Date: 16/03/2026

To: Shay Mc Donald
Principal Consent Planner
Otago Regional Council

Matakanui Gold Limited (the applicant) substantive fast-track approval application for the Bendigo-Ophir Gold Project: Update to technical review on freshwater matters

1 Background

Matakanui Gold Limited (the applicant/MGL) is seeking fast-track approval for the Bendigo-Ophir Gold Project. The Otago Regional Council (ORC) has asked me to undertake a technical review of the water quality and aquatic ecology components of their substantive application.

The purpose of this memorandum is to outline the extent to which the concerns raised in my initial review (dated 03/12/2025) have been addressed through:

- The additional information provided by the applicant on the:
  - 30/01/2026; and
  - 16/03/2026.
- The workshop held between the ORC's and the applicant's water experts on the 24/02/2026 – 25/02/2026.

2 Material considered

2.1 Provided with substantive application:

- B.04 – *Surface Water and Catchment Existing Environment and Effects Assessment* (Kōmanawa 2025c);
- B.06 – *Mine Impacted Water Overview Report* (MWM 2025), including:
  - B.06A – *Mine Impacted Water Overview Report – Appendix D: Baseline Water Quality Report*; and
  - B.06C – *Mine Impacted Water Overview Report – Appendix N*.
- B.07 – *Recommended Water Quality Compliance Limits for the Bendigo Ophir Gold Project* (Ryder 2025);
- B.17 – *Assessment of Effects on Aquatic Habitat* (Waterways 2025);
- B.18 – *Assessment of Freshwater Ecological Effects* (Boffa Miskell 2025a);
- B.43– *BOGP Flow Augmentation Strategy* (HGG 2025b);
- C.36 – *Proposed Stream Diversions;*
- D.02 – *Otago Regional Council Resource Consents and Conditions;*

- D.04 – *Schedule Two – General Conditions for Otago Regional Council Resource Consents*;
- G.01 – *Water Management Plan*
- G.13 – *Freshwater Ecology Management and Monitoring Plan*; and
- G. 14 – *Erosion and Sediment Control Management Plan*.

2.2 Provided post-substantive application

- Dr Greg Ryder's response to ORC request for further information dated 27/01/2026 (Ryder 2026a);
- Dr Ian Boothroyds response to ORC request for further information dated 30/01/2026 (Boffa Miskell 2026a);
- Mr Jens Rekker's response to ORC request for further information dated 30/01/2026 (Kōmanawa 2026a);
- Dr Paul Weber and Mr Ryan Burgess' response to ORC request for further information dated 30/01/2026 (MWM 2026a);
- Dr Ian Boothroyds updated to Boffa Miskell 2026a provided on the 16/03/2026 (Boffa Miskell 2026b); and
- Mr Ryan Burgess' Seepage Risk Assessment (Hydro Geochem Group 2026).

3 Issues raised in my initial assessment

3.1 Issues with proposed water quality limits

3.1.1 Nitrate and ammoniacal nitrogen limits

As set out in my initial review, it is my opinion that the proposed nitrate and ammonia limits for Shepherds Creek and Rise and Shine Creek are not protective against significant adverse effects associated with periphyton. In response to this concern Ryder 2026 notes that:

"[T]*here would also need to be sufficient bioavailable phosphorus present for nuisance growths to occur* […]. *Monitoring data indicates that the bioavailable phosphorus (DRP) concentrations in the local receiving waters are relatively low [and there] are no proposed activities associated with the mine that would potentially increase DRP concentrations. Therefore, I consider that the risk of elevated bioavailable forms of nitrogen resulting in nuisance algae and plant growths developing is low, provided bioavailable phosphorus does not increase*"

I disagree with this for the following reasons

- Single nutrient limitation is not as strong a driver of periphyton growth as previously hypothesised, and nitrogen additions can stimulate periphyton growth across a wide range of N:P ratios, including conditions traditionally interpreted as phosphorus-limited (Keck & Lepori, 2012). It is for this reason that the concept of single nutrient limitation is not incorporated in current national guidance on setting nutrient criteria to achieve periphyton outcomes (Snelder & Kilroy, 2023);
- National guidance on setting nutrient criteria suggests if single nutrient limitation is controlling growth in Shepherds and Rise and Shine Creek, the limiting nutrient is more likely to be nitrogen then phosphorus (Snelder & Kilroy, 2023);
- In my opinion, Dr Ryder's opinion regarding phosphorus limitation preventing adverse periphyton effects associated with the proposed nitrate and ammonia limits would need to be confirmed via field studies before being treated as valid. Even then, greater justification would be needed to

support his assertion that phosphorus concentration/availability will not increase with proposal given:

  - The turbidity limit as drafted would allow for an increase in sediment bound phosphorus to enter and be stored in Shepherds Creek;
  - Phosphorus concentrations have not been modelled to date[1]; and
  - Higher flows may increase stream velocity thereby improving the transfer of phosphorus to algae growing on the streambed even if concentrations in the water remain unchanged (Larned *et al.*, 2004).

Importantly, the hydrological changes predicted for both Rise and Shine Creek and Shepherds Creek could increase the risk of peak periphyton biomass even if nutrient concentrations do not increase. Significantly higher base flows without a corresponding increase in flood flows are expected to increase the return period of bed-mobilising events, meaning the streambed will be disturbed less frequently. This will increase the amount of time periphyton has to grow and the biomass it can accumulate before being removed by high flows.

Consequently, allowing substantially higher nitrogen concentrations under the proposed water quality standards, when modelling suggests such levels are not required following treatment, would, in my opinion, unnecessarily increase the risk of nuisance periphyton growth and associated significant adverse effects on aquatic life. This risk would undermine the ecological benefits anticipated from the applicant's proposed diversion and enhancement works.

An argument could be made that the proposed nitrate and ammonia compliance limits pose little real world risk as modelling suggests future water quality will not approach them. I do not accept this reasoning. My understanding is that treatment will be designed to achieve compliance with the limits, and additional treatment will not be implemented where it is not required to meet them. Accordingly, there is no basis to expect future nitrogen concentrations will be materially lower than the final compliance standards unless evidence is provided that this will occur as a by-product of achieving the limits set for another attributes.

In my view, the most reliable way to reduce the risk of nitrogen-driven periphyton growth is to set nitrate and ammonia limits that:

- Align with the modelled outcomes presented in MWM (2025); while
- Allowing an appropriate buffer to account for model uncertainty.

This should be paired with long-term periphyton monitoring and modelling, with clear triggers for additional management actions if the revised compliance standards are ultimately found not to be protective against nuisance blooms.

During the workshop held on 25–26 February 2026, the applicant indicated that they would consider amending the proposed nitrate and ammonia limits and the inclusion of long-term periphyton monitoring, and would report back to ORC with their decision. If appropriate amendments are made to the proposed water quality compliance limits, the ecological monitoring programme, and the relevant management

[1] Initial discussions with Dr Weber of MWM suggest the risk of substantial increases in instream phosphorus concentrations associated with tailings and waste rock seepage is low; which is consistent with water quality around the Macraes Flat mine.

plans, such that periphyton monitoring results trigger a management response that remedies significant adverse effects when detected, this issue would be resolved.

3.1.2 Other toxicant limits

3.1.2.1 Uncertainty around how standards are to be applied

In my initial assessment I noted that it was unclear how the proposed toxicant compliance standards are meant to be statistically assessed, and that if they are supposed to be applied as an annual median, they appear overly lenient based on the modelling provided to date.

In his memorandum dated 27 January 2026, Dr Greg Ryder confirmed that the limits should instead be applied as absolute maximums (i.e., hard limits that must not be exceeded). He noted that this is the most straightforward approach and is broadly consistent with the Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (2018) in which default guideline values (DGVs) for toxicants are typically expressed as 95^{th} percentiles. I agree with Dr Ryder on this matter. Provided his recommendations are incorporated into the final conditions, this issue can be considered resolved

3.1.2.2 Need to justify the level at which limits have been set

In Ryder 2025, Dr Ryder proposes adopting the ANZG (2018) 90% species protection toxicant DGVs as compliance limits on the basis that neither Shepherds or Rise and Shine Creek meets the definition of a *slightly to moderately disturbed system* that would justify more stringent standards. Accordingly, he has treated both streams as *highly disturbed systems* when proposing compliance limits, although he acknowledges that this classification is arguable.

In my view, the available evidence, including macroinvertebrate monitoring data, does not support the conclusion that Rise and Shine Creek or Shepherds Creek more closely reflect the ANZG (2018) definition of a *highly disturbed system* than that of a *slightly to moderately disturbed system*. The ANZG (2018) definition of *slightly to moderately disturbed systems* explicitly includes "*rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism*", whereas the highly disturbed category refers to "*rural streams receiving runoff from intensive horticulture*". On the available information, both Shepherds Creek and Rise and Shine Creek align more closely with the former category. Good practice would therefore be to adopt the ANZG (2018) 95% species protection DGVs as the default position, or alternatively to derive site-specific guideline values.

Nevertheless, I acknowledge that the approach ultimately recommended by Dr Ryder is unlikely to result in materially worse environmental outcomes than strict application of the ANZG (2018) framework, for the following reasons:

- The proposed large-scale modification of Shepherds Creek and associated hydrological shifts will restructure the resident macroinvertebrate community irrespective of the adopted toxicant thresholds. In that context, setting highly stringent water quality standards aimed at preserving the existing ecological assemblage may not be proportionate;
- Applying the 90% species protection DGVs as absolute maximums is arguably comparable in protectiveness against chronic toxicity effects to applying the 95% species protection DGVs as 95^{th} percentiles, and provides a higher level of protection against acute toxicity events; and
- If macroinvertebrate communities are monitored and identified adverse effects trigger a defined management response (not confirmed by the applicant), there will be a high degree of certainty that adoption of the 90% species protection thresholds will not result in significant adverse effects

on aquatic life (i.e., management response will be triggered if significant toxicity effects occur at concentrations below the compliance standards).

Consequently, provided that the final conditions formalise the toxicant limits as absolute maximums and include clear ecological trigger mechanisms requiring management responses to address water quality issues, this matter can be considered resolved.

3.1.3 Turbidity limits

In my initial assessment, I noted that the turbidity limit in the proposed consent conditions was not appropriate and that an end-of-pipe total suspended solids (TSS) limit would be more suitable. Although Dr Ryder disagreed with this in Ryder 2026a, further clarification of my reasoning during the workshop held on 25–26 February 2026 led to general agreement that an end-of-pipe standard, paired with a narrative instream limit, represented a better approach than that proposed in Ryder 2025 and adopted in *Schedule Two – General Conditions for Otago Regional Council Resource Consents*. Dr Ryder was not present for those discussions.

The clarification provided was as follows:

- The proposed turbidity limit does not control sediment inputs during rainfall events, when the sediment pond discharge will actually operate. As it applies only during baseflow conditions (specifically when river flow is below the median, approximately 80% of the time), it merely requires that the discharge not result in sufficient sediment deposition to increase baseflow resuspension rates;
- It allows for conspicuous changes in visual clarity when the discharge is operating, which is inconsistent with section 107(1) of the Resource Management Act 1991;
- It poses a significant compliance risk to the applicant, as compliance cannot be managed in real time. By the time the proposed limit is exceeded, the contributing discharge events will already have occurred and cannot be prevented; and
- Because any exceedance would arise from the resuspension of previously discharged sediment, remediation would likely require active removal of that sediment from the stream bed (e.g., dredging or excavation). I understand that consent is not being sought for such activities.

In short, the proposed turbidity limit introduces unnecessary complexity to the management of sediment pond discharges, is unlikely to deliver robust environmental outcomes, and materially limits the applicant's ability to ensure compliance through real-time operational control. In my opinion, this issue can be resolved through amendments to *Schedule Two – General Conditions for Otago Regional Council Resource Consents*, as outlined below.

7 Sediment retention devices and diversions must be sized and constructed in accordance with the Erosion and Sediment Control Management Plan and any relevant ESCP as required in the Common Conditions in **Schedule One**.

8 The concentration of total suspended solids in the discharge from any sediment retention device shall not exceed XX mg/L except when the background total suspended solids in the waterbody is greater than XX mg/L.

~~8~~9 The works authorised by this consent must not cause:

a. *increases in upstream or downstream flows which cause flooding on adjacent land; or*
b. *A conspicuous change in visual clarity in any river beyond the zone of reasonable mixing.*

Advice note: For the purposes of this condition, the length of the zone of reasonable mixing downstream of the outlet of a sediment retention device is greater of

a. *50 metres*
b. *XX times the wetted channel width of the receiving environment at the estimated seven day mean annual low flow*

Attachment 2 - Surface Water Compliance Parameters and Limits

PARAMETER	SURFACE WATER
(units are mg/L unless stated otherwise)	Recommended compliance limit(s)
pH (unitless)	6.5 - 9.0
~~Turbidity (NTU)~~	~~5 (over a 5 year rolling period, 80% of samples, when flows are at or below median flow, are to meet the limit)~~

I anticipate that the recommended TSS standard would apply to all sediment retention devices; however, routine compliance monitoring would only be required for ponds that will be in place for greater than 12 months[2]. Compliance with other ponds would only be quantitatively assessed by ORC during routine site visits or in response to complaints.

Importantly, TSS monitoring does not provide real-time information to enable active compliance management. I therefore recommend that the applicant amend their Erosion and Sediment Control Plan (ESCP) to require the development of site-specific relationships between turbidity and total suspended solids (TSS), enabling real-time turbidity data to trigger management responses when TSS concentrations are likely to approach the compliance limit. Formal compliance would then be confirmed through TSS sampling.

The recommended monitoring and response framework is as follows:

1. Establish a paired TSS–turbidity relationship using representative monitoring data.
2. Calculate a turbidity trigger level based on:
    a. the TSS compliance limit,
    b. the regression relationship between turbidity and TSS, and
    c. the residual variability of that relationship. The trigger should incorporate a conservative buffer (e.g., set at a turbidity value corresponding to 85% of the TSS limit, adjusted for prediction error).
3. Undertake ongoing turbidity monitoring, supplemented by periodic TSS sampling (ideally specified in conditions);
4. Regularly update the TSS–turbidity regression and associated trigger level as additional data are collected;
5. In the event that the turbidity trigger is exceeded:
    a. Immediately collect a confirmatory TSS sample; and
    b. Cease discharge or implement additional treatment until turbidity falls below the trigger level.
6. Report the results of confirmatory TSS sampling to ORC Compliance; and
7. If the TSS sample confirms non-compliance, implement the relevant corrective and reporting procedures.

3.2 Issues with effects assessment approach

In my initial assessment, I noted that the application did not include a synthesis document summarising the overall effects of the activity on stream values once all adverse effects are realised and mitigation measures implemented. The applicant sought to address this gap through the provision of Boffa Miskell (2026a). However, the scope of that document differed from what I had anticipated. Specifically:

- It relied solely on expert opinion and did not draw on quantitative evidence or relevant external research; and
- It did not describe how the form and function of the stream, or its ecological communities, are expected to differ from the current state.

[2] This threshold could be refined with the applicant.

Accordingly, in my view, even with the provision of Boffa Miskell (2026a), the application still lacked a clear summary of what Shepherds Creek will actually "look like" once the predicted changes in habitat, water quality, and hydrology are realised.

At the workshop held on 25–26 February 2026, I clarified that such an assessment did not need to quantify the magnitude of effects (e.g., whether they are "more than minor"). Rather, it should describe the plant and animal communities likely to be supported by a larger stream with poorer water quality and more stable flows once mitigation measures are implemented, and explain how these communities would differ from those currently present.

At that workshop, the applicant committed to providing such an assessment. This was subsequently received on 16 March 2026 (Boffa Miskell 2026b – refer Appendix A). The key conclusions of that assessment were:

- *"Post-closure catchment hydrology for both Shepherds and Rise and Shine Creeks will result in higher catchment flow yields and more stable creek flow* […] *with lower elevated flow/flood frequency with more consistent water quality and cooler temperatures"*;
- *"The transition of the landuse from agricultural to a vegetated character is expected to see a change in water quality"*;
- "[A]*quatic communities that may vary from those present in the current creeks*"; and
- "*The aquatic communities in the realigned diversion are more likely to reflect those currently occurring in the upper reaches of Shepherds Creek*".

Ultimately, the approach taken in Boffa Miskell (2026b) is no more robust than that previously provided in Boffa Miskell (2026a). There remains a general lack of quantitative evidence or supporting literature. A key shortfall of the memorandum is that it does not assume full implementation of the proposed water quality limits, and it makes no comment on the risk of periphyton growth associated with those limits in combination with the predicted hydrological changes in the affected waterways.

Nevertheless, the memorandum does highlight broad agreement that ecological communities in Shepherds and Rise and Shine Creeks will be fundamentally altered by the proposal due to changes in hydrology and habitat (both instream and riparian). Where our opinions differ is that Dr Boothroyd suggests this shift will move the streams towards the more natural conditions observed in the upper Shepherds Creek catchment, whereas I consider that unless the proposed nitrate and ammonia standards are revised downward, an alternative outcome, degradation of plant and macroinvertebrate communities, is equally, if not more, likely.

Importantly, if the applicant were to revise the proposed ammonia and nitrate compliance standards downward, there would likely be limited disagreement between myself and Dr Boothroyd. Both of us consider that, aside from water quality, key drivers of stream health (habitat and flow regime) are predicted to change in a manner that would generally be considered an improvement, even if the hydrological changes represent a departure from the natural state.

Whether a departure from the natural state constitutes an adverse effect where conventional stream health metrics are predicted to improve is ultimately a matter for the Expert Panel to determine. I note, however, that Shepherds Creek is not a rare or threatened habitat. Accordingly, at the catchment and regional scale, indigenous biodiversity values are unlikely to be materially adversely affected by the proposal.

3.3 Issues with the consent conditions related to the form of the stream diversions

In my initial assessment, I noted that the wording of Condition 22 in *Schedule Two – General Conditions for Otago Regional Council Resource Consents* provides very little certainty regarding how the diversion channels will ultimately be constructed. This matter was discussed during the workshop held on 25–26 February 2026. At that workshop, I raised the possibility of retaining flexibility in the final channel design while introducing greater certainty of outcome by requiring that the permanent diversion channels achieve a higher Stream Ecological Valuation (SEV) score than the reaches they are intended to replace.

The SEV is a standardised, science-based methodology used in New Zealand to quantify the functional health of streams. It is widely applied in Wellington and Auckland when assessing stream offsets associated with reclamation or realignment. The SEV generates a composite score derived from a range of hydraulic, biogeochemical, habitat and biodiversity indicators. In this context, it could be used to provide measurable assurance that the final design and construction of the permanent diversion channels will not result in a net loss of ecological function.

The SEV requirement could be incorporated into proposed Condition 22 as follows:

22. Stream diversions must be undertaken in accordance with the following high-level principles of design:
    a. As much as practicable, the diversion should be designed with an average width of no less than 0.8 m, and preferably 1 m for Shepherds Creek, and no less than 0.5 m for Rise and Shine Creek.
    b. As much as possible, the steam diversion channel must be a similar length and stream area than the channel to be reclaimed. This aims to ensure that there is no loss of extent and values of the watercourse.
    c. The channel design does not have to replicate the form of the channel to be reclaimed but would benefit from a low-flow (or baseflow) channel, a bank full channel and where available, a floodplain area.
    d. As much as possible, water flow should mimic the hydrology of the existing watercourse (i.e., flows intermittently or permanently same as existing channel).
    e. The design of the final diversions shall have an Stream Ecological Valuation (SEV) score equal to or greater than that measured in the corresponding diverted reaches prior to works beginning.
    f. The length and area of the final diversion at seven day mean annual low flow shall be equal to or greater than that measured in the corresponding diverted reaches prior to works beginning.

Advice note: The stream ecological values of the existing streams and final diversion designs are to be calculated by a SQEP in accordance with the methodologies set out the

"Stream Ecological Valuation (SEV): A User's Guide (Auckland Council Report No. GD2011/001). Auckland Council, Auckland, New Zealand".

The following functions are not considered when calculating the SEV:

- *Fish fauna intact*
- *Invertebrate fauna intact*

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4 Issues identified since my initial review

4.1 Appropriateness of RS03

During the workshop held on 25–26 February 2026, it became apparent that the compliance site on Rise and Shine Creek (RS03) receives dilution from Clearwater Creek downstream of the RAS Pit, SRC Pit, SRE Pit and SRX ELF. As a result, RS03 may not capture the highest contaminant concentrations occurring in Rise and Shine Creek. However, the site remains necessary to detect potential effects associated with the Western ELF.

The most straightforward way to address this limitation would be to establish an additional compliance site on Rise and Shine Creek immediately upstream of its confluence with Clearwater Creek. I am unable to comment on whether access constraints or other practical considerations would prevent this approach.

The applicant has committed to providing a short memorandum justifying the retention of RS03 as the sole compliance site on Rise and Shine Creek. I will provide further comment on the suitability of the proposed compliance monitoring regime for this creek once that memorandum has been received.

4.2 Lack of ecological monitoring

During the workshop held on 25–26 February 2026, it became apparent that ecological monitoring to identify adverse effects associated with the discharge of treated seepage water is not currently proposed. Instead, ecological monitoring is limited to assessing the effectiveness of the diversion channel establishment works.

Given the ecological risks associated with the proposed water quality compliance standards, particularly in relation to periphyton proliferation, I consider that, at a minimum, the following monitoring and response framework should be included:

- Annual summer macroinvertebrate and periphyton monitoring should be undertaken in Shepherds Creek at sites located upstream and downstream of the treated seepage water discharge point;
- The frequency, location and methodology of this ecological monitoring should be explicitly specified in a consent condition;
- Macroinvertebrate monitoring should be undertaken in accordance with the quantitative hard-bottom protocols described in Stark et al. (2001) (or any subsequent approved update);
- Periphyton biomass and cover monitoring should be undertaken in accordance with the relevant National Environmental Monitoring Standards (NEMS) protocols (MfE, 2022);
- If equivalence testing demonstrates a reduction in QMCI of greater than 20% between the upstream and downstream sites (indicative of potential significant adverse effects), a consent condition or management plan requirement should obligate the applicant to engage a suitably qualified and experienced person (SQEP) to investigate the cause of the degradation and implement appropriate remedial actions; and
- If periphyton biomass exceeds 200 mg chlorophyll-a per m^2 and/or weighted composite periphyton cover exceeds 50% at the downstream site but not at the upstream site, a consent condition or management plan requirement should similarly require engagement of an SQEP to investigate causation and implement any necessary management responses.

4.3 Issues with untreated seepage escape risk

The additional information provided in MWM 2026a identifies the potential for seepage to escape to the Ardgour Aquifer. However, it does not discuss the potential implications for surface water, including the Lindis River, the lower reaches of which are sustained by groundwater discharge from the Lindis Ribbon Aquifer during summer. As the Ardgour and Lindis Ribbon aquifers are hydraulically connected, there is a plausible pathway by which untreated tailings seepage could ultimately enter the Lindis River.

In response to this concern, the applicant has provided Hydro Geochem Group 2026 (refer Appendix B), which assesses the extent of this risk and outlines how it will be monitored and managed. On the basis of the information provided in Hydro Geochem Group 2026, I consider the risk of untreated seepage materially affecting the water quality and ecology of the Lindis River to be low. However, it is essential that the monitoring and management measures described in that document are formalised through consent conditions and/or approved management plans.

In addition, I consider that a condition explicitly stating that untreated seepage, as indicated by nitrate and sulphate concentrations shall not migrate beyond the boundary of the mine site would provide regulatory certainty that off-site contamination will not occur as a result of the proposed activity.

4.4 Lack of sediment quality monitoring and triggers for action

Metals can be toxic to benthic fauna both when suspended in the water column and when bound to bed sediments. On reflection, I consider that the consent conditions should require annual sediment sampling at the compliance sites identified in the final version of the consent.

Exceedance of the ANZG (2018) Guideline Value–High (GV-high) thresholds should trigger a management response requiring investigation of the source and ecological implications of elevated sediment concentrations, and implementation of any remedial actions necessary to address existing effects and prevent future significant adverse effects.

In my opinion, it is appropriate that the ANZG (2018) GV-high thresholds operate as management triggers rather than compliance standards for the following reasons:

- The lower ANZG (2018) DGVs represent concentrations below which there is a low risk of unacceptable effects. Applying these as sediment compliance standards would be inconsistent with the modified state of Shepherds Creek and with the intent of the proposed water quality limits, which are not framed as “no-effect” standards;
- Ecological monitoring, if adopted, would provide a direct measure of adverse ecological effects. This would allow a management response to be triggered if significant sediment toxicity effects occurred at concentrations below the GV-high threshold; and
- It is not appropriate to set sediment quality thresholds as strict compliance standards because sediment accumulation and subsequent release from bed sediments are inherently variable and not directly controllable in real time. The applicant may be unable to actively manage discharges to ensure sediment thresholds are met before an exceedance occurs. In practice, there may be no reliable indication that an exceedance is imminent until it has already occurred, particularly where sediment sampling is undertaken only annually.

Accordingly, a trigger-based framework provides a more practicable and effects-based mechanism for managing sediment-associated metal risks.

5 Summary

A summary of the issues I have identified with the application is provided in Table 1, together with a description of the applicant's proposed approach to addressing those issues and the extent to which those actions resolve them.

Importantly, the applicant is aware of all of these matters (with the exception of the need for sediment toxicity monitoring) and, based on discussions during the workshop held on 25–26 February 2026, is actively progressing additional information and amendments to consent conditions and management plans to address them.

Due to time constraints, this additional information and any associated amendments have not been able to be considered in this memorandum. An update will be provided once that material becomes available.

Table 1: Summary of issues identified to date and the extent to which they have been resolved by the applicant.

Topic	Issue description	Suggested resolution	Applicant's response	Resolved
Nitrate and ammonia limits	Proposed limits are too high to be protective against significant adverse effects associated with increased risk of nuisance periphyton (algae) blooms	• Reduce limits to be consistent with modelled outcomes of treatment post closure • Monitor periphyton and implement additional actions if revised limits found to be driving nuisance blooms	MGL have advised ORC that they are: • Reviewing suggested changes to water quality limits and that they will advise ORC of position. • Considering annual periphyton and macroinvertebrate monitoring as a "baseline" before commencement of water treatment at end of mine life.	**TBC** based on applicant's next lot of amended proposed consent conditions
Other toxicant limits	It was previously unclear how toxicants (other than ammonia and nitrate) would be assessed against the proposed limits, and why.	As per Dr Ryders recommendation, applying the current proposed limits as absolute maximum rather than a 95th percentile is not best practice but is appropriate in this case.		
Turbidity limits	Current limit introduces will result in questionable environment outcomes while limiting the ability of the applicant to ensure compliance through real-time management	Amend *Schedule Two – General Conditions for Otago Regional Council Resource Consents* as per suggested amendments in Section 3.1.3 (not verbatim)	Applicant has advised ORC that they will • Look at practical end of pipe TSS standards (potentially in ESCP); • Amend conditions to delete turbidity limit and replace with a 'no conspicuous change in visual clarity' type condition.	**Yes**, assuming applicant's next lot of amended proposed consent conditions are fit for purpose
Effects assessment approach	Application is still missing an overall summary of what Shepherds Creek will actually "look like" once the predicted changes in habitat, water quality, and hydrology are realised.	Provide an new assessment of surface water effects	Applicant has provided assessment in Boffa Miskell 2026b. That assessment acknowledges that ecological communities will be fundamentally changed by proposal, but suggests a return towards a more natural state. There is limited evidence provided in support of this conclusion and no consideration of periphyton effects with full implementation of proposed nitrate and ammonia compliance standards.	**TBC** based on applicant's next lot of amended proposed consent conditions. Specifically the compliance standards for nitrate and ammonia.
Conditions on diversion methodology	Proposed conditions provide little certainty regarding how the diversion channels will ultimately be constructed	• Amend condition to require the permanent diversion channels to achieve higher SEV scores than the reaches they are intended to replace. • Alternatively re-word condition 22 to specify absolute minimum design standards	**N/A**. the applicant has not signalled to ORC whether they are considering referencing the SEV in consent conditions.	**No**
Appropriateness of RS03	RS03 receives clean water from Clearwater Creek downstream of the RAS pit, SRC pit, SRE pit and SRX ELF. Accordingly it may not reflect the maximum concentrations in Rise and Shine Creek.	Provide further justification of RS03 as sole compliance site on Rise and Shine Creek and add additional site upstream of Clearwater Creek confluence if RS03 found to be inadequate	The applicant has advised ORC that they will provide further justification of RS03	**TBC** based on additional information to be provided by applicant
Lack of ecological monitoring	Ecological monitoring focused on identifying adverse effects associated with the treated seepage water discharge is not proposed	Amend conditions and monitoring plan to require annual macroinvertebrate and periphyton monitoring that will trigger further management when certain triggers are exceeded	Applicant has advised ORC that they are considering annual periphyton and macroinvertebrate monitoring as a "baseline" before commencement of water treatment at end of mine life.	**TBC** based on applicant's next lot of amended proposed consent conditions.

Topic	Issue description	Suggested resolution	Applicant's response	Resolved
Seepage escape risk	The additional information provided by MWM 2026a introduces the possibility of seepage escape to Ardgour aquifer which could ultimately impact the Lindis River	• Provide further information of the real risk of untreated seepage escape outside of mine boundary, including measures to detect, capture and treat an bypass. • Word conditions to provide certainty that the consent does not allow for the escape of untreated seepage water outside of the mine boundary • Monitor water quality in Lindis River and lower Bendigo Creek	The applicant has provided a memorandum outlining how untreated seepage can be contained within the mine boundary, and has committed to performance monitoring in the Lindis River and Bendigo Creek to demonstrate commitment to protecting these waterbodies.	**Yes**, assuming applicant's next lot of amended proposed consent conditions and management plans are consistent with the management approach described in Hydro Geochem Group 2026
Sediment monitoring	Metals can be toxic when bound to bed sediments. However, the proposed consent conditions do not manage this risk.	• Amend consent conditions to require annual sediment quality sampling. • Amend Water Management Plan so exceedance of GV-high thresholds trigger a management response.	The applicant is not aware of this issue. Thus has not the opportunity to respond	**No**

6 References

Australian and New Zealand Governments and Australian state and territory governments (ANZG), 2018. Australian and New Zealand guidelines for fresh and marine water quality. Governments and Australian state and territory governments, Canberra, Australia.

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Appendix A – Boffa Miskell 2026a

Boffa Miskell

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Attention:	Cheryl Low, Environmental Manager
Company:	Matakanui Gold,
Date:	16 March 2026
From:	Dr Ian Boothroyd
Message Ref:	Bendigo Ophir Gold Project: Assessment of freshwater ecological effects
Project No:	BM250590

Introduction

Matakanui Gold Limited ("MGL") have applied for approvals under the Fast Track Approvals Act (FTAA) for the Bendigo-Ophir Gold Project ("BOGP"), a new gold mine, ancillary facilities and environmental mitigation measures on Bendigo and Ardgour Stations in the Dunstan Mountains of Central Otago.

The Otago Regional Council have raised a question regarding the overall effects of the mining activities on freshwater values:

> *Please provide an overall synthesis report which summarises the overall effects of the mining activities on freshwater values once all adverse effects are realised and mitigations deployed. This report should consider the most up-to-date information available and should specifically include any new information that is produced in response to the letter RMFT25.007 Request for Information – GW, modelling, geochemistry 18 Dec 2025_with appendix.pdf.*

Response

Catchment Overview

Catchments within the Project Site footprint have relatively small surface water features, which drain to either Bendigo Creek or the Lindis River. Shepherds Creek is representative of a low gradient Dunstan Mountains perennial small stream. The upper reaches of Shepherd Creek have moderate to high ecological value while downstream of the gorge section ecological values are moderate. This is due to increasing habitat modification with various impacts including water abstraction, channel modifications (e.g., the dam), crack willow, and stock impacts evident. The Rise and Shine Creek catchment has a range of ephemeral, intermittent and perennial streams that support a fauna of high to low ecological value. Ecological surveys of these streams found no benthic invertebrate species that are classified as threatened and no kōura (freshwater crayfish) or kākahi (freshwater mussel) were detected.

Potential effects on freshwater values

Four potential adverse effects on freshwater values and stream habitat resulting from the development and operation of the proposed mine are considered:

- Complete loss of habitat;
- Permanent diversion of streams;
- Long term changes to stream flow; and
- Potential water quality changes.

Water quality

Potential sources of mine contaminants and Potential Constituents of Concern (PCOC) are detailed in reports prepared by MWM (2025) as:

- Elevated total suspended solids ("TSS") in surface waters.
- Neutral metalliferous drainage ("NMD") that may have elevated PCOC such as arsenic (As), sulphate (SO4) and potentially lesser amounts of trace metals; and
- Nitrate-rich (NO3-N) drainage due to the use of Ammonium-Nitrate Fuel Oil ("ANFO") explosives and cyanide (due to gold recovery) that may also include ammoniacal nitrogen.

The ORC reviewer (at section 3.1.13 of their review) contends that the proposed water quality compliance limits set forward by Ryder (2025) and adopted in the proposed conditions in D.03 – Schedule One - Central Otago District Council and Otago Regional Council Common Conditions allow for contaminant concentrations far beyond what the proposed activity as described in the application is expected to generate. In the opinion of the reviewer, full implementation of these limits would degrade water quality to the extent that there would be a risk of more than minor or significant adverse effects on aquatic life. It is a common practice to apply the ANZG DVG limits, accepting that the DVGs are set to reduce the risk to and for the protection of aquatic life. Therefore, with respect to PCOC in water, such as dissolved metals, ammonia and nitrate, 90% species protection is considered an acceptable level of protection for these freshwater ecosystems given their historic and current level of disturbance. Accordingly, it is very unlikely that adverse effects will occur even if actual instream quantities reach these set water quality compliance limits.

Changes to stream flow

Komanawa (2025) conclude that overall, the proposal for mining activities in the current location is assessed to have environmental effects in terms of catchment flows, surface water depletion and groundwater resource allocation that are less than minor.

During operations Shepherds Creek would lose perhaps 20% to 30% of previous upper catchment flow contribution and be affected by RAS pit dewatering related groundwater depletion. The proposed diversion of Shepherds Creek around these impact zones and removal of irrigation abstraction from Shepherds Creek (currently below the Project Site footprint) would remedy or offset these temporary operational catchment losses.

SRX pit dewatering would briefly draw off a significant portion of creek flow passing the immediate vicinity of the SRX pit's northwest corner in the latter operational stages of mine life, although upstream diversions above the SRX pit would preserve the bulk of upper Rise and Shine Creek flows. The loss of Rise and Shine flood flows, which could not pass the straddle culvert to the RAS pit sump, would be of low impact. The active closure and post-closure creek network would be significantly restored to their former hydrological function, except for the RAS pit lake and drainage to lower Shepherds Creek through flooded underground workings, altered former ELF and TSF substrates, and the former SRX pit lake.

Post-closure catchment hydrology for both Shepherds and Rise and Shine Creeks would be affected by the change in substrates and retention of soil moisture, resulting in higher catchment flow yields and more stable creek flow.

Higher flows may result in changes in the aquatic communities but are unlikely to result in loss or adverse effects on equivalent ecological values; a change does not constitute an adverse effect. The stream diversions will be designed to accommodate a range of flows, both for operational and for post-closure phases.

Groundwater seepage

Mine waste storage facilities (MWSFs), including the Tailings Storage Facility (TSF) and Engineered Landforms (ELFs), are planned to be situated within the deeply incised valleys at the BOGP. Given the hydrogeological conditions at the BOGP and the planned seepage collection elements included in the MWSF designs, it is reasonable to expect high levels of seepage collection (or low rates of bypass) (MWM/HGG 2026). Seepage control elements are planned to enhance seepage collection, including underdrains, a chimney drain, and a cutoff drain at the TSF; and underdrains and a toe sump at the MWSF. These drains will convey collected seepage to a lined sump.

Loss of habitat

Whilst complete loss of freshwater habitat is listed as a potential adverse effect, it is remedied through the diversion of Shepherds Creek and watercourses within the Rise and Shine Creek. In effect the habitat is moved, and new habitat is created aimed to provide equivalent habitat features.

The ORC review (at 3.1.4 in their review) acknowledge that that the performance monitoring will show an increase in habitat and ecological reporting indices due to a planned increase in woody riparian vegetation, the establishment of pool run riffle sequences, the construction of a hard bed, and a reduction in summer drought effects and a necessary increase in the amount of habitat provided by the stream due to higher flows.

Ecological values

Freshwater ecological values vary across the project area, ranging from moderate to high values in the Shepherds Creek catchment, and low to moderate in the Rise and Shine Creek catchment. No fish were recorded in either Shepherds Creek or Rise and Shine Creek.

The proposed BOGP comprises mine components that affect the watercourses. The proposed activities give rise to direct impacts in the manner of reclamation of some 10,626 m of perennial stream.

With the proposed rehabilitated stream diversions plus provision of stream enhancement, and additional compensation (management of willows and rehabilitation of Bendigo and Clearwater Creeks) along with the proposed BOGP activities, there is no permanent loss of streams or any loss of extent of watercourses. Streams are either replaced within a short timeframe (ecologically functional diversions) or re-established and rehabilitated later (Mt. Mocha Creek) or separately, Bendigo Creek and Clearwater Creek are subject to specific management (willow management and rehabilitation). Accordingly, the effects management hierarchy is satisfied and the outcome of the BOGP provides for a no net loss of stream extent and ecological values.

Nature of the rehabilitated stream diversions

As outlined above, the post-closure catchment hydrology for both Shepherds and Rise and Shine Creeks will result in higher catchment flow yields and more stable creek flow, largely from a greater contribution of spring flows. Spring flows tend to be more consistent, with lower elevated flow/flood frequency with more consistent water quality and cooler temperatures. The transition of the landuse from agricultural to a vegetated character is expected to see a change in water quality. Nevertheless, the maximum concentration of Nitrogen detected was below a level expected to have large detrimental effects on the stream community

These attributes are generally beneficial for aquatic ecosystem ecology, but as acknowledged above, may result in aquatic communities that may vary from those present in the current creeks.

It is worth emphasising that the ORC has acknowledged that the monitoring will demonstrate the increased habitat features and performance indicators and increase in the amount of habitat (wetted area) provided by the stream due to higher flows.

As for any aquatic ecosystem, the pool of colonisers (flora and fauna) for the realigned diversions will be largely sourced from local populations, so a range of flora and fauna that not currently present in the local availability is unlikely to occur. The range of planned habitat improvements means that there is a provision for varying communities of aquatic flora and fauna.

The aquatic communities in the realigned diversion are more likely to reflect those currently occurring in the upper reaches of Shepherds Creek which had several good habitat and or good water quality indicator species including stoneflies and caddisfles. Common, poor water or habitat quality indicator taxa, such as the purse case caddisflies and chironomids, present in lower Shepherds Creek are less likely to occur as the increased and more stable flows, as well as shade, may prevent any frequent proliferations of aquatic algae and/or macrophytes.

Furthermore, the functioning of the water course (e.g., water quality assimilation, habitat variability, decomposition, nutrient spiralling, trophic layers, refuge availability, terrestrial-aquatic interface, habitat for terrestrial phase of aquatic insects) will continue in the presence of modified aquatic communities.

Synthesis

The potential effects of the proposed BOGP on freshwater values are addressed through implementation of the effects management hierarchy and avoid, minimise or remedy any potential adverse effects with an outcome that results in no significant adverse effects. The overarching potential effects and the project response are provided in Table 1.

Conclusion

The application of the effects management hierarchy means that potential adverse effects are either avoided, minimised or remedied.

References

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Table 1. Summary of overall effects and the response to the mining activities on freshwater values.

Effect	Comment	Mitigation/Effects management	Outcome	Effects Management	Reference
Water quality	Potential toxic effects from constituents of concern: • Elevated total suspended solids. • NMD arsenic, sulphate, and potentially low amounts of trace metals. • Nitrate-rich (NO3-N) drainage that may also include ammoniacal nitrogen.	In-river compliance limits established for 90% species protection for freshwater ecosystems given their historic and current level of disturbance. Site-specific limit for sulphate based on	Nationally accepted ANZG DGVs and/or NPS-FM NOF bands have been applied. Compliance limits recommended as a hard limit as a further conservative measure to limit effects. Compliance limits protect aquatic ecosystem values. No adverse effects.	Minimise	Ryder (2025) Ryder (2026)
	Ammoniacal-N and nitrate-N compliance limits. Ammoniacal-N and nitrate-N compliance limits proposed were to protect aquatic species from the toxic effects of these compounds, not ecosystem effects.	Monitoring of benthic algae be undertaken as a part of routine monitoring that would fall under conditions proposed in the substantive application	Freshwater Ecology Management and Monitoring Plan (FEMMP, Proposed Condition 20) includes monitoring of periphyton cover in diversion channels. Recommend adding periphyton threshold to the FEMMP.	Minimise effect Remedy – adaptive monitoring	Boffa Miskell (2025b)
	Contamination from groundwater seepage.	Seepage collection, including underdrains, chimney drain, toe sump and cutoff drain.	No adverse effects on downstream receptors and environment.	Avoid	MWM/HGH (2026)
	Turbidity performance target	Instream turbidity target of 5 NTU (= approximately 2 mg/L suspended sediment).	Very conservative in stream compliance limit avoids adverse effects. Erosion-and-Sediment-Control-Management-Plan recommends turbidity	Minimise effect Remedy – adaptive monitoring	Ryder (2025) Ryder (2026)

			monitoring of silt pond inflows and outflows during rainfall trigger events plus review of performance.		
Water quantity	Stream depletion effect from the underlying RAS underground workings activities on Shepherds Creek is anticipated to be minor.	Nil required	Negligible effects on water quantity.	Avoid	Responses to ORC Technical Review in terms of the Fast-Track Approvals Act and RMA
	Loss of upper catchment (20-30% of water source)	Diversion of Shepherds Creek clean water around these impact zones and removal of irrigation abstraction will remedy or offset these temporary operational catchment losses.	Remedied through diversion and removal of land use practices. No adverse effects.	Remedy	Komanawa (2025)
	During and after mine closure the hydrology of Shepherds Creek will be significantly altered. Post-closure catchment hydrology for both Shepherds and Rise and Shine Creeks have higher catchment flow yields and more stable flow.	Creation of Shepherd Creek diversion will be designed to accommodate a range of flows and within a range of habitats. Increased flow may change ecological communities but unlikely to decrease ecological values. The same aquatic ecological communities e.g., species composition) are not expected but the equivalent or better ecological values are anticipated (and as measured by relevant and accepted ecological metrics).	Any change in ecological community is not an adverse effects if the same or better ecological values and function are retained or enhanced. No adverse effect. Effects management hierarchy satisfied.	Remedy through diversion design No adverse effects.	Komanawa (2025) Boffa Miskell (2025a)
Extent of stream length	Direct and indirect effects of the BOGP is remedied through intensive rehabilitation of stream diversions. Connectivity up and downstream in the catchment is retained. Additional compensation through improvements to other watercourses.	Creation of some 7,643 m rehabilitated stream diversion (7,643 m^{2*}) in Shepherds Creek and 1,599 m (800 m^2) of stream in Rise and Shine Creek catchment.	No net loss and overall gain in aquatic ecosystem extent. No adverse effect. Effects management hierarchy satisfied.	Remedy through diversion design	Boffa Miskell (2025a)

Stream habitat	The Shepherds Creek diversion is not intended to exactly match habitat conditions in the existing stream but to provide for no net loss of ecological values.	Design and implementation of FEMMP	No adverse effect	Remedy through diversion design	Boffa Miskell (2025a) Boffa Miskell (2025b)

Appendix B - Hydro Geochem Group 2026

HYDRO GEOCHEM GROUP
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MEMORANDUM

Recipient:	Cheryl Low – MGL
From:	Ryan Burgess
Date:	5 March 2026
Cc:	
Document Number:	J-H-NZ0238-003-M-Rev0
Document Title:	BOGP MWSF Seepage Risk Assessment

As an agreed action following the site visit and workshop held with representatives of Otago Regional Council (ORC) on 24 and 25 March 2026, Hydro Geochem Group Limited (HGG) was engaged by Matakanui Gold Limited (MGL) to prepare this memo to review and assess the risk of seepage migration from surface Mine Waste Storage Facilities (MWSFs) of the Bendigo-Ophir Project (BOGP) towards downstream receptors.

This document is intended to support the Assessment of Environmental Effects as part MGL's BOGP Fast Track Act Application.

BACKGROUND

The BOGP includes development of four surface MWSFs (Figure 1, see Attachment A):

- Tailings Storage Facility (TSF).
- Shepherds Engineered Landform (ELF).
- Western ELF.
- SREX ELF.

Without mitigation, generation of Acid and Metalliferous Drainage (AMD) seepage from these MWSFs has the potential negative impact downstream receptors. As such, design of these MWSFs includes seepage collection systems, which are described further in a separate section of this memorandum.

This memorandum assesses the operation and residual risk of MWSF seepage bypassing seepage collection systems by considering the following controlling factors:

- Hydrogeological setting, including sources, pathways, and receptors.
- Seepage collection systems included in the MWSF design.
- Adaptive management, including performance monitoring and contingency measures.

The remaining sections of this memorandum discuss these factors to assess the risk of MWSF seepage reporting to downgradient receptors.

HYDROGEOLOGICAL SETTING

Topography and Drainage

The BOGP is situated within the Shepherds and Clearwater Creek catchments of the Dunstan Mountains. The valley bottom creek channels are deeply incised into the schist bedrock terrain. Both creeks drain to the Clutha River system. All MWSFs are positioned within the creek catchments.

Hydrogeology

Three main hydrostratigraphic units are present at the BOGP:

- Valley bottom alluvium (aquifer).
- Weathered bedrock (aquifer).
- Fresh bedrock (aquitard).

Hydrostratigraphic units details are summarised in Table 1.

Table 1: Hydrostratigraphic unit details.

UNIT	DESCRIPTION[b]	PERMEABILITY	THICKNESS[b] AND DISTRIBUTION
Valley bottom alluvium	Typically unconsolidated, variable weathered gravels with interbeds of sands, silts and clays. This unit was generally observed in the site-specific geotechnical investigations as being located in the valley floor and comprising clays, silts, sands and gravels derived from parent materials upstream of the deposition location.	Primary porosity (pore space). Range between 10^{-6} to 10^{-5} m/s based on material description[a].	Typically <5 m depth. Constrained to valley bottom floor.
Weathered bedrock	Weathering profile of schist bedrock. Locally weathered to a silty gravel, consisting of fines from weathered micas with more competent schist blocks from less micaceous zones of the original rock.	Primary (where extensively weathered) and secondary porosity (fracture flow). Geometric mean of site-specific testing (n=7): $5x10^{-6}$ m/s[b]	Varies by landscape position. Thinnest in valley flows (few meters), thickest on valley flanks (up to 20 m thick). Project wide.
Fresh bedrock	Permian to Triassic era undifferentiated pelitic and psammitic schist and greenschist sequences.	Secondary porosity (fracture flow). Geometric mean of site-specific testing (n=29): 10^{-7} m/s[bc] Permeability reduces with depth.	>100 m thick. Project wide.

Sources:

a) *Freeze and Cherry (1979).*

b) *EGL (2025a).*

c) *KSL (2025a).*

Groundwater Flow Regime

Based on available data reported in KSL (2025) and EGL (2025a), the following observations are made, typical of valley settings:

- Groundwater levels are deepest on the valley flanks (approximately 25 m below ground level[bgl]) and shallowest in the valley bottoms (<2 m bgl).
- Lateral hydraulic gradients in fresh bedrock are relatively steep, ranging between 0.2 and 0.5 m/m. This suggests a relatively low hydraulic conductivity setting.
- Vertical gradients are typically downwards on valley flanks and upwards in valley bottoms, although variability does exist locally.

Based on these observations, it can be interpreted that at the BOGP, pre-mining groundwater generally flows from topographic highs (e.g., valley flanks) to topographic lows (e.g., local creeks); termed topographically driven flow. During mining and post-closure, pit and underground dewatering may alter this flow pattern locally, but at the scale of the BOGP, topographically driven flow will remain the dominant condition.

Figure 2 (see Attachment A) shows this conceptually for the Shepherds ELF, with any ELF seepage flowing either (i) along the original ground surface or (ii) along shallow weathered bedrock, both reporting to the valley bottom. Once at the valley bottom, seepage will migrate along the valley bottom towards seepage collection systems. Figure 3 (see Attachment A) shows this down valley seepage migration along the Shepherds Creek Valley. The same concepts apply to the Western ELF and SREX ELF in the adjacent catchment.

Potential Source-Pathway-Receptor

Based on the interpreted hydrogeological system described above, potential seepage migration from the MWSFs is summarised in a Source-Pathway-Receptor framework in Table 2. Unmitigated seepage pathways follow a similar pattern migrating along shallow groundwater systems towards potential surface and groundwater receptors. Seepage collection systems and contingency measures are planned to mitigate the risks of seepage migration from MWSFs.

Table 2: MWSF seepage SPR summary.

SOURCE	PATHWAY	POTENTIAL RECEPTOR
TSF seepage	Shallow groundwater system (alluvium and weathered bedrock)	Shepherds Creek. Ardgour aquifer groundwater users.
Shepherds ELF seepage	Shallow groundwater system	Shepherds Creek. Ardgour Aquifer groundwater users.
Shepherds Valley Fill seepage	Shallow groundwater system	Shepherds Creek. Ardgour aquifer groundwater users.
Western ELF seepage	Shallow groundwater system	Clearwater Creek Bendigo Aquifer Groundwater users.
SREX ELF seepage	Shallow groundwater system	Rise and Shine Creek[1]

[1]Note: Any shallow seepage migration not discharging to Rise and Shine Creek would report to RAS Pit.

Groundwater Travel Times

Groundwater travel times provide an indication of how long bypass must occur before it would reach a certain down valley location. Shorter travel time durations (e.g., less than a year) provide a higher risk (all else being equal) than longer durations. Screening level travel time estimates for potential seepage migration from MWSFs to surface water compliance locations are reported in Table 3 (assuming no seepage interception mitigation). Estimates suggest travel times for the larger MWSFs (i.e., Shepherds ELF and TSF) is on the order of a few decades, while 4 to 10 years for smaller MWSFs. Note that travel times to down gradient aquifers would be greater than shown here given the further travel distance.

Table 3: Screening level travel time estimates.

SOURCE	END POINT	DISTANCE	TRAVEL TIME
Shepherds ELF	SC01	3,300 m	26 years
TSF	SC01	4,800 m	38 years
Shepherds Valley Fill	SC01	1,000 m	8 years
Western ELF	RS03	500 m	4 years
SREX ELF	RAS Pit	1200 m	10 years

Note: travel time calculations are based on an average linear velocity of 126 m/year, derived by adopting the following parameter values: $K=10^{-5}$ m/s, a hydraulic gradient of 0.04 m/m (approximate slope of Shepherds Creek), and an effective porosity of 0.1.

SEEPAGE COLLECTION SYSTEMS

Primary[1] seepage collection systems are included in the designs of the MWSFs to minimise the potential for seepage reporting to the receiving environment. Table 4 summarises the elements of these systems (see EGL, 2025b and 2025c for further details).

Table 4: MWFS primary seepage collection system elements.

MWSF	MAX FOOTPRINT (ha)	PRIMARY SEEPAGE COLLECTION SYSTEM
Shepherds ELF	111	• Toe underdrainage system. • Low permeability toe bund (termed Zone A by EGL). • Seepage collection sump.
TSF	61	• Tailings Underdrainage. • Embankment Chimney drain. • Upstream Cutoff drain. • Low permeability core (termed Zone A by EGL). • Collected water piped to Shepherds ELF seepage collection sump.
Shepherds Valley Fill	11	Subsurface drains collect seepage at Run of Mine Pad and Process Plant. Water conveyed to collection point for management.
Western ELF	17	• Underdrainage system. • Collection sump.
SREX ELF	16	Seepage collection at toe of ELF via perimeter drain cut to rock to be directed to collection point management.

[1] *The term primary is used in this document to differentiate between seepage collection systems that are 'part' of the facility (e.g., underdrains, chimney drains, cutoff drains, etc.), and those that are contingency measures to intercept unacceptable seepage bypass of primary systems.*

The hydrogeological conditions underlying the MWSFs are favourable for high proportions[2] of seepage collection with the systems proposed. Only minor seepage is expected to bypass collection systems in the valley. Groundwater performance monitoring along key potential seepage migration pathways is proposed to ensure any seepage bypass remains at levels that pose a low risk to downgradient receptors. If performance monitoring identifies unacceptable levels of seepage bypass, contingency seepage interception systems (SIS) will be employed. Industry standard SIS components could include one or a combination of:

- Shallow rock filled interception drains (<5 m deep) to intercept near surface pathways.
- Interception wells to intercept deeper groundwater pathways.
- Lower permeability cut off walls to enhance hydraulic control of seepage interception.

In the author's experience, the examples described above have been successfully used to control seepage migration from MWSFs at many mine sites globally. Examples where these have been employed (or identified as selected contingencies) include the Faro Mine Complex and Myra Falls in Canada, Resolution Copper in the USA, and McArthur River in Australia, among many others not publicly available. Further unnamed examples are provided in Fortuna et al. (2021).

The constrained migration pathways within the valley bottom will also allow implementation of secondary / contingency SISs if for some reason the primary collection systems do not perform as intended. In other words, there are multiple opportunities to collect migrating seepage prior to it leaving the upland valleys (if it were to bypass primary collection systems).

From an offsite seepage migration potential risk, the Shepherds ELF seepage collection sump is the most important collection system given it is down valley of the largest MWSFs at the BOGP (Shepherds ELF and TSF) which will contribute the highest load for most potential constituents of concern (PCOC, see MWM, 2025 for example). The conceptual operation of this seepage collection system is shown conceptually in Figure 4 (see Attachment A), where:

- The combination of the low permeability toe bund and underdrain are anticipated to collect the majority of seepage.
- Potential bypass of primary seepage collection systems is monitored for in standpipe piezometers installed in alluvium, weathered bedrock, and fresh bedrock.
- Contingency SIS options are shown that could be employed to intercept seepage that bypasses primary collection systems.

The same concept of performance monitoring informing the need for secondary / contingency SIS measures is proposed for other MWSFs at the BOGP. These smaller MWSF pose a lower risk given their smaller size. The Western ELF is in an incised gully and cutoff is possible at the toe. At the SREX ELF perimeter cutoff can be achieved in rock along the downstream. Subsurface drains will collect Shepherds Creek Valley fill seepage.

[2] *In the author's experience, collection of a high proportion of seepage from MWSFs is more challenging where they either reside (i) over thicker (e.g., >10 m thick) high permeability aquifers, or (ii) across flatter terrain with less (or no) hydrodynamic containment concentrating seepage to valley bottoms.*

PERFORMANCE MONITORING

Groundwater performance monitoring is proposed (MGL, 2025) at the BGOP. A number of the groundwater monitoring locations have been purposefully selected to monitor for potential bypass from primary seepage collection systems, including:

- Immediately downstream from each of the MWSFs, to provide an early warning of potential bypass. Data collected from these locations will screen for the potential need for contingency measures.
- Adjacent to SC1 and RS03 (surface water compliance sites in Shepherds Creek and Clearwater Creek catchments, respectively). Shallow groundwater monitoring at these locations will allow an understanding of the magnitude of surface and subsurface PCOC load migration off site.

At each monitoring location proposed, they key hydrogeological units identified as potential pathways will be monitored (where present): valley bottom alluvium and/or weather bedrock. Where appreciable saturated thicknesses of each unit is present, nested standpipe individually screening each unit will be installed. Given its higher risk profile, fresh bedrock will also be monitored at the Shepherds Seepage Collection Sump to provide certainty that even lower likelihood pathways (e.g., low K fresh bedrock) are monitored.

Regular interpretation (i.e., annually or more frequently) of routine groundwater sampling (i.e., quarterly) at performance monitoring locations will allow for identification in increasing trends (e.g., breakthrough curves) that may be associated with potential bypass. In the author's professional experience, sulfate and nitrate are often the first PCOCs to be seen break through from seepage migrating from MWSFs. This is due to their conservative transport properties under most conditions. The breakthrough of metals for example is often delayed due to natural attenuation processes. Baseline monitoring indicates sulfate concentration in surface and groundwater to be approximately 15 mg/L or less compared with seepage source terms that are expected to be 10 to 100 time greater (MWM, 2025). In other words, there will likely be a strong signal to noise ratio allowing early detection. Nitrate is expected to have a similar ratio favourable to detecting potential bypass.

CONCLUSIONS

In summary, the risk of seepage migration off the BOGP site to down valley receptors is considered to be low due the following controlling factors:

- The hydrogeological setting and placement of MWSFs within constrained valleys will act to concentrate seepage in valley bottoms, enabling relatively easy collection.
- Primary seepage collection measures are proposed to collect a high proportion of seepage within the MWSFs themselves.
- Groundwater performance monitoring is proposed along key potential seepage migration pathways as close to MWSFs as practicable to allow early warning of bypass risks.
- With constrained valleys that make up the BOGP, potential seepage migration pathways provide redundancy to the seepage collection strategy as they provide for multiple opportunities to implement proven secondary / contingency seepage interception system measures to enhance seepage collection (if performance monitoring indicates they are required).

RECOMMENDATIONS

Despite the interpreted low risk, the following forward works recommendations are made to verify our assessments and support the detailed design of primary seepage collection systems:

- Complete further field characterisation to advance understanding of alluvium and weathered bedrock conditions at primary seepage collection system locations, including:
  - Groundwater levels.
  - Hydraulic conductivity.
  - Thickness and spatial distribution.
- Complete seepage modelling of primary seepage collection systems to improve confidence that high levels of collection are likely.
- Install groundwater performance monitoring and begin sampling as early as practicable to confirm pre-mining groundwater quality conditions of potential seepage migration pathways.

MGL have commissioned workstreams to complete these proposed forward works.

CLOSING REMARKS

Please do not hesitate to contact Ryan Burgess at +64 21 284 3999 or ryan.burgess@hydrogeochem.com.au should you wish to discuss our memorandum in greater detail.

Attachments: Attachment A – Figures

REFERENCES

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ATTACHMENT A – FIGURES

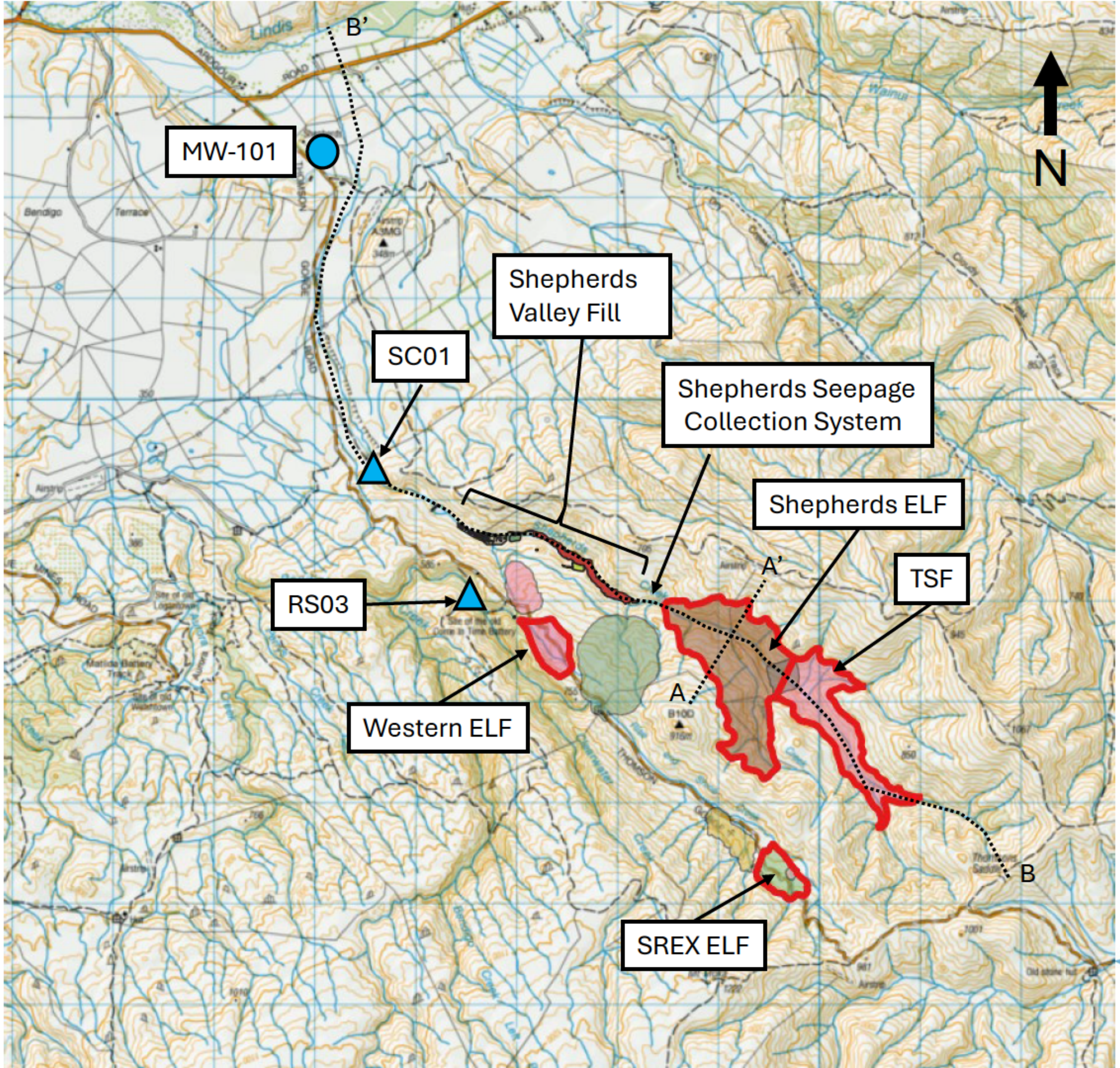
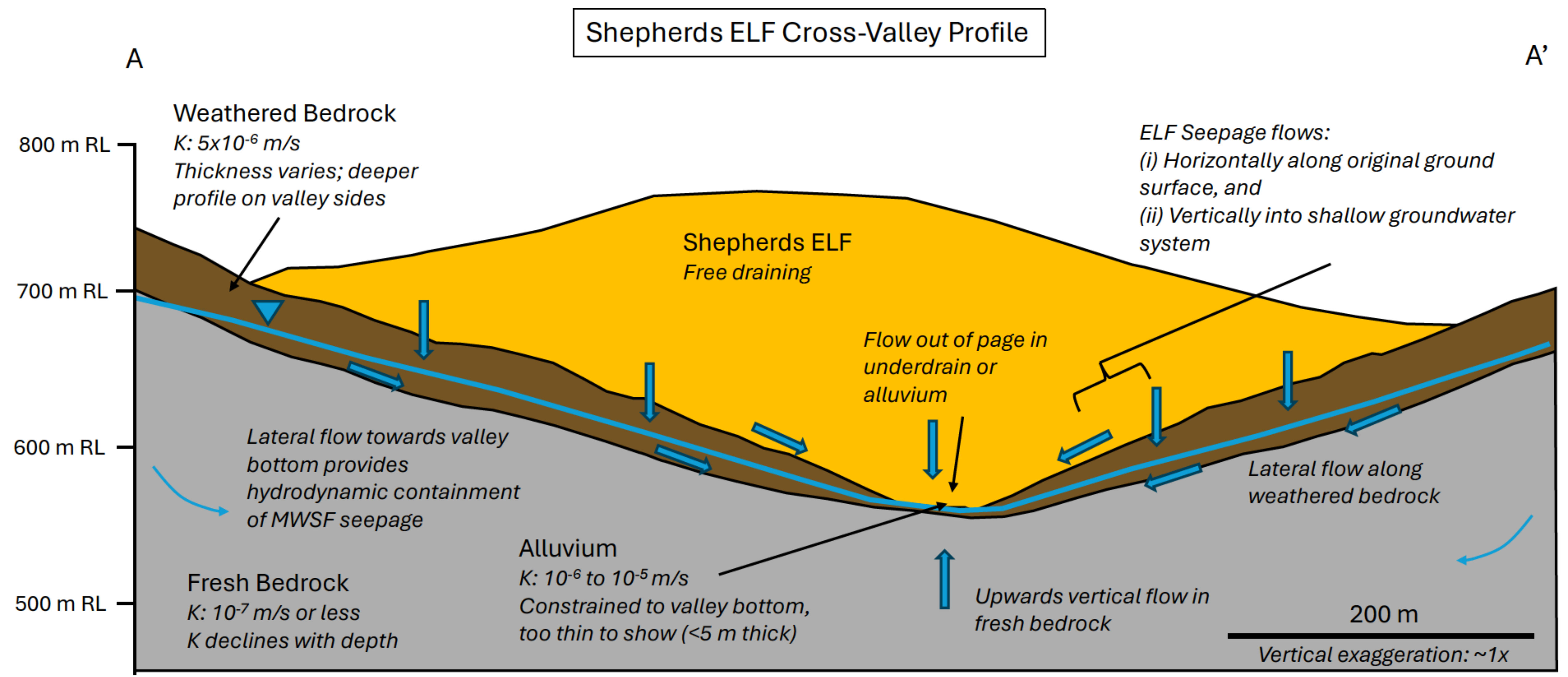


Figure 1

HYDRO GEOCHEM GROUP
GREENROAD GROUP



Shepherds ELF Cross-Valley Profile
A
A'
Weathered Bedrock
K: 5x10-6 m/s
Thickness varies; deeper profile on valley sides
800 m RL
700 m RL
600 m RL
500 m RL
ELF Seepage flows:
(i) Horizontally along original ground surface, and
(ii) Vertically into shallow groundwater system
Shepherds ELF
Free draining
Flow out of page in underdrain or alluvium
Lateral flow towards valley bottom provides hydrodynamic containment of MWSF seepage
Lateral flow along weathered bedrock
Alluvium
K: 10-6 to 10-5 m/s
Constrained to valley bottom, too thin to show (<5 m thick)
Fresh Bedrock
K: 10-7 m/s or less
K declines with depth
Upwards vertical flow in fresh bedrock
200 m
Vertical exaggeration: ~1x

Figure 2

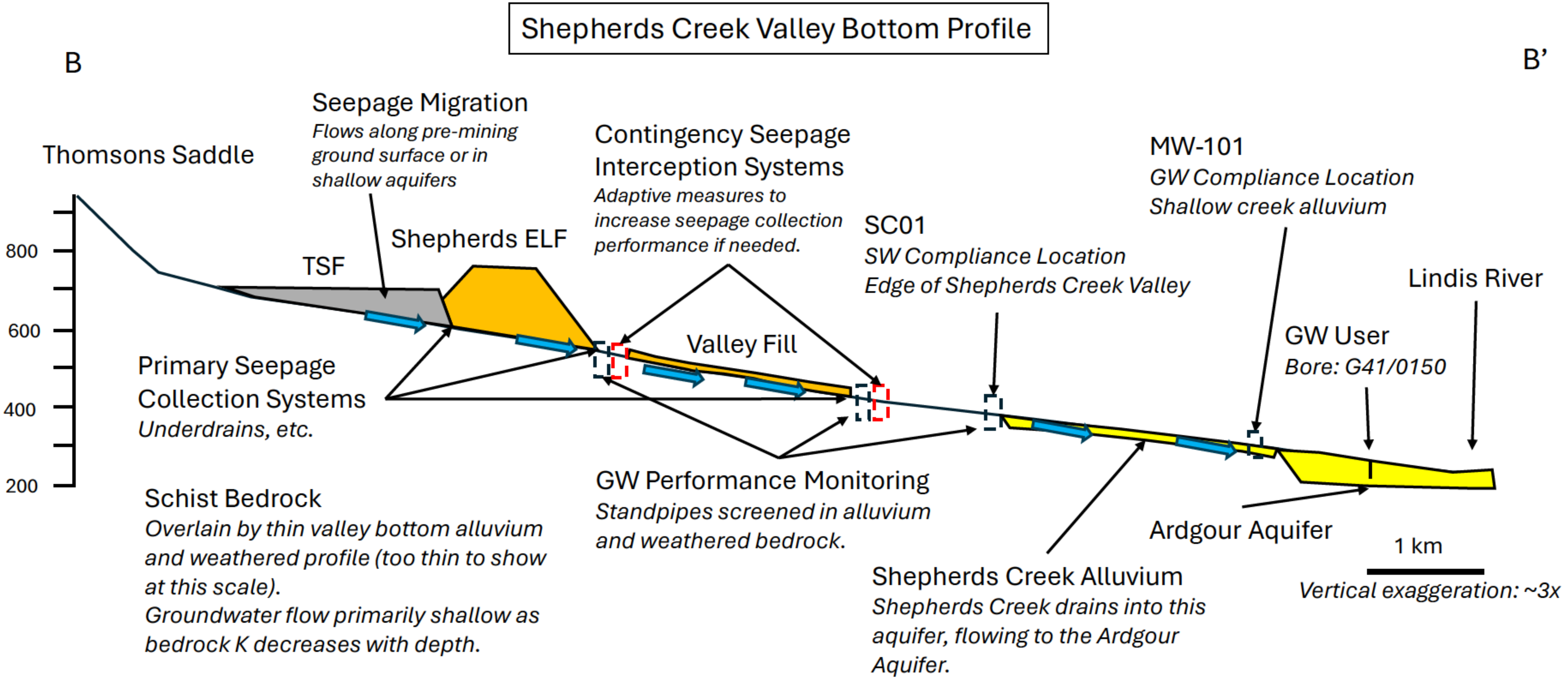


Figure 3

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Shepherds ELF Seepage Collection System

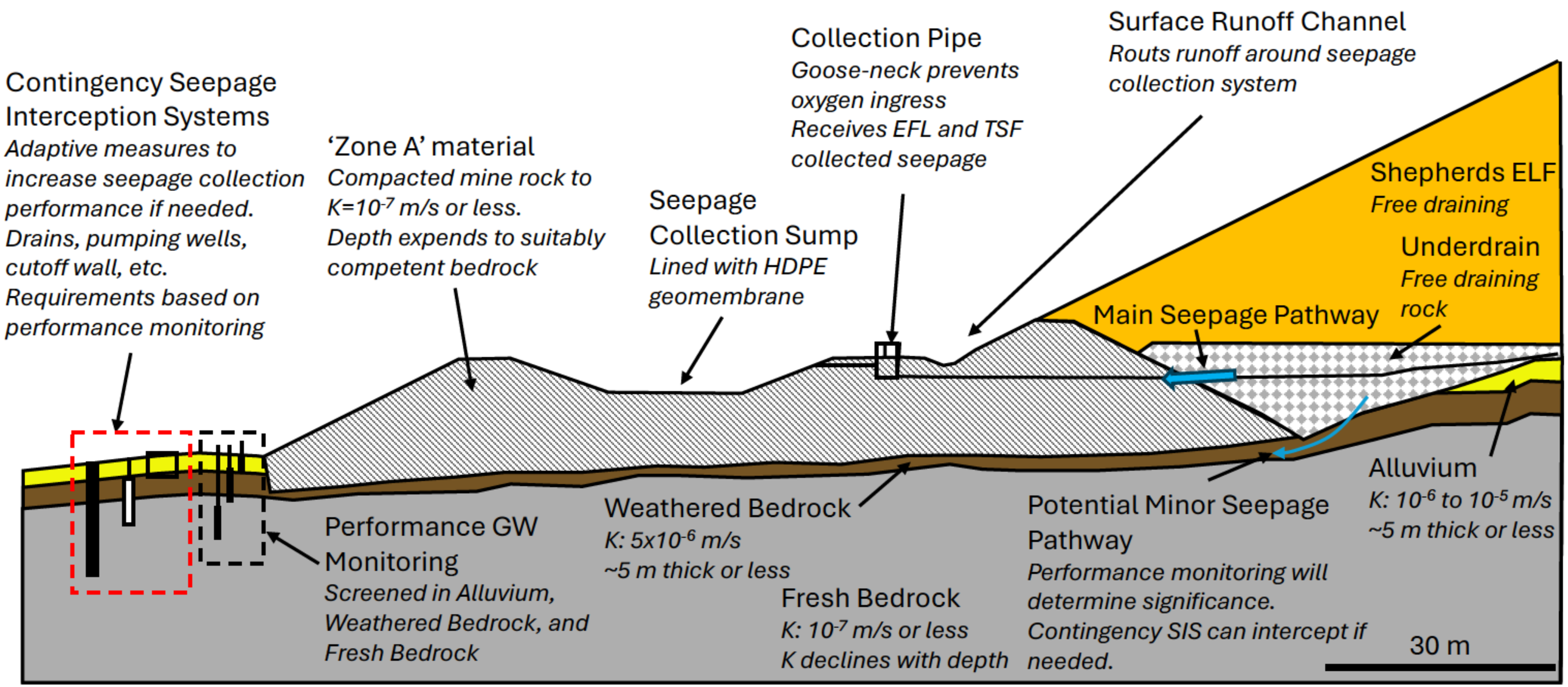

Figure 4

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