TECHNICAL MEMORANDUM

PROJECT NO.: WGA212252

DATE: 14 MAY 2024

COMPANY NAME	Oceana Gold (New Zealand) Ltd
ATTENTION	Dean Fergusson
SUBJECT	MPIV Water Management Technical Documents Review Summary

EXECUTIVE SUMMARY

Oceana Gold (New Zealand) Ltd (OceanaGold) has applied for resource consents authorising the proposed Macraes Phase 4 Project (MPIV) at the Macraes Gold Project (MGP), East Otago. In general, the MPIV Project consists of the planned mining of ore from areas outside those authorised under existing resource consents, the storage of associated overburden waste rock in planned in-pit and ex-pit waste rock stacks (WRS) and the storage of processed ore wastes (tailings) in existing and proposed tailings storage facilities (TSF).

Brett Sinclair of Wallbridge Gilbert Aztec (WGA) has provided technical peer review services to OceanaGold covering the hydrological and hydrogeological reports submitted in support of the application for consents authorising the MPIV Project.

The project components reviewed in this memorandum are:

- Coronation Stage 6 (CO6)
- Golden Bar Stage 2 (GB Stage 2)
- MPIV Project Cumulative Effects, which includes the effects out of the proposed CO6 and GB Stage 2 developments

The above project components cumulatively affect water quality in the Deepdell Creek, Shag River, Mare Burn and Waikouaiti River North Branch (NBWR) catchments.

The work undertaken by OceanaGold and their technical consultants GHD Ltd and Mine Water Management Ltd with respect to modelling the effects of the MPIV and the existing MGP on water quality and developing a selected mitigation scenario is of high quality. The Water Balance Model produced in support of this consent application is robust and defensible.

The proposed mitigation scenario for the MGP, including the mitigations proposed for the Coronation Stage 6 and the Golden Bar Stage 2 developments, presents a coherent and reasonable set of measures that should enable OceanaGold to comply with existing MGP water quality compliance criteria for the long-term future. Through the modelling and mitigation testing process, mitigation options that are practically unachievable, overly optimistic or not adequately supported by existing trials were excluded from the selected mitigation scenario proposed for water management.

Additional potential mitigation measures have been identified by OceanaGold but not incorporated in the proposed mitigation scenario. Some of these measures may offer other and improved means of achieving compliance with the existing water quality criteria, such as optimised mine water treatment systems. However, additional work would be necessary to verify the performance and applicability of these measures. Continuing to apply an adaptive water management process is appropriate for this complex mine site. Such a process encourages ongoing investigation and optimisation of the mine water management plan.

1. INTRODUCTION

Oceana Gold (New Zealand) Ltd (OceanaGold) has applied for resource consents authorising the proposed Macraes Phase 4 Project (MPIV) at the Macraes Gold Project (MGP), East Otago. In general, the MPIV Project consists of the planned mining of ore from open pit extensions at Coronation, Innes Mills and Golden Bar, outside the pit extents authorised under existing resource consents, the storage of associated overburden waste rock in planned in-pit and ex-pit waste storage in backfills and waste rock stacks (WRS), respectively, and the storage of the by-product of processed ore (tailings) in existing and proposed tailings storage facilities (TSF).

OceanaGold approached Wallbridge Gilbert Aztec (WGA) in 2022 to provide technical peer review services for several planned mine developments at the MGP. One of these developments was the proposed MPIV Project. Contractual arrangements for the provision of technical review services were completed on 7 April 2022. The peer review process began at this time and has been finalised once final versions of technical reports from the various consultants engaged by OceanaGold to undertake the MPIV assessment have become available. This memorandum documents the outcomes of peer reviews covering the hydrological and hydrogeological reports submitted in support of the application for consents authorising the MPIV Project.

In addition to this introduction, this memorandum consists of the following sections:

- Section 2 provides information on the peer reviewer.
- Section 3 summarises the components of the MPIV Project.
- Section 4 lists the reports peer reviewed in this memorandum.
- Section 5 presents the peer review outcomes for the Coronation Stage 6 (CO6) components of the MPIV project.
- Section 6 presents the peer review outcomes for the Golden Bar Stage 2 (GB Stage 2) components of the MPIV project.
- Section 7 presents the peer review outcomes for the hydrological and hydrogeological aspects of the MPIV Project as a whole. That is, emissions from the above pit stages and mining and tailings storage at the Frasers-Innes Mills pits and Golden Point Pit to the Deepdell Creek and North Branch Waikouaiti River catchments.
- Section 8 presents the conclusions from the peer review process.

2. REVIEWER

I, Brett Sinclair, am a Senior Principal Hydrogeologist at WGA, an engineering consultancy based in Australia and New Zealand with approximately 650 employees. I have a Master of Science in Geology, awarded by the University of Auckland in 1986. I also have a Postgraduate Certificate in Hydrogeology and Engineering Geology awarded by the University of Tübingen, Germany, in 1995. I have approximately 30 years professional experience in geology and hydrogeology, working predominantly as a consultant.

I have undertaken numerous groundwater and mine water assessments for OceanaGold related to the MGP since 2000. I have extensive knowledge of the MGP site, the groundwater system at the site, mine water management at the site, and resource consents authorising existing operations at the site.

I have undertaken the groundwater and mine water management peer review work related to the MPIV Project for OceanaGold on behalf of WGA since 7 April 2022. I am the author of this memorandum, which summarises the findings of my reviews of technical reports documenting effects projected to arise from the MPIV Project on receiving water quality and flow, and the mitigation of those projected effects.

My review is formulated based on attendance at regular hydrogeology specialists meetings, review of incremental surface and hydrology models and reports, and interaction with both the OceanaGold project team and the key consultants engaged by them to assess effects on the surface and groundwater at Macraes. This includes GHD for surface and groundwater associated with MPIV mine extensions, and, to the extent that it is a contributor to surface and groundwater effects, WSP for the Golden Point Underground Mine Expansion and Extension.

3. BACKGROUND

The MPIV Project includes:

1. Coronation Open Pit extension: The dewatering, overburden stripping and ore extraction operations that constitute an expansion to the existing Coronation Pit (designated as Coronation Pit Stage 6). The storage of the associated overburden waste rock in the existing Coronation North Pit (designated as the Coronation North WRS).

2. Golden Bar Pit extension: The dewatering of the existing Golden Bar Pit in preparation for mining operations to extend mining in this pit. Overburden stripping and ore extraction operations that constitute an expansion to Golden Bar Pit (designated as Golden Bar Stage 2). The storage of the associated overburden waste rock in an expansion of the adjacent Clydesdale WRS (designated as Golden Bar WRS).

3. Overburden stripping and ore extraction operations in several small areas peripheral to the existing Innes Mills Pit (designated as IM9-10). The storage of the associated overburden waste rock in relatively small WRSs on the western side of the existing Golden Point Pit and as backfills in the existing Frasers and Innes Mills Pits and the Frasers Waste Rock Stack.

4. The storage of associated processed ore tailings in either the existing consented Top Tipperary Tailings Storage Facility (TTTSF) or in a proposed TSF in the mined-out Frasers Pit (Frasers TSF).

I understand that OceanaGold has also recently applied separately to the ORC for resource consents authorising several proposed mine developments at the MGP that complement the scope of the MPIV Project. These applications are for consents covering:

1. Renewal of various lapsed consents associated with MP3 and the Coronation projects. Consents authorised.

2. A raise in the Top Tipperary Tailings Storage Facility (TTTSF) embankment crest elevation from 568 mRL to 570 mRL, enabling the storage of an additional ~3.1 Mm^3 of tailings in this facility. Consents authorised.

3. The co-disposal of 6 Mt of remined tailings from Southern Pit TSF, with approximately 37 Mt of waste rock from Innes Mills Pit, totalling approximately 38.9 Mm^3, into the Frasers Backfill in the existing Frasers Pit. Consents authorised.

4. An expansion and extension to the existing Golden Point Underground Mine within the Deepdell Creek catchment, to a total area of approximately 38 ha and a maximum depth of 375 m below ground level. Some consents authorised; others are awaiting approval from ORC.

5. Stripping at Innes Mills and an initial stage of waste storage at Frasers TSF to provide for continuity of the operation (Continuity Consent Project). Consents authorised.

The above developments influence the water balance and water quality modelling undertaken for MPIV but are outside the scope of the current review and this memorandum. I have previously reviewed the groundwater and mine water assessments undertaken in support of the consenting process for the above developments. I consider that the effects of the above proposed developments are appropriately accounted for in the groundwater and/or mine water models developed in support of the current consent application.

4. REVIEWED DOCUMENTS AND ADDITIONAL DOCUMENTS CONSIDERED

The documents reviewed under the scope of the MPIV project are:

- GHD 2023. Golden Bar Dewatering Assessment. Report produced for OceanaGold (New Zealand) Limited by GHD Limited, dated 21 July 2023.
- GHD 2024a. Macraes Phase IV. Coronation – Surface and Groundwater Assessment. Report produced for OceanaGold (New Zealand) Limited by GHD Limited, dated 26 February 2024. GHD document number 12576793-REP-Macraes Coronation Stage III Final.
- GHD 2024b. Macraes Phase IV. Golden Bar – Surface and Groundwater Assessment. Report produced for OceanaGold (New Zealand) Limited by GHD Limited, dated 28 January 2024. GHD document number 12576793-REP-Macraes Golden Bar Stage III.
- GHD 2024c. Macraes Phase IV, Stage III – Surface and Groundwater Assessment. Report produced for OceanaGold (New Zealand) Limited by GHD Limited, dated 26 March 2024. GHD document number 12576793-REP-Macraes Golden Bar Stage III Final.

The modelling work documented in the above reports relies heavily on geochemistry and water quality analyses undertaken by Mine Water Management Ltd (MWM) and documented in the report below. This MWM report presents in a single document analysis work that was referenced to earlier MWM memoranda in the above GHD reports. Information presented in the report below has been taken into account in WGA's MPIV peer review process. However, the MWM report is outside the scope of this MPIV review and outside the expertise of WGA's reviewer.

- MWM 2024. Macraes Mine Phase 4.3: Environmental Geochemistry Assessment. OceanaGold Macraes Mine Site. Report produced for OceanaGold Limited by Mine Waste Management Limited, dated 28 February 2024. MWM document number J-NZ0229-004-R-Rev0.

Copies of the groundwater and the surface water models developed to support the MPIV consent application process were not interrogated by WGA as part of this review process. However, I have had the opportunity to review model boundary conditions, key assumptions, constraints and basis of calibration and satisfied myself that the approach to modelling that informed the outputs in the reviewed reports provides an accurate and correct representation of the documented models. Through the report review process and through numerous discussions with the modellers, no grounds have arisen to doubt the veracity of this assumption.

The Assessment of Environmental Effects produced in support of the application by OceanaGold for consents authorising the MPIV Project has not been read or reviewed within the scope of this technical review process. However, I have provided technical review feedback on the GHD reports through the course of this project. This feedback is implicitly accounted for in the water effects section of the AEE.

In addition to the above documents, within the past two years I peer reviewed the following documents in support of separate resource consent applications by OceanaGold. The outcomes from these peer reviews are not replicated in this current review memorandum. The effects of the MGP extensions evaluated in the reports below have been incorporated in the current assessment covering the MPIV Project as a whole.

- WSP 2023. Golden Point Underground Mine (GPUG), GPUG Extension Hydrogeological Assessment. Report produced for OceanaGold (New Zealand) Limited by WSP Australia Pty Ltd. Dated 26 April 2023. WSP document number PS130025-003-R-Rev5.
- GHD 2022a. TTTSF crest raise. Surface water and groundwater assessment. Report submitted to Oceana Gold (New Zealand) Ltd by GHD Limited. Dated August 2022.
- GHD 2022b Frasers Co-disposal surface water and groundwater assessment. Report submitted to Oceana Gold (New Zealand) Ltd by GHD Limited. Dated 21 October 2022.

5. CORONATION STAGE 6 (CO6)

The technical review of the report documenting the evaluation of surface and groundwater effects arising from the proposed CO6 development (GHD 2024a) is presented in Appendix A.

The structure and calibration of the groundwater model simulating the Coronation area of the MGP is consistent with past modelling work at the MGP. The calibrated model and the associated predictive models documented in the report (GHD 2024a) are considered to be fit for the purposes of simulating groundwater drawdown and recovery related to the CO6 development and sulfate transport in groundwater around the Coronation area.

The groundwater model indicates that all dissolved contaminants transported in groundwater away from the opencast pits and stored wastes in the Coronation area, including the C06 development will eventually discharge to receiving waters upstream from the MB02 compliance monitoring point.

The structure and input parameters for the WBM is appropriate to simulate the effects of the proposed CO6 development on downstream flows and water quality. The input water quality values applied to the modelling appear reasonable, although a detailed review of these values is outside the scope of this document.

The modelled exceedance curves for sulfate, nitrate-N, and ammoniacal-N at the existing water quality compliance monitoring points MB01 and MB02 appear reasonable. These exceedance curves are consistent with the concentrations of these contaminants applied as input parameters to the model and the availability of dilution water in the receiving streams. The contaminant exceedance frequencies documented in Table 5.7 of the GHD (2024a) report also appear reasonable.

The modelled <1% probability of exceedance for sulfate at both MB01 and MB02 following mine closure is dependent on the buffer storage capacity of both Trimbells Silt Pond and Maori Hen Silt Pond being retained indefinitely. If either or both of these silt ponds are removed, the sulfate exceedance frequency is likely to increase.

A key assumption in the WBM is that the dissolved contaminant concentrations in seepage flows from the CO6 pit lake through Trimbells WRS toward Trimbells Gully will not increase due to contact with the stored wastes. MWM has identified several management techniques to reduce the oxidation of sulfide minerals and minimise the mobilisation of any oxidation products. These techniques include the installation of an advective barrier (equivalent to a low flow barrier) against the downstream toe of the WRS to reduce the potential ingress of oxygen to the base of the WRS (Section 7.2.4, MWM 2024). Conceptually, this technique is reasonable and has been applied elsewhere although further research at the MGP is likely to be needed into its effectiveness.

The already consented Coal Creek Dam was not incorporated in the modelling, as the model results indicated it is unnecessary. However, construction of this dam remains a valid contingency measure to provide augmented base flows in Mare Burn during dry summer periods should future compliance necessitate this.

Overall, the technical assessment of the water quality effects arising from the proposed C06 development is considered to be defensible and fit for purpose.

6. GOLDEN BAR STAGE 2 (GB STAGE 2)

The technical review of the report documenting the evaluation of surface and groundwater effects arising from the proposed dewatering of the existing Golden Bar Pit (GHD 2023) and implementation of the proposed GB Stage 2 development (GHD 2024b) is presented in Appendix B.

Golden Bar Pit Dewatering

The structure and input parameters for the WBM developed to simulate the effects of the proposed dewatering of Golden Bar Pit on water quality in Golden Bar Creek is appropriate for this purpose. The input water quality values applied to the modelling appear reasonable and are consistent with observed mine and receiving water quality data from the same area. A detailed review of these water quality values is outside the scope of this document.

The calibration of this WBM has been undertaken targeting several water flow, water storage and water quality datasets from the same area. Overall, the WBM model covering the water quality effects in the Golden Bar Creek catchment arising from dewatering of Golden Bar Pit is considered to be well calibrated and fit for purpose.

The water quality input data indicate only sulfate, dissolved arsenic and ammoniacal-N are likely to present risks in terms of existing MGP compliance criteria or National Policy Statement for Freshwater Management (2023) Band A attributes being exceeded through the dewatering of Golden Bar Pit.

Three constant pumping rates have been considered in the pit dewatering evaluation; 15 L/s, 20 L/s and 30 L/s. The modelling indicates pit dewatering can be achieved in between one and three years using these pumping rates. The pumped water would comprise more than 50% of the flow in Golden Bar Creek at NB01 for more than 50% of the time, irrespective of which pumping rate is applied.

In terms of receiving water quality, the Golden Bar Pit dewatering model outcomes are focused on sulfate and dissolved arsenic. In Golden Bar Creek at NB01 there is no existing compliance criterion for sulfate. The receiving water would slightly exceed a sulfate concentration of 250 mg/L, which is the criterion applicable at NB03, slightly more than 5% of the time for all three pumping rates. In the NBWR at NB03 the model indicates the discharged mine water has a lower concentration than the receiving river water during low river flow periods. Consequently, the simulated pumped discharge would result in an improvement in sulfate concentrations at NB03 across the upper 15% of the currently observed range.

Measured dissolved arsenic levels in the pit lake are currently just below the compliance criterion of 0.15 g/m^3 at NB01 and exceed the NB03 criterion of 0.01 g/m^3. The model indicates the discharge of lake water to Golden Bar Creek would not lead to the dissolved arsenic criterion at NB01 being exceeded. In contrast, the modelled discharge would lead to dissolved arsenic at NB03 frequently exceeding the existing compliance criterion applicable at that point, irrespective of which pumping rate was applied.

The modelling indicates water management measures would need to be implemented to enable Golden Bar Pit dewatering to occur within a period of three years, while complying with the existing consented water quality criterion for dissolved arsenic at NB03. Although compliance with the existing sulfate criterion at NB03 would also not be achieved under the pumping rates tested, this outcome was principally due to elevated existing sulfate concentrations in the NBWR at NB03.

Two water quality management measures have been proposed to address this risk: pumping the Golden Bar pit lake water back to Frasers Pit or discharge of the water to the Golden Bar WRS silt pond. Both measures are conceptually practical but would need to be incorporated into a wider water quality management program for the entire MGP. The wider MPIV assessment has separately identified two further management measures to enable dewatering of the Golden Bar Pit while enabling OceanaGold to continue to meet existing water quality compliance criteria at the site.

GB Stage 2 Mine Water Management

A 3D groundwater flow and contaminant transport model has been developed to help evaluate groundwater inflows to the proposed GB Stage 2 opencast mine, pit lake recovery following mine closure and seepage losses from GB Stage 2 to surrounding surface water bodies. The structure and calibration of the groundwater model simulating the Golden Bar area is consistent with past modelling work at the MGP. The calibrated model and the associated predictive models documented in the report (GHD 2024b) are considered to be fit for the purposes of simulating groundwater drawdown and recovery around the GB Stage 2 Pit and groundwater transport of sulfate within the Golden Bar area.

Maintaining the GB Stage 2 Pit in a dewatered state is projected to result in a stream depletion rate of 0.55 L/s. However, this ‘depletion’ is spread across the entire modelled area and represents less than 1% of the total simulated outflows to the simulated surface water features. Changes to groundwater contributions to local creeks/streams arising from the operational dewatering of GB Stage 2 are expected to be negligible.

The groundwater model indicates that almost all dissolved contaminants transported in groundwater from the GB Stage 2 Pit and Golden Bar WRS will eventually discharge to receiving waters upstream from the NB03 compliance monitoring point. A minor sulfate mass load of <0.1 kg/day sourced from GB Stage 2 is expected to be transported in groundwater and discharged to receiving waters in the Tipperary Creek catchment.

The structure and input parameters for the WBM developed to simulate the effects of the proposed GB Stage 2 development on downstream flows and water quality is appropriate for this purpose. The input water quality values applied to the modelling appear reasonable, although a detailed review of these values is outside the scope of this document.

The calibration of this WBM has been undertaken targeting several water flow, pit lake filling/water storage and water quality datasets from the same area. Overall, the WBM model covering the water quality effects in the NBWR catchment arising from the GB Stage 2 development is considered to be well calibrated and fit for purpose.

Runoff and seepage water from the Golden Bar area is captured and returned for use on site. This process will cease following the completion of mining operations at Golden Bar. Therefore, the key model outcomes with respect to assessing receiving water quality are for the post-closure period.

The WBM indicates that the GB Stage 2 Pit will fill to an elevation of 497.5 mRL and then overflow to Golden Bar Creek, as the existing pit lake currently does. The filling period was modelled to be in the order of 40 years, with an uncertainty range of approximately 10 years, based on the previous filling history.

The key contaminants identified through the WBM simulations are sulphate, nitrate-N and ammoniacal-N. The modelled exceedance curves for these parameters at the existing water quality compliance monitoring points GB02 and NB01 appear reasonable. The exceedance curves are consistent with the concentrations of the contaminants applied as input parameters to the model and the availability of dilution water in the receiving streams.

Overall, the WBM model outcomes indicate only dissolved arsenic may present a water quality compliance risk at either GB02 or NB01, and this risk only arises following the filling and overflow of the GB Stage 2 pit lake. This outcome assumes water discharged during dewatering of the existing Golden Bar pit lake water is pumped to either Frasers Pit or to the Golden Bar WRS silt pond. Release of this water to the NBWR catchment may need to be actively managed to ensure compliance with the downstream water quality criteria applicable at NB03.

Statistics covering the projected water quality at NB03 have not been presented in this (GHD 2024b) report. The quality of water at the NB03 compliance monitoring point is more dependent on mine water management across the wider MGP than on focused management of water in the Golden Bar and Clydesdale Creek catchments. Therefore, projected water quality at NB03 is documented in the separate Macraes Phase IV water management report (GHD 2024c).

Overall, the technical assessment of the water quality effects arising from the proposed GB Stage 2 development is considered to be defensible and fit for purpose.

7. MACRAES PHASE IV (MPIV) CUMULATIVE EFFECTS

The structure, defined boundary conditions and calibration of the groundwater model simulating the MPIV project is consistent with past modelling work at the MGP. The model used by GHD is generally considered to be fit for the intended purpose of assessing groundwater flows to the simulated opencast pits and identifying the discharge areas for contaminant plumes arising from simulated MGP mining features.

The groundwater model indicates that all dissolved contaminants transported in groundwater away from mining impacted areas of the MGP, including the opencast pits, stored waste rock and tailings, will eventually discharge to receiving waters upstream from the existing compliance monitoring points on the Shag River, Tipperary Creek, Murphys Creek, and the NBWR. Although the model indicates some sulfate transport to a discharge area on Deepdell Creek immediately downstream from DC08, the WBM incorporates all contaminant mass loads from the MGP as reporting to Deepdell Creek upstream from DC08.

OceanaGold does not currently plan to construct the Back Road WRS as part of MPIV. Therefore, the Back Road WRS and associated effects on water quality have been excluded from the groundwater and surface water modelling for MPIV.

A key outcome of the groundwater modelling is the difference in simulated mass loads between 20 years post-closure and 200 years post-closure. This difference emphasises the delay between the loss of contaminants from stored wastes at the MGP and the eventual discharge of these contaminants to the receiving surface waters. Therefore, the water quality management planning undertaken by OceanaGold has taken into account the need to plan for increasing contaminant mass loads for a considerable period (200 + years) into the future.

Simulation of predicted effects for this length of time exceeds normal practice in New Zealand, as uncertainty regarding future climate patterns increases over such long periods. Additionally, the maximum effects arising from almost all projects have manifested themselves within much shorter periods. However, in the case of a large mine focused on the extraction, processing, and storage of wastes from sulfide ores, very long-term model projections are appropriate and represent good practice.

The groundwater model identifies stream depletion effects arising from the MGP. However, the simulated stream depletion effects are almost all existing effects arising from development of existing opencast pits. The only new reduction in stream flows that is linked to the MPIV development arises out of the proposed extension and expansion of the GPUG mine, which at 0.5 L/sec maximum, is a ‘no more than minor effect’ that was subject to a separate consent application. The depletion effect arising from the extension and expansion of the GPUG mine is not a permanent effect, with the reasonable expectation that it will last between 35 and 70 years (subject to mine recharge rates and inundation time).

An important assumption built into the groundwater mass transport modelling, and into the mine water balance modelling, is that historical underground mine workings at the northern end of the Golden Point Pit are to be effectively sealed as part of site closure. This management measure is required to ensure rising groundwater levels within the Golden Bar Pit backfill do not result in overflows to Deepdell Creek via these workings.

The structure and input parameters for the WBM are appropriate to simulate the effects of the proposed MPIV development on downstream flows and water quality at existing water quality compliance points. A review of the mine water model schematic confirms that the significant mine structures and receiving water catchments have been incorporated into the model. The input water quality values applied to the modelling appear reasonable, being based on more than 30 years of water quality monitoring records from the MGP, although a detailed review of these values is outside the scope of this document.

Runoff and groundwater discharges from catchment areas unimpacted by mining operations are calculated using the AWBM (Australian Water Balance Model) method. This method has been applied for past water balance modelling at the MGP and the outcomes accepted by ORC. The runoff calculations have been calibrated separately for the Deepdell Creek and NBWR catchments. The calibration outcomes are of good quality and have been appropriately applied to other catchments intersecting the MGP.

No information has been provided on the calibration of simulated versus measured flows for the Shag River. The Shag River catchment has different rainfall patterns to those recorded at the MGP. The Shag River also receives a substantial groundwater contribution providing a reliable base flow, which is not the case for Deepdell Creek or Tipperary Creek. It appears that the WBM may underestimate base flows in the Shag River and correspondingly overestimate peak contaminant concentrations at the compliance monitoring points in the Shag River (i.e. the outcomes are conservative).

The WBM simulating the post-closure period incorporates projected changes in seasonal rainfall based on the RCP8.5 climate projections from NIWA. The model inputs indicate increased annual rainfall over the long term is approximately balanced by increased evaporative losses.

All simulated contaminants are assumed to be conservatively transported within both the groundwater and surface water environments. This means contaminants introduced to the model are not removed from the model or otherwise attenuated through geochemical reactions, oxidation state changes or precipitation processes. For sulfate, this is a reasonable assumption. However dissolved metals may be subject to adsorption or precipitation within the groundwater or at the groundwater discharge points. The documented model outcomes for dissolved metals and metalloids such as iron and arsenic at the defined compliance points may therefore be significantly overestimated.

The WBM water quality outcomes for D08 indicate that sulfate concentrations are likely to exceed the existing compliance concentration of 1,000 mg/L in the long term <0.5% of the time. Implementation of in-stream flow augmentation using water sourced from a freshwater dam at Camp Creek or an alternative source of augmentation water results in sulfate compliance at DC08 over the long term. Although non-compliance with the sulfate criterion in the short term is also indicated by the model, this outcome seems unlikely, given almost all surface discharges from the site are actively managed and the site layout within the Deepdell Creek catchment is not changing significantly under MPIV. Furthermore, the highest recorded sulfate concentration at DC08 was 950 g/m^3 in February 2015 and concentrations have been significantly lower since then (Ryder 2024).

It is important to note that other mitigation options for water quality in Deepdell Creek have been identified as part of the modelling program but not incorporated in the WBM. It is possible other mitigations may offer other routes by which full compliance with the sulfate criterion at DC08 can be achieved through the long term. It is possible OceanaGold may opt for other mitigations than the construction and operation of a flow augmentation regime.

The modelled concentrations for the other key contaminants are all within compliance at DC08, even without the implementation of management measures other than those defined in the base case model. Mitigations incorporated in the base case model (Section 5.11.1) are the collection of drain discharges from the MTI and the SP11 TSFs and seepage discharging to the Northern Gully, Battery Creek and Maori Tommy Gully. The release of the accumulated water from these sites is subject to active flow management linked to the receiving water flow rate in Deepdell Creek to reduce the risk of water quality non-compliance in Deepdell Creek.

The WBM indicates median and 95th percentile concentrations for sulfate will be within the compliance criterion of 250 mg/L at the Loop Road and McCormicks compliance monitoring points over the long term. However, the model indicates the maximum concentrations for sulfate will exceed the criterion concentration. A check on the potential availability of dilution water in the Shag River has been undertaken as part of this review. Taking into account base flows available in the Shag River, the peak concentrations at the Loop Road compliance monitoring point should be in the order of 75% less than those simulated for DC08. However, the peak simulated concentrations at Loop Road indicate a much lower dilution factor. Therefore, it appears likely the peak simulated concentrations at the Loop Road and McCormicks compliance monitoring points are overly conservative.

The WBM indicates both dissolved iron and dissolved arsenic may occasionally exceed their respective compliance criteria at the Loop Road and McCormicks compliance monitoring points. However, both of these contaminants have been assumed to be conservatively transported in groundwater and surface water systems. Furthermore, the simulated peak concentrations may not fully account for base flows in the Shag River. Finally, in the case of dissolved iron, the background concentration for undisturbed catchments contributing to the Shag River is very close to the designated compliance criterion of 0.2 mg/L. Exceedance of this criterion at the compliance points is primarily due to the elevated background concentrations applied in the model. Therefore, the modelled exceedances for dissolved iron and arsenic are considered to be very conservative or a consequence of elevated background concentrations in the river water.

Through the modelling process (that I observed in my role as peer reviewer), it became clear that the 'unmanaged' or 'unmitigated' discharge of water from areas within the NBWR catchment impacted by mining operations led to unacceptable downstream water quality outcomes. Consequently, OceanaGold worked with GHD and MWM to progressively develop and test a set of mitigations that would enable long-term compliance with the existing water quality consent criteria appliable at the various monitoring points within the NBWR catchment.

Through the mitigation testing process, mitigation options that were practically unachievable, overly optimistic or not adequately supported by existing trials were excluded from the selected mitigation scenario. This does not mean that some of these mitigations could not be implemented as part of the final water management system for the MGP. It simply means that insufficient supporting information was available at the time of modelling to justify their incorporation into the selected mitigation scenario that OceanaGold expects to implement to ensure future compliance.

As the technical reviewer, I was party to the mitigation selection process. Risks and benefits linked to each identified mitigation were identified and evaluated through this process. Overall, I consider the process followed by OceanaGold to develop a 'selected mitigation scenario' was thorough and reasonable. As a package of mitigation measures, the selected scenario presented in Section 5.12.3 of the GHD (2024c) report is reasonable and should be practically achievable.

The WBM outcomes indicate that the current site water management system can be improved substantially through the implementation of the proposed selection of mitigation measures. In my opinion, the modelled improvements in sulfate concentrations should be reasonably achievable during the operational period of the mine.

Implementation of the mitigation scenario measures in the WBM results in long-term compliance with the water quality compliance criteria at the NBWRRF and MC02 monitoring points. Implementation of the mitigation scenario results in long-term compliance with the 250 mg/L criterion for sulfate at the NB03 compliance monitoring point on the NBWR approximately 98% of the time. It is not clear whether the maximum simulated concentrations of 340 mg/L are a realistic outcome or if this is an artifact of uncertainty in the flow model calibration under very low flow conditions. This exceedance would probably arise in the model outputs irrespective of whether the MPIV Project is incorporated in the model or not, as the sources of the contaminants predominantly appear to be existing consented mine structures.

The proposed mitigations would result in long-term compliance for most other contaminants with compliance criteria set for NB03 (Table F7, Appendix F). Dissolved arsenic is the primary exception. The modelling shows little difference in exceedance curves between the base case and the mitigated scenarios. However, the modelled exceedances for dissolved arsenic arise from overflow of the GB Stage 2 pit lake. Work undertaken by OceanaGold at the Globe Progress Mine indicates dosing the lake with ferric chloride could substantially reduce dissolved arsenic concentrations in the lake water and thereby resolve the modelled exceedances for dissolved arsenic at NB03. This process was not incorporated in the selected mitigation scenario.

Dewatering of the Golden Bar Pit in preparation for mining under GB Stage 2 was excluded from the MPIV WBM simulations because the dewatering is subject to operational control to ensure water quality compliance. Options for this pit lake dewatering process have been assessed for the 1 to 2 years it will take. These options include:

- Pumping the water to Frasers Pit for operational use at the site,
- Discharge to the NBWR river catchment with active management of flows linked to receiving water flows to ensure compliance with the water quality criteria at NB03, and
- Dosing of the Golden Bar pit lake with ferric chloride to reduce dissolved arsenic concentrations in the lake water.

Overall, modelling indicates implementation of the proposed selected mitigation scenario, which includes existing base case mitigations, can enable OceanaGold to operate and close the MGP while complying with the existing water quality criteria applicable at monitoring points in the NBWR catchment. Other mitigation measures that offer potential benefits have also been considered and may be incorporated into a selected mitigation scenario in the future, if necessary or if they offer cost benefits. I accept this conclusion from the GHD report as reasonable and defensible.

8. CONCLUSIONS

I consider the work undertaken by OceanaGold and their technical consultants GHD Ltd and Mine Water Management Ltd with respect to modelling the effects of the MPIV and the existing MGP on water quality and developing a selected mitigation scenario is of high quality. The WBM produced in support of this consent application is robust and defensible. Through the modelling and mitigation testing process, mitigation options that are practically unachievable, overly optimistic or not adequately supported by existing trials were excluded from the selected mitigation scenario.

Overall, the proposed mitigation scenario for the MGP, including the mitigations proposed for the Coronation 6 and the Golden Bar Stage 2 developments, presents a coherent and reasonable set of measures that should enable OceanaGold to comply with existing water quality criteria applicable to the MGP for the long-term future.

Some potential mitigation measures have been identified by OceanaGold but not incorporated in the proposed mitigation scenario. Some of these measures may offer other and improved means of achieving compliance with the existing water quality criteria. Additional work may be necessary to verify this possibility. Continuing to apply an adaptive water management process is appropriate for managing water emissions from this complicated mine site, as such a process encourages ongoing investigation and optimisation of the operational mine water management plan.

Should you have any questions regarding the contents of this memorandum, please contact the undersigned.

Yours Sincerely

Brett Sinclair
Senior Principal Hydrogeologist
WALLBRIDGE GILBERT AZTEC

APPENDIX A CORONATION STAGE 6 (CO6) REPORT TECHNICAL REVIEW
APPENDIX B GOLDEN BAR STAGE 2 (GB STAGE 2) REPORTS TECHNICAL REVIEW
APPENDIX C MACRAES PHASE IV (MPIV) REPORT TECHNICAL REVIEW
APPENDIX D LIST OF REFERENCED REPORTS

APPENDIX A
CORONATION STAGE 6 (CO6) REPORT TECHNICAL REVIEW

A.1 Review Components

The assessment of the effects of the proposed Coronation Stage 6 (CO6) pit and the associated Coronation North WRS (waste rock backfill in Coronation North Pit) on the surrounding groundwater system and on surface water flows and water quality has been based on three components of work.

1. The assessment of the quality of seepage water from stored mine wastes and water accumulating in the proposed CO6 pit (MWM 2024).

2. The assessment of the effects of CO6 development and closure on the surrounding groundwater system, including groundwater quality (GHD 2024a).

3. The assessment of the effects of CO6 development, including the Coronation North WRS, and closure on water flows and water quality in Mare Burn. Mare Burn is the primary surface water body potentially impacted by flow losses and mine water discharges from the proposed CO6 pit and the associated Coronation North WRS (GHD 2024a).

A.2 Groundwater Modelling

A 3D groundwater flow and contaminant transport model has been developed to help evaluate groundwater inflows to the proposed CO6 opencast mine, pit lake recovery following mine closure and seepage losses from CO6 to surrounding surface water bodies.

Model Structure

The layout and topographic shells of the existing and proposed mine structures, including opencast pits and WRS areas, are consistent with the existing mine as-built layout and with the layout of the proposed CO6 features. The modelled area is sufficiently large (9 km x 9 km) that the edges of the modelled area do not impact on the simulation of the CO6 or the Coronation North WRS. The modelled area also appropriately incorporates reaches of Mare Burn and Deepdell Creek, which are the principal surface water bodies potentially impacted by CO6 and the Coronation North WRS. The existing consented water quality compliance monitoring points for Mare Burn, MB01 and MB02, are within the modelled area (Figure 1). On this basis, the extent of the 3D groundwater flow model documented in the GHD (2024a) report is appropriate for the assessment of the effects on the groundwater system arising from the proposed CO6 development.

The model of grid discretization is appropriate for the size of the overall model and the intended objectives. Lateral cell discretization close to key features, including Deepdell Creek, Mare Burn and the proposed CO6 pit, is at 25 m; increasing to 50 m across the wider modelled area. Vertical discretization of the local geology into 8 model layers is consistent with past modelling approaches. The model discretisation is appropriate to the model size and objectives.

The simulated geology in the groundwater model relates predominantly to the degree of weathering and therefore hydraulic characteristics of the in-situ schist. Additionally, the simulated geology incorporates the WRS structures as these effectively behave as localised artificial aquifers. The geological representation applied in the Coronation groundwater model is consistent with previous groundwater evaluations covering this area of the MGP (Golder 2016a, URS 2013a).

Boundary Conditions

The hydraulic boundary conditions applied to the Coronation groundwater model are appropriate to simulate the groundwater system relevant to the proposed development of the CO6 pit and the Coronation North WRS. Specifically:

- Recharge is applied across the entire model at a rate of 29.2 mm/year, which is consistent with groundwater recharge of 32 mm/year applied to past groundwater models of the MGP (Kingett Mitchell 2005, Golder 2011a).
- River boundary conditions have been used to simulate Deepdell Creek and Mare Burn. The river stage conditions are consistent with local topography and acceptable for intended model objectives. Conductance values applied to these cells are reasonable.

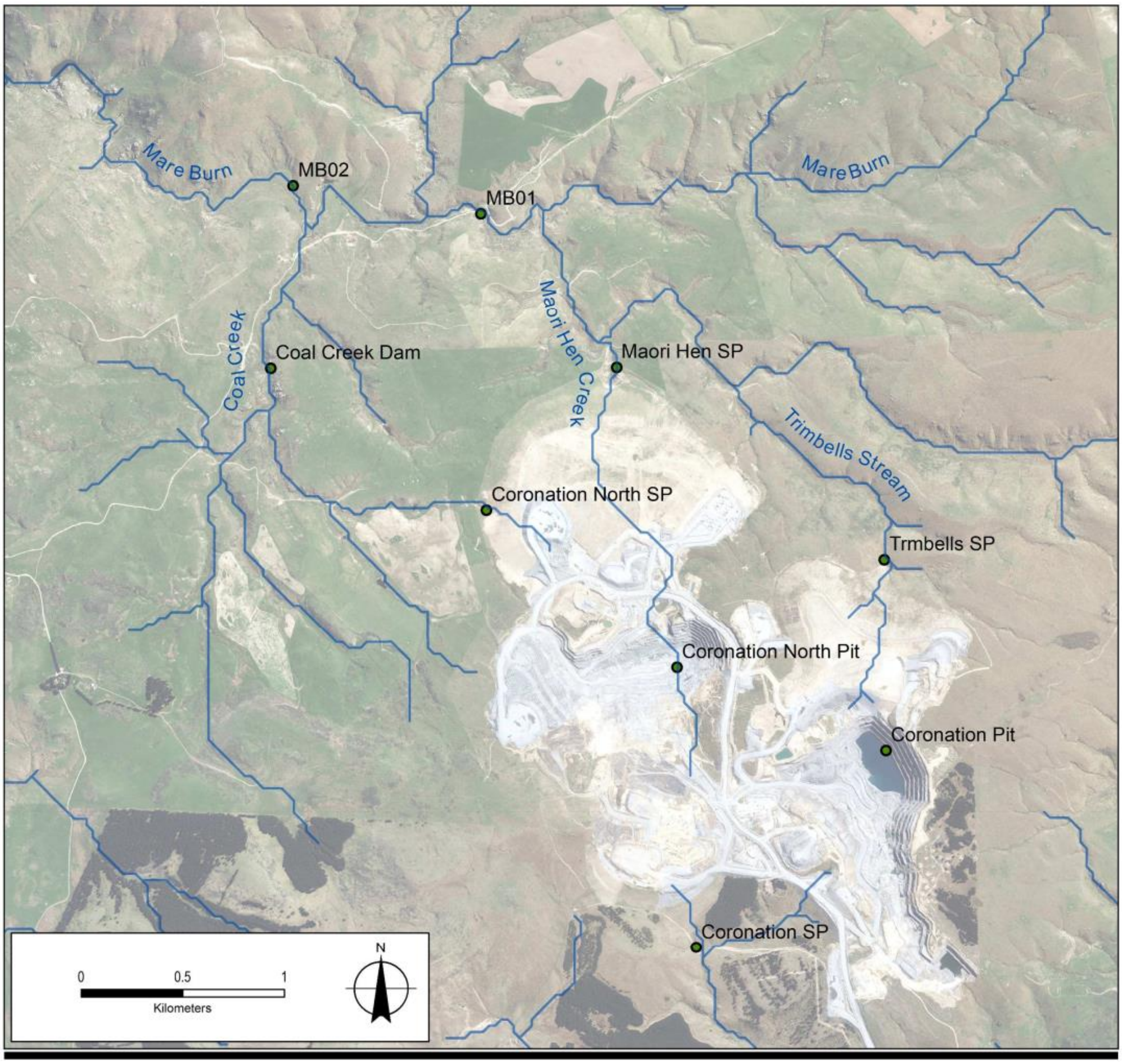

Figure 1. Mare Burn catchment water quality monitoring points (GHD 2024a).

- Drain boundary conditions have been used to simulate the hydraulic behaviour of other creeks and gullies within the modelled area. Drain elevations are consistent with the local topography and appropriate for the intended purpose of stream tributary simulation. Conductance values applied to these cells are reasonable.
- A general head boundary (GHB) condition has been used to simulate the recovery of water level within the proposed CO6 pit. As inflows to the pit are primarily derived from surface water run-off and direct rainfall, the transient post-closure water levels applied to this boundary condition have been derived from the WBM. This approach is considered appropriate and reasonable.
- The base and most of the lateral edges to the model are defined by default as no-flow boundaries, which is standard modelling practice and is appropriate in this model.

Flow Model Calibration and Numerical Performance

Model calibration has been performed on a steady-state basis simulating the pre-mining groundwater system. The water balance discrepancy for the calibrated model was low at less than 0.01%, indicating the model is numerically stable and functioning acceptably.

The calibrated hydraulic characteristics applied to the simulated bulk rock mass are consistent with the hydraulic characteristics applied to groundwater models of the wider MGP. The calibrated hydraulic conductivity values for the schist are also consistent with the cumulative results from hydraulic tests performed on schist at the MGP over the past three decades (Kingett Mitchell 2005, Golder 2011a, URS 2013b)

The calibration result of a SRMS value of 5.7% is acceptable, following acceptance guidance from the Australian Groundwater Modelling Guidelines (Barnett et al 2012). A visual review of the chart showing modelled versus observed groundwater heads indicates a negligible systematic deviation when referenced against head. There does not appear to be any systematic deviation spatially across the model. The model calibration is therefore considered to be appropriate, with the steady state model being fit for purpose.

Predictive Flow Models and Model Outcomes

The transient predictive model used to simulate dewatering of the proposed CO6 Pit is based directly on the calibrated steady state model. The hydraulic boundary conditions as summarised above are suitable to simulate the proposed CO6 Pit. This transient model appears to be numerically stable, with a water balance discrepancy at less than 0.01%. This model is considered fit for the intended purpose of evaluating groundwater inflows to the CO6 Pit.

The simulated inflows to the existing Coronation CO5 Pit (approximately 0.9 to 1.2 L/s or 80 to 100 m^3/day) are smaller than previously calculated inflow projections for the CO5 Pit (Golder 2016a). The simulated inflows to the planned C06 Pit (approximately 0.8 to 2.0 L/s or 70 to 170 m^3/day) are also smaller than previously calculated inflow projections for the CO5 Pit (Golder 2016a). However, both the GHD and the earlier Golder calculated inflows to the CO5 represent a small fraction of the measured net inflows to the pit over the period from August 2021 to July 2023 (WGA 2023). Uncertainty regarding the groundwater inflow rates to the CO6 Pit does not represent a significant issue with respect to the environmental effects of the pit, including the post-closure filling rate for the pit lake.

The transient predictive model used to simulate groundwater inflows to the proposed CO6 Pit following closure is based directly on the calibrated steady state model. The GHB hydraulic boundary condition used to simulate the rising water level in the pit following the close of dewatering operations has been based on Coronation WBM outputs. This means, the numerical boundary condition is not a numerically exact simulation of the expected water levels in the pit following closure. However, the model uncertainty relates primarily to the pit lake filling times, which are not critical components of the overall model projections.

The transient model appears to be numerically stable, with a water balance discrepancy at less than 0.01%. The model run time of 400 years is substantially longer than the projected pit lake filling time of approximately 200 years. This run time is provided to ensure the contaminant transport simulation has sufficient time to indicate the full potential extent of future contaminant plumes. Uncertainty regarding the outcomes of the flow simulation increases beyond a period of a few decades, in line with uncertainty regarding long-term climate change projections.

Overall, the groundwater model uncertainty does not represent a significant issue with respect to the assessment of environmental effects of the pit, including the post-closure filling rate for the pit lake. This model is considered fit for the intended purposes of evaluating groundwater inflows to the CO6 Pit and identifying the discharge areas for contaminant plumes arising from mining features in the Coronation area.

Predictive Contaminant Transport Models and Model Outcomes

The predictive contaminant transport groundwater model for CO6 has been based on the long-term transient groundwater model described above. The contaminant transport model focuses on sulfate transport in the groundwater system, with the sulfate almost entirely derived from mining operations and stored wastes.

A very small (0.0001 mg/L) background sulphate concentration was applied to all layers simulated in the groundwater model. Overprinted on this background concentration are sulfate concentrations applied to:

1. Recharge to the Trimbells, Coronation and Coronation North WRS's. The sulfate concentration in each case is linked to the height of the individual WRS, as documented in the MWM (2024) report. Each WRS acts as a constant source of sulfate to the surrounding groundwater system, with depletion of the sulfate source not incorporated in the model.
2. The developing Coronation Pit lake. The projected sulfate concentration in the pit lake is derived from the mixing of incipient rainfall to the lake surface, surface run-off entering the pit and groundwater seepage discharging to the pit. The sulfate concentration applied in simulating the pit lake water has been taken directly from the MWM (2024) report.

In addition to the rock mass parameters applied in the groundwater flow model, values for effective porosity and longitudinal and transverse dispersivity have been incorporated into the contaminant transport model. These factors influence the rate of contaminant transport and therefore the contaminant plume breakthrough curves at various receiving water bodies. The values applied in the groundwater model to the above parameters are reasonable.

As the depletion of sulfate from stored mine wastes and the pit lake over time is not incorporated in the model, the simulated mine structures act as constant contaminant sources. Therefore, the simulated contaminant plumes approach a steady-state status over the long term. Consequently, the contaminant transport factors listed above become less important in evaluating contaminant mass loads and discharge areas over the long term.

The model outcomes are summarised as sulfate groundwater plume maps in Figures 4.19 to 4.21 (GHD 2024a). The sulfate plume maps only show concentrations above 10 mg/L, which is a reasonable lower cut-off concentration. Within the Mare Burn catchment sulfate transported by groundwater impacted by mining operations discharges to Trimbells Gully, Coal Creek, Maori Hen Creek and Mare Burn. The discharge areas for these plumes are all upstream from the MB02 compliance monitoring point. Toward the south, sulfate transported by groundwater impacted by mining operations discharges to the upper reaches of Camp Creek and tributaries of Highlay Creek. The discharge areas for these plumes are all upstream from the DC08 compliance monitoring point on Deepdell Creek.

Other contaminants to groundwater due to mining operations are either conservatively transported or are subject to attenuation through adsorption or geochemical reactions. Groundwater plumes for these other contaminants are expected to be similar or smaller in extent to those simulated for sulfate.

Groundwater Model Results Used in Water Balance Model

The report indicates in Section 5.7 that the only output from the groundwater modelling that is incorporated in the WBM for the evaluation of effects on downstream water quality is the inflow and outflow from the CO6 pit lake (GHD 2024a, Figure 4.27). The modelled pit lake outflows are distributed between the Deepdell Creek and the Mare Burn catchments.

The sulfate mass loads derived from the predictive groundwater model are compared with the WBM outputs (GHD 2024a, Section 5.7), to help validate the MBM outputs.

One of the WBM assumptions listed in Section 5.6.1 of the report is the conceptualisation for the distribution of seepage water leaving the Coronation North Pit WRS. This conceptualisation indicates any lateral seepage flows within the WRS above an elevation of 580 mRL reports to Coal Creek as overflow seepage. Seepage flows below this elevation are considered to flow out into the underlying schist, to form part of the contaminant plumes described above. These seepage components have apparently been derived from the groundwater modelling, but no documentation is provided in the report.

At the end of the 400-year predictive model run, the groundwater elevations within the Coronation North Pit WRS are below 580 mRL (GHD 2024a, Figure 4.17). Furthermore, the simulated groundwater pressure gradient within the WRS is toward the north and Maori Hen Silt Pond rather than toward the West and Coal Creek Silt Pond. This gradient implies that overflow seepage from the Coronation North Pit WRS is likely to be predominantly via Maori Hen Silt Pond.

This discrepancy in seepage flow interpretation may have a minor effect on the sulfate mass load calculation. The unsaturated zone in Coronation North Pit WRS is assumed to be 20 m thick in the conceptual model. This thickness implies a median sulfate concentration in the shallow seepage water of approximately 1,000 mg/L. However, the groundwater model output (Figure 4.17) suggests an unsaturated zone some 30 m in thickness, which implies a sulfate concentration in the order of 1,600 mg/L. For comparison, the deep seepage water is simulated with a concentration of 3,852 mg/L. The uncertainty regarding the shallow seepage concentration and the sulfate mass load from Coronation North Pit WRS is unlikely to have a significant effect on the simulated water quality at MB02. However, it does highlight the need to retain the buffer water storage capacity represented by Maori Hen Silt Pond following site closure, as described in Section A.3 of this appendix.

A.3 Water Balance Modelling

Model Design and Input Parameters

The mine water model used to simulate the effects of the contaminant discharges from the Coronation area on water quality in Mare Burn is the same model as that used to simulate the effects of mining operations on water quality for the wider MGP. A review of the overall WBM is presented separately in Appendix C. Key components of the model performance with respect to water quality in the Mare Burn catchment are summarised below.

The model developed using the GoldSim package includes all contributing catchments and the key mine structures upstream from the MB02 compliance point on Mare Burn. The model also incorporates all contributing catchments and the key mine structures upstream from the DC08 compliance point on Deepdell Creek. The impacted catchment areas and receiving catchments for surface water and groundwater flows are documented as maps in Appendix A-3 of the report. All contaminant losses carried by groundwater or surface water flows from mine structures in the Coronation area eventually discharge to either Mare Burn or Deepdell Creek upstream from the two compliance monitoring points identified. Therefore, the mine water model covers an extent appropriate to evaluate the effects of CO6 on receiving water quality.

Runoff and groundwater discharges reporting to Mare Burn from catchment areas that are not impacted by mining operations are calculated using the AWBM method (refer Appendix C) and have been calibrated against the flows recorded at Golden Point Weir in Deepdell Creek. The catchments of Deepdell Creek and Mare Burn are adjacent and are similar in topography characteristics, geology and land use. These two catchments are comparable in size and are expected to be similar in weather patterns. Therefore, the calibrated AWBM parameters developed for simulation of flows in Deepdell Creek (GHD 2024a) are considered appropriate for the simulation of flows in Mare Burn.

Run-off from mine impacted surfaces is calculated using the rational method. The run-off coefficients applied to mine structures in the Coronation area are consistent with those applied in the site-wide model and are generally reasonable values for the rainfall intensities simulated.

The stage / volume / area relationship for the CO6 pit, as incorporated in the WBM, is appropriately documented in Appendix A-1. Although not documented in the report, I have been advised that a similar stage / volume / area relationship for backfilled Coronation North Pit has been incorporated into the model. This guidance is supported by the structure of the GoldSIM WBM as presented in Figure 5.1.

The water quality values applied to run-off from natural, impacted and rehabilitated areas for the key contaminants are documented in Table 5.4 of the report. The values appear reasonable, based on my background knowledge of water quality at the site, but I have not reviewed monitoring data from OceanaGold to confirm this conclusion. The projected water quality for the CO6 Pit has been provided by MWM (2024) and incorporated into the WBM. The WRS seepage water quality has also been provided by MWM (2024) for incorporation into the WBM.

Previous receiving water quality projections for Mare Burn have indicated that a freshwater dam may be required to provide a reliable base flow in Mare Burn. The WBM has provision for the storage and release of water from Coal Creek Dam in the model structure. However, this dam component is inactive in most of the predictive scenarios.

An important component of the WBM is the simulation of Trimbells Silt Pond, Māori Hen Silt Pond, and Coronation North Silt Pond with defined water storage capacities. During the mining phase, the water from each of these silt ponds is captured and pumped back to the site water management system for use on site. Following site closure these ponds act to capture seepage from the upgradient WRS areas and any run-off from rehabilitated WRS surfaces. The GHD (2024a) report states:

> *"The majority of sulphate mass (and that of other elements of concern) draining to the Mare Burn catchment will likely be captured in the Trimbells and Maori Hen Silt Ponds where mixing with rehabilitated WRS runoff and natural runoff will occur. Post closure, the release of water from these silt ponds to the receiving environment will be controlled by the spillway and overflow during low flow periods is likely to be small and/or cease. This should enable the silt ponds to provide a 'buffering' effect to the receiving water in the Mare Burn. The surface water model therefore replicates this scenario and does not mirror the groundwater model which assumes constant discharge of seepage waters into the receiving water bodies."*

The silt pond buffer capacity is important as it helps to manage the contaminant mass loads discharged to Mare Burn during dry summer periods. This process in turn reduces the peak simulated sulfate concentrations in Mare Burn and Trimbells Gully (T. Mulliner; pers. comm). The peak concentrations of other contaminants at MB02 would be similarly reduced.

With regards to water quality model input, the GHD (2024a) report documents the input values for contaminant parameters in impacted and non-impacted surface waters (Table 5.4). However, the water quality values for seepage water and values for the CO6 pit lake other than sulfate are not presented. The GHD report references the MWM (2024) report for WRS and pit lake contaminant values, and appropriate tables for these values are provided in the MWM report.

Seepage flows from the CO6 pit lake to Trimbells Gully through the Trimbells WRS have been simulated with the same quality as provided for the pit lake. It has been assumed that the passage of this water through the WRS does not influence its quality. This is a reasonable assumption but one of the proposed water quality management measures described below is intended to support this assumption.

Four model scenarios have been simulated, as set out in Table 5.6 of the GHD report. These scenarios cover the active CO6 mining period through to the long-term post-closure behaviour of CO6. The scenarios investigated are appropriate to investigate the effects on receiving water quality throughout the life and closure period of CO6.

Model Outputs

Mine impacted water from the Coronation area is captured and returned for use on the site as best possible. This process will cease following the completion of mining operations at Coronation. Therefore, the key model outcomes with respect to assessing receiving water quality are for the post-closure period.

The WBM indicates that the Coronation CO6 Pit will fill to an elevation of 660 mRL and then overflow toward Deepdell Creek at a mean rate of 1.5 L/s. The filling period was modelled to be in the order of 200 years. However, once the lake level exceeds an elevation of 640 mRL seepage losses will occur through Trimbells WRS to Trimbells Gully. These seepage losses are modelled to start approximately 90 years following the close of pit dewatering operations. As the lake level rises above 640 mRL, the rate of seepage to Trimbells Gully was modelled to increase to a maximum rate of 0.61 L/s. It is not clear from the report how the seepage loss rates to Trimbells Gully have been calculated.

The uncertainty regarding the relative discharge rates from CO6 pit lake to Trimbells Gully and toward Deepdell Creek is primarily an issue to be addressed through the appropriate design and installation of proposed water quality management measures for the site. The potential water quality management measures identified for both catchments may be adjusted to address any shift in the seepage water balance from the CO6 pit.

The key contaminants identified through the WBM simulations are summarised in the GHD (2024a) report as follows:

> *"Sulphate, Nitrate N and Ammoniacal N predictions are presented as they are considered key elements in terms of the current and predicted future impacts. Other consented parameters (arsenic, cyanide, copper, iron, lead and zinc) are not considered key elements in terms of compliance and modelling suggests they are unlikely to exceed their consented concentrations at either MB01 or MB02 throughout both the duration of the operational period and post closure period based on the assumptions and considerations as outlined in this report."*

A review of the water quality assessment undertaken by MWM (2024) is outside the scope of this document and outside my (Brett Sinclair) area of expertise. I have assumed MWM's assessment is technically valid and reliable.

A check on the assessment of water quality characteristics for stored wastes and pit lakes undertaken by MWM (2024), excluding the key elements listed above, indicated:

1. Dissolved zinc in WRS seepage water can become elevated above receiving water reference compliance values (MWM 2024, Tables 24 and 25);
2. Dissolved arsenic in the pit lakes can become elevated above receiving water reference compliance values (MWM 2024, Table 26);

After checking the input concentrations derived from the report for the 'non key' parameters relating to the pit lakes and the WRS seepage (both MWM 2024) and the surface run-off (GH 2024a), I consider this conclusion to be reasonable. Only the sulfate, nitrate-N and ammoniacal-N concentrations are elevated in water derived from a range of mining operations and therefore of significant concern with respect to future compliance.

Exceedance probability curves for sulfate, nitrate-N and ammoniacal-N at MB02 and MB01 are presented in Figures 5.10 to 5.15 of the GHD (2024a) report. The outcomes in these charts appear reasonable and are consistent with the reported input parameters.

The modelled exceedance frequency for the parameters with compliance criteria, as presented in Table 5.7, is reasonable based on the modelled scenarios. However, the <1% probability of exceedance for sulfate at both MB01 and MB02 is dependent on the buffer storage capacity of both Trimbells Silt Pond and Maori Hen Silt Pond. If either or both of these silt ponds are removed, the sulfate exceedance frequency is likely to increase.

Recommendations

A key assumption in the WBM is that the dissolved contaminant concentrations in seepage flows from the CO6 pit lake through Trimbells WRS toward Trimbells Gully will not increase due to contact with the stored wastes. Installation of a low flow barrier against the downstream toe of the WRS has been recommended as a potential water quality management measure. The objective is to maintain the downstream toe of the WRS in a saturated state and reduce the potential ingress of oxygen to the base of the WRS. Reducing the ingress of oxygen would correspondingly reduce oxidation of sulfides in the stored wastes and thereby reduce sulphate and dissolved metal concentrations in the seepage water. Conceptually, this recommendation is reasonable although further research is likely to be needed into its effectiveness.

The already consented Coal Creek Dam was not incorporated in the modelling, as the model results indicated it is unnecessary. However, construction of this dam remains a valid contingency measure to provide augmented base flows in Mare Burn during dry summer periods.

A.4 Review Summary

The structure and calibration of the groundwater model simulating the Coronation area of the MGP is consistent with past modelling work at the MGP. The calibrated model and the associated predictive models documented in the report (GHD 2024a) are considered to be fit for the purposes of simulating groundwater drawdown and recovery related to the CO6 development and sulfate transport in groundwater around the Coronation area.

The groundwater model indicates that all dissolved contaminants transported in groundwater away from the opencast pits and stored wastes in the Coronation area, including the C06 development will eventually discharge to receiving waters upstream from the MB02 compliance monitoring point.

The structure and input parameters for the WBM is appropriate to simulate the effects of the proposed CO6 development on downstream flows and water quality. The input water quality values applied to the modelling appear reasonable, although a detailed review of these values is outside the scope of this document.

The modelled exceedance curves for sulfate, nitrate-N, and ammoniacal-N at the existing water quality compliance monitoring points MB01 and MB02 appear reasonable. These exceedance curves are consistent with the concentrations of these contaminants applied as input parameters to the model and the availability of dilution water in the receiving streams. The contaminant exceedance frequencies documented in Table 5.7 of the GHD (2024a) report also appear reasonable.

The modelled <1% probability of exceedance for sulfate at both MB01 and MB02 following mine closure is dependent on the buffer storage capacity of both Trimbells Silt Pond and Maori Hen Silt Pond being retained indefinitely. If either or both of these silt ponds are removed, the sulfate exceedance frequency is likely to increase.

A key assumption in the WBM is that the dissolved contaminant concentrations in seepage flows from the CO6 pit lake through Trimbells WRS toward Trimbells Gully will not increase due to contact with the stored wastes. MWM has identified several management techniques to reduce the oxidation of sulfide minerals and minimise the mobilisation of any oxidation products. These techniques include the installation of an advective barrier (equivalent to a low flow barrier) against the downstream toe of the WRS to reduce the potential ingress of oxygen to the base of the WRS (Section 7.2.4, MWM 2024). Conceptually, this technique is reasonable and has been applied elsewhere although further research at the MGP is likely to be needed into its effectiveness.

The already consented Coal Creek Dam was not incorporated in the modelling, as the model results indicated it is unnecessary. However, construction of this dam remains a valid contingency measure to provide augmented base flows in Mare Burn during dry summer periods should future compliance necessitate this.

Overall, the technical assessment of the water quality effects arising from the proposed C06 development is considered to be defensible and fit for purpose.

APPENDIX B
GOLDEN BAR STAGE 2 (GB STAGE 2) REPORTS TECHNICAL REVIEW

B.1 Review Components

The assessment of the effects of the proposed Golden Bar Stage 2 (GB Stage 2) pit and the associated Golden Bar WRS on the surrounding groundwater system and on surface water flows and water quality has been based on three components of work.

1. An assessment of the quality of seepage water from stored mine wastes and water accumulating in the proposed GB Stage 2 pit (MWM 2024). An assessment of the effects of dewatering the existing Golden Bar pit lake and discharging the pumped water to Golden Bar Creek immediately outside the pit footprint (GHD 2023).

2. An assessment of the effects of GB Stage 2 development and closure on the surrounding groundwater system, including groundwater quality (GHD 2024b).

3. An assessment of the effects of GB Stage 2 development and closure on water flows and water quality in Golden Bar Creek, Clydesdale Creek, Murphys Creek and the North Branch Waikouaiti River (NBWR). Of these water bodies, Golden Bar Creek is the primary surface water body potentially impacted by flow losses due to mining operations. All four of these water bodies would potentially be affected by mine water discharges from either the proposed GB Stage 2 pit or the associated Golden Bar WRS (GHD 2024b). The location of water quality monitoring points relevant to Golden Bar Pit are presented in Figure 2.

A review of the first component above is outside the scope of this document and is outside my (Brett Sinclair) area of expertise. Reviews of items 2 to 4 are documented in this appendix.

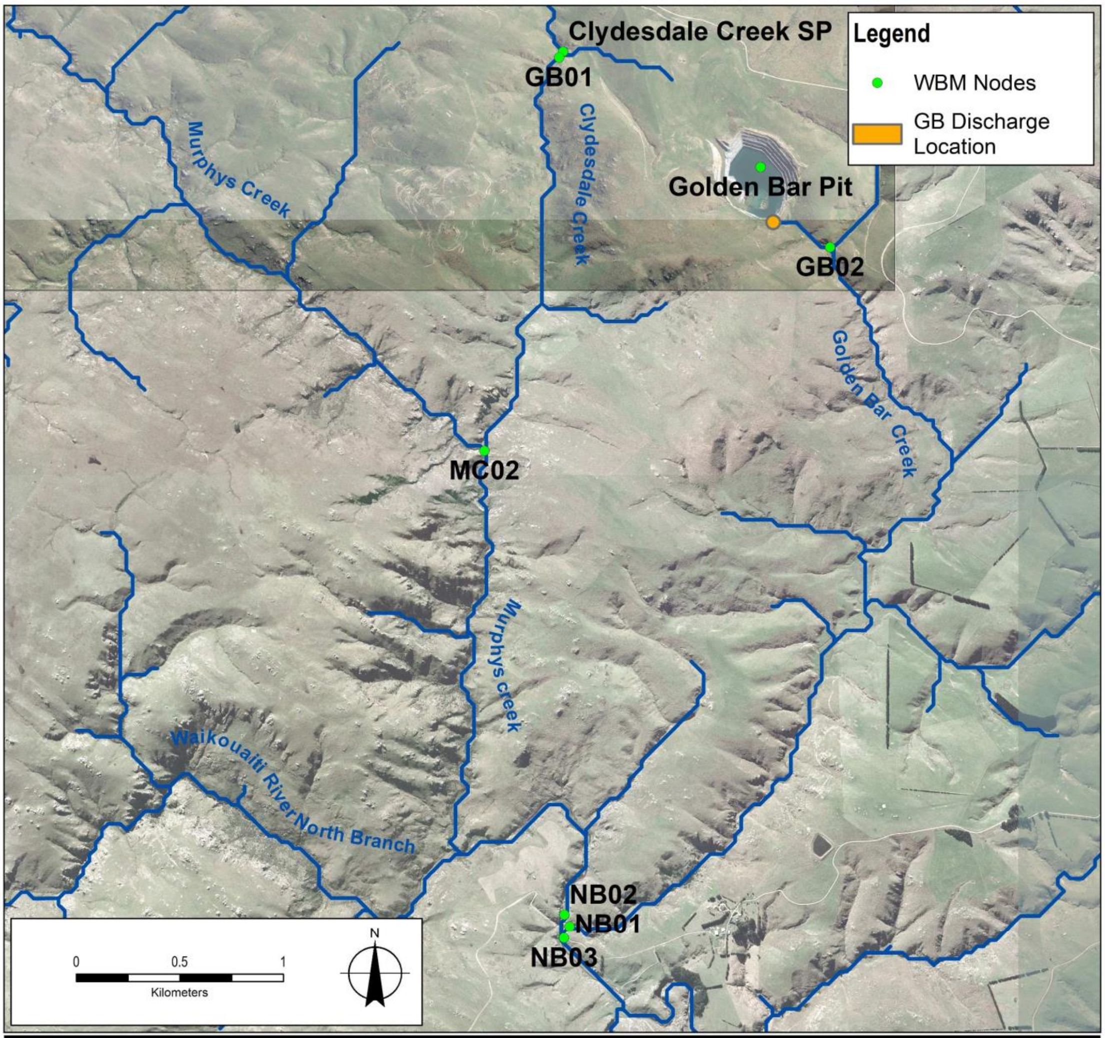

Figure 2. Golden Bar Creek catchment water quality monitoring points (GHD 2024b).

B.2 Golden Bar Pit Dewatering Assessment

The existing Golden Bar Pit contains a pit lake that is currently overflowing to Golden Bar Creek upstream of the GB02 and NB01 water quality monitoring and compliance points. Golden Bar Creek discharges to the NBWR upstream from the NB03 water quality compliance point. The NBWR upstream from NB03 also receives water influenced by mining operations related to Frasers Pit and Frasers Waste Rock Stacks (WRS).

The Golden Bar pit lake will need to be mostly dewatered before GB Stage 2 mining operations can begin. The Golden Bar Pit dewatering report (GHD 2023) provides estimates of the rate at which the water level in Golden Bar pit could be drawn down under given pumping rates. The report also assesses the likely change in receiving water quality, with specific reference to sulfate within the receiving environment. At the time, the GHD (2023) report was produced, work on assessing mine water management options for the MGP a whole was ongoing. Therefore, an indicative discharge point for the Golden Bar pit lake water was designated on Golden Bar Creek, immediately to the South of the pit (Figure 2). The designated discharge point is effectively the current pit lake overflow point to Golden Bar Creek.

The volume of water in the Golden Bar Pit lake is not documented in the dewatering report. However, detailed information on the pit volume to elevation relationship is presented in the GB Stage 2 water management report (GHD 2024b, Appendix A, Table 12).

The water balance model used to evaluate the effects of dewatering Golden Bar Pit is the same one as is used to evaluate the effects of GB Stage 2 (GHD 2024b) mining operations across the wider MGP (GHD 2024c). Specifically, the receiving water flows in the NBWR derived from catchment areas unaffected by mining operations have been calculated using the same Australian Water Balance Model (AWBM) methodology and coefficients as have been applied to the wider site. Therefore, the indicated NBWR receiving water flows are consistent with those documented in the GHD (2024c) report.

The calibration for the MWB model is documented separately in the MPIV report (GHD 2024c, Appendix A). The geology, topography and general catchment size for Golden Bar Creek are comparable to other creek catchments at the MGP. Therefore, it is accepted that the WBM rainfall run-off calibration applied to the wider model is appropriate for the Golden Bar Creek catchment. The WBM run-off parameters for the catchment around the Golden Bar Pit have been calibrated against pit lake water level records from the period when the pit lake formed. This calibration is documented in the GB Stage 2 water management report (GHD 2024c, Appendix A).

The Golden Bar Pit dewatering report provides further supporting calibration information based on measured and simulated in-stream sulfate concentrations. Figure 3 in the pit dewatering report (GHD 2023) presents a comparison between the measured and simulated sulfate concentrations at the NB03 compliance monitoring point for the period between 2015 and 2021. The key calibration outcome from this chart is that the WBM generally overestimates sulfate concentrations in the NBWR at NB03. Simulated sulfate concentrations at NB03 exceed 200 g/m^3 more often and to a greater magnitude than has actually been observed.

A comparison in modelled and observed sulfate concentrations at NB01 (Figure 2) and NB03 has also been presented to support the model calibration documentation (GHD 2023, Figure 4). This chart indicates the frequency at which sulfate concentrations above approximately 100 g/m^3 are generated by the calibrated WBM model is substantially higher than the observed frequency.

The report indicates this conservatism in sulfate predictions may arise from active management of Murphys Creek and Frasers West Silt Pond discharges. The report also suggests there may be a greater base flow in the NBWR "than that represented by the AWBM calibrated to a flow gauge on Deepdell Creek." However, the simulated flows in the NBWR have been calibrated against flow monitoring undertaken at two points on that river (GHD 2024b, 2024c) rather than against Deepdell Creek flow monitoring. No clear reason for the model conservatism in terms of sulfate concentrations has been identified in the report.

This conservatism in model calibration against sulfate does not impact on the overall validity of the water quality modelling. However, it should be taken into account when considering the water quality predictions for the dewatering process.

Overall, the calibrated WBM model covering the water quality effects in the Golden Bar Creek catchment is considered to be fit for purpose.

Water quality data from sampling at the Golden Bar pit lake surface for the period from 2015 to 2022 has been summarised in the GHB (2023) report (Table 2). The quality of water at a range of depths in the existing Golden Bar pit lake has been measured twice, once in late summer and once in late winter, and the results were consistent (GHB 2023, Table 3). It is reasonable to accept that the water quality from these sampling rounds will be indicative of the discharge water quality during the pit dewatering process. This acceptance assumes excessive sediment will not be disturbed from the pit walls or floor during the dewatering process.

The water quality input data indicate only sulfate, dissolved arsenic and ammoniacal-N are likely to present risks in terms of existing MGP compliance criteria or National Policy Statement for Freshwater Management (2023) Band A attributes being exceeded through the dewatering of Golden Bar Pit.

Three constant pumping rates have been considered in the pit dewatering evaluation; 15 L/s, 20 L/s and 30 L/s. The modelling indicates pit dewatering can be achieved in between one and three years using these pumping rates.

The contribution of the pumped water to flows in Golden Bar Creek and the NBWR is documented in Table 4 of the dewatering report (GHD 2023). In summary, the pumped water would comprise more than 50% of the flow in Golden Bar Creek at NB01 for more than 50% of the time, irrespective of which pumping rate is applied. At monitoring point GB02 under a pumping rate of 30 L/s the pumped water would comprise more than 93% of the flow in the creek for more than 50% of the time. In the NBWR at NB03, the pumped water would increase the median river flow by between 16% and 33%, depending on the pumping rate. These documented increases in flows are consistent with the model input parameters and are considered a reasonable indication of the effects the dewatering program would have on in-stream flows. Simulated stream flow exceedance curves have not been presented in the report.

In terms of receiving water quality, the model outcomes are focused on sulfate (Section 5.3.1) and dissolved arsenic (Section 5.3.2). In Golden Bar Creek at NB01 there is no existing compliance criterion for sulfate. The receiving water would slightly exceed a sulfate concentration of 250 mg/L, which is the criterion applicable at NB03, slightly more than 5% of the time for all three pumping rates. In the NBWR at NB03 the modelled mine water discharges result in sulfate concentrations increasing over much of the in-stream flow range. However, during low flow periods the model indicates the discharged mine water has a lower concentration than the receiving river water. Consequently, the model indicates the pumped discharge would result in an improvement in sulfate concentrations at NB03 across the upper 15% of the currently observed range.

Measured dissolved arsenic levels in the pit lake are currently just below the compliance criterion of 0.15 g/m^3 at NB01 and exceed the NB03 criterion of 0.01 g/m^3. The model indicates the discharge of lake water to Golden Bar Creek would not lead to the dissolved arsenic criterion at NB01 being exceeded. In contrast, the modelled discharge would lead to dissolved arsenic at NB03 frequently exceeding the existing compliance criterion applicable at that point, irrespective of which pumping rate was applied.

The modelling indicates water management measures would need to be implemented to enable Golden Bar Pit dewatering to occur within a period of three years, while complying with the existing consented water quality criterion for dissolved arsenic at NB03. Although compliance with the existing sulfate criterion at NB03 would also not be achieved under the pumping rates tested, this outcome was principally due to elevated existing sulfate concentrations in the NBWR at NB03. The documented water quality modelling results are consistent with what would be expected, based on the model inputs.

It should be noted that consent water quality compliance criteria also apply to Golden Bar pit lake and by extension the GB02 monitoring point when the Golden Bar pit lake is overflowing (Consent 2002.763). These criteria are not mentioned in the dewatering report. However, the projected pit lake water quality (MWM 2024) would meet the compliance criteria for the lake. The projected concentration for dissolved arsenic in the lake water is 0.145 mg/L, slightly under the 0.15 mg/L compliance criterion. Moreover, measured dissolved arsenic concentrations in the surficial pit lake water have generally been below this compliance concentration. When the lake becomes stratified in late summer and the deeper water is characterised by more reducing conditions, dissolved arsenic concentrations in the deep water increase above the compliance criterion. However, this potential issue may be addressed through the water quality management measures proposed in the dewatering report.

Conceptual water quality management measures are presented in the GHD (2023) report, but not tested through additional documented model runs. The measures identified are effectively:

- Reduce the sulfate loads in the NBWR derived from mining operations upstream from NB02, then actively manage the dewatering pumping to ensure compliance with the 250 mg/L criterion applicable at NB03 is achieved. Use the same active water discharge management to ensure compliance with the 0.01 mg/L criterion for dissolved arsenic applicable at NB03.
- Treat the pit lake water to reduce dissolved arsenic concentrations prior to the start of the dewatering programme. Such a process has been successfully applied by OceanaGold to manage dissolves arsenic in a pit lake at the Reefton Gold Project.

Both of these proposed water quality management measures are conceptually practical but would need to be incorporated into a wider water quality management program for the entire MGP.

The later mine water management report for GB Stage 2 has the discharge point for the Golden Bar pit lake water shifted from Golden Bar Creek, as indicated in the following report extract (GHD 2024b, Section 2.3):

> *"Dewatering of the current Stage 1 Golden Bar pit is outlined in GHD (2023b) (Appendix B) and will likely consist of active management of the discharge to the upper NBWR and Murphys Creek catchments as is currently undertaken to allow for sufficient dilution within the receiving environment to ensure compliance with the existing compliance limits at NB03."*

This shift in the discharge point is a proposed water management measure designed to enable OceanaGold to comply with existing discharge consent compliance criteria.

B.3 Golden Bar Groundwater Modelling

A 3D groundwater flow and contaminant transport model has been developed to help evaluate groundwater inflows to the proposed GB Stage 2 opencast mine, pit lake recovery following mine closure and seepage losses from GB Stage 2 to surrounding surface water bodies.

Model Structure

The layout and topographic shells of the existing and proposed mine structures, including opencast pits and WRS areas, are consistent with the existing mine as-built layout and with the layout of the proposed GB Stage 2 features. The modelled area is sufficiently large (9 km x 9 km) that the edges of the modelled area do not impact on the simulation of the GB Stage 2 or the Golden Bar WRS. The modelled area also appropriately incorporates reaches of Golden Bar Creek, Clydesdale Creek, Murphys Creek and Tipperary Creek, which are the principal surface water bodies potentially impacted by GB Stage 2 or the Golden Bar WRS. The existing consented water quality compliance monitoring points in the NBWR catchment, NB01 and NB03 are within the modelled area. On this basis, the extent of the 3D groundwater flow model documented in the GHD (2024a) report is appropriate for the assessment of the effects on the groundwater system arising from the proposed GB Stage 2 development.

The model of grid discretization is appropriate for the size of the overall model and the intended objectives. Lateral cell discretization close to key features, including Tipperary Creek and Murphys Creek and the proposed GB Stage 2 pit, is at 25 m; increasing to 50 m across the wider modelled area. Vertical discretization of the local geology into 8 model layers is consistent with past modelling approaches. The model discretisation is appropriate to the model size and objectives.

The simulated geology in the groundwater model relates predominantly to the degree of weathering and therefore hydraulic characteristics of the in-situ schist. Additionally, the simulated geology incorporates the WRS structures as these effectively behave as localised artificial aquifers.

Boundary Conditions

The hydraulic boundary conditions applied to the GB Stage 2 groundwater model are appropriate to simulate the groundwater system relevant to the proposed development of the GB Stage 2 pit and the Golden Bar WRS. Specifically:

- Recharge is applied across the entire model at a rate of 29.2 mm/year, which is consistent with groundwater recharge of 32 mm/year applied to past groundwater models of the MGP (Kingett Mitchell 2005, Golder 2011a).
- River boundary conditions have been used to simulate Tipperary Creek and Murphys Creek. The river stage conditions are consistent with local topography and acceptable for intended model objectives. The conductance value of 5 m^2/day/m applied to these river cells is reasonable.
- Drain boundary conditions have been used to simulate the hydraulic behaviour of other creeks and gullies within the modelled area. Drain elevations are consistent with the local topography and appropriate for the intended purpose of stream tributary simulation. The conductance value of 10 m^2/day/m applied to these cells is reasonable.
- A general head boundary (GHB) condition has been used to simulate the recovery of water level within the proposed GB Stage 2 pit. As inflows to the pit are primarily derived from surface water run-off and direct rainfall, the transient post-closure water levels applied to this boundary condition have been derived from the WBM. This approach is considered appropriate and reasonable.
- The base and most of the lateral edges to the model are defined by default as no-flow boundaries, which is standard modelling practice and is appropriate in this model.

Flow Model Calibration and Numerical Performance

Model calibration has been performed on a steady-state basis simulating the pre-mining groundwater system. The water balance discrepancy for the calibrated model was low at less than 0.01%, indicating the model is numerically stable and functioning acceptably.

The calibrated hydraulic characteristics applied to the simulated bulk rock mass (GHD 2024b, Table 2) are consistent with the hydraulic characteristics applied to groundwater models of the wider MGP. The calibrated hydraulic conductivity values for the schist are also consistent with the cumulative results from hydraulic tests performed on schist at the MGP over the past three decades (Kingett Mitchell 2005, Golder 2011a, URS 2013b)

The calibration result of a SRMS value of 13.8% is marginal, following acceptance guidance from the Australian Groundwater Modelling Guidelines (Barnett et al 2012). However, this value was significantly affects by a groundwater level measurement from one isolated bore (RCH3004), which is distant from the Golden Bar area. A visual review of the chart showing modelled versus observed groundwater heads (GHD 2024b, Figure 13) did not identify any systematic deviation from the ideal best-fit line. Additionally, there does not appear to be any systematic deviation spatially across the model. In effect, the relatively large SRMS appears to be due to a wide scatter in the groundwater level readings taken in deep open bores.

Irrespective of the marginal SRMS result, the model calibration is consistent with the calibrations from other 3D groundwater models covering other areas of the MGP. The groundwater flow patterns, and general levels are reasonable for the local terrain. The model mass balance is good, and the spatially distributed recharge is consistent with that applicable to the wider MGP area. Therefore, the groundwater model is considered to be appropriate, with the steady state model being fit for purpose.

Predictive Flow Models and Model Outcomes

The transient predictive model used to simulate dewatering of the proposed GB Stage 2 Pit is based directly on the calibrated steady state model. The hydraulic boundary conditions as summarised above are suitable to simulate the proposed GB Stage 2 Pit. This transient model appears to be numerically stable, with a water balance discrepancy at less than 0.01%. This model is considered fit for the intended purpose of evaluating groundwater inflows to the GB Stage 2 Pit.

The simulated inflows to the existing Golden Bar Pit (0.2 to 0.4 L/s) and the simulated inflows to the planned GB Stage 2 Pit (approximately 0.7 to 1.7 L/s) are small. They represent a small fraction of the net inflows to the GB Stage 2 Pit simulated using the WBM as described below. This is consistent with observations and modlling results for other pits at the MGP. Uncertainty regarding the groundwater inflow rates to the GB Stage 2 Pit does not represent a significant issue with respect to the environmental effects of the pit, including the post-closure filling rate for the pit lake.

The transient predictive model used to simulate groundwater inflows to the proposed GB Stage 2 Pit following closure is based directly on the calibrated steady state model. The GHB hydraulic boundary condition used to simulate the rising water level in the pit following the close of dewatering operations has been based on GB Stage 2 WBM outputs. This means, the numerical boundary condition is not a numerically exact simulation of the expected water levels in the pit following closure. However, the model uncertainty relates primarily to the pit lake filling times, which are not critical components of the overall model projections.

The transient model outcomes for stream and river depletion arising from construction of the GB Stage 2 indicate negligible changes in flows in Tipperary Creek and Murphys Creek compared to the steady state baseline model. Cumulative reductions in the groundwater contributions to the smaller tributary creeks (drain cells) compared to the steady state model indicate a depletion rate of 0.55 L/s. However, this ‘depletion’ is spread across the entire modelled area and represents less than 1% of the total simulated outflows to the simulated surface water features. The report indicates that changes to groundwater contributions to local creeks/streams arising from the of GB Stage 2 are expected to be negligible. This is a reasonable conclusion, although potential stream depletion effects are likely to be focused on the upper reach of Golden Bar Creek, which is already impacted through loss of catchment to Golden Bar Pit.

The long-term model appears to be numerically stable, with a water balance discrepancy at less than 0.01%. The model run time of 400 years is substantially longer than the projected pit lake filling time of approximately 40 years. This run time is provided to ensure the contaminant transport simulation has sufficient time to indicate the full potential extent of future contaminant plumes. Uncertainty regarding the outcomes of the flow simulation increases beyond a period of a few decades, in line with uncertainty regarding long-term climate change projections.

Overall, the groundwater model uncertainty does not represent a significant issue with respect to the assessment of environmental effects of the pit, including the post-closure filling rate for the pit lake. This model is considered fit for the intended purposes of evaluating groundwater inflows to the GB Stage 2 Pit and identifying the discharge areas for contaminant plumes arising from mining features in the Golden Bar area.

Predictive Contaminant Transport Models and Model Outcomes

The predictive contaminant transport groundwater model for GB Stage 2 has been based on the long-term transient groundwater model described above. The contaminant transport model focuses on sulfate transport in the groundwater system, with the sulfate almost entirely derived from mining operations and stored wastes.

A very small (0.0001 mg/L) background sulphate concentration was applied to all layers simulated in the groundwater model. Overprinted on this background concentration are sulfate concentrations applied to:

1. Recharge to the Golden Bar WRS. The sulfate concentration applied to the seepage water is 2,048 mg/L, which is linked to the height of the WRS, as documented in the MWM (2024) report. The WRS acts as a constant source of sulfate to the surrounding groundwater system, with depletion of the sulfate source not incorporated in the model.

2. The developing GB Stage 2 pit lake. The projected sulfate concentration in the pit lake of 400 mg/L incorporates mixing of incipient rainfall to the lake surface, surface run-off entering the pit and groundwater seepage discharging to the pit. The sulfate concentration applied to the pit lake water is slightly higher than the value of 373 mg/L presented in the MWM (2024, Table 26) report.

In addition to the rock mass parameters applied in the groundwater flow model, values for effective porosity and longitudinal and transverse dispersivity have been incorporated into the contaminant transport model. These factors influence the rate of contaminant transport and therefore the contaminant plume breakthrough curves at various receiving water bodies. The values applied in the groundwater model to the above parameters are reasonable.

As sulfate depletion from stored mine wastes and the pit lake is not incorporated in the model, the simulated mine structures act as constant contaminant sources. Therefore, the simulated contaminant plumes approach a steady-state status over the long term. Consequently, the dispersivity becomes less important in evaluating contaminant mass loads and discharge areas over the long term.

The model outcomes are summarised as sulfate groundwater plume maps in Figures 22 to 24 (GHD 2024b). The sulfate plume maps only show concentrations above 10 mg/L, which is a reasonable lower cut-off concentration. Within the NBWR catchment, sulfate transported by groundwater impacted by mining operations discharges to Clydesdale Creek and Golden Bar Creek. The discharge areas for these plumes are all upstream from the NB03 compliance monitoring point (Figure 2). Toward the east, a small deep-seated plume is simulated as extending toward a tributary of Tipperary Creek. The report indicates a minor sulfate mass load of <0.1 kg/day sourced from GB Stage 2 is expected to be transported in groundwater and discharge to receiving waters in the Tipperary Creek catchment. This is a reasonable interpretation and consistent with my understanding of the geology and topography of this area of the MGP.

Other contaminants to groundwater due to mining operations are either conservatively transported or are subject to attenuation through adsorption or geochemical reactions. Groundwater plumes for these other contaminants are expected to be similar or smaller in extent to those simulated for sulfate.

Groundwater Model Results Used in Water Balance Model

The report indicates in Section 5.7 that the only output from the groundwater modelling that is incorporated in the WBM for the evaluation of effects on downstream water quality is the seepage inflow to the developing GB Stage 2 pit lake (GHD 2024b, Figure 4.27). No outward groundwater seepage from the pit lake is incorporated in the WBM.

The sulfate mass loads derived from the predictive groundwater model are compared with the WBM outputs (GHD 2024b, Section 5.7), to help validate the MBM outputs.

B.3 Golden Bar Water Balance Modelling

Model Design and Input Parameters

The mine water model used to simulate the effects of the contaminant discharges from the Golden Bar area on water quality in the NBWR and its' tributaries is the same model as that used to simulate the effects of mining operations on water quality for the wider MGP. A review of the overall WBM is presented separately in Appendix C. Key components of the model performance with respect to water quality in the tributary catchments around Golden Bar are summarised below.

The model developed using the GoldSim package includes all contributing catchments and the key mine structures upstream from the NB03 compliance point on NBWR. The impacted catchment areas and receiving catchments for surface water and groundwater flows are documented as maps in Figures 22 to 24 of the report. All contaminant losses carried by groundwater or surface water flows from mine structures in the Golden Bar area eventually discharge to the NBWR upstream from the NB03 compliance monitoring point. Therefore, the mine water model covers an extent appropriate to evaluate the effects of GB Stage 2 on receiving water quality.

Runoff and groundwater discharges reporting to NBWR from catchment areas that are not impacted by mining operations are calculated using the AWBM method and have been calibrated against the flows recorded at two points on NBWR, as described in Appendix C. Futher model calibration against sulfate measured concentrations was also undertaken, as described above with regards the Golden Bar Pit dewatering report. The calibrated AWBM parameters developed for simulation of flows in the NBWR (GHD 2024b) are considered appropriate for the simulation of flows in the NBWR.

Run-off from mine impacted surfaces is calculated using the rational method. The run-off coefficients applied to mine structures in the Golden Bar area are consistent with those applied in the site-wide model and are generally reasonable values for the rainfall intensities simulated.

The discharge of mine water pumped from the GB Stage 2 Pit is to be "*either pumped back to Frasers or pumped into the silt control structures for the WRS runoff."* This means mine water from the GB Stage 2 Pit is not to be discharged to Golden Bar Creek during the operational period of the mine.

The stage / volume / area relationship for the GB Stage 2 Pit, as incorporated in the WBM, is appropriately documented in Appendix A-1 of the GHD (2024b) report.

The water quality values applied to run-off from natural, impacted and rehabilitated areas for the key contaminants are documented in Table 7 of the GB Stage 2 report. The values appear reasonable, based on my background knowledge of water quality at the site, but I have not reviewed monitoring data from OceanaGold to confirm this conclusion. The projected water quality for the GB Stage 2 Pit has been provided by MWM (2024) and incorporated into the WBM. The WRS seepage water quality has also been provided by MWM (2024) for incorporation into the WBM.

Model Outputs

Mine impacted water from the Golden Bar area is captured and returned for use on the site as best possible. This process will cease following the completion of mining operations at Golden Bar. Therefore, the key model outcomes with respect to assessing receiving water quality are for the post-closure period.

The WBM indicates that the GB Stage 2 Pit will fill to an elevation of 497.5 mRL and then overflow to Golden Bar Creek, as the existing pit lake currently does. The filling period was modelled to be in the order of 40 years, with an uncertainty range of approximately 10 years. Taking into account the WBM for the Golden Bar area has been calibrated against the observed filling time for the current pit lake, this projected GB Stage 2 Pit filling time is defensible and reasonable.

The key contaminants identified through the WBM simulations are summarised in the GHD (2024b) report as follows:

> *"The water quality results are presented at monitoring points GB01, GB02 and NB01. Sulphate, nitrate and Ammoniacal N predictions are presented as they are considered key elements in terms of the current and predicted future impacts and the modelled results are within the range of consented limits applied to other surface water bodies within the wider MGP area. Other consented parameters (arsenic, copper, iron, lead and zinc) are not considered key elements in terms of monitoring and modelling suggests they are unlikely to reach values of concern at either GB01, GB02 or NB01 throughout both the duration of the operational period and post closure period based on the assumptions and considerations as outlined in this report."*

A review of the water quality assessment undertaken by MWM (2024) is outside the scope of this document and outside my (Brett Sinclair) area of expertise. I have assumed MWM's assessment is technically valid and reliable.

A check on the assessment of water quality characteristics for stored wastes and pit lakes undertaken by MWM (2024), excluding the key parameters listed above, has been made. The results of this check indicate dissolved arsenic in the GB Stage 2 pit lake may become elevated substantially above the 0.01 mg/L receiving water compliance concentration applicable at NB03 (MWM 2024, Table 26).

After checking the input concentrations derived from the report for the ‘non key’ parameters relating to the pit lakes and the WRS seepage (both MWM 2024) and the surface run-off (GH 2024a), I consider the above conclusion regarding the key contaminants to be reasonable. Sulfate, nitrate-N and ammoniacal-N concentrations are elevated in water derived from a range of mining operations and therefore of significant concern with respect to future compliance with existing consent criteria. However, the elevated dissolved arsenic concentration of 0.145 mg/L predicted for the GB Stage 2 pit lake water (MWM 2024) is elevated, indicating a possible future need for management measures focused on arsenic in the lake.

Exceedance probability curves for sulfate, nitrate-N and ammoniacal-N at GB01, GB02, NB01 and NB03 (Figure 2) are presented in the GHD (2024b) report. A check has been made comparing the chart outputs against the model input concentrations documented in the GHD (2024b) and MWM (2024) reports.

Monitoring site GB01, which is in Clydesdale Creek at the toe of the proposed Golden Bar WRS, is a monitoring site only and has no designated compliance limits. The outcomes in the contaminant exceedance probability charts for sulfate and nitrate-N appear reasonable compared to the input parameters. The chart for ammoniacal-N appears to under-represent the likely range of concentrations that may be expected, which would be dominated by WRS run-off and seepage.

Monitoring site GB02, which is in Golden Bar Creek at the overflow point for the GB Stage 2 pit lake, has designated compliance limits applicable once the pit lake starts to overflow. The outcomes in the contaminant exceedance probability chart for sulfate appear reasonable compared to the input parameters. The charts for ammoniacal-N and nitrate-N appear to over-represent the likely range of concentrations that may be expected when compared to the input parameter for the pit lake (MWM 2024). Furthermore, the modelled concentrations at GB02 also exceed measured concentrations for ammoniacal-N and nitrate-N in surficial waters in the existing Golden Bar pit lake (GHD 2023, Table 3). Therefore, the modelled concentrations for these latter two parameters in Golden Bar Creek are expected to be conservatively high.

During the operational period of the mine, water pumped from the pit is intended to be *“pumped initially for use in dust suppression, but any excess water from the pit will need to be either pumped back to Frasers or pumped into the silt control structures for the WRS runoff”*. This intent is not reflected in the mine water management concept layout presented in Figure 28 of the GHD (2024b) report. However, it appears that this intended discharge of mine water was incorporated into the MWB model, as modelled sulfate concentrations at GB02 for the mining and closure periods reflect undisturbed land run-off concentrations rather than mine water concentrations. The modelling outputs indicates the eventual overflow of pit lake water to Golden Bar Creek will result in nitrate-N and ammoniacal-N concentrations in Golden Bar Creek decreasing. This outcome is consistent with the model input parameters and observed water quality in the existing Golden Bar Pit lake.

The model water quality outputs for compliance point NB01 are similar to those for GB02. The post-closure sulfate exceedance curves reflect the influence of pit lake discharges, diluted with run-off from the Golden Bar Creek undisturbed catchment area. Concentrations for both ammoniacal-N and nitrate-N are dominated by run-off from the Golden Bar Creek undisturbed catchment area, with concentrations decreasing once the pit lake starts to overflow.

The statistical results from the WBM are presented for monitoring points GB01, GB02 and NB01 in Tables 9, 10 and 11 of the GB Stage 2 water management report (GHD 2024b). The water outcomes for NB03 have not been presented in this report as the water quality at that compliance monitoring point is more controlled by discharges from the wider MGP and are presented in the Macraes Phase IV water management report (GHD 2024c).

Overall, the WBM outcomes documented in the GB Stage 2 water management report indicate only dissolved arsenic may present a water quality compliance risk at either GB02 or NB01, and this only arises following the filling and overflow of the GB Stage 2 pit lake. This outcome already includes the pumping of mine water from the GB Stage 2 pit to either Frasers Pit or to the Golden Bar WRS silt pond during the operational period of the mine.

Recommendations

No specific recommendations have been provided in the GB Stage 2 water management report (GHD 2024b). However, the modelling documented in the report incorporates the assumption that any excess water from the pit will be either pumped back to Frasers or pumped into the silt control structures for the WRS runoff. This is effectively a proposed water management measure implemented to enable OceanaGold to comply with water quality criteria applicable at NB01 and NB03 during the Golden Bar Pit lake dewatering process.

It is possible that other management options for the operational mine water discharge may be implemented, enabling mine water from GB Stage 2 Pit to be discharged directly to Golden Bar Creek without leading to exceedance of existing consented receiving water quality criteria. This is especially the case if measures are put in place to manage dissolved arsenic concentrations in the mine water, which was one of the pit water quality management recommendations in the Golden Bar Pit dewatering report (GHD 2023).

B.4 Review Summary

Golden Bar Pit Dewatering

The structure and input parameters for the WBM component developed to simulate the effects of the proposed dewatering of Golden Bar Pit on water quality in Golden Bar Creek is appropriate for this purpose. The input water quality values applied to the modelling appear reasonable and are consistent with observed mine and receiving water quality data from the same area. A detailed review of these water quality values is outside the scope of this document.

The calibration of this WBM has been undertaken targeting several water flow, water storage and water quality datasets from the same area. Overall, the WBM model covering the water quality effects in the Golden Bar Creek catchment arising from dewatering of Golden Bar Pit is considered to be well calibrated and fit for purpose.

The water quality input data indicate only sulfate, dissolved arsenic and ammoniacal-N are likely to present risks in terms of existing MGP compliance criteria or National Policy Statement for Freshwater Management (2023) Band A attributes being exceeded through the dewatering of Golden Bar Pit.

Three constant pumping rates have been considered in the pit dewatering evaluation; 15 L/s, 20 L/s and 30 L/s. The modelling indicates pit dewatering can be achieved in between one and three years using these pumping rates. The pumped water would comprise more than 50% of the flow in Golden Bar Creek at NB01 for more than 50% of the time, irrespective of which pumping rate is applied.

In terms of receiving water quality, the Golden Bar Pit dewatering model outcomes are focused on sulfate and dissolved arsenic. In Golden Bar Creek at NB01 there is no existing compliance criterion for sulfate. The receiving water would slightly exceed a sulfate concentration of 250 mg/L, which is the criterion applicable at NB03, slightly more than 5% of the time for all three pumping rates. In the NBWR at NB03 the model indicates the discharged mine water has a lower concentration than the receiving river water during low river flow periods. Consequently, the simulated pumped discharge would result in an improvement in sulfate concentrations at NB03 across the upper 15% of the currently observed range.

Measured dissolved arsenic levels in the pit lake are currently just below the compliance criterion of 0.15 g/m^3 at NB01 and exceed the NB03 criterion of 0.01 g/m^3. The model indicates the discharge of lake water to Golden Bar Creek would not lead to the dissolved arsenic criterion at NB01 being exceeded. In contrast, the modelled discharge would lead to dissolved arsenic at NB03 frequently exceeding the existing compliance criterion applicable at that point, irrespective of which pumping rate was applied.

The modelling indicates water management measures would need to be implemented to enable Golden Bar Pit dewatering to occur within a period of three years, while complying with the existing consented water quality criterion for dissolved arsenic at NB03. Although compliance with the existing sulfate criterion at NB03 would also not be achieved under the pumping rates tested, this outcome was principally due to elevated existing sulfate concentrations in the NBWR at NB03.

Two water quality management measures have been proposed. to address this risk: pumping the Golden Bar pit lake water back to Frasers Pit or discharge of the water to the Golden Bar WRS silt pond. Both measures are conceptually practical but would need to be incorporated into a wider water quality management program for the entire MGP. The wider MPIV assessment has separately identified two further management measures to enable dewatering of the Golden Bar Pit while enabling OceanaGold to continue to meet existing water quality compliance criteria at the site (refer to Appendix C).

GB Stage 2 Mine Water Management

A 3D groundwater flow and contaminant transport model has been developed to help evaluate groundwater inflows to the proposed GB Stage 2 opencast mine, pit lake recovery following mine closure and seepage losses from GB Stage 2 to surrounding surface water bodies. The structure and calibration of the groundwater model simulating the Golden Bar area is consistent with past modelling work at the MGP. The calibrated model and the associated predictive models documented in the report (GHD 2024b) are considered to be fit for the purposes of simulating groundwater drawdown and recovery around the GB Stage 2 Pit and groundwater transport of sulfate within the Golden Bar area.

Maintaining the GB Stage 2 Pit in a dewatered state is projected to result in a stream depletion rate of 0.55 L/s. However, this ‘depletion’ is spread across the entire modelled area and represents less than 1% of the total simulated outflows to the simulated surface water features. Changes to groundwater contributions to local creeks/streams arising from the of GB Stage 2 are expected to be negligible.

The groundwater model indicates that almost all dissolved contaminants transported in groundwater from the GB Stage 2 Pit and Golden Bar WRS will eventually discharge to receiving waters upstream from the NB03 compliance monitoring point. A minor sulfate mass load of <0.1 kg/day sourced from GB Stage 2 is expected to be transported in groundwater and discharged to receiving waters in the Tipperary Creek catchment.

The structure and input parameters for the WBM developed to simulate the effects of the proposed GB Stage 2 development on downstream flows and water quality is appropriate for this purpose. The input water quality values applied to the modelling appear reasonable, although a detailed review of these values is outside the scope of this document.

The calibration of this WBM has been undertaken targeting several water flow, water storage and water quality datasets from the same area. Overall, the WBM model covering the water quality effects in the NBWR catchment arising from the GB Stage 2 development is considered to be well calibrated and fit for purpose.

Mine impacted water from the Golden Bar area is captured and returned for use on the site as best possible. This process will cease following the completion of mining operations at Golden Bar. Therefore, the key model outcomes with respect to assessing receiving water quality are for the post-closure period.

The WBM indicates that the GB Stage 2 Pit will fill to an elevation of 497.5 mRL and then overflow to Golden Bar Creek, as the existing pit lake currently does. The filling period was modelled to be in the order of 40 years, with an uncertainty range of approximately 10 years.

The key contaminants identified through the WBM simulations are sulphate, nitrate-N and ammoniacal-N. The modelled exceedance curves for these parameters at the existing water quality compliance monitoring points GB02 and NB01 appear reasonable. The exceedance curves are consistent with the concentrations of the contaminants applied as input parameters to the model and the availability of dilution water in the receiving streams.

Overall, the WBM model outcomes indicate only dissolved arsenic may present a water quality compliance risk at either GB02 or NB01, and this risk only arises following the filling and overflow of the GB Stage 2 pit lake. This outcome assumes mine water is pumped from the GB Stage 2 pit to either Frasers Pit or to the Golden Bar WRS silt pond during the operational period of the mine.

Statistics covering the projected water quality at NB03 have not been presented in this (GHD 2024b) report. The quality of water at the NB03 compliance monitoring point is more dependent on mine water management across the wider MGP than on focused management of water in the Golden Bar and Clydesdale Creek catchments. Therefore, projected water quality at NB03 is documented in the separate Macraes Phase IV water management report (GHD 2024c).

Overall, the technical assessment of the water quality effects arising from the proposed GB Stage 2 development is considered to be defensible and fit for purpose.

APPENDIX C
MACRAES PHASE IV (MPIV) REPORT TECHNICAL REVIEW

C.1 Review Components

The assessment of the effects of the proposed Macraes Phase IV (MPIV) development on the surrounding groundwater system and on surface water flows and water quality has been based on four components of work.

1. The assessment of the quality of seepage water from stored mine wastes and water accumulating in closed mine pits (MWM 2024).

2. The assessment of the effects of MPIV development and closure on the surrounding groundwater system, including groundwater quality (GHD 2024c).

3. The assessment of the effects of MPIV development and closure on water flows and water quality in Deepdell Creek, the North Branch Waikouaiti River and associated tributaries.

4. The development and evaluation of water quality management measures to enable OceanaGold to operate and close the MGP, including the MPIV development, while complying with all receiving water quality consent compliance criteria.

The focus of the MPIV assessment is surface water and groundwater cumulative effects of the proposed Innes Mills Opencast Pit (IMOP) extension, Golden Point Pit filling and Frasers Tailings Storage Facility (FTSF) developments within the Deepdell and the Waikouaiti River North Branch (NBWR) catchments. These key features of the MPIV development are presented in Figure 3 and Figure 4. The key surface water quality monitoring and compliance points for the MGP are presented in Figure 5.

The cumulative effects incorporated in the MPIV assessment include the reported effects from the

- Golden Point Underground (GPUG) Expansion and Extension (under separate application)
- CO6 and the GB Stage 2 developments (reviewed separately in this memorandum)

In addition to the documents reviewed in this memorandum, I (Brett Sinclair) also reviewed the following documents that have a direct relevance to the MPIV assessment:

- WSP 2023. Golden Point Underground Mine (GPUG), GPUG Extension Hydrogeological Assessment. Report produced for OceanaGold (New Zealand) Limited by WSP Australia Pty Ltd. Document # PS130025-003-R-Rev5. Dated 26 April 2023.
- GHD 2022. TTTSF Crest Raise, Surface Water and Groundwater Assessment. Report produced for OceanaGold New Zealand Limited by GHD Ltd. Dated 29 August 2022.

C.2 Proposed MPIV Operations

Components of the proposed MPIV development summarised in Section 2 of the GHD (2024c) report. There are numerous components to the proposed development, and these are not listed here. These components are appropriately documented in the GHD report, including the project timeline and a short summary of the proposed MPIV closure plan.

A general description of the site setting including the topography, climate, background geology, hydrostratigraphy and relevant surface water catchments is provided in Section 3 of the GHD (2024c) report. These descriptions are sufficient to enable a general understanding of the site environment to be gained. No description of the existing mine structures is provided in this section.

C.3 Groundwater Modelling

Two components of groundwater modelling have been documented in the MPIV report:

1. The drain down modelling for the proposed raised Top Tipperary Tailings Storage Facility (TTTSF), which is located in the Tipperary Creek catchment (Section 4.1 in MPIV report)
2. The 3D groundwater flow and contaminant transport model for the wider MGP site (Section 4.2 in MPIV report).

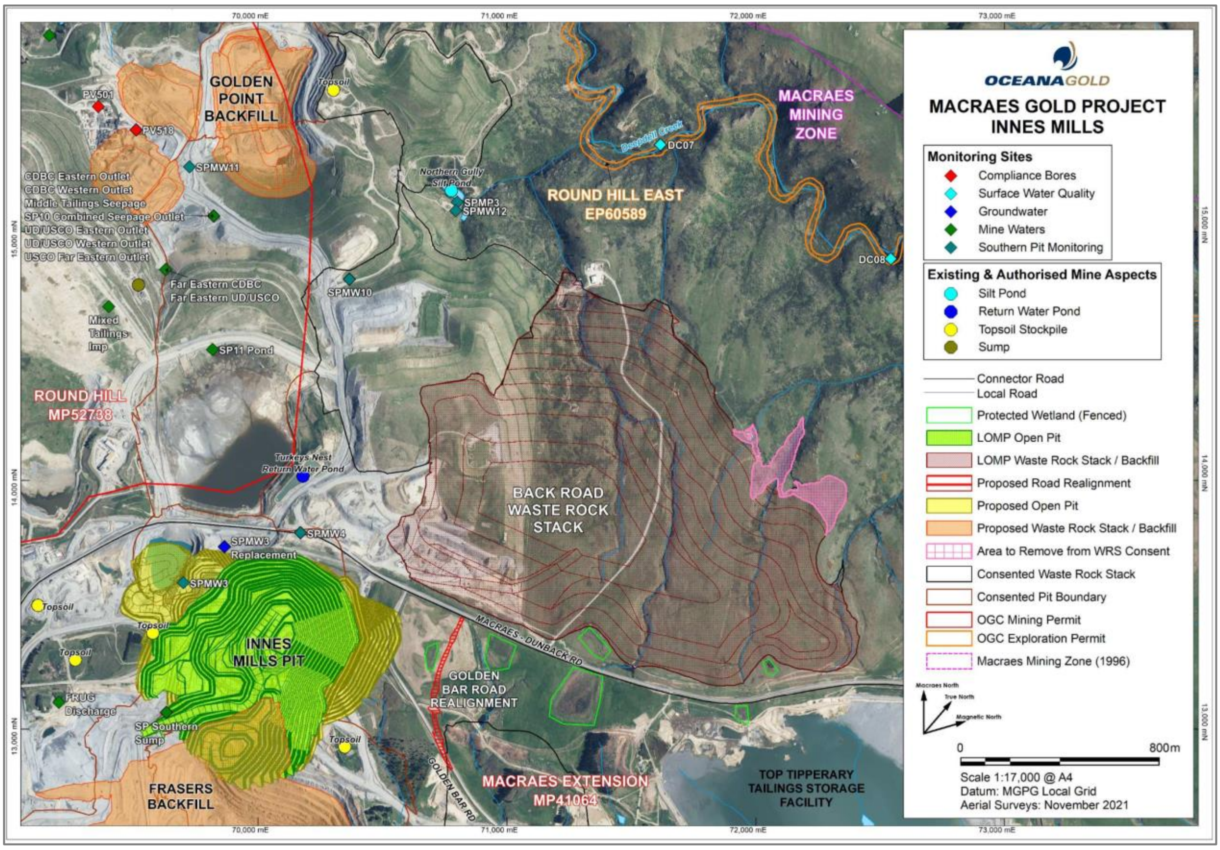

Figure 3. MPIV Innes Mills Pit Development (GHD 2024c).

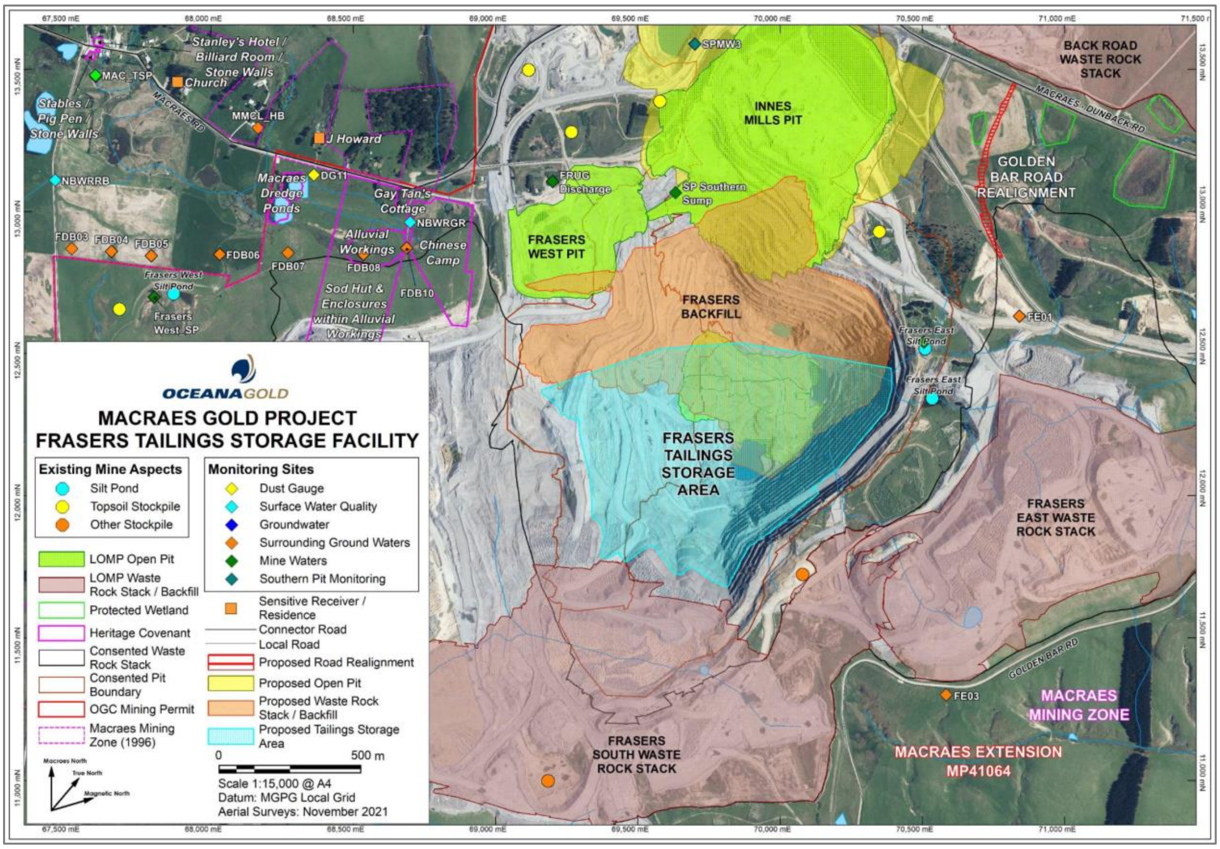

Figure 4. FTSF / IMOP Waste Rock Stacks and Development (GHD 2024c).

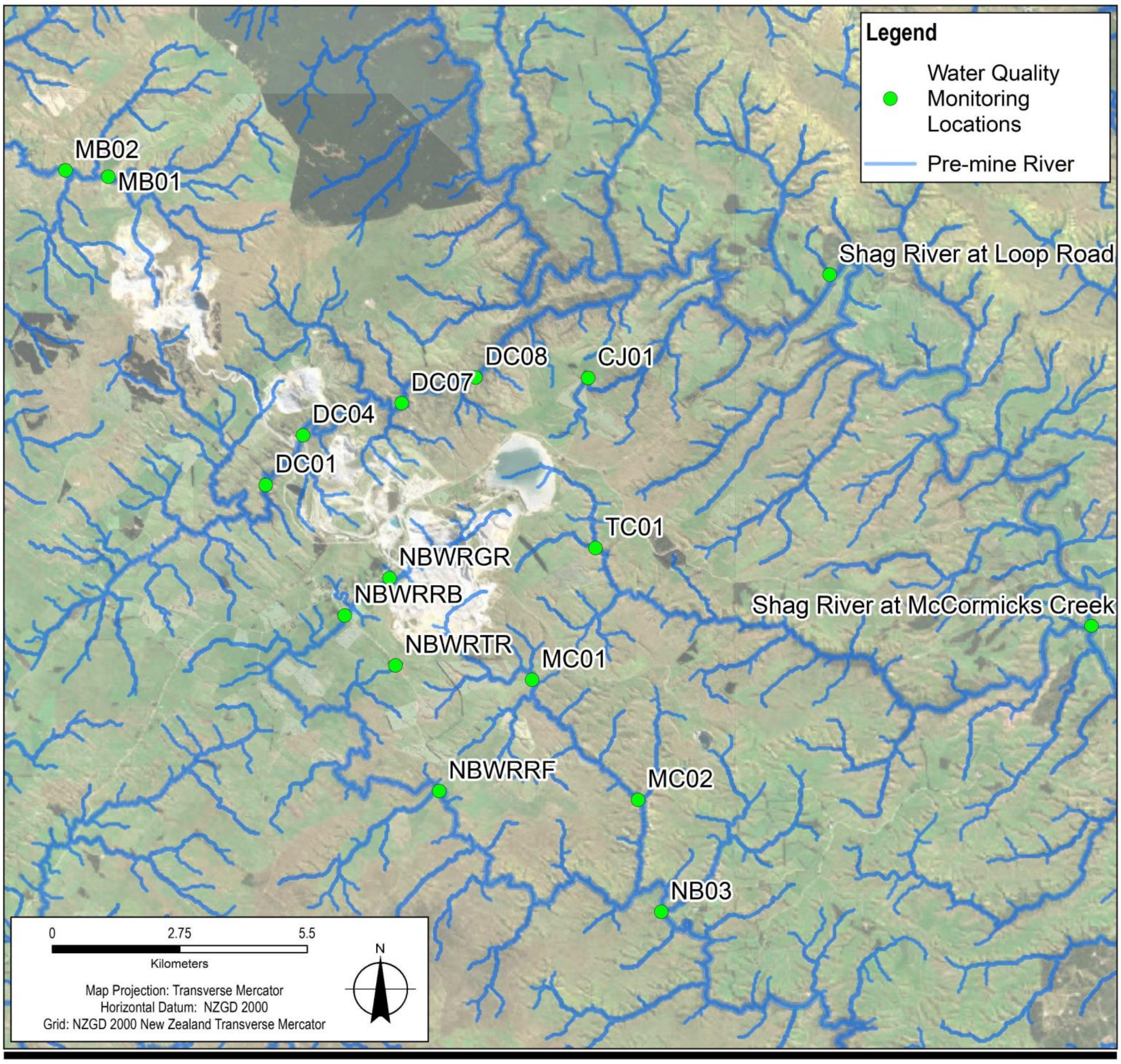

Figure 5. Water quality monitoring and compliance locations for the MGP (GHD 2024c).

C.3a TTTSF Modelling

Section 4.1 of the MPIV report presents a summary of sections from the earlier GHD report (GHD 2022a), which documented the effects of the proposed raise to the TTTSF to an embankment crest elevation of 570 mRL. The sections of the GHD (2022a) report summarised in the MPIV report focus on the post-closure drain-down of groundwater within the stored tailings and the rate of seepage flows discharging from these tailings following closure of the TSF.

Three 2D SEEP/W groundwater models were used to simulate TTTSF drain-down scenarios, with the scenarios summarised in Table 4 of the report. These models have been previously reviewed, with the review documented in a memorandum from WGA to OceanaGold (WGA 2022). The numerical functioning of the models was found to be generally appropriate for the intended purpose of simulating seepage losses from the TTTSF.

Current measured drainage system discharge flows for the three existing TSFs on site are summarised in Table 7 of the MPIV report. Projections for flows at mine closure (2030), 20 years post-closure and 400 years post-closure are presented in the same table. These projections are based on the 2D drain-down modelling undertaken for the TTTSF and apparently extrapolated for the other two TSFs based on stored tailings footprint area. The conceptual method applied to drain-down simulation is reasonable, but GHD notes that the simulated decline in TTTSF drainage rates is slower than observed declines for the other two TSFs.

An analysis of TSF drainage system discharge flows at the MGP has previously been done by Golder (2011b). This analysis was based on observed declines in drain flows during periods when tailings storage in the MTI and the SP11 TSF ceased. The analysis indicated that the combined drain discharge flows from a TSF were likely to decline by between 50% and 90% within two years of the TSF closure. This projection by Golder is consistent with the conclusion reached by GHD that there is an *"apparent stabilisation of seepage volumes after a period of approximately 3 years"*, and the suggestion that *"drawdown is a lot faster than modelled within the TTTSF"* (GHD 2022a).

A check on the modelled drainage system discharge rates has been undertaken based on the indicated groundwater recharge rate of 29.2 mm/year applied to the area of the closed TSFs. The results are presented in the second column of Table 1. For comparison, the projected long-term TSF drainage system discharges presented in the Golder (2011c) surface water modelling report produced to support the consenting of the Macraes Phase 3 Project are presented in the fourth column of Table 1.

Although three different analysis methodologies were applied to generate the long-term drainage flow rates presented in Table 1, the results are very similar. On that basis, the long-term TSF drain discharge flows produced by GHD are considered to be defensible and reasonable.

Table 1: Comparison in TSF drain discharges between different analyses (L/s).

TSF	MPIV MODELLED (GHD 2024C)	TAILINGS RECHARGE ESTIMATE (1)	MP3 MODELLED (GOLDER 2011C)
MTI	1.5	0.7	3.5
SP11	1.2	0.5	0.3
TTTSF	4.0	1.4	3.0

Note: 1) Assumes recharge of 29.2 mm/year to the surface tailings footprint.

C.3b MPIV Groundwater Model

A 3D groundwater flow and contaminant transport model has been developed to help evaluate groundwater inflows to the opencast mines in the core MGP area, focusing on mine workings between Deepdell Creek, Tipperary Creek and Murphys Creek. The simulation of groundwater flows around the Coronation and Golden Bar areas is excluded from this model as they have been addressed using other groundwater models.

The modelling code applied is MODFLOW USG, which is an industry standard code. Its use to simulate groundwater flows and contaminant transport across the MGP is appropriate.

Model Structure

The layout and topographic shells of the existing and proposed mine structures, including opencast pits and WRS areas, are consistent with the existing mine as-built layout and with the layout of the proposed MPIV features. The modelled area is sufficiently large (204 km^2) that the edges of the modelled area do not impact on the simulation of the mine structures in the core MGP area. The modelled area also appropriately incorporates reaches of Deepdell Creek, the NBWR and Tipperary Creek, which are the principal surface water bodies potentially impacted by the MPIV development.

The existing consented water quality compliance monitoring points for the MGP Deepdell Creek, the NBWR, Murphys Creek and Tipperary Creek (Figure 5), are within the modelled area. On this basis, the extent of the 3D groundwater flow model documented in the GHD (2024c) report is appropriate for the assessment of the effects on the groundwater system arising from the proposed MPIV development.

The model of grid discretization is appropriate for the size of the overall model and the intended objectives. Lateral cell discretization close to key features, including Deepdell Creek, Mare Burn and the proposed CO6 pit, is at 25 m; increasing to 100 m across the wider modelled area. Vertical discretization of the local geology into 12 model layers is consistent with a past FEFLOW modelling approach to the site (GHD 2021). The model discretisation is appropriate to the model size and objectives.

The simulated geology in the groundwater model relates predominantly to the degree of weathering and therefore hydraulic characteristics of the in-situ schist. Additionally, the simulated geology incorporates the TSF and WRS structures as these effectively behave as localised artificial aquifers. The geological representation applied in the MPIV groundwater model is consistent with previous groundwater evaluations covering this area of the MGP (Golder 2011b, GHD 2021).

Boundary Conditions

The hydraulic boundary conditions applied to the groundwater model are appropriate to simulate the groundwater system relevant to the proposed MPIV development. The boundary conditions have been documented in Appendix C of the report. Specifically:

- Recharge is applied across the entire model at a rate of 29.2 mm/year, which is consistent with groundwater recharge of 32 mm/year applied to past groundwater models of the MGP (Kingett Mitchell 2005, Golder 2011b).
- River boundary conditions have been used to simulate several watercourses that carry permanent or near permanent flows. The river stage conditions are consistent with local topography and acceptable for intended model objectives. The conductance value applied to these cells 5 m^2/day/m is reasonable.
- Drain boundary conditions have been used to simulate the hydraulic behaviour of other creeks and gullies within the modelled area. Drain elevations are consistent with the local topography and appropriate for the intended purpose of stream tributary simulation. The conductance value of 10 m^2/day/m applied to these cells is reasonable.
- Drain boundary conditions have also been used to simulate the hydraulic behaviour of Frasers and Innes Mills Opencast Pits (FROP and IMOP), and Frasers and Golden Point Underground Mines (FRUG and GPUG) during their operational dewatering periods. Drain elevations were defined to correspond to the base of each mining operation. These drain conditions were removed once the MGP closed.
- General head boundary (GHB) conditions have been used to simulate the recovery of water level within the Innes Mills and Frasers Opencast Pits. As inflows to the pits are primarily derived from surface water run-off and direct rainfall, the transient post-closure water levels applied to these boundary conditions have been derived from the WBM. This approach is considered appropriate and reasonable.
- Constant head boundaries have been used to simulate water ponding on the surface of TSFs during the operational period of the mine. This approach is considered appropriate.
- The base and most of the lateral edges to the model are defined by default as no-flow boundaries, which is standard modelling practice and is appropriate in this model.

The boundary conditions applied to the model are considered to be appropriate for the intended purpose.

Flow Model Calibration and Numerical Performance

Model calibration has been performed on a steady-state basis simulating the pre-mining groundwater system. The water balance discrepancy for the calibrated model was low at less than 0.01%, indicating the model is numerically stable and functioning acceptably.

The groundwater level data used as a target for the model calibration process are presented in Appendix D of the report. Both measured and modelled groundwater levels are presented in this appendix. The date of each measurement has not been provided and it seems unlikely all of the measurements were made within the same week, or even the same year. A spread in the measurement dates is likely to have contributed to scatter in the model calibration outcome summarised below.

The calibration result of a SRMS value of 7.9% is acceptable, following acceptance guidance from the Australian Groundwater Modelling Guidelines (Barnett et al 2012). A visual review of the chart showing modelled versus observed groundwater heads (Figure 13) indicates a slight tendency of the model to overestimate groundwater levels at the lower end of the observed range. As the groundwater measurements at the lower end of the range predominantly come from bores located on the valley slopes of Deepdell Creek. The calibration data is also heavy focused on bores located in a relatively small area of the model. However, the overall simulation of groundwater levels across the model is considered reasonable and appropriate, with the steady state model being fit for purpose.

The calibrated hydraulic characteristics applied to the simulated bulk rock mass are consistent with the hydraulic characteristics applied to past models of the MGP. The calibrated hydraulic conductivity values for the schist presented in Table 8 of the report are also consistent with the cumulative results from hydraulic tests performed on schist at the MGP over the past three decades (Kingett Mitchell 2005, Golder 2011b, URS 2013b, WSP 2022).

A check on the behaviour of the transient model was made by comparing inflows to the drainage cells simulating the FRUG against the recorded inflows to the underground workings. Once the modelled inflows had settled down, the stable inflow rate was in the order of 25 L/s, which is in general agreement with recorded FRUG dewatering rates of 12 L/s to 24 L/s.

The groundwater model calibration has produced a model consistent with models previously used to simulate the groundwater system at the MGP. The model is generally considered to be fit for the intended purpose of assessing groundwater flows to the MGP mining operations and contaminant transport in groundwater around those mining operations.

Predictive Flow Models and Model Outcomes

The transient predictive model used to simulate dewatering of the opencast Pit is based directly on the calibrated steady state model. The hydraulic boundary conditions as summarised above are suitable to simulate the operational and closed opencast pits and underground mines at the site. This transient model appears to be numerically stable, with a water balance discrepancy at less than 0.01%. This model is considered fit for the intended purpose of evaluating groundwater inflows to the IMOP and FROP.

The model run time of 400 years is substantially longer than the projected pit lake filling times. This run time is provided to ensure the contaminant transport simulation has sufficient time to indicate the full potential extent of future contaminant plumes. Uncertainty regarding the outcomes of the flow simulation increases beyond a period of a few decades, in line with uncertainty regarding long-term climate change projections.

The simulated inflows to the simulated opencast pits are documented in Section 4.2.6.1 of the report. The projected inflows are small compared to the total inflow rates calculating using the mine water model reviewed later in this memorandum. Uncertainty regarding the groundwater inflow rates to the pits does not represent a significant issue with respect to the environmental effects of each pit. The model uncertainty relates primarily to the pit lake filling times, which are not critical components of the model projections.

Overall, the uncertainty in aspects of the groundwater model does not represent a significant issue with respect to the assessment of environmental effects of the pit, including the post-closure filling rate for the pit lakes. This model is considered fit for the intended purposes of evaluating groundwater inflows to the simulated opencast pits and identifying the discharge areas for contaminant plumes arising from simulated MGP mining features.

With respect to stream depletion effects, the GHD (2024c) report states:

> *"Modelling results indicate a reduction of ~260 m^3/d (3 L/s) or ~ 8% (at the river boundary) and ~215 m^3/d (2.5 L/s) or ~8 % at the drain boundary, of the groundwater contributions to the Deepdell Creek due to pit dewatering. For the remaining of the creeks, modelling results show a reduction of 23 m^3/d (from 6134 m^3/d to 6,111 m^3/d or by 0.4%) on the river boundary and a reduction by 789 m^3/d (from 10,360 m^3/d to 9,571 m^3/d or by 7.6%) on the drain boundary at the end of pit dewatering. Most creeks in the mine area are transient in nature and there are no surface flows during summer as evaporative losses from the creeks exceed the groundwater discharges to these creeks. Therefore, modelled reductions in seepage discharges to creeks are expected to have negligible impacts on creek and river flows through summer low flow periods."*

It is important to recognise that the simulated stream depletion effects are almost all existing effects arising from development of existing opencast pits. The only new reduction in stream flows that is linked to the MPIV development arises out of the proposed extension and expansion of the GPUG mine, which is subject to a separate consent application.

Predictive Contaminant Transport Models and Model Outcomes

The predictive contaminant transport groundwater model has been based on a long-term transient groundwater model. The contaminant transport model focuses on sulfate transport in the groundwater system, with the sulfate almost entirely derived from mining operations and stored wastes.

A very small (0.0001 mg/L) background sulphate concentration was applied to all layers simulated in the groundwater model. Overprinted on this background concentration are sulfate concentrations applied to:

1. Recharge to the simulated WRS's. The sulfate concentration in each case is linked to the height of the individual WRS, as documented in the MWM (2024) report. Each WRS acts as a constant source of sulfate to the surrounding groundwater system, with depletion of the sulfate source not incorporated in the model.
2. Seepage through tailings stored in the TSFs.
3. The developing lakes in the Frasers / Innes Mills Pit (FRIM) and the Golden Bar Pit. The projected sulfate concentrations in the pit lakes is derived from the mixing of incipient rainfall to the lake surface, surface run-off entering the pit and groundwater seepage discharging to the pit. The sulfate concentration applied in simulating the pit lake water has been taken directly from the MWM (2024) report.

A map identifying the areas where specific sulfate concentrations have been applied to the model is presented in Figure 24 of the report. The indicated sulfate sources to the model are consistent with the site layout.

A detailed review of the sulfate concentrations applied to the various mine structures has not been undertaken. However, in general the concentrations documented in Table 10 of the report are consistent with concentrations observed in seepage water at environmental monitoring points around the MGP.

In addition to the rock mass parameters applied in the groundwater flow model, values for effective porosity and longitudinal and transverse dispersivity have been incorporated into the contaminant transport model. These factors influence the rate of contaminant transport and therefore the contaminant plume breakthrough curves at various receiving water bodies. The values applied in the groundwater model to the above parameters are reasonable.

As the depletion of sulfate from stored mine wastes and the pit lake over time is not incorporated in the model, the simulated mine structures act as constant contaminant sources. Therefore, the simulated contaminant plumes approach a steady-state status over the long term. Consequently, the contaminant transport factors listed above become less important in evaluating contaminant mass loads and discharge areas over the long term.

The long-term sulfate mass balance for the groundwater model is presented in Figure 25 of the report. The percent discrepancy in cumulative mass passing though the model is <0.01%, indicating the contaminant transport model is numerically stable and functioning appropriately.

The model outcomes are summarised as sulfate groundwater plume maps in Figures 26 and 27 of the MPIV report (GHD 2024c). The sulfate plume maps only show concentrations above 10 mg/L, which is a reasonable lower cut-off concentration. These maps present the sulfate plumes simulated in Layer 6 of the model because the higher modelled layers are very thin across most of the model. The upper layers are primarily used to simulate stored wastes at the site and consequently do not provide a good indication of the extent of contaminant plumes in the in-situ schist rock.

The simulated sulfate discharge areas for these plumes are all upstream from the water quality compliance monitoring points on the Shag River at Loop Road and McCormicks Creek, on Tipperary Creek at TC01 and on the NBWR at NB03 (Figure 5). However, the modelling suggests some contaminants transported in groundwater may eventually discharge to Deepdell Creek and Murphys Creek downstream from designated compliance points on these water bodies (DC08 and MC01, respectively).

Other contaminants to groundwater due to mining operations are either conservatively transported or are subject to attenuation through adsorption or geochemical reactions. Groundwater plumes for these other contaminants are expected to be similar or smaller in extent to those simulated for sulfate.

The sulfate mass flux projections from the modelling are presented in Table 11 of the MPIV report. The key outcome from the groundwater modelling is not the absolute mass flux values presented in this table. Rather, the key outcome is the difference in simulated mass loads between 20 years post-closure and 200 years post-closure. This difference emphasises the delay between the loss of contaminants from stored wastes at the MGP and the eventual discharge of these contaminants to the receiving surface waters. Much of the water quality management planning undertaken by OceanaGold has taken into account the need to plan for increasing contaminant mass loads for a considerable period into the future.

An important assumption built into the groundwater mass transport modelling, and into the mine water balance modelling, is that historical underground mine workings at the northern end of the Golden Point Pit are to be effectively sealed (Section 1.4.3 of the MPIV water management report). This management measure is required to ensure rising groundwater levels within the Golden Bar Pit backfill do not result in overflows to Deepdell Creek via these workings.

Groundwater Model Results Used in Water Balance Model

Groundwater inflows and outflows from the pit lakes simulated in the groundwater model have been incorporated in the WBM to support the analysis of lake filling times. These groundwater flows have also been utilised by MWM (2024) in the evaluation of future pit lake water quality.

Sulfate mass loads (flux values) originating from specific mine features are incorporated in the WBM. These features include TTTSF drain and basal seepage discharges from the GHD (2022) report, drainage flows from the Mixed Tailings Impoundment and the SP11, and pit lake seepage losses to receiving water bodies. The mass loads for other contaminants have been based on the correlations between these contaminants and sulfate concentrations for various contaminant sources but are not directly derived from the groundwater model.

The sulfate mass loads derived from the predictive groundwater model are compared with the WBM outputs in Table 18 of the GHD (2024c) report. This has been done as a check on assumptions built into both models and to help validate the MBM outputs. The sulfate mass load outcomes from the WBM are consistently higher than those derived from the groundwater model. Part of the discrepancy is due to the delayed mass discharge to the receiving waters as simulated in the groundwater. The WBM does not incorporate any delay linked to groundwater seepage flow paths.

C.4 Water Balance Modelling

Key Assumptions

A list of key assumptions for the MPIV WBM is provided by GHD (2024c) in Section 5.8.1 of the report. Most of these assumptions simply set out aspects of how the model functions. However, there are a few assumptions that have direct practical implications for future mine water management at the site.

Dewatering of flooded pits at the site is not included in the MPIV WBM, mainly because this process is subject to direct operational control to ensure the receiving water quality remains in compliance with the existing consented criteria. This modelling approach is reasonable. However, it does imply a duty of care from OceanaGold with respect to appropriate mine water discharge management, especially regarding dewatering of the Golden Bar Pit.

It has been assumed that *"the backfilling of Golden Point Pit will also include measures to control seepage through these workings in the long term and as such, this seepage has not been included in the modelling undertaken."* This assumption was also built into the modelling of mine water management undertaken to support the consenting of the MP3 development in 2011 (Golder 2011c). Active water management at site since 2011 has minimised seepage losses through the historical workings to date. Sealing of these workings remains a necessary mitigation measure for long-term management of mine water discharges and receiving water quality in Deepdell Creek.

All simulated contaminants are assumed to be conservatively transported within both the groundwater and surface water environments. For sulfate, this is a reasonable assumption. However dissolved metals may be subject to adsorption or precipitation within the groundwater or at the groundwater discharge points. The documented model outcomes for dissolved metals and metalloids such as iron and arsenic at the defined compliance points may therefore be significant overestimates.

A release rate curve for the Camp Creek dam has been provided. The release rate is linked to the background in-stream flow measured at Golden Point Weir on Deepdell Creek, with flows below 50 L/s at the weir resulting in a "make up" flow of up to 20 L/s from the dam. Should Camp Creek Dam be required as a water quality management measure, these discharge rates incorporated to the model are consistent with the release rates incorporated as a potential management measure during consenting of the MP3 development in 2011 (Golder 2011c). Modelling indicates the dam should be able to provide for the discharges to top up flows during dry summers. This assumption regarding progressive discharge rates for incorporation as a potential water quality management measure is reasonable and has been accepted by ORC during past consenting processes.

Model Design and Input Parameters

The MGP water balance model developed by GHD using the GoldSim package includes all river and stream catchments potentially impacted by developments at the MGP. It also incorporates all of the mine structures that could potentially have a significant impact, either individually or collectively, on receiving water quality. This model includes the water balance modelling undertaken for the Coronation and Golden Bar areas, which have been reviewed in Appendices A and B of this memorandum.

A schematic summarising the water balance model is presented in Figure 28 of the report (GHD 2024c). A review of the mine water model schematic presented in Figure 28 confirms that the significant mine structures and receiving water catchments have been incorporated into the model. Not all of the water flow connections presented in this schematic are active at any one time, with many of the indicated model components becoming inactive when mining operations at the site cease. For example, the need to pump water from the Taieri River for ore processing will disappear once mining operations cease and ore stockpile processing is completed. Maps presenting the layout of the contributing areas and contributing features to the model are documented in Appendix A to the report.

The water balance model structure indicates:

- All contaminant losses carried by groundwater or surface water flows from mine structures in or hydraulically linked to the Deepdell Creek catchment will eventually discharge to the creek upstream from DC08. This interpretation differs slightly from the groundwater model outcomes but does not affect the water balance model outcomes significantly.
- All contaminant losses carried by groundwater or surface water flows from mine structures in or hydraulically linked to the NBWR catchment will eventually discharge to the NBWR upstream from NB03. This interpretation is correct, with compliance monitoring points higher in the catchment at NBWRRF, MC01 on Murphys Creek and NB01 on Golden Bar Creek also built into the model.
- All contaminant losses carried by groundwater or surface water flows from mine structures in or hydraulically linked to the Tipperary Creek catchment will eventually discharge to the creek upstream from the compliance monitoring point TC01 or to Cranky Jims Creek upstream from monitoring point CJ01. This interpretation is reasonable.
- All contaminant losses from the site that report to Deepdel Creek, Cranky Jims Creek or Tipperary Creek will enter the Shag River upstream from the ultimate compliance monitoring point at the confluence with McCormicks Creek. This interpretation is correct.

Runoff and groundwater discharges from catchment areas unimpacted by mining operations are calculated using the AWBM method (refer Appendix A, GHD 2024c). The runoff calculations have been calibrated separately for the Deepdell Creek and NBWR catchments. The calibration of runoff coefficients has been undertaken against flows measured at Golden Point Weir on Deepdell Creek (1991 – 2018) and against flows measured at Golden Bar Road and Gifford Road on the NBWR (1991 to 1998). The calibration outcomes are summarised in graphic form in Figures A-1 and A-1 presented in Appendix A of the reviewed report (GHD 2024c). The AWBM coefficients derived for each of these catchments have then been applied to the Mare Burn and Tipperary Creek catchments, as appropriate for their geology and topographic layouts.

No information has been provided on the calibration of simulated versus measured flows for the Shag River. MGP water balance model calibrations against flows in the Shag River have been problematic for all iterations of modelling that I have been involved with or reviewed. The issue arises because the Shag River catchment has different rainfall patterns to those recorded at the MGP. The Shag River also receives a substantial groundwater contribution providing a reliable base flow, which is not the case for Deepdell Creek or Tipperary Creek. Water balance models focusing on the MGP tend to underestimate the base flow in the Shag River. Consequently, these models also tend to overestimate peak contaminant concentrations at the compliance monitoring points in the Shag River. This issue is discussed further with regards the model outputs, later in this memorandum.

The undisturbed catchment runoff calibrations are supported by separate calibration checks against water quality within the WBM. Receiving water quality calibration checks for the NBWR have been reviewed with the outcomes documented in Appendix B to this memorandum.

It should be noted that the AWBM calibration for Deepdell Creek does not account for the occasionally transient nature of flows in the creek during extended dry summers. During these summers evaporative losses from the creek bed are interpreted to exceed groundwater seepage flows into the creek bed. The NBWR carries a permanent flow and the model is less subject to overestimation of flows in the river during very dry conditions.

Runoff from mine impacted surfaces is calculated using the rational method. The run-off coefficients applied to opencast pit and mine impacted areas across the MGP are generally reasonable values for the rainfall intensities simulated. These coefficients have been applied consistently to impacted areas across the MGP.

Rainfall patterns applied to the model are based on records from rainfall monitoring stations at the site. This is appropriate for the current operational period of the mine, through to 2030. The WBM simulating the post-closure period incorporates projected changes in seasonal rainfall based on the RCP8.5 climate projections from NIWA. The seasonal percentage changes in rainfall for the site are documented in Table 13 of the GHD (2024c) report and are accepted as reasonable. The modelled runoff coefficients are not influenced by projected changes in rainfall patterns, which is an acceptable approach.

The stage / volume / area relationship for the proposed Frasers Pit lake, as incorporated in the WBM, is appropriately documented in Table A-1 of Appendix A. Although not documented in the MPIV report, the stage / volume / area relationships for the CO6 Pit and the GB Stage 2 Pit are provided in separate reports as documented in Appendices A and B of this memorandum. These relationships have been provided to the modeller by OceanaGold and I have assumed they are correct for the proposed pit layouts.

Overall, the performance of the WBM in simulating receiving water flows from catchments unaffected by mining operations is considered to be defensible and reasonable. The runoff coefficients applied to mine impacted surfaces are also considered to be reasonable. The WBM runoff components are considered to be fit for the intended purpose of evaluating the effects of the MGP on receiving water quality through the operational and post-closure periods of the mine.

The water quality values applied to runoff from natural, impacted and rehabilitated areas for the key contaminants are documented in Table 15 of the report. The values appear reasonable, based on my background knowledge of water quality at the site, but I have not reviewed monitoring data from OceanaGold to confirm this conclusion. The projected water quality for the various opencast pit lakes has been provided by MWM (2024) and incorporated into the WBM. The WRS seepage water quality has also been provided by MWM (2024) for incorporation into the WBM.

With regards to water quality model input, the GHD (2024c) report documents the input values for contaminant parameters in impacted and non-impacted surface waters (Table 15). The water quality values for WRS seepage water are not presented in the report but they are documented in the MWM (2024) report (Table 24). Water quality values for contaminants in the pit lakes are also not presented in the GHD report but they are presented in the MWM report (Table 26). The GHD report references the MWM (2024) report for WRS and pit lake contaminant values, and the tables for these values provided in the MWM report are appropriate for the purpose.

Four model scenarios have been simulated, as set out in Table 5.8 of the GHD report. Three scenarios cover the active mining period through to the long-term post-closure behaviour under current climate patterns. The fourth scenario incorporates long-term climate change to rainfall patterns.

Model Outputs

The WBM indicates that the combined Frasers and Innes Mills (FRIM) pit lake will fill to an approximately stable level over a period of some 150 years following the close of mining operations. The final lake water level is projected to develop a dynamic equilibrium between 486 m and 494 m RL. The upper end of this range is some 3 m below the intact schist spill level of 497 mRL at the northwestern pit rim. Overflow at this point would discharge to the NBWR. However, the pit lake within the equilibrium range represents a large buffer storage capacity. The model indicates seasonal fluctuations in response to changes in rainfall patterns are unlikely to lead to overflows on this side of the like.

The outcomes from the model incorporating climate change do not change the long-term FRIM lake water level outcome significantly (GHD 2024c, Table 19). The model inputs indicate increased annual rainfall over the long term is approximately balanced by increased evaporative losses from the lake surface. The lake water level outcome therefore reflects the balance in input parameters.

Frasers pit lake water levels above 487 mRL may lead to seepage through the Frasers South WRS toward Murphys Creek Silt Pond. Mine water accumulating in Murphys Creek Silt Pond is to be managed through long-term pumping back to Frasers Pit. Therefore, this loss of water from the pit lake toward the south is part of a closed cycle, with no downstream implications. It is however noted that other water quality management options developed through future research into passive treatment may negate the need for the proposed long-term pumping from Murphys Creek Silt Pond.

Modelled inflows to FRIM (Figures 36 and 38) are dominated by direct rainfall and runoff from surrounding catchments. Modelled water losses from FRIM are predominantly evaporative losses (Figures 37 and 40). These outcomes are consistent with the model layout and also consistent with past site water balance modelling results (Golder 2011c).

The key contaminants identified through the WBM simulations are summarised in the GHD (2024c) report as follows:

> *"Selected contaminants (comprising Sulphate, Ammoniacal N, Nitrate N, Arsenic and Iron) predictions are presented for each location where they are considered key elements in terms of the current and predicted future impacts. The modelled results of these constituents are also within the range of consented limits applied to other surface water bodies within the wider MGP area. Other consented constituents (cyanide, copper, lead and zinc) are typically lower in the receiving water bodies and modelled concentrations are generally well below the stated compliance limits."*

A review of the water quality assessment undertaken by MWM (2024) is outside the scope of this document and outside my (Brett Sinclair) area of expertise. I have assumed MWM's assessment is technically valid and reliable.

A check on the assessment of water quality characteristics for stored wastes and pit lakes undertaken by MWM (2024), excluding the key elements listed above, indicated:

1. Dissolved zinc in WRS seepage water can become elevated above receiving water reference compliance values (MWM 2024, Tables 24 and 25);
2. Dissolved arsenic in the pit lakes can become elevated above receiving water reference compliance values (MWM 2024, Table 26);

After checking the input concentrations derived from the report for the 'non key' parameters relating to the pit lakes and the WRS seepage (both MWM 2024) and the surface run-off (GHD 2024c), I consider this conclusion with respect to the key contaminants to be reasonable. Model input concentrations for the non-key parameters in water derived from a range of mining operations across the MGP are below the compliance concentrations applicable at downstream compliance points. Therefore, these parameters are not of significant concern with respect to modelling future compliance at the compliance points.

Statistical summaries of the model results for water quality are presented in Appendix F of the GHD (2024c) report. The results for the key compliance points on Deepdell Creek, the Shag River, the NBWR and Murphys Creek are presented in tables in Appendix F.

<u>Deepdell Creek</u>

The model results with respect to Deepdell Creek are reported for monitoring points DC07 and DC08. I have ignored DC07 and focused on DC08 as the current downstream compliance point on Deepdell Creek.

The WBM outcomes for D08 indicate that sulfate concentrations are likely to exceed the existing compliance concentration of 1,000 mg/L in the long term <0.5% of the time. Implementation of in-stream flow augmentation using Camp Creek Dam as a source of make-up water results in sulfate compliance over the long term. Although non-compliance with the sulfate criterion in the short term is also indicated by the model, this outcome seems unlikely, given almost all surface discharges from the site are actively managed, the site layout within the Deepdell Creek catchment is not changing significantly under MPIV. Furthermore, the highest recorded sulfate concentration at DC08 was 950 g/m^3 in February 2015 and concentrations have been significantly lower since then (Ryder 2024).

The nitrate-N criterion at DC08 is ≤2.4 mg/L median and <3.5 mg/L 95% of the time. The model results for both the median and 95^{th} percentile values indicate compliance with this criterion, even without the implementation of a flow augmentation regime (Table F-2 in Appendix F).

The modelled concentrations for the other key contaminants identified above are all within compliance, even without the implementation of management measures other than those defined in the base case model. These outcomes are consistent with the contaminant input concentrations applied to the model and with the outcomes from past predictive water balance modelling for the MGP (Golder 2011c).

Shag River

The WBM indicates median and 95th percentile concentrations for sulfate will be within the compliance criterion of 250 mg/L at the Loop Road and McCormicks compliance monitoring points over the long term. However, the model indicates the maximum concentrations for sulfate will exceed the criterion concentration.

A check on the potential availability of dilution water in the Shag River has been undertaken as part of this review. From past modelling work (Golder 2011c) the undisturbed catchment area upstream from DC08 is approximately 5,000 ha. This compares to the undisturbed catchment area upstream from Loop Road but downstream from DC08 of approximately 20,000 ha. All other things being equal, this difference in undisturbed catchment area implies modelled sulfate concentrations in the Shag River at Loop Road should be 75% lower than those at DC08. Taking into account the base flows available in the Shag River, the difference in peak concentrations should be greater than 75%.

Approximate dilution factors for sulfate have been calculated for the Loop Road compliance monitoring point and presented in Table 2. The dilution factors derived for the median and 95th percentile are slightly higher than that derived on the basis of catchment areas alone. However, the peak simulated concentrations at Loop Road indicate a much lower dilution factor. This outcome suggests the simulated sulfate concentrations at the Loop Road compliance monitoring point under most river flow rates are reasonable. However, it appears likely the peak simulated concentrations at the Loop Road compliance monitoring point (GHD 2024c, Table F3) are overly conservative. The same issue arises for the peak simulated concentrations at the McCormicks compliance monitoring point on the Shag River (GHD 2024c, Table F4). It should be noted that the same issue with respect to overly conservative predictions for peak sulfate concentrations at the Shag River monitoring points also arose in the modelling for the MP3 project done by Golder (2011c).

Table 2: Comparison of sulfate dilution factors for Loop Road compliance monitoring point

PARAMETER	UNITS	DC08	LOOP ROAD	DILUTION PERCENTAGE
Undisturbed catchment area (1)	ha	5,000	20,000	75%
Median SO_4 concentration	mg/L	100 (2)	21 (3)	79%
95th percentile SO_4 concentration	mg/L	520 (2)	74 (3)	86%
Maximum SO_4 concentration	mg/L	1070 (2)	750 (3)	30%

Notes: 1) Areas approximated from MP3 water balance model inputs (Golder 2011c).
2) From Table F2, Appendix F, GHD 2024c.
3) From Table F2, Appendix F, GHD 2024c.

Simulated dissolved iron concentrations at the Shag River compliance monitoring points are simulated to exceed the 0.2 mg/L criterion applicable at these points. However, the model input concentration for undisturbed catchments ranges from 0.1 to 0.2 mg/L (Table 15). The modelled criterion exceedance dissolved iron is therefore primarily a consequence of the background concentrations in the river being at or close to this concentration, rather than being mining induced. This conclusion is further emphasised by the simulated dissolved iron concentration at both Loop Road (Figure 60) and McCormicks (Figure 65) exceeding 0.15 mg/L almost 100% of the time.

The 95th percentile and maximum concentrations for dissolved arsenic at the Shag River monitoring points also appear to be elevated compared to what would be expected based on the simulated concentrations at DC08. For example, the maximum long-term dissolved arsenic concentration at Loop Road is 0.02 mg/L, compared to the 0.024 mg/L projected at DC08. Taking into account the input concentration for surface water catchments not impacted by mining is 0.0025 mg/L (Table 15), this again suggests an underestimation of base flow contributions to the Shag River.

A key assumption in the water quality modelling is that all parameters are conservatively transported in both groundwater and surface water environments. In the case of dissolved metals or metalloids such as iron and arsenic, in-stream attenuation is also very likely to play a part in reducing concentrations upstream from the Shag River compliance points.

Overall, the modelled water quality outcomes for the Shag River appear to be reasonable and defensible, although the peak concentrations appear to be conservatively overestimated or are heavily influenced by high background concentrations.

<u>NBWR</u>

Water quality modelling results are presented in the report for the NBWR at the Ross Ford (NBWRRF) and NB03 compliance monitoring points, and for the MC02 compliance monitoring point on Murphys Creek (Figure 5). Model outcomes for compliance monitoring points related to the GB Stage 2 development have been reviewed in Appendix B of this memorandum and are not affected by the MPIV model outcomes.

It should be noted that dewatering of the Golden Bar Pit in preparation for mining under GB Stage 2 was excluded from the MPIV WBM simulations. This dewatering will probably need to be undertaken with active management of flows to ensure compliance with the water quality criteria at NB03.

No results for an ‘unmanaged’ scenario have been presented in the GHD (2024c) report. Through the modelling process that I observed, it became clear that the ‘unmanaged’ or ‘unmitigated’ discharge of water from areas within the NBWR catchment impacted by mining operations led to unacceptable downstream water quality outcomes. This outcome is consistent with the model outcomes from the MP3 (Golder 2011c) water balance modelling, which also covered the entire MGP.

Sulfate concentration exceedance curves from the base case scenario have been presented in the GHD (2024c) report. The base case scenario only includes the pumping back of water from Murphys Creek Silt Pond to Frasers Pit as an existing mitigation measure developed during the MP3 consenting process in 2011 (Golder 2011c). The sulfate exceedance curves for compliance points at Ross Ford (Figure 67) and NB03 (Figure 77) clearly indicate that additional mitigation measures need to be implemented to ensure compliance with existing water quality criteria applicable within the NBWR catchment.

OceanaGold worked with GHD and MWM to progressively develop and test a set of mitigations that would enable long-term compliance with the existing water quality consent criteria appliable at the monitoring points within the NBWR catchment. Numerous water quality mitigation scenarios that were tested through this process have also not been documented in the GHD (2024c) report. The base case and proposed mitigations tested are summarised in Sections 5.12.1 and 5.12.2 of the GHD report.

Through the mitigation testing process described above, mitigation options that were practically unachievable, overly optimistic or not adequately supported by existing trials were excluded from the final selected mitigation scenario. This does not mean that some of these mitigations could not be implemented as part of the final water management system for the MGP. It simply means that insufficient supporting information was available at the time of modelling to justify their incorporation into the selected mitigation scenario.

As the technical reviewer, I was party to the mitigation selection process. Risks and benefits linked to each identified mitigation were identified and evaluated through this process. Overall, I consider the process followed by OceanaGold to develop a ‘selected mitigation scenario’ was thorough and reasonable.

A selected mitigation scenario was identified that would enable the MGP to be operated and closed in compliance with the water quality criteria. The components of this scenario are documented in Sections 5.12.1 through to 5.12.3 of the report, with the selected mitigations listed in Section 5.12.3. Each of the individual mitigations presented in Section 5.12.3 are achievable by OceanaGold. Specifically:

1. On-site monitoring indicates rehabilitation of WRS areas to limit recharge to 29.2 mm/year has already been achieved for at least one closed WRS at the MGP.
2. A passive water treatment system tested and installed by OceanaGold at the Globe Progress mine has resulted in the reduction in sulfate concentrations by more than 25% in the treated water stream (MWM 2024). This occurred even though the treatment systems were not being optimised for sulfate removal but rather for the removal of dissolved arsenic. A sulfate removal rate of 30% was considered by MWM to be reasonably achievable and I accept their expert opinion in this matter.
3. Controlled discharge of water from silt ponds, combined with overflow prevention systems, is a matter of engineering design and can be reasonably achieved.
4. The installation of a new sump (NBWRTR) together with collection drains to capture seepage from the Frasers West WRS follows established practice in other areas of the MGP site.

During period of low flow in the NBWR (<25 L/s) all release of captured water at the existing and proposed sumps at Murphys Creek Silt Pond, NBWRTR silt pond, Frasers West Silt P and Clydesdale Creek Silt Pond is to cease. If necessary, that may mean the pumping of water captured by these silt ponds to Frasers Pit or to other on-site storage.

As a package of mitigation measures, the selected scenario presented in Section 5.12.3 of the GHD (2024c) report is reasonable and should be practically achievable.

The mitigated water quality results are summarised in Sections 5.12.4 through to 5.12.6 on the GHD (2024c) report. Statistical summaries of the outcomes are provided in Appendix F.

The model outcomes indicate that the current site water management system can be improved substantially through the implementation of the proposed mitigation measures. This opportunity is highlighted through the modelled reductions in sulfate concentrations at Ross Ford (Figure 68), MC02 (Figure 73) and NB03 (Figure 78). Implementation of the proposed mitigations would result in similar reductions in the modelled concentrations of other contaminants through the operational period of the MGP. In my opinion, the modelled improvements in sulfate concentrations should be reasonably achievable during the operational period of the mine.

Implementation of the mitigation scenario results in long-term compliance with the 1,000 mg/L criterion for sulfate at the NBWRRF (Ross Ford) compliance monitoring point (Figure 68). Similarly, the proposed mitigations would result in tong-term compliance for other contaminants with compliance criteria set for NBWRRF (Table F5, Appendix F). A conceptual check on the mitigations that would be implemented upstream from this monitoring point indicates the model outcomes are consistent with these mitigations.

Implementation of the mitigation scenario results in long-term compliance with the water quality compliance criteria applicable at MC02 (Table F6, Appendix F). A conceptual check on the mitigations that would be implemented upstream from this monitoring point indicates the model outcomes are consistent with these mitigations. No sulfate concentration is designated as a compliance criterion at this monitoring site. A conceptual check on the mitigations that would be implemented upstream from this monitoring point indicates the model outcomes are consistent with these mitigations.

Implementation of the mitigation scenario results in long-term compliance with the 250 mg/L criterion for sulfate at the NB03 compliance monitoring point on the NBWR approximately 98% of the time (Figure 78). It is not clear whether the maximum simulated concentrations of 340 mg/L are a realistic outcome (Table F-7) or if this is an artifact of uncertainty in the flow model calibration under very low flow conditions. This exceedance would probably arise in the model outputs irrespective of whether the MPIV Project goes ahead or not, as the sources of the contaminants predominantly appear to be existing consented mine structures.

Similarly, the proposed mitigations would result in long-term compliance for most other contaminants with compliance criteria set for NB03 (Table F7, Appendix F). Dissolved arsenic is the primary exception. The modelling shows little difference in exceedance curves between the base case and the mitigated scenarios. However, GHD have identified that the modelled exceedances for dissolved arsenic arise from overflow of pit lake water from the GB Stage 2 pit.

Work undertaken by OceanaGold at the Globe Progress Mine has shown that dissolved arsenic levels in a pit lake can be substantially reduced by dosing the lake with ferric chloride. Ferric chloride dosing of the GB Stage 2 pit lake was not incorporated into the mitigation scenario. I have reviewed the outcomes of this work at the Globe Progress Mine under a separate work stream for OceanaGold. I accept that the ferric chloride dosing process can be effective at reducing dissolved arsenic in a pit lake provided it is correctly implemented. MWM is also confident that this process can be implemented at the MGP and I accept their expertise in this matter.

Overall, modelling indicates implementation of the proposed mitigation scenario combined with existing base case mitigations can enable OceanaGold to operate and close the MGP while complying with the existing water quality criteria applicable at monitoring points in the NBWR catchment. I accept this conclusion from the GHD report as reasonable and defensible.

Recommendations

Incorporation of the proposed mitigation scenario into the WBM and review of the model outcomes indicates that OceanaGold can operate and close the MGP, including the proposed MPIV project, while complying with existing water quality conditions applicable to the site. The modelling suggests changes in the mine water management system can be progressively implemented during the operational period of the mine, leading to clear improvements in receiving water quality. Progressive implementation or trialling of the proposed mitigations would enable optimisation of the proposed measures and verification of their effectiveness prior to MGP closure. It is reasonable to expect OceanaGold to document the changes and the associated improvements in receiving water quality as one component of their environmental compliance reporting process.

C.5 Review Summary

The structure, defined boundary conditions and calibration of the groundwater model simulating the MPIV project is consistent with past modelling work at the MGP. The model used by GHD is generally considered to be fit for the intended purpose of assessing groundwater flows to the simulated opencast pits and identifying the discharge areas for contaminant plumes arising from simulated MGP mining features.

The groundwater model indicates that all dissolved contaminants transported in groundwater away from mining impacted areas of the MGP, including the opencast pits, stored waste rock and tailings, will eventually discharge to receiving waters upstream from the existing compliance monitoring points on the Shag River, Tipperary Creek, Murphys Creek, and the NBWR. Although the model indicates some sulfate transport to a discharge area on Deepdell Creek immediately downstream from DC08, the WBM incorporates all contaminant mass loads from the MGP as reporting to Deepdell Creek upstream from DC08.

A key outcome of the groundwater modelling is the difference in simulated mass loads between 20 years post-closure and 200 years post-closure. This difference emphasises the delay between the loss of contaminants from stored wastes at the MGP and the eventual discharge of these contaminants to the receiving surface waters. Therefore, the water quality management planning undertaken by OceanaGold has taken into account the need to plan for increasing contaminant mass loads for a considerable period (200 + years) into the future.

Simulation of predicted effects for this length of time exceeds normal practice in New Zealand, as uncertainty regarding future climate patterns increases over such long periods. Additionally, the maximum effects arising from almost all projects have manifested themselves within much shorter periods. However, in the case of a large mine focused on the extraction, processing, and storage of wastes from sulfide ores, very long-term model projections are appropriate and represent good practice.

The groundwater model identifies stream depletion effects arising from the MGP. However, the simulated stream depletion effects are almost all existing effects arising from development of existing opencast pits. The only new reduction in stream flows that is linked to the MPIV development arises out of the proposed extension and expansion of the GPUG mine, which at 0.5 L/sec maximum, is a 'no more than minor effect' that was subject to a separate consent application. The depletion effect arising from the extension and expansion of the GPUG mine is not a permanent effect, with the reasonable expectation that it will last between 35 and 70 years (subject to mine recharge rates and inundation time).

An important assumption built into the groundwater mass transport modelling, and into the mine water balance modelling, is that historical underground mine workings at the northern end of the Golden Point Pit are to be effectively sealed prior to site closure. This management measure is required to ensure rising groundwater levels within the Golden Bar Pit backfill do not result in overflows to Deepdell Creek via these workings.

The structure and input parameters for the WBM are appropriate to simulate the effects of the proposed MPIV development on downstream flows and water quality at existing water quality compliance points. A review of the mine water model schematic confirms that the significant mine structures and receiving water catchments have been incorporated into the model. The input water quality values applied to the modelling appear reasonable, being based on more than 30 years of water quality monitoring records from the MGP, although a detailed review of these values is outside the scope of this document.

Runoff and groundwater discharges from catchment areas unimpacted by mining operations are calculated using the AWBM (Australian Water Balance Model) method. This method has been applied for past water balance modelling at the MGP and the outcomes accepted by ORC. The runoff calculations have been calibrated separately for the Deepdell Creek and NBWR catchments. The calibration outcomes are of good quality and have been appropriately applied to other catchments intersecting the MGP.

No information has been provided on the calibration of simulated versus measured flows for the Shag River. The Shag River catchment has different rainfall patterns to those recorded at the MGP. The Shag River also receives a substantial groundwater contribution providing a reliable base flow, which is not the case for Deepdell Creek or Tipperary Creek. It appears that the WBM may underestimate base flows in the Shag River and correspondingly overestimate peak contaminant concentrations at the compliance monitoring points in the Shag River.

The WBM simulating the post-closure period incorporates projected changes in seasonal rainfall based on the RCP8.5 climate projections from NIWA. The model inputs indicate increased annual rainfall over the long term is approximately balanced by increased evaporative losses.

All simulated contaminants are assumed to be conservatively transported within both the groundwater and surface water environments. This means contaminants introduced to the model are not removed from the model or otherwise attenuated through geochemical reactions, oxidation state changes or precipitation processes. For sulfate, this is a reasonable assumption. However dissolved metals may be subject to adsorption or precipitation within the groundwater or at the groundwater discharge points. The documented model outcomes for dissolved metals and metalloids such as iron and arsenic at the defined compliance points may therefore be significantly overestimated.

The WBM water quality outcomes for D08 indicate that sulfate concentrations are likely to exceed the existing compliance concentration of 1,000 mg/L in the long term <0.5% of the time. Implementation of in-stream flow augmentation using water sourced from a freshwater dam at Camp Creek or an alternative source of augmentation water results in sulfate compliance at DC08 over the long term. Although non-compliance with the sulfate criterion in the short term is also indicated by the model, this outcome seems unlikely, given almost all surface discharges from the site are actively managed and the site layout within the Deepdell Creek catchment is not changing significantly under MPIV. Furthermore, the highest recorded sulfate concentration at DC08 was 950 g/m^3 in February 2015 and concentrations have been significantly lower since then (Ryder 2024).

It is important to note that other mitigation options for water quality in Deepdell Creek have been identified as part of the modelling program but not incorporated in the WBM. It is possible other mitigations may offer other routes by which full compliance with the sulfate criterion at DC08 can be achieved through the long term. It is possible OceanaGold may opt for other mitigations than the construction and operation of a flow augmentation regime.

The modelled concentrations for the other key contaminants are all within compliance at DC08, even without the implementation of management measures other than those defined in the base case model. Mitigations incorporated in the base case model (Section 5.11.1) are the collection of drain discharges from the MTI and the SP11 TSFs and seepage discharging to the Northern Gully, Battery Creek and Maori Tommy Gully. The release of the accumulated water from these sites is subject to active flow management linked to the receiving water flow rate in Deepdell Creek to reduce the risk of water quality non-compliance in Deepdell Creek.

The WBM indicates median and 95th percentile concentrations for sulfate will be within the compliance criterion of 250 mg/L at the Loop Road and McCormicks compliance monitoring points over the long term. However, the model indicates the maximum concentrations for sulfate will exceed the criterion concentration. A check on the potential availability of dilution water in the Shag River has been undertaken as part of this review. Taking into account base flows available in the Shag River, the peak concentrations at the Loop Road compliance monitoring point should be in the order of 75% less than those simulated for DC08. However, the peak simulated concentrations at Loop Road indicate a much lower dilution factor. Therefore, it appears likely the peak simulated concentrations at the Loop Road and McCormicks compliance monitoring points are overly conservative.

The WBM indicates both dissolved iron and dissolved arsenic may occasionally exceed their respective compliance criteria at the Loop Road and McCormicks compliance monitoring points. However, both of these contaminants have been assumed to be conservatively transported in groundwater and surface water systems. Furthermore, the simulated peak concentrations may not fully account for base flows in the Shag River. Finally, in the case of dissolved iron, the background concentration for undisturbed catchments contributing to the Shag River is very close to the designated compliance criterion of 0.2 mg/L. Exceedance of this criterion at the compliance points is primarily due to the elevated background concentrations applied in the model. Therefore, the modelled exceedances for dissolved iron and arsenic are considered to be very conservative or a consequence of elevated background concentrations in the river water.

Through the modelling process (that I observed in my role as peer reviewer), it became clear that the 'unmanaged' or 'unmitigated' discharge of water from areas within the NBWR catchment impacted by mining operations led to unacceptable downstream water quality outcomes. Consequently, OceanaGold worked with GHD and MWM to progressively develop and test a set of mitigations that would enable long-term compliance with the existing water quality consent criteria appliable at the various monitoring points within the NBWR catchment.

Through the mitigation testing process, mitigation options that were practically unachievable, overly optimistic or not adequately supported by existing trials were excluded from the selected mitigation scenario. This does not mean that some of these mitigations could not be implemented as part of the final water management system for the MGP. It simply means that insufficient supporting information was available at the time of modelling to justify their incorporation into the selected mitigation scenario that OceanaGold expects to implement to ensure future compliance.

As the technical reviewer, I was party to the mitigation selection process. Risks and benefits linked to each identified mitigation were identified and evaluated through this process. Overall, I consider the process followed by OceanaGold to develop a 'selected mitigation scenario' was thorough and reasonable. As a package of mitigation measures, the selected scenario presented in Section 5.12.3 of the GHD (2024c) report is reasonable and should be practically achievable.

The WBM outcomes indicate that the current site water management system can be improved substantially through the implementation of the proposed selection of mitigation measures. In my opinion, the modelled improvements in sulfate concentrations should be reasonably achievable during the operational period of the mine.

Implementation of the mitigation scenario measures in the WBM results in long-term compliance with the water quality compliance criteria at the NBWRRF and MC02 monitoring points. Implementation of the mitigation scenario results in long-term compliance with the 250 mg/L criterion for sulfate at the NB03 compliance monitoring point on the NBWR approximately 98% of the time. It is not clear whether the maximum simulated concentrations of 340 mg/L are a realistic outcome or if this is an artifact of uncertainty in the flow model calibration under very low flow conditions. This exceedance would probably arise in the model outputs irrespective of whether the MPIV Project is incorporated in the model or not, as the sources of the contaminants predominantly appear to be existing consented mine structures.

The proposed mitigations would result in long-term compliance for most other contaminants with compliance criteria set for NB03 (Table F7, Appendix F). Dissolved arsenic is the primary exception. The modelling shows little difference in exceedance curves between the base case and the mitigated scenarios. However, the modelled exceedances for dissolved arsenic arise from overflow of the GB Stage 2 pit lake. Work undertaken by OceanaGold at the Globe Progress Mine indicates dosing the lake with ferric chloride could substantially reduce dissolved arsenic concentrations in the lake water and thereby resolve the modelled exceedances for dissolved arsenic at NB03. This process was not incorporated in the selected mitigation scenario.

Dewatering of the Golden Bar Pit in preparation for mining under GB Stage 2 was excluded from the MPIV WBM simulations because the dewatering is subject to operational control to ensure water quality compliance. Options for this pit lake dewatering process have been assessed for the 1 to 2 years it will take. These options include:

- Pumping the water to Frasers Pit for operational use at the site,
- Discharge to the NBWR river catchment with active management of flows linked to receiving water flows to ensure compliance with the water quality criteria at NB03, and
- Dosing of the Golden Bar pit lake with ferric chloride to reduce dissolved arsenic concentrations in the lake water.

Overall, modelling indicates implementation of the proposed selected mitigation scenario, which includes existing base case mitigations, can enable OceanaGold to operate and close the MGP while complying with the existing water quality criteria applicable at monitoring points in the NBWR catchment. Other mitigation measures that offer potential benefits have also been considered and may be incorporated into a selected mitigation scenario in the future, if necessary or if they offer cost benefits. I accept this conclusion from the GHD report as reasonable and defensible.

APPENDIX D
LIST OF REFERENCED REPORTS

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GHD 2022b Frasers Co-disposal surface water and groundwater assessment. Report submitted to Oceana Gold (New Zealand) Ltd by GHD Limited. Dated 21 October 2022.

GHD 2023. Golden Bar Dewatering Assessment. Report produced for OceanaGold (New Zealand) Limited by GHD Limited, dated 21 July 2023.

GHD 2024a. Macraes Phase IV. Coronation – Surface and Groundwater Assessment. Report produced for OceanaGold (New Zealand) Limited by GHD Limited, dated 26 February 2024. GHD document number 12576793-REP-Macraes Coronation Stage III Final.

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Golder 2011c. Macraes Phase III Project. Site wide surface water model. Report produced for OceanaGold (New Zealand) Limited by Golder Associates (NZ) Limited. Dated April 2011. Golder document number 0978110562 R008 vD.

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