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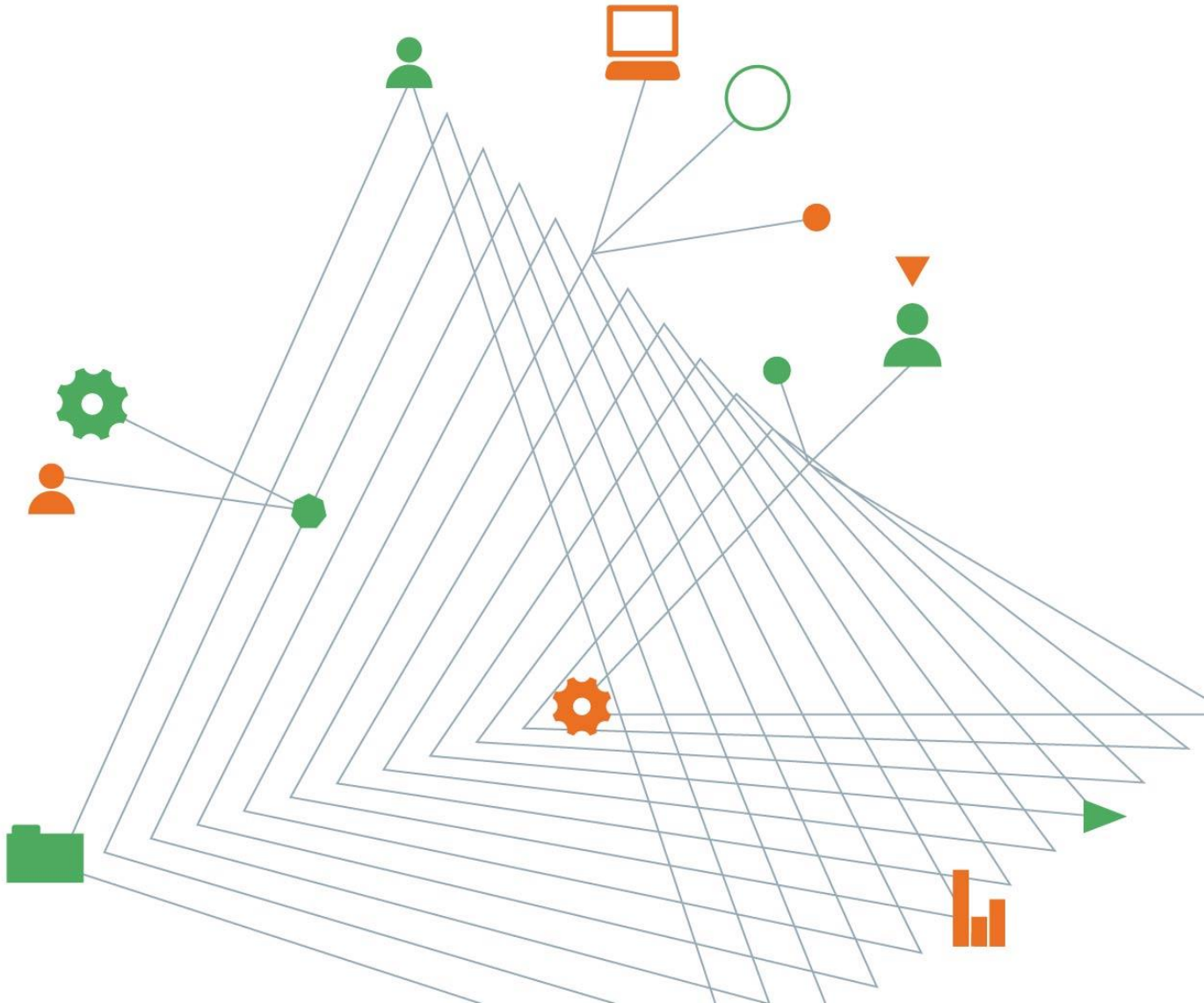


John Sweeney

Fingerboards Mineral Sands Project IAC hearings

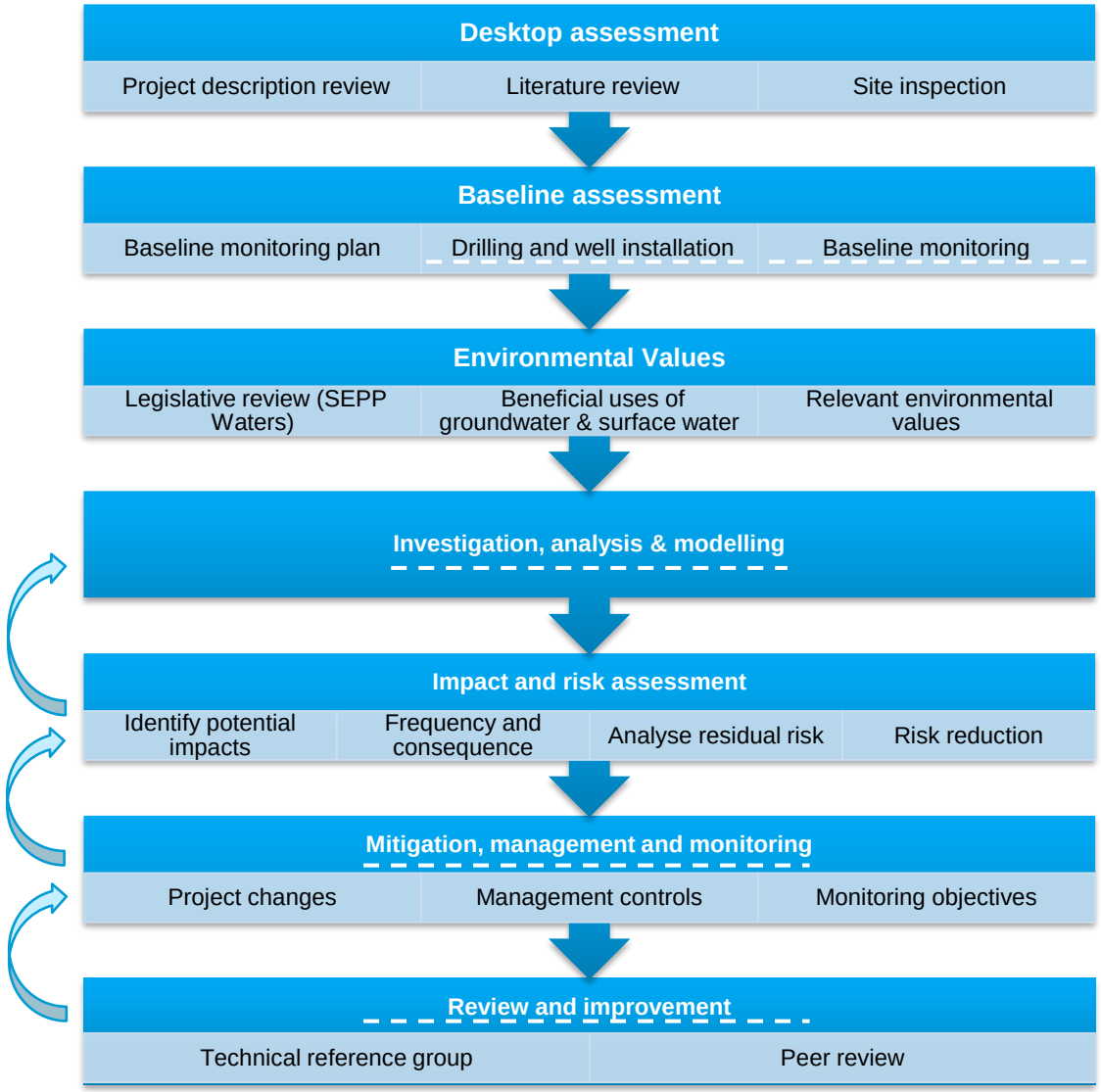
Contents

01
Scope of work

Scope of work

Overview

- Co-author of Appendix A006 – Groundwater and Surface Water Impact Assessment
  - Establish baseline conditions
  - Summarise work by specialists
  - Assess project impacts to groundwater and surface water



02
Overview of key findings

Baseline assessment

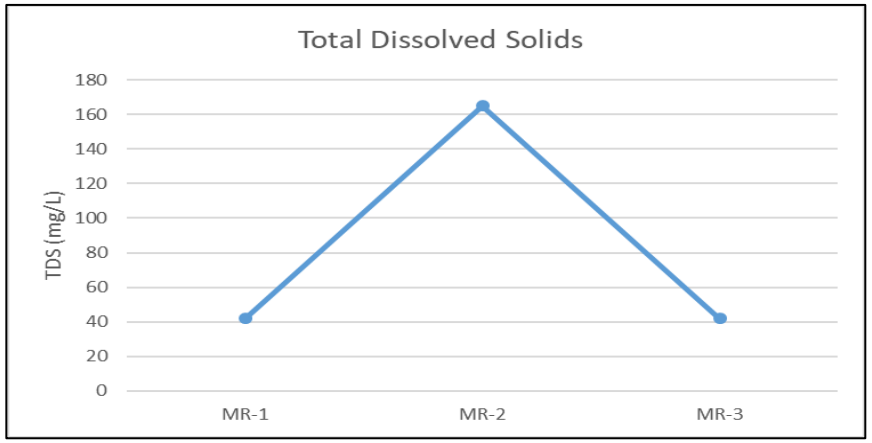
Surface water

Project area

- Ephemeral creeks draining project area
  - 3 flow events recorded/sampled between 2018 and 2020
  - Routine monitoring of water-filled ponds
- Onsite water quality
  - Salinity: 100 to 1,800 mg/L TDS
  - pH: 5.5 to 7
  - Variable but high sediment load
  - Some metals above ecological WQO (aluminium, copper, chromium, manganese)
  - E.Coli, nitrate, ammonia, phosphorus – all locations

Mitchell River

- Water quality
  - Salinity: 25 mg/L to 110 mg/L TDS
  - pH: neutral 6 to 7.5
  - Metals: aluminium > ecosystem WQO
- Flow events:
  - Spikes in TDS and turbidity



A006, Figure 4.5: Mitchell River TDS during 21 January 2020 flow event

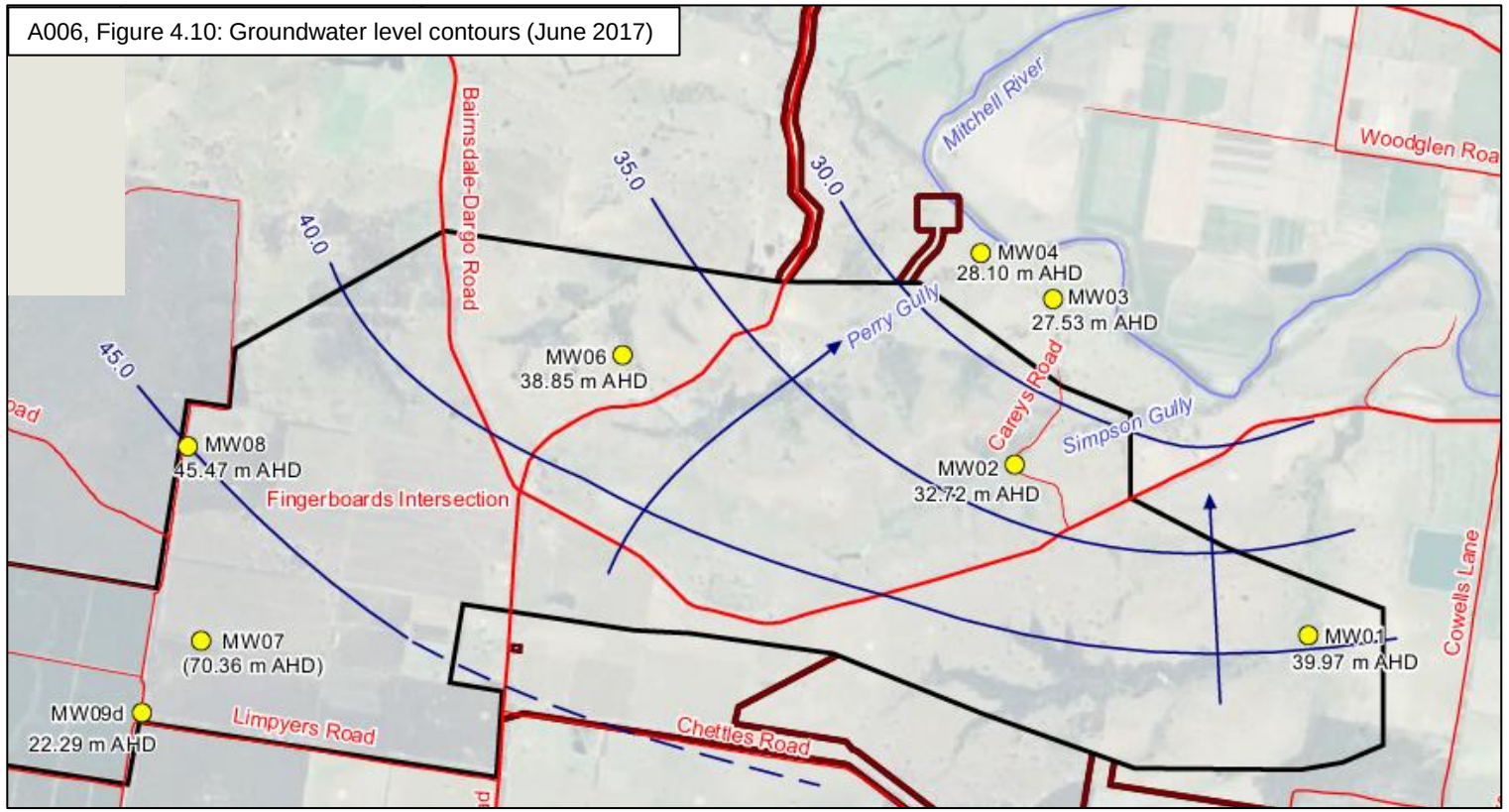
Baseline assessment
Groundwater

Coongulmerang formation

- Unconfined watertable 40 - 60 m bgs
  - Below base of target ore
  - Flow towards Mitchell River
- Low hydraulic conductivity
- Variable salinity: fresh (125 mg/L TDS) to more saline (2,700 mg/L TDS)
- Some metals in groundwater exceed screening criteria (aluminium, arsenic, cadmium, chromium, copper, iron, manganese, nickel and zinc)
- Existing anthropogenic contamination (nitrate, phosphorus, E. Coli) indicative of impact from agricultural practices.

Latrobe Group aquifer

- Salinity: ~500 mg/L TDS
- No exceedance of WQOs except phosphorus and nitrogen



Impact assessment

Environmental values of water

- Environmental values derived from beneficial uses in SEPP (Waters)
- Largely consistent with new proposed Environmental Reference Standards

A006, Table 3-12: Likelihood of beneficial uses of surface water to be realised

Beneficial Uses of Surface Water	Project Area	Study Area		
	Ephemeral gullies	Mitchell River	Perry & Avon River, Providence Ponds	Gippsland Lakes
Water dependent ecosystem and species	✓	✓	✓	✓
Human consumption after treatment	X	✓	-	-
Agriculture and irrigation	X	✓	✓	✓
Human consumption of aquatic foods	X	✓	✓	✓
Aquaculture	X	X	✓	✓
Industrial and commercial	X	✓	✓	-
Water-based recreation	X	✓	✓	✓
Aesthetic enjoyment	✓	✓	✓	✓
Traditional owner cultural values	✓	✓	✓	✓
Cultural and spiritual values	✓	✓	✓	✓

A006, Table 3-8: Summary of beneficial uses considered to apply to groundwater

Beneficial Uses of Groundwater	PROJECT AREA	STUDY AREA
	Coongulmerang Formation	Latrobe Group aquifer Mitchell River alluvium
Water dependent ecosystems and species	✓	✓
Potable water supply	✓	✓
Agriculture and irrigation	✓	✓
Industrial and commercial	✓	✓
Water based recreation	✓	✓
Traditional Owner cultural values	✓	✓
Cultural and spiritual values	✓	✓
Buildings and structures	✓	✓
Geothermal properties	✓	✓

Impact assessment

Impact assessment process

Hazard identification

- Review of all project activities to identify potential impacts
- Potential impacts assessed:
  - 29 potential groundwater impacts
  - 24 potential surface water impacts
- Negligible impacts identified, managed by SOPs

Investigation, analysis, modelling

- Completed by various specialists

Risk evaluation

- Apply consistent risk evaluation methodology

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Negligible	Very low	Very low	Very low	Low	Moderate
	Minor	Very low	Low	Low	Moderate	Moderate
	Moderate	Low	Low	Moderate	High	High
	Major	Low	Moderate	High	Major	Major
	Extreme	Moderate	High	Major	Major	Major

Descriptor	Description
Likelihood	
Almost certain	A hazard, event and pathway exists, and harm has occurred in similar environments and circumstances elsewhere, and is expected to occur more than once over the duration of the project activity, project phase or project life.
Likely	A hazard, event and pathway exists, and harm has occurred in similar environments and circumstances elsewhere, and is likely to occur at least once over the duration of the project activity, project phase or project life.
Possible	A hazard, event and pathway exists, and harm has occurred in similar environments and circumstances elsewhere, and may occur over the duration of the project activity, project phase or project life.
Unlikely	A hazard, event and pathway exists, and harm has occurred in similar environments and circumstances elsewhere, but is unlikely to occur over the duration of the project activity, project phase or project life.
Rare	A hazard, event and pathway is theoretically possible on this project, has occurred once elsewhere but not anticipated over the duration of the project activity, project phase or project life.
Consequence	
Negligible	A temporary or short-term localised impact that will resolve itself in the short-term without intervention.
Minor	A temporary or short-term localised impact that can be effectively managed with standard management measures.
Moderate	A short to medium term impact that extends beyond the area of disturbance to the surrounding area. Specific management measures may be required to effectively manage the impact.
Major	A medium to long term impact that is widespread. Specific management measures are required to effectively manage the impact.
Extreme	A long term, widespread and potentially irreversible impact. Design modification is required to eliminate the impact or specific management measures are required to reduce the likelihood of occurrence of the impact.

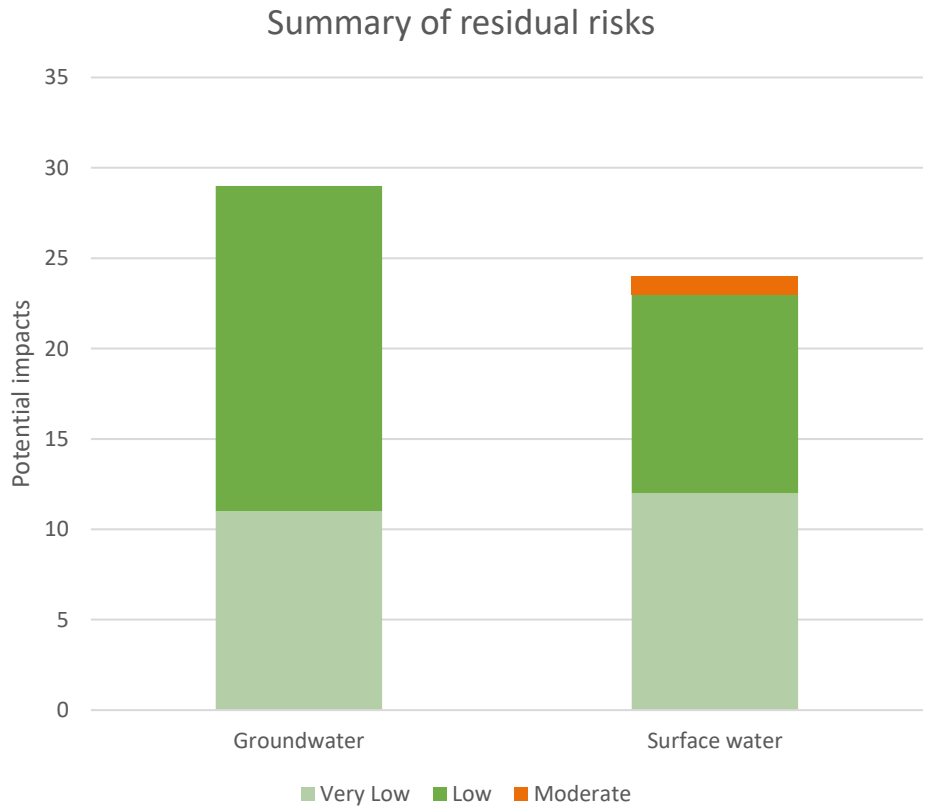
(A006, Tables 2.1 and 2.2)

Impact assessment

Summary of impacts

Residual risks

- Groundwater: 29 potential impacts - 11 very low, 18 low
- Surface water: 24 potential impacts – 12 very low, 11 low, 1 moderate
  - Moderate residual risk for TSF failure (obsolete)
- Continual improvement over time



03
Issues raised in submissions

Issues raised in submissions

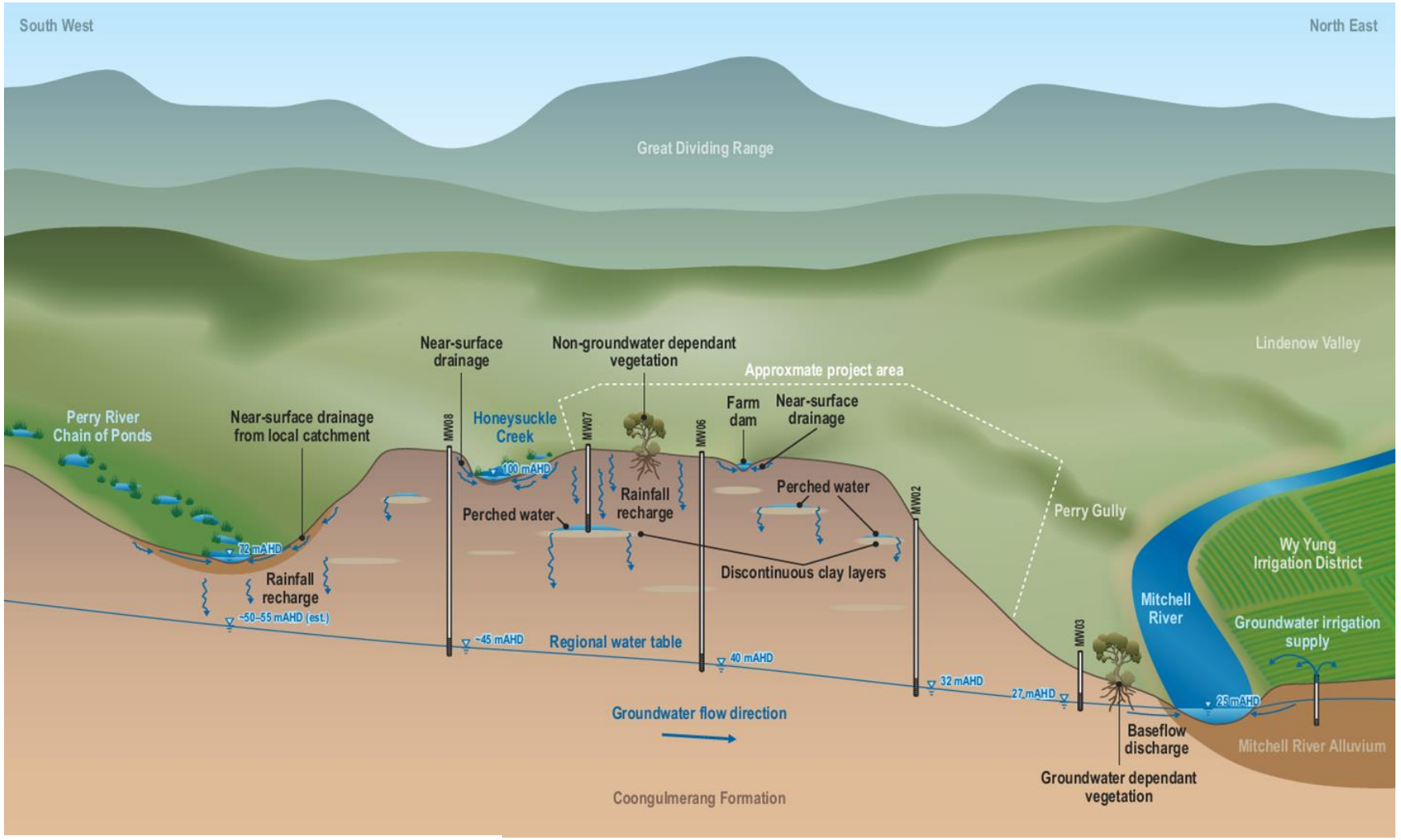
Groundwater conceptualisation

Confusion regarding groundwater occurrence

- Regional groundwater
- Perched water:
  - perched groundwater
  - near surface drainage

Spring fed dams

- Locations of dams unconfirmed
- Dams significantly (~40 m) above watertable.
- Unlikely to pose a risk of impact to farm dams outside the project boundary.



Expert witness statement of John Sweeney, Figure 1.

Issues raised in submissions

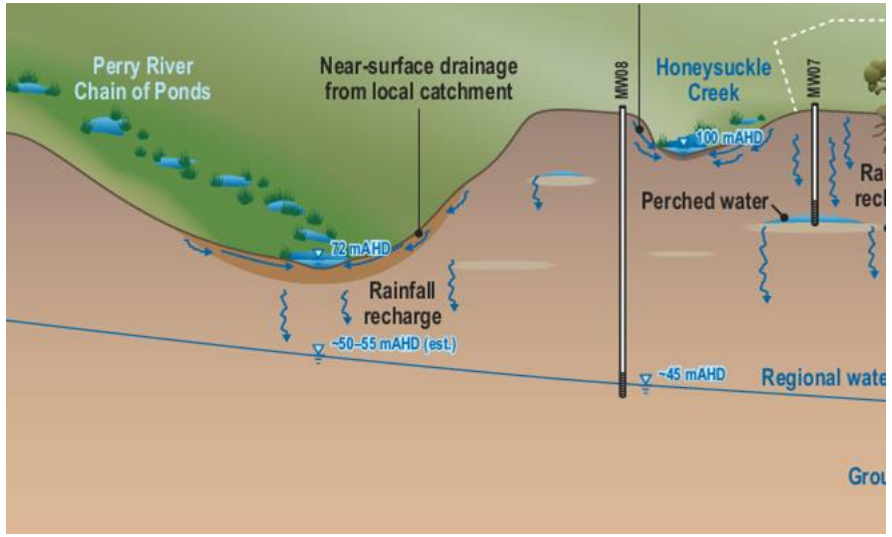
Groundwater conceptualisation

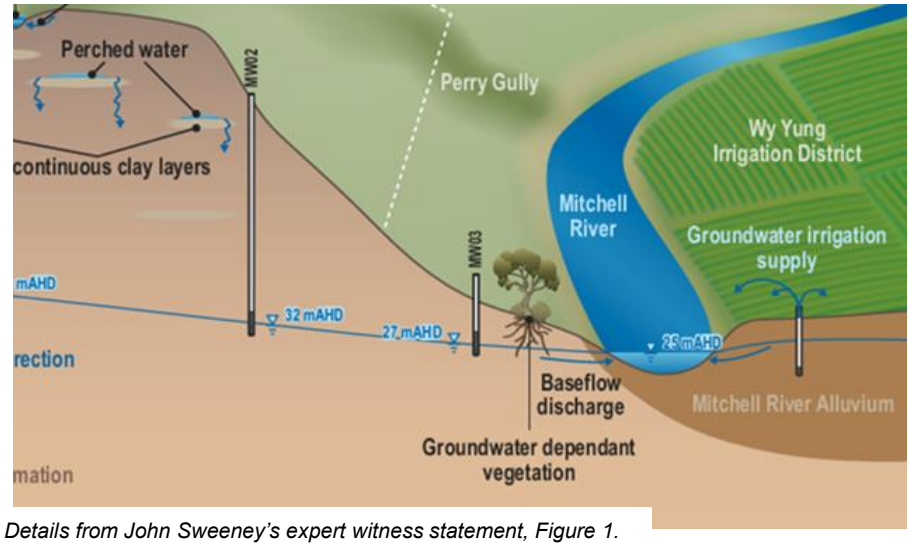
Lack of data to support Perry River conceptualisation

- Multiple lines of evidence support conceptualisation:
  - Groundwater level monitoring onsite
  - Modelling of pre-mining conditions
  - Exploration drilling – water strike ~20 m bgs
  - Absence of permanent flow
- Viable impact pathway does not exist
- Risk-based assessment - further investigation not warranted

Uncertainty regarding groundwater discharge pathway from the mine site towards the Mitchell River.

- Sufficient data to support conceptualisation
- Uncertainty does not prevent risk assessment
  - managed by monitoring and adaptive management





Details from John Sweeney's expert witness statement, Figure 1.

Issues raised in submissions

Baseline conditions

Radiation, uranium, thorium not addressed by baseline assessment

- Radionuclides in Appendix A011 of the EES
- Uranium and thorium assessed by Kalbar and EGI:
  - Little or no enrichment in tailings – exported with mineral concentrate
  - Low leachable concentrations from tailings
  - Dissolved concentrations in process water <LOR
- Low risk posed by uranium and thorium
- Agree future baseline monitoring

Presence of cyanide in groundwater

- Single occurrences of cyanide at two locations
- No likely sources (mining, manufacturing)
- Not of material concern to the EES

Summary of cyanide results (mg/L) in groundwater (Table A1 of A006)

DATE	MW01	MW07
22-Jun-17	<0.004	<0.004
04-Jun-19	<0.004	<0.004
16-Jul-19	<0.004	<0.004
18-Sep-19	<0.004	**0.012**
02-Dec-19	<0.004	<0.004
31-Mar-20	**0.006**	<0.004

Issues raised in submissions

Water supply

Winter-fill allocation will compete with other users

- Kalbar's winter-fill licence trigger: 1,400 ML/day (1st July – 31st October)
  - Year-round users / irrigators: 185 ML/day
  - Woodglen ASR: 600 ML/day
- Licence inherently protective of other users
- Competes with other winter-fill users
  - 16 reduced days during past 10 year record (0.53%)

Groundwater is fully allocated

- Correct – Latrobe Group aquifer fully allocated
- Purchase temporary or permanent allocations from existing users
- Requires licence from SRW
- No shallow aquifers have been considered by the EES

Uncertainty associated with droughts and climate change

- Uncertainty recognised
- EES considers impacts of two options:
  - 3 GL winter-fill Mitchell River
  - 3 GL groundwater Latrobe Group (0.6 GL/y in 90% of years)
- If water supply is restricted, mining operations will scale down
- Only project risks – no added environmental risk

Issues raised in submissions

Tailings seepage – quality impacts

Tailings seepage will cause contamination of groundwater

- Tailings seepage quality:
  - Aluminium and copper slightly above freshwater ecosystem criteria
  - Below background concentrations in groundwater
- 10t composite sample – representative of first 7 years.

Recycling of process water may concentrate solutes

- Agree – centrifuges will improve recovery
- Likely low risk:
  - Dissolved metals from single leach <LOR
  - Dilution with 3GL water per year
- Agree – further assessment to verify

Flocculants may impact groundwater quality

- Centrifuges will increase the use of PAM flocculant
- Advice provided by Wave International:
  - PAM mostly immobilised in subsurface
  - UV degradation may produce nitrogen compounds
- Agree further work to understand mobility & mass flux of nutrients to Mitchell River and Gippsland Lakes

Adequacy of acid sulfate soil assessment

- Acid sulfate soil risk assessment by EGi:
  - desktop study and review of available sulfur content
- Consistent with *The Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils*
- Groundwater expert meeting:
  - Spoil management plans to include ASS testing of saturated material if encountered to guide appropriate management.

Summary of sulfur content of site materials (A006 Table 7-8)

Geological unit / material type	%S
Topsoil (0 to 0.2 m)	0.019
Subsoil (0.2 to 0.5 m)	**0.042**
Sandy Clay Horizon (0.5 to 3.4 m)	0.012
Sandy Gravel (3.4 to 8.6 m)	0.011
Sand (8.6 to 9 m)	0.009
Upper Sand (14.7 to 23.8 m)	0.009
10 tonne Bulk Sample - Ore	0.028
10 tonne Bulk Sample - Fine Tailings	0.01
10 tonne Bulk Sample - Coarse Tailings	<0.01
10 tonne Bulk Sample - Heavy Mineral Con.	<0.01

Issues raised in submissions

Surface water

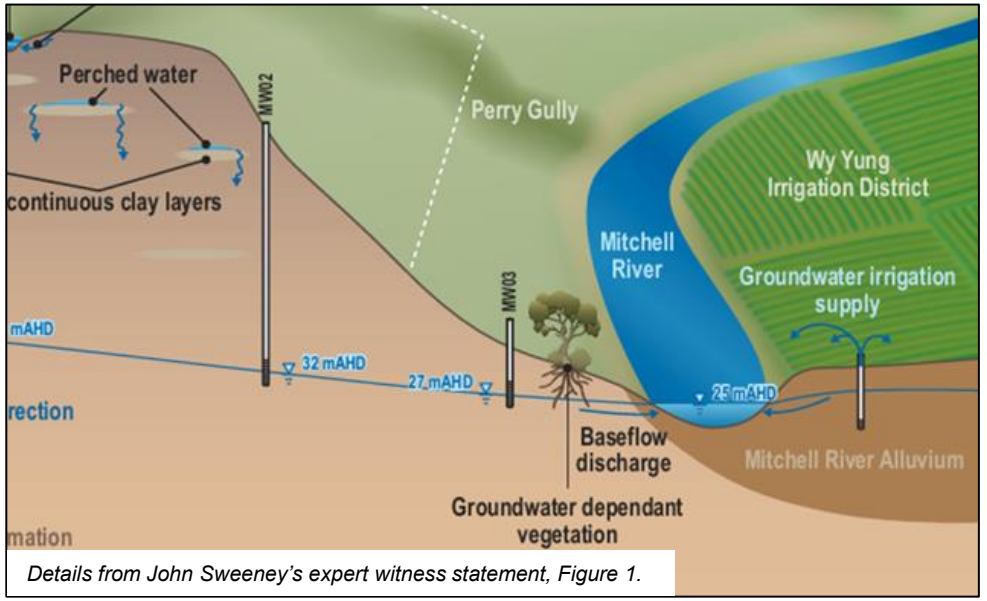
Concern regarding water management dam release

- Mine contact water
  - TSS, aluminium, chromium, copper above natural runoff and ecosystem WQO
- Mitchell River:
  - Release frequency 3.4% AEP
  - Modelling shows no increase above Mitchell River background or Ecosystem WQOs
  - No increase load of total phosphorus or total nitrogen
  - Slight increase in sediment load in some years

    (2.5 x 10^{-10} mm/year = negligible impact)
- Perry River
  - Release frequency 0.9% AEP
  - Modelling shows downstream quality consistent with natural runoff (above ecosystem WQOs)

Increased baseflow discharge to Mitchell River

- Potential for increased discharge of salts/metals/nutrients from groundwater
  - 0.73 ML/day increased baseflow
  - 1-2% increased flow volume (conservative)
  - Basic mass balance: TDS from 52 mg/L to 66 mg/L
- Further work to quantify effect on TDS, nutrients and selected metals



Details from John Sweeney's expert witness statement, Figure 1.

04
Summary of future work

Summary of future work

- Existing work is sufficiently robust to support the EES
- Further work agreed to support continual improvement

Additional work

- Additional pumping test.
- Unsaturated zone modelling (SEEP-W) to inform seepage rates.
- Quantify effect increased baseflow on Mitchell River water quality.
- Leachate analysis using Latrobe Group groundwater.
- Quantify effects of recycling on process water quality.
- Flocculant quality and mobility assessment.

Adaptive management

- Monitoring the escarpment (north and east of the mine area) for seepage.
- Seepage estimates and groundwater monitoring to inform the post-mining monitoring period.
- Expanded groundwater monitoring network.
- Model refinement.
- GDE monitoring and management plan: including Chain of Ponds.
- Spoil management plan: including ASS assessment for saturate soils.
- Public reporting of monitoring data and annual reports.