Fingerboards Mineral Sands Project — Inquiry and Advisory Committee (IAC)

Expert meeting statement — Groundwater

Meeting held: *Monday 1st April 2021. Online*

Experts:

Experts	Organisation	Briefed by counsel representing
Hugh Middlemis	*HydroGeoLogic*	*Kalbar*
Joel Georgiou	*EMM Consulting*	*Kalbar*
Tony McAlister	*Water Technology*	*Kalbar*
John Sweeney	*Coffey TetraTech*	*Kalbar*
Matthew Currell	*RMIT*	*Mine Free Glenaladale*
Julia Jasonsmith	*Murrang Earth Sciences*	*Mine Free Glenaladale*
John Webb	*Latrobe University*	*East Gippsland Shire Council*

Observers:

Observer	Organisation	Representing
Mick Hannan	*EPA Victoria*	

Note taker:

Tavis Kleinig (EMM Consulting)

The following key issues and areas of agreement and disagreement were identified by the participating experts at the meeting:

Item No.	Issue	
1	***Conceptual model***	
	Matters of agreement	
	No.	**Agreed fact/opinion**
	1.1	*The conceptual hydrogeological model presented as Figure 1 in the expert witness statement of John Sweeney (dated 2nd February 2021) was accepted as the basis for representing the current understanding of baseline hydrogeological conditions of the project area, drawing on available data.*
	1.2	*Kalbar's exploration drilling program has included approximately 680 exploration boreholes collected over several years that included observations of logged water cuts (locations and depths where water was encountered in the subsurface). The available borehole data has been spatially mapped to support the conceptualisation of perched water. Localised evidence of perched water has been encountered and has been presented in Attachment A006 of the EES and the expert witness statements of John Sweeney and Joel Georgiou. The need for further investigation of perching of groundwater was not agreed (see matters of disagreement).*
	1.3	*Landowners have stated that some farm dams are spring-fed. While it is not disputed that some dams may be sustained by the subsurface flow of water during dry periods, it was agreed that these dams are unlikely to be supported by groundwater from the regional watertable aquifer of the Coongulmerang Formation, which exists at depths in excess of 30 m below the ground surface in most places (i.e.. they are most likely dependent on isolated perched water). Referring to John Webb's second expert witness statement dated the 11 March 2021; some spring-fed dams are likely supported by soil/subsurface water stored within the porous and permeable dunal sands. Springs may emerge at the boundary between the dune sand and the less permeable underlying Haunted Hills Formation. The need to further understand the relationship between these dams and the underlying groundwater system as part of baseline studies was not agreed.*
	1.4	*Seepage from, and mounding beneath the mined voids is unlikely to pose a risk of impact to farm dams outside the project boundary. Exceptions may exist where earthworks or other mining activities disturb the local catchments that support farm dams outside the project area and interfere with subsurface recharge pathways.*
	1.5	*There is agreed uncertainty in relation to how seepage water moves in the vadose zone, however it was also agreed that it is most commonly vertical, unless localised low permeability (i.e. clay rich layers) are encountered.*
	1.6	*Further to item 1.5, the risk of seepage water below the mine void encountering a low permeability layer and moving laterally was recognised. This could feasibly result in the discharge of seepage water at the escarpment face under some conditions. It was agreed that this is beyond the resolution of a numerical groundwater model. This risk has been considered in Section 8.3.2 of the Attachment A006 of EES in response to peer review comments. Ongoing groundwater level monitoring and adaptive management (including recommendation 1.22 herein) is the agreed best approach to addressing this risk if the mine is given approval.*
	1.7	*In the context of the Coongulmerang Formation, the EES and statement of Joel Georgiou have presented information on exploration drilling records across the mine area which have not identified any laterally continuous low permeability clay horizons. The available data suggests that where low permeability horizons exist, they are more likely to be 'localised' (i.e. in the order of 10s of metres) rather than 'extensive' (in the order of 100s of metres). However, the need for further investigation of this issue was not agreed (see matters of disagreement).*
	1.8	*The vertical extent of any natural perching and/or mounding of seepage will be limited by the process of drainage at the edges of the localised perching unit. This would occur whether the edge of the low permeability horizon is within the undisturbed aquifer or, for example, at the face of the mine excavation.*
	1.9	*The modelling of groundwater mounding from tailings deposition in the mine void is likely to be conservative, as it does not account for water efficiencies achieved by the use of centrifuges, but instead uses a higher rate of seepage (53 L/s) than is now estimated with the use of centrifuges (35 L/s). The higher seepage rate would result in predictions of higher mounding than the use of the updated seepage rate (but this has not yet been modelled for groundwater mounding). There is remaining uncertainty with respect to the pre-mining and post-disturbance groundwater recharge rates, and thus the exact timing and extent of groundwater mounding that will develop below the site.*

Item No.	Issue		
	1.10	*The conceptual model, supported by results of the numerical groundwater model, predicts that the groundwater mound will increase the hydraulic gradient towards the Mitchell River and increase the rate of natural groundwater discharge from the Coongulmerang Formation aquifer to the Mitchell River. The main risk due to increased groundwater discharge driven by steeper gradients during mining periods is related to groundwater quality at times of low flow in the Mitchell River.*	
	1.11	*Some uncertainty remains regarding the discharge pathway from the mine site towards the Mitchell River. Groundwater discharge is likely to be at least partly taken up by floodplain and riparian plants (evapotranspiration). It was not agreed whether this can be anticipated to benefit or harm these ecosystems or what the likely environmental impact of the increased discharge along this pathway is (see point 1.26). These issues are discussed further at item 4.*	
	1.12	*The depiction of the basement unit in the conceptual model cross-section (Figure 3-3 of A006) was agreed to be incorrect. A revised conceptual cross section has been provided in the statement of John Sweeney, and the text description of the geological and hydrogeological setting in the EES is correct.*	
		Assumptions relied upon in reaching agreement	
	1.13	*The definition of perched groundwater presented in expert statement of Hugh Middlemis, item 5(c) on page 13 (dated 28 Jan 2021)*	
	1.14	*The precise location of spring fed dams has not been provided to or confirmed by any of the expert witnesses, so specific comment could not be offered beyond that presented.*	
		Individual comments in respect of agreed fact/opinion	
	1.15	*Hugh Middlemis*	*Re item 1.6; it is noted that the model includes layers with very low vertical permeability values (Coongulmerang Kv = 0.0005 m/d and Seaspray Group Kv = 0.0001 m/d), although the model results were shown to be not sensitive to further reductions by a factor of 2 in the Kv for these units.*
	1.16	*Joel Georgiou*	
	1.17	*John Sweeney*	
	1.18	*Tony McAlister*	
	1.19	*Matthew Currell*	
	1.20	*John Webb*	
	1.21	*Julia Jasonsmith*	
		Agreed actions:	**Suggested timing:**
	1.22	*The groundwater monitoring plan should include periodic monitoring of the escarpment to the north and east of the mine area for seepage.*	*Post-EES approval (if approval is granted)*
	Matters of disagreement		
	No.	**Summary of fact/opinion not agreed**	
	1.23	*Localised perched low permeability layers could allow tailings seepage to exist above regional water table to the extent that it would cause perched water to rise substantially towards ground level.*	

Item No.	Issue	
	1.24	*Further data is required to understand the extent and cause of perching of groundwater below the site, particularly, to reconcile the very different water level depth encountered in one of the monitoring bores (MW07), which is more than 20 m higher than the others in the Coongulmerang Formation.*
	1.25	*More information is required on hydraulic gradients near the Mitchell river to support the conclusions of the EES, via installation of bore transects between proposed mine site and the river bed.*
	1.26	*Field-based investigation of any 'spring-fed' dams which occur close to the mine site should be conducted as part of baseline monitoring and included in further revisions of the hydrogeological conceptualisation.*
2	***Pumping test and aquifer properties***	
	Matters of agreement	
	No.	**Agreed fact/opinion**
	2.1	*The pumping test completed to date has provided one key data point with which to estimate aquifer properties for the groundwater model (storativity and transmissivity). The groundwater model is not founded solely on the results of the pumping test, but has been tested for sensitivity and uncertainty across an expected range of aquifer parameter values.*
	2.2	*Early time storativity values from the pumping test were used in the modelling, with results consistent with previously reported regional data. The pumping test resulted in storativity values similar to that of an unconfined aquifer for the late time data. The use of multiple methods to process data from the same test gave similar storativity and transmissivity results; however these are still considered to be uncertain. A longer duration test, where high-quality late time data can be derived, would be needed to better understand the aquifer's behaviour in response to pumping, including the extent of confinement, hydraulic parameters, and potential boundary effects which may impact the response(s) of water levels to the proposed borefield in the long-term.*
	2.3	*The sub-optimal production bore design for the pumping test resulted in low bore efficiency, with rapid drawdown in the production bore (due to large well loss) and far less drawdown in the monitoring bore (aquifer loss). This affected the level of confidence with which the data could be used to estimate aquifer parameters.*
	2.4	*The pumping test data indicated a potential boundary effect, shown by the increased drawdown seen in the semi-log plot in the late stages of the test (where this would stabilise in a confined aquifer unaffected by a nearby boundary). The Australian Standard was followed for the design and conduct of the pumping test, however ideally the test would have run for longer than four days.*
	2.5	*The spacing of the monitoring bores 10 m away from the production bore was used in order to ensure that a response (drawdown) in the monitoring bore was recorded. Ideally, a future pumping test (which Southern Rural Water has indicated will likely be required to support a groundwater licence application) would include monitoring bores at more than one distance and direction from the pumping well.*
	2.6	*The risk of the potential boundary effect whereby the drawdown cone reaches the edge of the aquifer (northern outcrop areas) and associated impacts such as water table drawdown or increased inter-aquifer leakage where the aquifer thins, outcrops and/or becomes more connected with other units, has not been considered in the pumping test analysis or groundwater impact assessment.*
	2.7	*The groundwater model considers cumulative pumping impacts, with cumulative impact drawdown contours and the incremental drawdown contours due to Kalbar's pumping shown and including the known aquifer extents based on investigations and drilling and the VAF dataset.*
	2.8	*Reasonable storativity and transmissivity values were used in the groundwater model, with a range of values considered..*
	2.9	*The risk assessment should consider a less extensive aquifer than anticipated (in light of the pumping test results and apparent boundary effect encountered), and the impacts of the edge of the aquifer and Woodglen managed aquifer recharge (MAR) site. A less extensive aquifer beneath the mine site (in the south-west corner) was simulated as an alternative conceptualisation but this is currently insufficient to fully explore the full extent and implications of potential boundary effects.*
	2.10	*The updated water balance work presented in the expert witness statement of Jarrah Muller notes that use of the centrifuges changes the water needed for the mine (now ~2.8 GL/y rather than 3 GL/yr), with more water recycled on site. The water balance model assumed that the main source of make up water was expected to be Mitchell River winter-fill (consistent with the current project description). A surface water licence for this river water is yet to be approved by Southern Rural Water (SRW).*
	2.11	*If a surface water licence is not granted by SRW or the full winterfill allocation is not available in a given year, Kalbar would seek a groundwater supply from the Latrobe Group aquifer (via the proposed borefield) and/or mine production would be scaled down.*
	2.12	*Groundwater modelling for the EES includes the conservative scenario of pumping 3 GL/y from the borefield (for 3 years and for 15 years), however this is not the preferred scenario for Kalbar. According to the latest water balance analysis (incorporating centrifuging of tailings) the extraction volume over-estimates the likely volumes*

Item No.	Issue		
		required from the borefield (notwithstanding residual uncertainty in the water balance). If the maximum winter fill allocation licence from the Mitchell River is granted, the groundwater demand would generally decrease proportionally to the quantity of licensed surface water available. In the preferred scenario for Kalbar (with the winter fill licence granted) groundwater requirements would reduce to not more than 0.6 GL/y in 90% of years (this scenario has not yet been modelled).	
	2.13	*There is inherent uncertainty in water balance modelling which is considered in the updated water balance presented in the expert witness statement of Jarrah Muller. It is understood that the adequacy of this modelling has been discussed in the joint statement of the water balance conclave. The water supply volumes discussed at item 2.10 represents the mean annual requirement within a range of possible supply requirements dictated by climate variability.*	
	2.14	*The proponent is planning an additional pumping test during 2021. This should ideally be pumped for longer than the original test, with post-pumping recovery of water levels monitored as well as drawdown for the full duration. A pumping rate should be chosen to allow further investigation of boundary effects. More monitoring locations should be included to ensure the data can inform further estimates of aquifer parameters, analysis of the realistic groundwater yield(s) from a borefield, and the potential boundary effects noted above.*	
		Assumptions relied upon in reaching agreement	
	2.15	*That the water balance modelling reported in (EMM 2021) presents definitive estimates of the different water source requirements per annum for the mine under different climate conditions and mine plans (based on year 5, 8 and 12 layouts)*	
	2.16		
		Individual comments in respect of agreed fact/opinion	
	2.17	*Hugh Middlemis*	
	2.18	*Joel Georgiou*	
	2.19	*John Sweeney*	
	2.20	*Tony McAlister*	
	2.21	*Matthew Currell*	*MC believes the representation of the modelling results corresponding to different aquifer parameters in the tested range (referred to in 2.8) was somewhat ambiguous in the reporting.*
	2.22	*John Webb*	
	2.23	*Julia Jasonsmith (not present for conversation)*	
		Agreed actions:	**Suggested timing:**
	2.24	*Additional pumping test is proposed by the proponent at a separate production bore location. This should be conducted for a period longer than four days. This is to be undertaken in accordance with Southern Rural Water's groundwater licence application guidelines.*	*Post-hearings (already in progress)*
	2.25	*Following pumping test, consider implications for the numerical model and, review conclusions drawn in the EES that relate to the potential impacts associated with groundwater drawdown around the bore field.*	*Post-hearings, to support the groundwater licence application*
	2.26	*Monitor pH, redox and TDS during the pumping test every 30-60 minutes*	*Post-hearings, during pumping test (in progress).*

Item No.	Issue	
	Matters of disagreement	
	No.	**Summary of fact/opinion not agreed**
	2.27	*The extent to which the pumping test is an important line of evidence pertaining to the viability of, and potential impacts of, the proposed borefield (e.g. its relevance to assessing the extent and magnitude of drawdown and potential for inter-aquifer leakage that would be experienced as a result of the borefield).*
	2.28	*Whether the modelled drawdown impacts in the numerical model, at the pumping rate of 3 GL/year for 3 and 15 years, incorporating the selected aquifer parameters, represents an 'extreme' scenario (as opposed to 'conservative' or 'appropriate'), for the purpose of the groundwater impact assessment.*
3	***Numerical modelling***	
	Matters of agreement	
	No.	**Agreed fact/opinion**
	3.1	*For the modelled EES seepage rate of 53 L/s, groundwater affected by mounding is simulated to 'daylight' into mine pits. Kalbar engineers are aware of this (according to statements of Joel Georgiou). There are common engineering methods available to manage this water.*
	3.2	*According to the EES and to the best of the experts' knowledge, the tailings management principles outlined in Section 8.5 of the Draft Work Plan (Attachment B of the EES) will be applied by Kalbar, including maintaining a low phreatic surface via drainage and dewatering.*
	3.3	*Upper and Lower Coongulmerang Formation is an economic rather than lithological delineation by Kalbar, with Kalbar targeting the higher grades in the Upper Coongulmerang for mining. From a hydrogeological perspective the Upper and Lower Coongulmerang are likely to behave as a single, connected unconfined aquifer unit (although, this has not been explicitly tested).*
	3.4	*Kalbar intend to implement a range of drainage infrastructure (toe drains, wet wells, subsurface drainage network etc) installed within the pits to minimise seepage and maximise the recycling of water. The recovery of seepage water is a key part of the water balance and water re-use at site. If the mound develops and moves away from the tailing cells, and presents a risk to offsite receptors greater than that assessed in the EES (such as discharge at the escarpment), corrective actions (such as installation of perimeter interception bores) can be implemented to reduce the mound.*
	3.5	*To support groundwater licence (take and use) applications, Southern Rural Water (SRW) has indicated that it will require Kalbar to rerun the numerical model with the latest hydrostratigraphy and intended bore field layout (and intended volumes). This assessment will need to follow SRWs guidelines document titled " Hydrogeological Assessment Guidelines for non-Urban Supply Groundwater License Applications", dated March 2020. At that time, the model will also be updated with the latest tailing seepage estimates based on the Centrifuge method, and the extent of mounding reassessed,*
	3.6	*Some uncertainty remains in relation to unsaturated zone behaviour and the timing for seepage water to reach the watertable, and subsequent groundwater mound development. As such a monitoring program would need to be designed as suitable to characterise the spatial and temporal extent of mounding, with monitoring to continue into the post closure period (if the mine proceeds).*
	3.7	*Groundwater mounding is likely to develop over a period of months to years. This is discussed further in relation to the timing of potential impacts to GDEs and future monitoring requirements in item 4 below.*
	3.8	*Mine engineers revised the mine plan to move the original mine pit away from the escarpment in response to peer review comments, and the recognised risk of seepage daylighting into the escarpment between the site and Mitchell River floodplain. This risk was assessed in Sections 8.3.2 of Appendix A006 of the EES, and proposed monitoring to manage this risk was included in the EES and has been recommended at item 3.23, herein.*
	3.9	*The original modelling of groundwater mounding below the site used a seepage rate of 53 L/s, while the updated water balance modelling with the use of centrifuges reduces the estimated seepage to 35 L/s and thus would result in a lesser degree (and/or slower development) of mounding (but this has not yet been modelled). This rate also includes entrainment and thus the available water that can drain under gravity may reduce further. The appropriateness of the methodology used to simulate the timing and extent of groundwater mounding was not agreed (See matters of disagreement).*
	3.10	

Item No.	Issue	
	Assumptions relied upon in reaching agreement	
3.11		
3.12		
3.13		
	Individual comments in respect of agreed fact/opinion	
3.14	*Hugh Middlemis*	
3.15	*Joel Georgiou*	
3.16	*John Sweeney*	
3.17	*Tony McAlister*	
3.18	*Matthew Currell*	
3.19	*John Webb*	
3.20	*Julia Jasonsmith (not present for conversation)*	
	Agreed actions:	**Suggested timing:**
3.21	*Kalbar to monitor groundwater for several years post-mine closure to ensure the effects of seepage lag are addressed. The period of monitoring to be guided by results of further work recommended in item 3.22. The details of this documented in the groundwater management plan*	*Post-EES approval (if approval is granted).*
3.22	*Collect soil samples from base of pit to water table, and submit these to laboratory for analysis for van Genuchten parameters. Use this data in an unsaturated zone model (SEEP-W) to inform seepage rates and lag.*	*As soon as possible to inform updated groundwater monitoring strategy*
3.23	*monitoring of the escarpment for lateral seepage from mine pits during operation.*	*Post-EES approval (if approval is granted).*
3.24	*Install strategic nested bores (across multiple depths) in the mine area to monitor seepage and the rise in water table and to understand vertical hydraulic gradients.*	*Post-EES approval (if approval is granted).*
3.25	*Modelling inputs and scenarios to be updated on the basis of new information and data. This will be required by SRW to support licence applications.*	*Prior to groundwater licence application*
3.26		

Item No.	Issue	
	Matters of disagreement	
	No.	**Summary of fact/opinion not agreed**
	3.27	*The extent to which the numerical modelling approach is able to simulate the timing and extent of groundwater mounding below the site in the short and long-term, based on the methodology adopted, and whether the current model represents a 'conservative' estimate of this effect.*
	3.28	*Whether rainfall recharge (and changes to rates due to mining) has been adequately considered in the assessment of groundwater mounding.*
4	***GDEs***	
	Matters of agreement	
	No.	**Agreed fact/opinion**
	4.1	*GDEs have variable and unique interactions with groundwater and the potential for impact by project activities should be considered individually - consistent with the approach in the EES (noting relevant Matters of Disagreement below).*
	4.2	*Pooled water within the ephemeral drainage gullies onsite, and in the unnamed tributary of Honeysuckle Creek immediately south of the project area currently are several tens of metres above the regional groundwater table, and under existing conditions are unlikely to be considered GDEs that rely on the regional water table. Whether these are features at risk of impact as a result of changed groundwater conditions due to mining (e.g. mounding) was not agreed (see 4.26).*
	4.3	*The hydrology of the Providence Ponds and other chain of ponds features west of the project area has not been directly assessed by field investigations to confirm connectivity with the regional groundwater system. The conceptual model draws on exploration data (including local water strikes), interpretation of measured groundwater levels within the project area, and model calibration to existing groundwater levels, which uses regional data (state database, VAF etc) and data local to the mine area, noting that there are currently no monitoring bores to determine groundwater levels in the vicinity of the ponds.*
	4.4	*If the conceptual model is correct (as presented in items 1.1, 1.2, 4.3) and the regional water table is several tens of metres below the base of the Providence Ponds (consistent with the statements made in the EES, and the expert statements of John Sweeney and Joel Georgiou), a viable groundwater pathway would not exist for the project to have a direct impact on the Chain of Ponds system. Whether it is acceptable to assume this conceptual model is true without further collection of groundwater level data in the vicinity of the Providence Ponds and between the mine site and ponds, was not agreed (see 4.29).*
	4.5	*The Mitchell River is considered an aquatic GDE that likely receives (and relies on) baseflow discharge from the Coongulmerang Formation aquifer, via upward flow of groundwater either directly to the river, or via the Mitchell River alluvium (where it is present beneath the river base).*
	4.6	*During dry periods, the flow in the Mitchell River would be almost entirely sourced from baseflow (groundwater) with contributions from both the upstream catchment and the surrounding catchment near the mine area (with the precise relative contribution of each unknown).*
	4.7	*Groundwater mounding is likely to increase the rate of groundwater that discharges from the Coongulmerang Formation aquifer to the Mitchell River and associated alluvium. Coongulmerang Formation groundwater has naturally elevated concentrations of some salts, metals and nutrients which may be discharged to the Mitchell River at a higher rate than occurs naturally due to mounding induced by the mine. This potential effect was not directly addressed by the EES but has subsequently been considered for TDS in the expert statement of John Sweeney (Section 6.3.4). The adequacy of this assessment to characterise potential risk to the Mitchell River GDE, encompassing all potential water quality constituents, was not agreed (see point 4.30).*
	4.8	*Terrestrial vegetation has been assessed for potential groundwater dependence within the area of predicted groundwater mounding by desktop and field assessments. High likelihood terrestrial GDEs were identified in the riparian zone around Mitchell River and Moilun Creek. The effect of raised groundwater levels with naturally higher salinity and/or naturally elevated concentrations of some metals on ecosystem health is unknown. Based on the vegetation surveys conducted by EHP and their statement that "vegetation in this area (Leptospermum lanigerum and Melaleuca ericifolia, and rushes and sedges) is frequently waterlogged for extended periods", the potential for adverse impacts due to mounding and increased interaction with native groundwater was considered to be low in the EES risk assessment matrix, however the validity of this conclusion and need for further investigation were not agreed (see Matters of disagreement below).*

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	4.9	*The time lag between the release of tailings seepage (potentially containing increased concentrations of metals and other solutes) migrating via groundwater and impacting on GDEs has not been estimated. However, the predicted transport pathways have been estimated via particle tracking (Section 7.7.4 and Appendix B of EES Appendix A006). The particle tracking modelling indicates that the primary discharge points for groundwater below the mine site will be the Latrobe Group aquifer to the south and Mitchell River floodplain to the north. The relative importance of these pathways will be dependent on the extent of pumping within the proposed borefield and degree of mounding below the mine site, which are currently uncertain.*	
		Assumptions relied upon in reaching agreement	
	4.10	*The precise location of spring fed dams has not been confirmed to any of the expert witnesses so specific comment could not be offered beyond that presented.*	
	4.11	*John Sweeney's expert witness statement (particularly Section 6.3 and Figure 1) provides a generally agreed basis for conceptualising the different sources of water in the subsurface (regional groundwater, perched water and near-surface drainage) and their different interactions with GDEs (noting some disagreement in the level of site assessment data that may be required to verify these conclusions).*	
	4.12		
		Individual comments in respect of agreed fact/opinion	
	4.13	*Hugh Middlemis*	
	4.14	*Joel Georgiou*	
	4.15	*John Sweeney*	
	4.16	*Tony McAlister*	
	4.17	*Matthew Currell*	
	4.18	*John Webb*	
	4.19	*Julia Jasonsmith*	
		Agreed actions:	**Suggested timing:**
	4.20	*The groundwater monitoring network should include monitoring bore(s) at an appropriate location between the project area and the Perry River catchment and/or Chain of Ponds system, suitable to verify the current hydrogeological conceptualisation of the Chain of Ponds, and to provide ongoing monitoring of groundwater mounding towards the west during mine operation.*	*As soon as practical in order to improve conceptualisation, allow for appropriate assessment of risk and baseline data to be gathered.*
	4.21	*The GDE monitoring and management plan should include periodic ecosystem health monitoring at the high-value Chain of Ponds ecosystems in the Perry River catchment.*	*Post-EES approval (if approval is granted)*

<table>
<tr><th>Item No.</th><th colspan="3">Issue</th></tr>
<tr><td></td><td>4.22</td><td>Groundwater monitoring plans and periodic reporting should include a requirement to use appropriate methods to quantify and assess the effect of the lag period for seepage to report to the watertable. This assessment should inform the reasonable timeframe for groundwater and surface water monitoring post-mining.</td><td>Post-EES approval (if approval is granted).</td></tr>
<tr><td></td><td>4.23</td><td>Further work should be conducted to quantify the effect of increased baseflow discharge due to mounding on dissolved metals and nutrient concentrations in surface water of the Mitchell River.</td><td>As soon as practical to inform the approval decision</td></tr>
<tr><td></td><td>4.24</td><td>The EES has not identified a potential chemical hazard posed by tailings seepage that might affect GDEs. However, if recommended further work (items 5.22 through to 5.25) or actual conditions indicate a quality hazard exists, undertake modelling to predict the likely concentrations in groundwater discharging to receptors.</td><td>As soon as practical to further inform GDE risk assessment and resolve current uncertainties.</td></tr>
<tr><td></td><td>4.25</td><td>Groundwater, surface water and GDE monitoring plans should be prepared as soon as possible to provide confidence to the community and stakeholders and to allow for baseline data to be collected.</td><td>Timing not agreed.</td></tr>
<tr><td></td><td colspan="3">Matters of disagreement</td></tr>
<tr><td></td><td>No.</td><td colspan="2">Summary of fact/opinion not agreed</td></tr>
<tr><td></td><td>4.26</td><td colspan="2">The accuracy of the predicted extent of mounding as a result of mining (encompassing the assumptions made in the numerical model regarding groundwater recharge rates), and whether the water table is likely to intersect the surface aside from within the mine pits, and create points of groundwater discharge, which may experience salinisation or other water quality impacts.</td></tr>
<tr><td></td><td>4.27</td><td colspan="2">The groundwater-surface water interaction between the Coongulmerang Formation, Mitchell River alluvium and the Mitchell River, and extent of connectivity between these water sources is not well characterised, representing a knowledge gap in assessing potential pathways for impact between the project and the Mitchell River and alluvial aquifer. This should be assessed in detail using nested groundwater monitoring bores and/or bore transects.</td></tr>
<tr><td></td><td>4.28</td><td colspan="2">The scale of the likely lag period between tailings deposition in the mine void and seepage reaching the watertable was not agreed. The suggestion that not all impacts may be realised until after the cessation of mining was not agreed.</td></tr>
<tr><td></td><td>4.29</td><td colspan="2">The suggestion that an insufficient level of work had been completed to adequately understand the connectivity of regional groundwater to the Chain of Ponds system in the Perry River catchment was not agreed.</td></tr>
<tr><td></td><td>4.30</td><td colspan="2">The extent of potential increase in the concentrations of metals, salts, and nutrients as a result of increased baseflow contributed from the Coongulmerang Formation to the Mitchell River (in response to groundwater mounding), and the potential environmental impact of this was not agreed.</td></tr>
</table>

Item No.	Issue	
	4.31	*The extent of further collection of data and modelling required to characterise rates of groundwater discharge and associated quality risks to the Mitchell River GDE(s) was not agreed.*
	4.32	*If there is seepage to a perched layer then this will be a localised issue, and would be unlikely to have regional-scale impacts.*
	4.33	*The adequacy of the current monitoring network and proposed future groundwater monitoring program (in current form) to adequately identify and mitigate potential impacts on GDEs was not agreed.*
	4.34	*It was not agreed that any increased concentrations of metals in surface water as a result of increased baseflow contributed from the Coongulmerang Formation would reasonably be expected to be at least an order of magnitude lower than in surface water runoff from the site entering the Mitchell River, which has been modelled in Section 7.6.2 (and Appendix E and F) of Appendix A006 of the EES. It was not agreed that the potential impact from metals, suspended solids, and nutrients in runoff would therefore be unlikely to pose an unacceptable risk to the aquatic ecosystem.*
	4.35	*The level of certainty required to assess impacts to GDEs for the purpose of the EES was not agreed.*
	4.36	*The level of agreement/disagreement is not uniform across the experts as to the optimum timing of the actions 4.20 to 4.25 should be post-EES approval or as soon as practical, irrespective of the timing of approval decision.*
5	***Groundwater and seepage quality***	
	Matters of agreement	
	No.	**Agreed fact/opinion**
	5.1	*Tailings seepage quality was assessed from representative samples of fine tailings, coarse tailings (using deionised water) and unprocessed ore (using a sample of Mitchell River water). Similar leachability assessments were not conducted using a sample of water from the Latrobe Group aquifer.*
	5.2	*The leachability results that were presented in the EES suggested that the dissolved concentrations of metals (which would be mobile and might migrate via groundwater) were not elevated above the mean baseline concentrations measured in Coongulmerang Formation groundwater beneath the site. This statement is agreed noting the context provided in item 5.3 and 5.4.*
	5.3	*The dissolved concentrations of metals and other constituents in process water could increase over time due to the recycling of supernatant water from the deposited tailings, underdrains and from the centrifuges. Any increase in concentrations would be diluted to some degree by fresh make up water sourced from the Mitchell River and/or the borefield. The net effect on water quality has not been estimated and has not been addressed by the EES.*
	5.4	*An assessment of radionuclides in groundwater and surface water is presented in Appendix A011 of the EES but not in Appendix A006. Uranium and thorium concentrations were not measured in the baseline groundwater quality assessment but were assessed for potential to be mobilised from tailings seepage.*
	5.5	*The baseline groundwater monitoring has identified concentrations of some chemical parameters (such as nitrate, phosphorus, and E.coli) that are pre-existing in the aquifer and that are likely be attributed to existing anthropogenic sources of contamination. The sources of existing contamination have not been identified by the EES, but these contaminants are commonly associated with agricultural practices common to the local region (application of fertilisers and stock grazing) and/or use of domestic septic systems.*
	5.6	*The baseline concentrations of metals in groundwater, including aluminium, cadmium, chromium, copper, nickel, and zinc, exceed water dependent ecosystem beneficial use assessment guidelines. The source of these metals has not been assessed by the EES.*
	5.7	*Cyanide (a contaminant most commonly associated with industrial processes such as gold mining) was reported at concentrations above the laboratory detection limit on single occasions at two groundwater monitoring locations. Concentrations of cyanide have otherwise (and subsequently) been consistently below the detection limited during all other rounds. Note relevant disagreement listed at item 5.31.*

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	5.8	*The EES Appendix A006 has assessed all elements of the project description for activities that may pose a hazard to groundwater and surface water quality, and contaminants of potential concern (COPC) have been identified and assessed throughout the document. Relevant receptors have been identified in line with the protected beneficial uses of groundwater and surface water as established by the State Environment Protection Policy (Waters of Victoria). The main potential impacts of the project have been identified qualitatively (noting that the adequacy of qualitative assessment of potential impacts was not agreed for all risks - refer to item 5.30) and the project-specific risk assessment methodology has been applied. The adopted risk assessment methodology and presentation style of EES Appendix A006 aligns with the commonly accepted practice for Victorian EES. The extent to which this assessment has adequately characterised or quantified risks to all potential receptors was not agreed (see matters of disagreement).*	
	5.9	*The acid sulfate soils assessment presented in the EES is consistent with the minimum requirements of The Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (DSE, 2010), on the basis that the desktop assessment of risk of the presence of acid sulfate soils did not indicate likelihood of presence based on mapping, geomorphology or soil and water indicators, so specific acid sulfate soils testing (Scr or SPOCAS) was not required under the guidelines. However, it was not agreed whether further testing should have been undertaken prior to issuing the EES to further investigate potential acid sulfate soils (see point 5.32*	
	5.10	*Elevated sulfur values that are close to or above 0.03% were recorded for some soil samples analysed, and may indicate potential to generate acid. These reported results correspond with shallow soils (upper ~1 m of soil), and are likely to be oxidised, in which case they would not pose a likely risk of acid generation when disturbed by mining. However, no analyses to confirm that the sulfur is present in an oxidised form were carried out. The most likely areas of risk for potential acid generation would be where perched groundwater exists in the subsurface, if that perched groundwater has been sufficiently stable over geological time to have prevented oxidation, so that the saturated sediment contains sufides. If this saturated overburden material contained >0.03% Scr and was excavated, it might generate acidic runoff. This possibility was not considered in the desktop assessment. If such areas of perched, saturated sediment are encountered during mining, they need to be analysed for Scr, and a spoil management plan will need to be developed if any Scr values are >0.03%.*	
	5.11	*The use of groundwater sourced from the Latrobe Group aquifer may produce different seepage water quality than estimated by the leachability results presented in the EES and as such further leaching studies using this groundwater, as well as further replicates of leaching tests using combinations of river and groundwater samples (using a variety of sediment samples) are required to verify the conclusions reached in the EES and understand the range of water quality compositions that might develop below the mine site.*	
		Assumptions relied upon in reaching agreement	
	5.12	*Assessment of radionuclides was excluded from the scope of the groundwater and surface water impact assessment.*	
	5.13	*The groundwater management plan will include details of groundwater monitoring locations, frequency, methods, and laboratory analytical suite. At the time of the conclave, these had not been developed in detail and could not be reviewed.*	
	5.14	*The National Environment Protection (Assessment of Site Contamination) Measure (1999) (herein referred to as the NEPM) provides guidance on the assessment of contaminated land and principals of assessing pollutant linkages (e.g., source-pathway-receptor models).*	
		Individual comments in respect of agreed fact/opinion	
	5.15	*Hugh Middlemis*	
	5.16	*Joel Georgiou*	
	5.17	*John Sweeney*	
	5.18	*Tony McAlister*	
	5.19	*Matthew Currell*	
	5.20	*John Webb*	

Item No.	Issue		
	5.21	*Julia Jasonsmith*	*I do not consider myself to be in a position to assess whether the information presented in the EES Appendix A006 presents an evaluation of impacts in a way that meets regulatory requirements. I consider that the presentation of information in the EES Appendix A006 is inadequate to accurately constrain the potential risks of environmental harm that may result from the proposed Fingerboards mine, regardless of whether the regulatory requirements outlined in point 5.8 above are otherwise met (see point 5.29, below).*
		Agreed actions:	**Suggested timing:**
	5.22	*Undertake tailings leachate analysis using Latrobe Group Aquifer groundwater*	*Timing not agreed.*
	5.23	*Undertake additional tailings and ore leachate analysis to achieve a higher sample density so that heterogeneity can be assessed and to verify that the adopted seepage water quality is representative.*	*Timing not agreed.*
	5.24	*Future baseline monitoring (completed prior to construction) should include dissolved uranium, thorium, and radium to characterise any potential risk of mobilisation of these elements in groundwater due to the project.*	*As soon as practical to inform more detailed risk assessment and monitoring program design.*
	5.25	*Calculations should be undertaken to quantify the potential effect of recycling process water on the dissolved concentration of metals and salts.*	*Timing not agreed.*
	5.26	*If future drilling or test pit work encounters zones of perched groundwater, soil samples should be collected to assess acid generating potential (including chromium reducible sulfur analysis).*	*Post-EES approval (if approval is granted).*
	5.27	*Spoil management plans should include suitable contingency if acid sulfate soil testing of saturated material encountered during mining above the water table (such as in layers of perched groundwater) demonstrates that acid sulfate soils are present.*	*Post-EES approval (if approval is granted).*
	5.28	*Groundwater and surface water monitoring results, and annual reports should be made available to the public, including through an open access website.*	*Post-EES approval (if approval is granted).*
	Matters of disagreement		
	No.	**Summary of fact/opinion not agreed**	
	5.29	*The EES Appendix A006 does not include an adequately detailed conceptual site model, specifically in relation to the assessment of chemical hazards, potential receptors, and pathways between these hazards and receptors, and there is insufficient detail to allow for robust hazard and risk assessment for certain impacts. Relevant receptors and potential hazards have not been identified in a way that would allow for the potential for harm for the environment to be elucidated.*	

Item No.	Issue		
	5.30	*The elevated concentrations of some chemical constituents (e.g. nutrients and heavy metals), and their status as contaminants of potential concern, in the pre-existing Coongulmerang Formation groundwater was not agreed. Furthermore, the risk posed by these pre-existing solutes on surface water quality and GDEs was not agreed.*	
	5.31	*Further analysis is needed to confirm (or rule out) the presence of cyanide in groundwater in the Coongulmerang Formation groundwater.*	
	5.32	*Additional testing of oxidisable sulfur in the soils which may be disturbed by mining should have been completed to support the EES (noting agreement for testing during construction to support stockpile management at items 5.27)*	
	5.33	*The level of agreement/disagreement is not uniform across the experts as to the optimum timing of the actions 5.22, 5.23, 5.24 and 5.25 should be post-EES approval or as soon as practical, irrespective of the timing of approval decision.*	
6	***Centrifuges***		
	Matters of agreement		
	No.	**Agreed fact/opinion**	
	6.1	*The updated technical note regarding centrifuges is an input to the water balance, with the input parameters having uncertainty analysis applied to them at a mine scale water balance.*	
	6.2	*With the exception of Julia Jasonsmith, the chemical composition of flocculants and the toxicity of biodegradation by-product degradation was generally not within the field of expertise of the other expert witnesses. The comments presented by Julia Jasonsmith were not disputed and are listed as individual comments*	
	6.3	*Stockpiled fine tailings, if not appropriately managed, would represent a hazard to the undisturbed downstream catchment.*	
		Assumptions relied upon in reaching agreement	
	6.4		
		Individual comments in respect of agreed fact/opinion	
	6.5	*Hugh Middlemis*	
	6.6	*Joel Georgiou*	
	6.7	*John Sweeney*	
	6.8	*Tony McAlister*	
	6.9	*Matthew Currell*	
	6.10	*John Webb*	
	6.11	*Julia Jasonsmith*	
		Agreed actions:	**Suggested timing:**
	6.12	*Further study needed on the breakdown products of the nominated flocculant to confirm risks posed to the aquatic ecosystem of the Mitchell River. Depending on the results of this assessment, this may result in the need for laboratory trials or other risk assessment.*	*Post-EES approval*
	6.13	*If nitrate is confirmed as likely to be generated as a flocculant biodegradation by-product, contaminant fate and transport modelling and a contaminant mass balance may be required to*	*Post EES approval*

Item No.	Issue		
		consider the potential for an added nutrient load to the Gippsland Lakes (via groundwater discharge to the Mitchell River)	
	Matters of disagreement		
	No.	**Summary of fact/opinion not agreed**	

Prepared jointly by:

John Sweeney

30/04/2021

Joel Georgiou

30/04/2021

Hugh Middlemis

30/04/2021

Tony McAlister

30/04/2021

Julia Jasonsmith

30/04/2021

Matthew Currell

30/04/2021

John Webb

30/04/2021