duration curve method. Given the evaluation of model performance as presented in the SHSM report, this percentage comparison must be a typographical error.

A final comment regarding the application of the duration curve method to a single month focuses on the first paragraph of page 9. This entire paragraph is confusing and insufficient to explain the analysis performed by the author. The first sentence correctly reports the minimum residual for USGS Gage 13311250 for December which represents the largest magnitude over prediction observed during the calibration period for the SHSM. This value is then compared to a 95 percent exceedance value that is represented as a monthly flow value for the same time as the residual was observed. This claim is confusing for two important reasons. First, Table 4-6 of the SHSM report is identified as the source of the minimum residual value, yet, the year that it occurs is not provided in the table. The second point of confusion is the reference to monthly 95 percent exceedance value for a specific month when the data from the SHSM are monthly yields and no corresponding monthly exceedance value could be calculated. As explained in paragraph 6 of this response section, the duration curve methodology would provide a monthly exceedance value for a year indicating the value that would be expected to be exceeded by 95 percent of the months in that specific year. If there is some application of statistics where monthly data can be used to generate a 95 percent exceedance value for a specific month using only monthly data, the NPT author has not provided either an explanation of the method, or a justification case for its application to model simulation data. Therefore, without detailed clarification of these two issues, this element of the NPT comment is unsupported. In addition, the sentence asserting that “Perpetua’s model could simulate the flow to be 13 cfs, or 133% of the actual flow” seems to be based on adding actual residual to the purported 95 percent exceedance value. Again, the logic behind this approach has not been provided and on examination seems to be illogical. The residual reported is already a measure of the difference between the SHSM results and the observed data at the stated stream gauge. Adding that residual to a statistical probability value doesn’t have any clear meaning, is not explained by the author, and certainly doesn’t support a statement indicating there may be a 33 percent error in the SHSM predicted flow when compared to the actual flows. It is much simpler to look at the reported residual and compare it to the measured flow for the same period to get a measure of the maximum indicated error in terms of percentage. This data is available in Appendix B of the SHSM report and indicates a maximum observed overprediction of approximately 45 percent of observed flow for the month that the greatest overprediction occurred. The maximum deviation for December represents a single observation over the calibration period; the mean residual for all December values is an overprediction of 1.25 cfs and the maximum magnitude underprediction for all December data is 2.21 cfs. Based on this data, the maximum overprediction does not seem to be an outlier or signal any specific concern about overall calibration of the SHSM. The reviewer appears to agree with this overall perspective by stating that “...the calibration statistics Perpetua provided (RMSE) suggest that the model performs well...”. The follow up claim that the “...magnitude of difference at low flows suggests otherwise” is in direct conflict with the ample data provided in the SHSM report

demonstrating the actual performance of the SHSM in contrast with an unsupported and unexplained comparison to a potentially misused statistical method.

The final sentence of this paragraph asserts that all of this complex and unexplained conjecture taken with what is characterized as vague results (referring to simulated basin yield) prevents the NPT author "...from assessing the actual effects on surface water and groundwater". Aside from the obvious internal contradiction after attempting to do exactly what is claimed to be prevented, it is worth noting that the basin yield comparisons are large scale and serve to check the overall suitability of applying the SHSM to this portion of the upper EFSFSR basin. In fact, this evaluation is essentially based on the output of the model meteoric water balance, which is discussed in Section 4.2 above (see paragraph response to Bullett 6) and is a valuable high-level evaluation of whether the SHSM reasonably reflects the hydrologic setting for which it is designed. Basin yield evaluations by their nature do not provide specific information such as seasonal variability in stream flow or any other short-term behavior of the system, and they are not expected to do so.

Finally Figure 3 and Table 2 are poorly presented and poorly explained to the point of being no help in understanding the NPT authors evaluation and comment. Figure 3 appears to be a classic depiction of model fit when comparing measured to simulated values. However, the use of 95 percent exceedance values that are unexplained, confuses the graphic to the point of uselessness. In addition, the figure labels seem to indicate that the USGS gage data were evaluated using the duration curve method while no mention of having done this evaluation is provided in the text. Table 2 is a lengthy production of percentage values supposedly representing differences between the SHSM and observed gage data. It is not clear if these are based on the unexplained calculation described in the preceding paragraph or if the values have their origin in a more defensible process. There is still no identification of which year this data is based on, if it somehow represent the entire calibration period (perhaps all of the EC simulation period), or even the no action alternative simulation. Without much additional clarification, both Figure 3 and Table 2 add nothing to the discussion regarding the performance and applicability of the SHSM.

Section 5

Projected Effects of Perpetua's Proposed Water Rights and Conditions on EFSFSR Streamflow and Groundwater

The following section addresses the groundwater and streamflow effects analysis in Kaiser (2023).

5.1 Analysis of Perpetua Resources' Modeled Streamflow Statistics and Potential Effects of Proposed Water Withdrawals on Surface Water

Kaiser's claim that, *Perpetua does not model the effect that withdrawing their full water right of 10.43 cfs would have on surface flows*, is correct. However, it is based on an incorrect understanding of the water right application, Stibnite Gold Project (SGP) water management and the water modeling that has been conducted for the SGP. With Kaiser's consideration of 10.43 cfs, her effects analysis is an extremely rare worst-case scenario that is not likely to occur continuously.

First, Perpetua Resources does not have 10.43 cfs strictly for surface water rights, as represented in Appendix A of Kaiser (2023). Total of surface water-specific water rights is 0.58 cfs and 9.6 cfs for point of diversions (PODs) that are located throughout the SGP and for which surface water is one source contributing to diversion demand. Other water sources contributing to industrial and domestic diversion demand are industrial supply wells in the Meadow Creek valley, Hangar Flats pit dewatering wells, Yellow Pine pit dewatering wells, and West End pit dewatering wells. Dewatering of each pit is offset in time so that dewatering water from one of the pits is always available while mining is active. The full 9.6 cfs will never be sourced primarily from surface water as portrayed in Appendix A. Kaiser (2023) overstates potential streamflow impacts in the statement that, *Table 3 above shows that if total water right is used, the stream will go dry during low flow conditions (August – March)*. While the low flow water right condition is recognized in the next sentence, the assertion that Perpetua Resources will dry the East Fork South Fork Salmon River (EFSFSR) is false and this statement, or similar, is repeated multiple times. The low flow water right condition is active when the flows in the EFSFSR below Sugar Creek are less than 25 cfs and limits net diversion from both groundwater and surface water diversions to 20 percent of the streamflow during these times (PRII 2022).

Lastly, the representation that a 10.43 cfs diversion rate should be modeled reflects a misunderstanding of the site wide water balance (SWWB) and the SWWB interaction with the Stibnite Hydrologic Site Model (SHSM). The SHSM simulates quantity and timing of dewatering water and the SWWB uses this as an input for industrial water supply. The SWWB then derives the required diversion rate by source for freshwater makeup considering the other sources of water – reclaim, contact water, dewatering water. The SWWB cannot simulate a balanced water balance with a fixed

10.43 cfs diversion rate. This would result in runaway accumulation of stored water, i.e., an imbalanced water balance, or senseless treatment and discharge of water without any beneficial use. Input data to the SHSM would therefore not be available, or not be sensible. The SHSM could simulate a 10.43 cfs diversion rate in the absence of the SWWB output, however, the model simulation would be detached from mine operations and the output would not be representative of anticipated impacts.

The 9.6 cfs industrial diversion rate is the sum of the peak diversion modeled in the SWWB and SHSM (dewatering) for mill water, rate of excess dewatering water (treated and discharged), dust suppression, and water needed for drilling. The cumulative peak rate is used to determine the applied for diversion rate to account for modeling uncertainties including the monthly timestep not being resolved to a daily rate, the deterministic climate condition that is based on a 14-year historical period and timing, and quantities of reclaim water from the tailings storage facility (TSF; BC 2021a). Instantaneous or daily diversion demand will be higher and lower than the expected monthly diversion demand and could be as high as 9.6 cfs; actual climate conditions will vary from the climate series used in the model and TSF reclaim water could be available earlier or later in mine life than simulated. Kaiser (2023) does cite the SGP Diversion Rate and Storage Volume memo with this explanation, then proceeds to assert that that peak diversion rate by source is not anticipated to occur simultaneously (BC 2021a).

While the discussion surrounding the point of quantification (POQ) in Kaiser (2023; page 11-12) is unclear, it is implied that the point of quantification, that is the EFSFSR below Sugar Creek, will be the measurement point to quantify water diversions. This is inferred because Water District 63 POD measurement is discussed; however, it is not relevant to the SGP. The interpretation that the SGP's diversion rate will be measured at the POQ is incorrect. It is anticipated that measurement of water diversions at their POD will be stipulated as a water right condition and Perpetua Resources will report diversions. Utilization of the POQ is limited to calculated of unimpaired flow for administration of the low flow water right condition (PRII 2022).

The criticism of the SHSM that simulated no action streamflows are greater than the 7Q10 flows and 95 percent exceedance flows is an inappropriate comparison because the SHSM temporal scale is monthly and therefore it simulates streamflows based on monthly-resolved meteoric and soil/groundwater conditions. The SHSM objective is to simulate anticipated monthly conditions for long term estimation of future conditions, not to simulate rare occurrences at a sub-monthly or greater than monthly period. The 7Q10 flow is quantified on a 7-day period and the 95 percent exceedance estimated by Rio is based on the entire period of use by each fish species that spans multiple months (Rio 2021).

Similarly, Table 3 in Kaiser (2023) presents monthly 95 percent exceedance flows for various sources. The calculation of a monthly 95 percent exceedance flow using monthly values from the SHSM is not discussed and flow exceedances are typically calculated using daily data. Nonetheless, it is an inappropriate expectation that the SHSM would simulate a very rare condition, such as the 95 percent exceedance flow, when the modeling objective is to simulate an anticipated future condition at the monthly timestep.

It is incorrect to evaluate the impact of the total water right during low flow periods because of the low flow water right condition. The months in their Table 3 that show zero flow in the Full Water Right column represent flows that are less than 25 cfs and therefore the low flow water right condition will limit diversion rate. Kaiser (2023) makes the claim that when flows at the point of quantification are below 17 cfs, flows at the EFSFSR at Stibnite gage will be less than 7 cfs. No data is presented to justify this claim.

5.2 Summary of the Predicted Groundwater Effects of Perpetua's Water Rights

The NPT expert witness report begins this section by stating that model limitations of the SHSM, a lack of understanding of specific well locations and construction information prevents the author's assessment of the magnitude of effects Perpetua's water rights will have on groundwater levels. Each of the model limitations identified by the author are discussed in Section 4.2 of this rebuttal and are shown to stem from poor understanding of the model structure (e.g., model boundary condition west of Yellow Pine pit), misinterpretation of data (e.g., groundwater levels in the Yellow Pine pit area), unsupported criticism (e.g., model layer thickness and vertical hydraulic gradients, and claimed lack of sensitivity analysis), items likely of no significant consequence (e.g., SFR stream stage depth, additional structural element inclusion), and a misunderstanding of ASTM groundwater model calibration standards. The SHSM is a well calibrated, thoroughly reviewed hydrologic model that is well suited to assess the magnitude of effects that Perpetua's utilization of water rights will have on groundwater levels.

In the second paragraph of this section, the NPT report first discusses the alteration of local recharge resulting from construction of the tailings storage facility (TSF) and then shifts to a contention that the rate of groundwater level rebound is uncertain because of a lack of sensitivity analysis on modeled hydraulic conductivities. The SHSM predictive model simulations include changes in recharge due to the presence of the TSF, so it is unclear what the point of this criticism is. The statement about the lack of sensitivity analysis on modeled hydraulic conductivity is not supported by additional discussion; it is also unclear how this would affect water level rebound or why the author felt this should be included here. As described more fully in section 4.2 above, a sensitivity analysis was conducted to understand how sensitive the model calibration is to changes in a particular parameter. The sensitivity analysis does not change the calibration of the model. With respect to the SHSM, the calibration of the model around the mine pits, in relation to both hydraulic conductivity and specific yield (storage in the NPT author's terminology), is confirmed through the sensitivity evaluation.

The last paragraph of this section of the NPT report states that specific impact on stream flows beyond the mining period is challenging to quantify because of the alleged limitations of the SHSM and lack of uncertainty analysis. Section 4.2 provides discussion that demonstrates that the limitations referred to by the author are either invalid or unlikely to produce meaningful change in model simulation results. It is unclear what the mention of uncertainty analysis is intended to relate to. It is unclear whether the author is conflating sensitivity analysis with uncertainty analysis.

Section 6

Summary

The NPT expert report presents an inflated total of Perpetua Resources combined water rights under the applications and, in discussion of the potential impacts to surface water flows, fails to disclose the low flow water right condition reached between Perpetua and the IDFG and the OSC that would limit withdrawals of surface water. Further, it does not account for stream augmentation from treated dewatering water to Meadow Creek and the EFSFSR. The NPT report also fails to note annual volumetric limitations on diversions and incorrectly portrays diversions at maximum allowable rates for extended period. Further, the NPT report incorrectly states that water rights for dewatering water are not included in the applications. This rebuttal shows that, while mischaracterized in the NPT expert report, the Project's water rights, water usage, and potential impacts to surface water are properly characterized through the extensive efforts conducted by Perpetua Resources. These documents are largely misinterpreted or misunderstood by the NPT and the resulting impact assessment overstated.

Perpetua Resources rebuttal to the NPT expert witness report shows that the NPT claim that climate change effects have not been appropriately addressed through Perpetua Resources hydrogeologic analysis and modeling efforts are not substantiated and are misleading. The NPT report presents information from various literature sources and implies the interpretations are directly relevant to the SGP but fails to show that the information and interpretations are actually applicable. For example, the NPT expert report implies that changes in the proportion of precipitation falling as snow versus rain in late fall and early spring will have a direct impact on low flows. Contrary to this, there is evidence presented in the scientific literature that total precipitation has a greater influence on low flows. Section 4.1 of this expert witness rebuttal shows that this and other characterizations of the effects of climate change are inappropriately applied and misleading.

The NPT expert witness report attempts to discredit the appropriateness of Perpetua's SHSM and its ability to properly characterize surface water and groundwater flows for assessment of project impacts by claiming that sensitivity analyses were not conducted, model domain is inappropriate, geologic structures were inadequately addressed, together with other purported model inadequacies. Section 4.2 of this expert witness rebuttal shows that, in fact, sensitivity analyses were conducted, the NPT is misleading in their SHSM critique, and the groundwater and surface water modeling conducted by Perpetua Resources has been thorough and appropriate for characterization of SGP impacts.

Assessment of assertions in the NPT report that the SHSM no action model simulates higher greater streamflow than observed during low flow conditions reveals that the NPT report misidentifies the annual low flow period at the SGP and presents misapplied statistics with unexplained graphics to support the assertions. Section 4.3 of this rebuttal to the NPT report identifies the misapplied statistical evaluations, provides support that the SHSM does indeed appropriately simulate low flow conditions and shows that the assertions regarding low flow simulations by the SHSM are unsupported and misleading.

In summary, the NPT expert witness report does not support its stated premise that hydrologic and water balance modeling fail to adequately address climate change and potentially resulting effects on surface water and groundwater flows at the SGP or that there is cause for the State of Idaho to not approve Perpetua's applications for water appropriations.

Section 7

References

- Abatzoglou, J. T., Marshall, A. M., Harley, G. L. 2021. Observed and Projected Changes in Idaho's Climate. *Idaho Climate-Economy Impacts Assessment*. James A. & Louise McClure Center for Public Policy Research, University of Idaho. Boise, ID.
- Brown and Caldwell (BC), 2023. Nez Perce Tribe Fisheries Expert Report Rebuttal for Perpetua Resources Water Right Application. Prepared for Perpetua Resources Idaho, Inc. November.
- Brown and Caldwell (BC), 2021a. SGP Water Right Diversion Rate and Storage Volume. Prepared for Perpetua Resources, Idaho, Inc. October.
- BC, 2021b. Hydrologic Site Model Refined Proposed Action (ModPRO2) Report. Prepared for Perpetua Resources Idaho, Inc. April
- BC, 2021c. Stibnite Gold Project Stibnite Hydrologic Site Modeling (SHSM) Sensitivity Analysis. Prepared for Perpetua Resources Idaho, Inc. September.
- Bloschl, g., and A. Montanari. 2010. Climate change impacts – throwing the dice?. *Hydrologic Processes*, 24(3).
- Bloschl, G., et al. 2007. At what scales do climate variability and land cover change impact on flooding and low flows?. *Hydrologic Processes*, 21(9).
- IPCC. 2007. Climate change 2007: The physical science basis, in Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, edited by S. Solomon et al., Cambridge University Press.
- Klos, P. Z., and Coauthors, 2015. Indicators of Climate Change in Idaho: An Assessment Framework for Coupling Biophysical Change and Social Perception. *Wea. Climate Soc.*, 7, 238– 254, <https://doi.org/10.1175/WCAS-D-13-00070.1>.
- Kormos, P. R., Luce, C. H., Wenger, S. W., Berghuijs, W. R. 2016. Trends and Sensitivities of Low Streamflow Extremes to Discharge Timing and Magnitude in Pacific Northwest Mountain Streams. *Water Resources Research*.
- McMillen Jacobs Associates, 2022. Supplemental Tunnel Hydraulic Modeling. Prepared for Perpetua Resources, Idaho, Inc. December.
- Perpetua Resources Idaho, Inc (PRII), 2021. Stibnite Gold Project Site-Wide Water Balance Model Refined Proposed Action (ModPRO2) Report. October.
- Perpetua Resources Idaho, Inc. (PRII), 2022. Request for Technical Assistance Review – Perpetua Resources Idaho, Inc. Letter to the Governor's Office of Energy and Mineral Resources. June 27.
- Pfannerstill, Matthias, Guse, B., Fohrer, N. 2014. Smart low flow signature metrics for an improved overall performance. *Journal of Hydrology*. 510, 447-458.
- Rio ASE. 2023a. Stream Functional Assessment Report for Modified Proposed Action #2 (ModPRO2): Stibnite Gold Project. Prepared for Perpetua Resources Idaho, Inc. April 2023.
- Rio ASE 2023b. Stibnite Gold Project Fish Passage Evaluation Technical Memorandum. Prepared for Gene Bosley, Perpetua Resources Idaho, Inc. from Joe Young and Jeff Fealko, Rio ASE. Dated March 21, 2023.
- RioASE. 2021. Stream Design Report. Prepared for Midas Gold Idaho, Inc., Appendix A.
- Seneviratne, S. I., et al. 2012. Changes in climate extremes and their impacts on the natural physical environment, in *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, edited by C.B. Field et al. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Tague, C. and G. Grant. 2009. Groundwater dynamics mediate low-flow response to global warming in snow-dominated alpine regions. *Water Resources Research*, 45,

