Bowdens Proposal: Hydrogeology

IPC 15 Feb 2023

Lue Action Group

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Presentation Objectives

- Encourage leading practice to enable sustainable resources development
  - Create a 2023 industry ‘roadmap’ by requiring application of the latest risk management and water resources management
- Clearly demonstrate the link between the environment and human health
  - Develop a robust model between (ground)water quality, significant species and people
  - Bring evidence, policy and practical solutions to address biodiversity loss and climate change
  - Adopt a collaborative partnership in NSW to showcase a behavioural change
- Ensure any proposal aligns with 2022 WaterNSW strategy and principles for sustainable development

Content: Key groundwater concerns

1. An unclear definition of groundwater users is influencing risk conceptualisation and conclusions
    1. Significant or unique endemic species in groundwater dependent ecosystems are not presented
    2. Neither licensed nor unregistered bore users have an activity-pathway-likelihood-consequence risk assessment
    3. Lack of hydrogeological investigations between the Lue village and the site
2. Conceptualisation of acid mine drainage
    1. Inconsistent groundwater flow direction
    2. Lack of clarity around containment of Waste Rock Emplacement and cyanide leachate
3. Lack of a formal risk assessment
    1. Long term / indefinite 'Take' from (ground)water resources through evaporation
    2. Insufficient data for Trigger Action Response Plan or Water Management Plan

1. Unclear definition of groundwater users is influencing risk conceptualisation and analysis

1.1 Risks to licensed bore users

1. Groundwater yield is “highly productive” and thus protected by the AIP
2. Regional groundwater quality is likely potable
   (details in LAG Attachment 3, Planning Portal)
3. Bowdens has insufficient water supply approvals
   a. Groundwater: No guarantee of Water NSW/NRAR approval of an extraction borefield even if sufficient water allocation licences are obtained DPIE (2018)

1. Unclear definition of groundwater users is influencing risk conceptualisation and analysis

1.2 Risks to listed species in groundwater dependent ecosystems

1. Creeks and surrounding alluvium aquifers can support significant aquatic species
2. No evidence of investigations targeting endemic aquatic species in local springs, nor the nature of their groundwater dependence
3. Under-utilised hydrogeological information:
   - The conceptual model appears to be based on a literature review rather than site data
   - No evidence of significant hydraulic barriers laterally or vertically around the site
   - R.W Corkery & Co. (2021) state that the objective of the numerical groundwater simulation model was **not** to consider contamination of local springs nor dependent ecosystem health

> 'no water quality impacts beyond 40 m from the Mine Site boundary and no changes to the beneficial uses of aquifers are predicted'

RW. Corkery & Co. Appendix 9 p. A9-6 Mar 22

40 m in Context: potential to alter regional hydrology

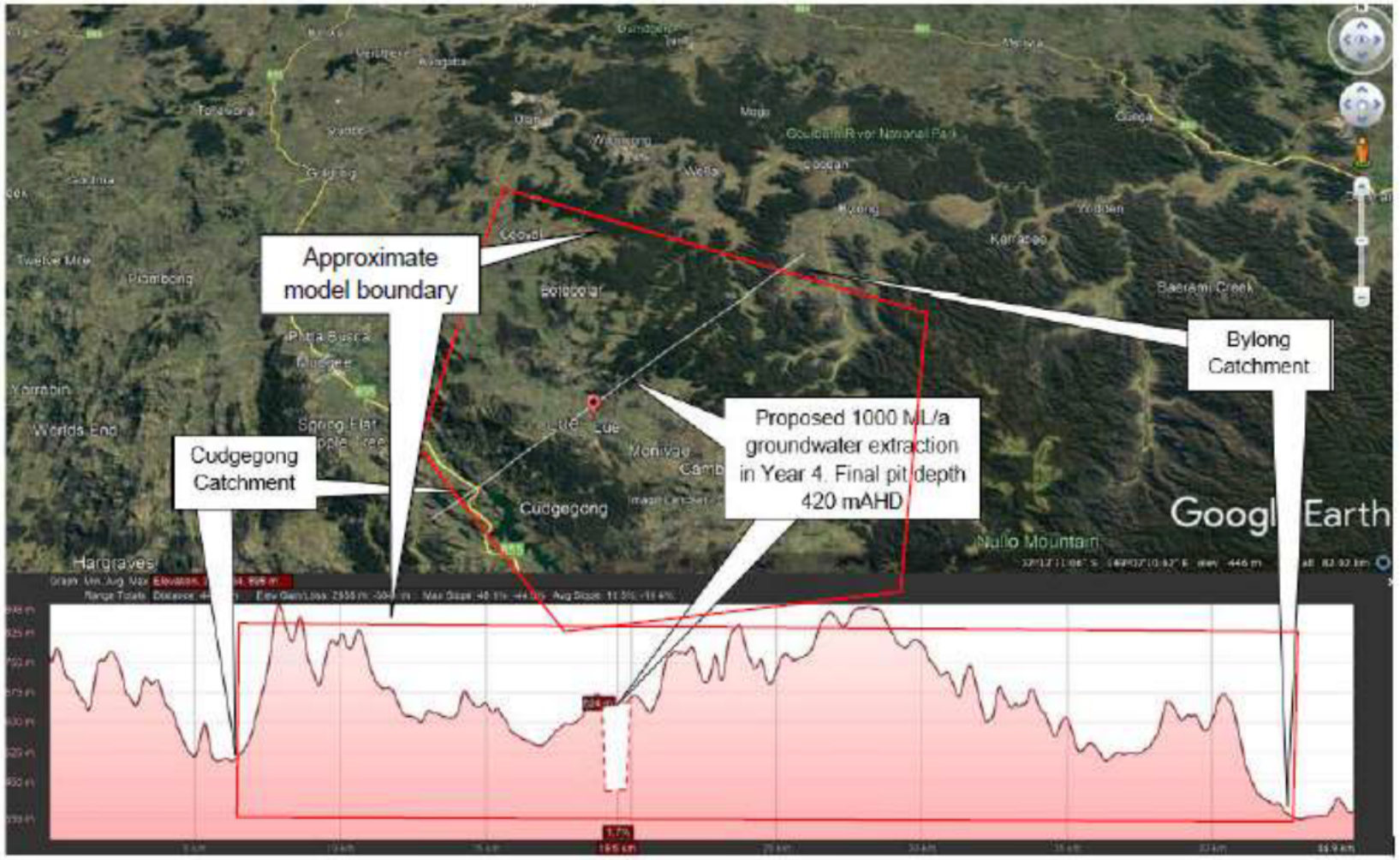
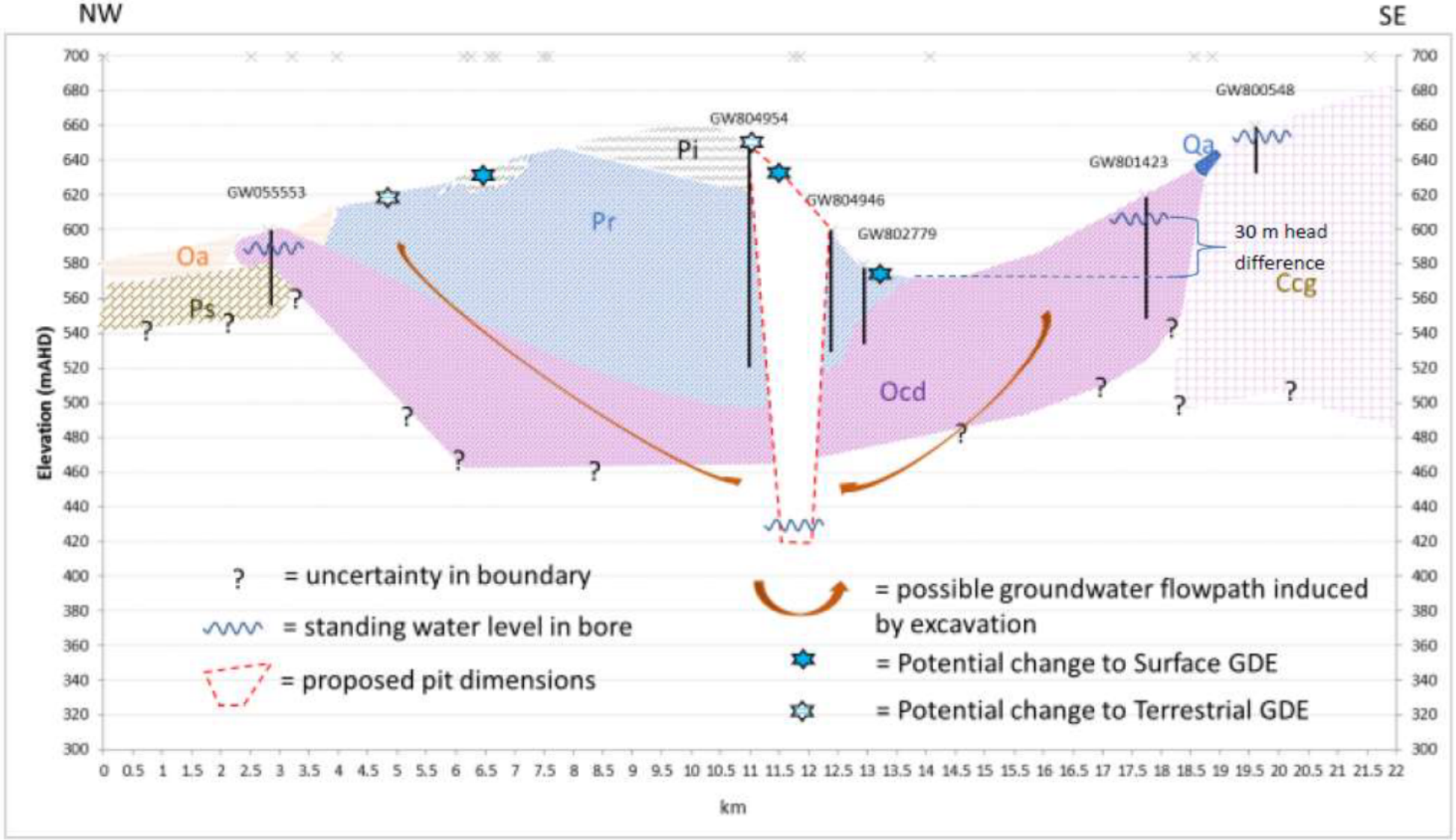


Figure 3: SW-NE Cross Section Source: GoogleEarth 2022

NW-SE Section during proposed dewatering – showing potential GDEs



Source: LAG report by Australian Water Environments (2018) indicating water salinity and regional impact

1. Unclear definition of groundwater users is influencing risk conceptualisation and analysis

1.3 Lack of hydrogeological data between the Lue village and the site

1. R.W. Corkery & Co. A4 (Feb 2022): enhanced permeability within fractured rock aquifers near major geological structures
2. Aquifer Interference Policy
    1. AIP 14: there is potential for causing and enhancing hydraulic connections that has not been clearly presented.
    2. AIP Table 4: potential unquantified water quality impacts on nearby licensed groundwater users

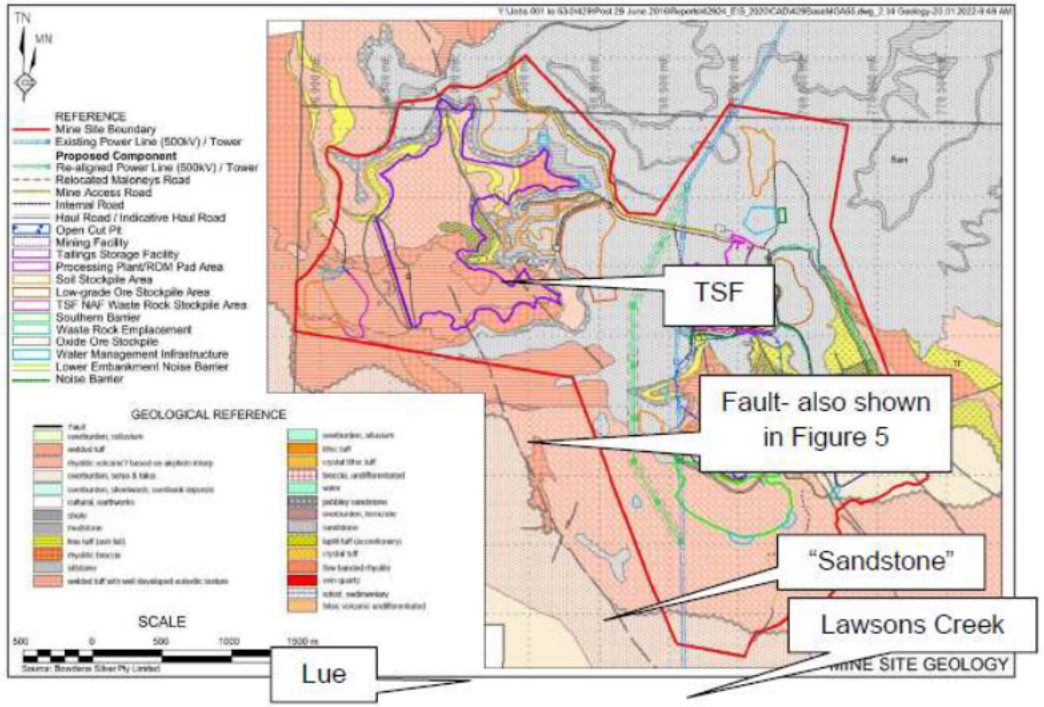


Figure 4: Site Geology, adapted from (R.W. Corkery & Co., March 2022c, pp. 2-10)

2. Conceptualisation of acid mine drainage

2.1 Inconsistent groundwater flow direction

1. The post mining groundwater flows are **unlikely** to be towards the pit (R.W.Corkery & Co. Dec 2022 & HydroGeoLogic Dec 2022)

2. Significant and unexplained alterations to model Layer 1 and 2 were made around the TSF in 2022 (HydroGeoLogic 2022)

2020 Numerical Simulation Modelling

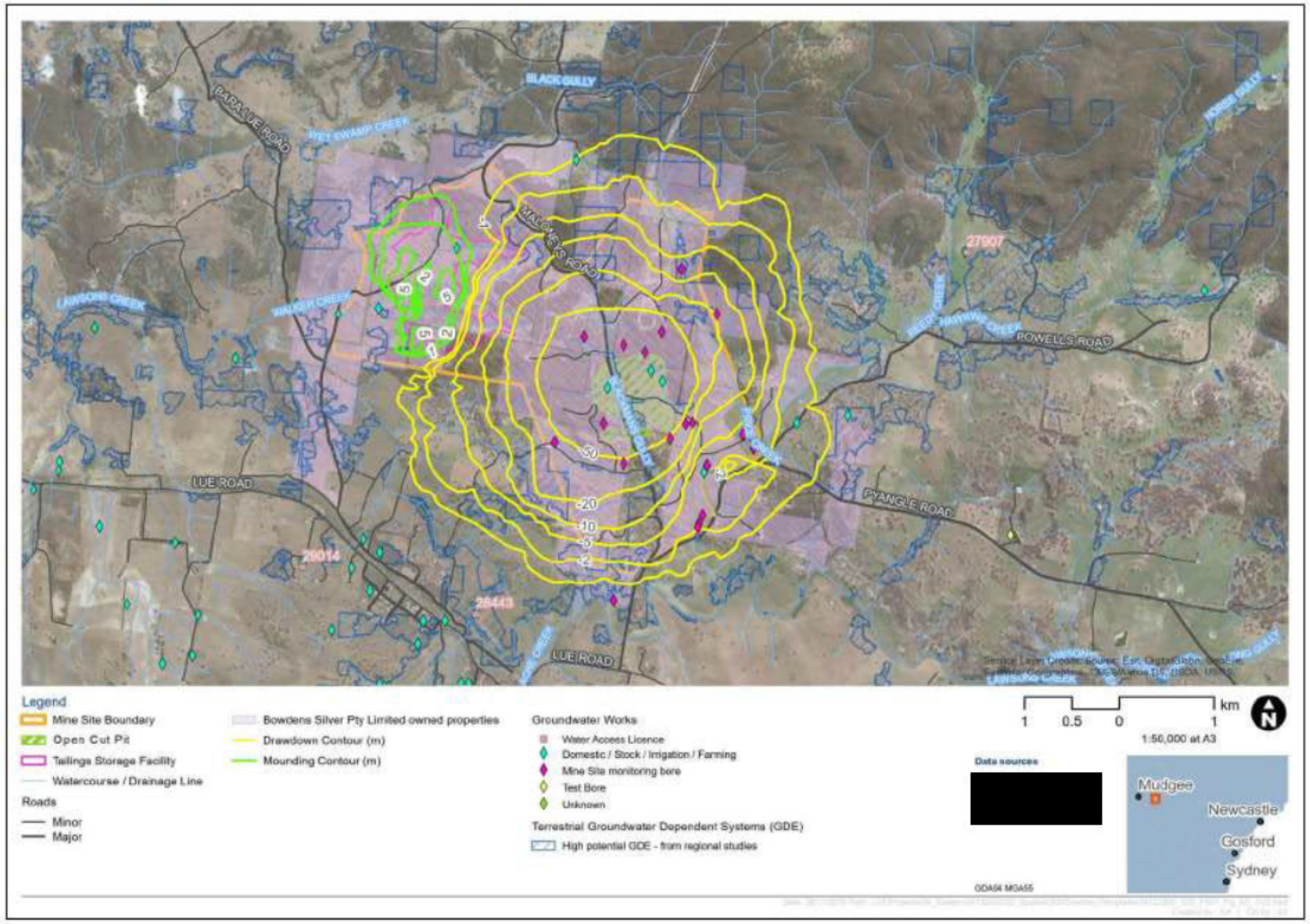


Figure 35 Predicted Drawdown at End of Mining (Year 15.5)

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Source: (R. W. Corkery & Co., March 2021, p. 5-333)

Hydrogeological Model Relayering for 2022

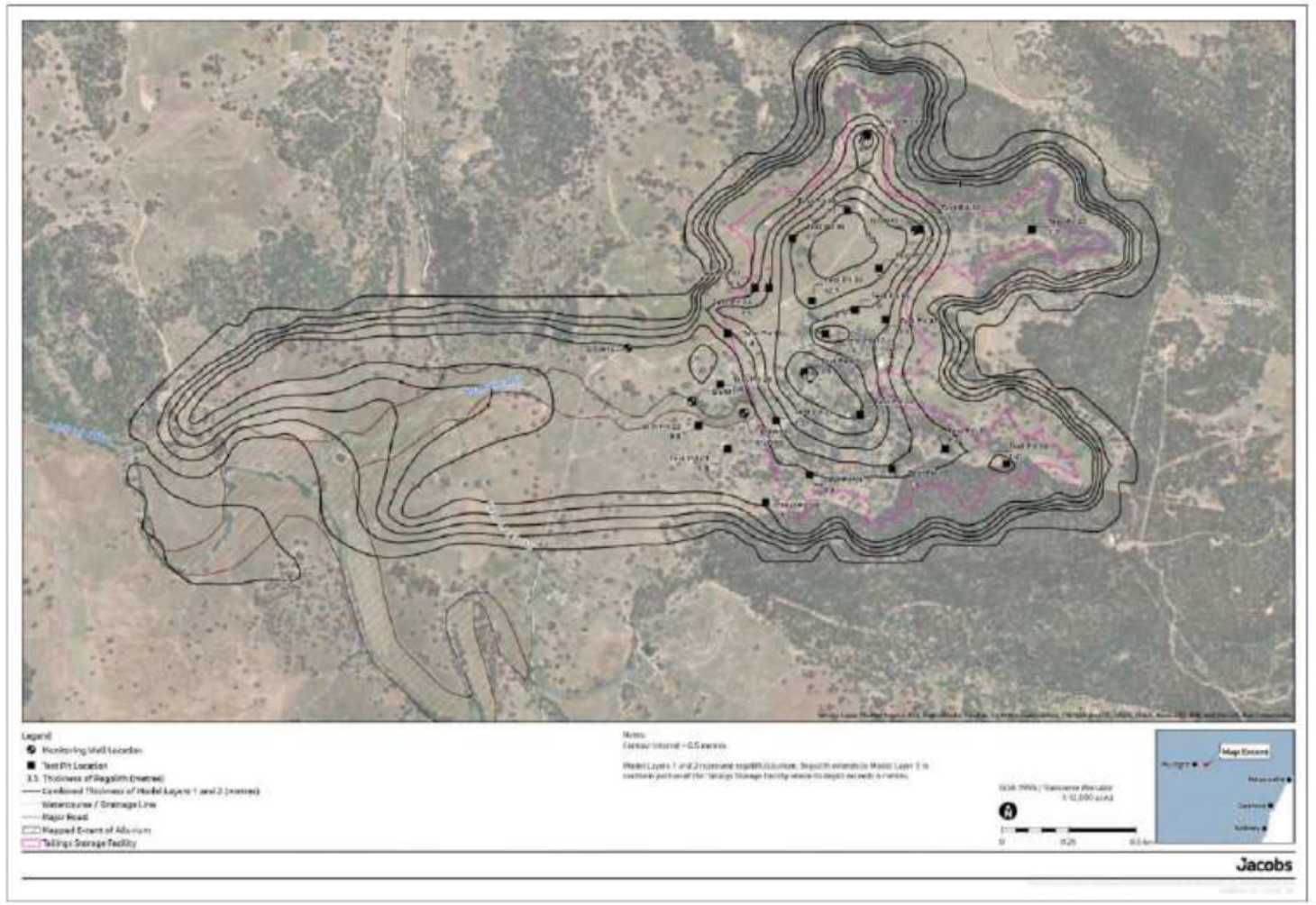
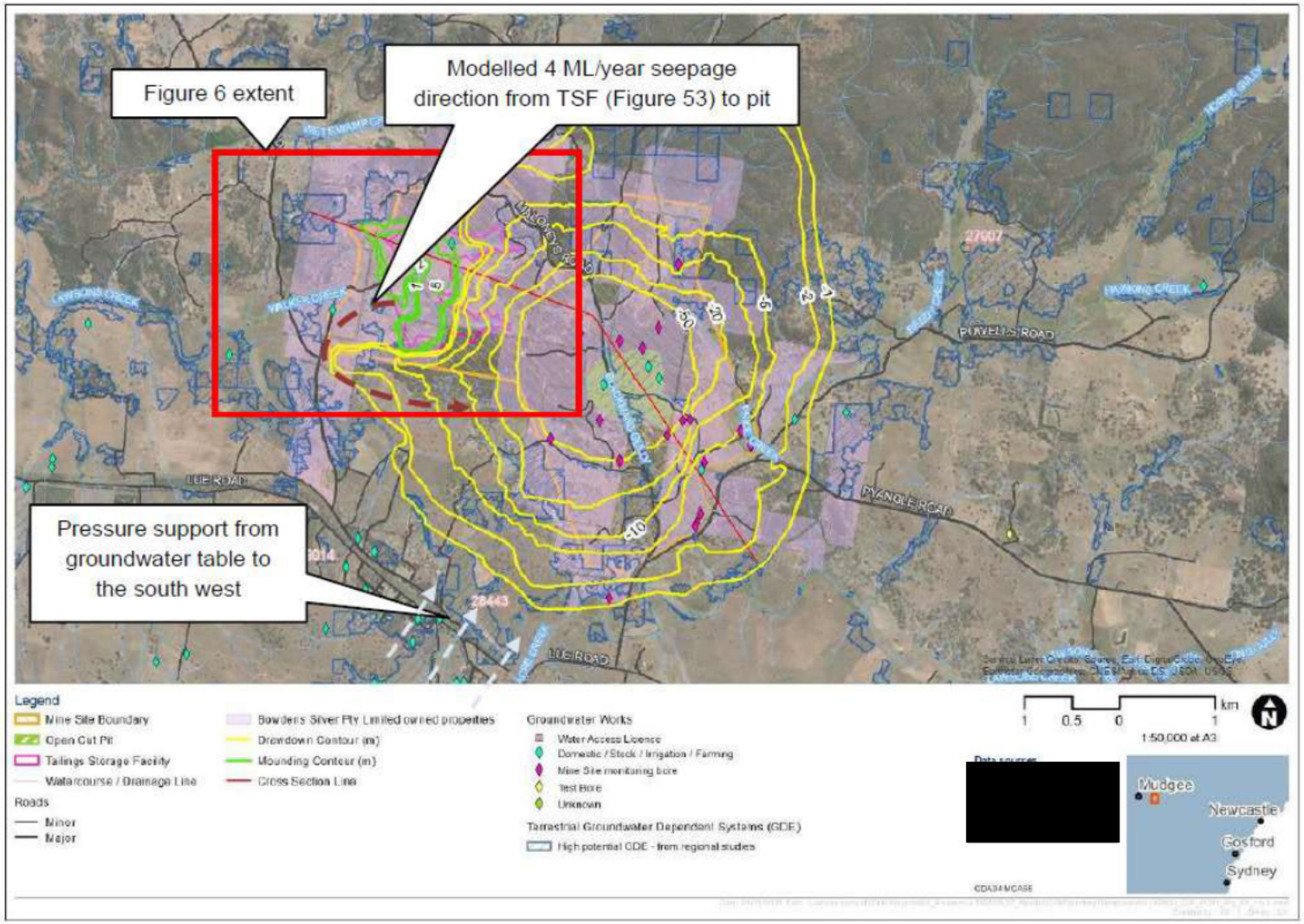


Figure 6: Modelled thickness of combined Layers 1 and 2 (R. W. Corkery & Co., 2022d, pp. 5-397)

2022 Numerical Simulation Modelling



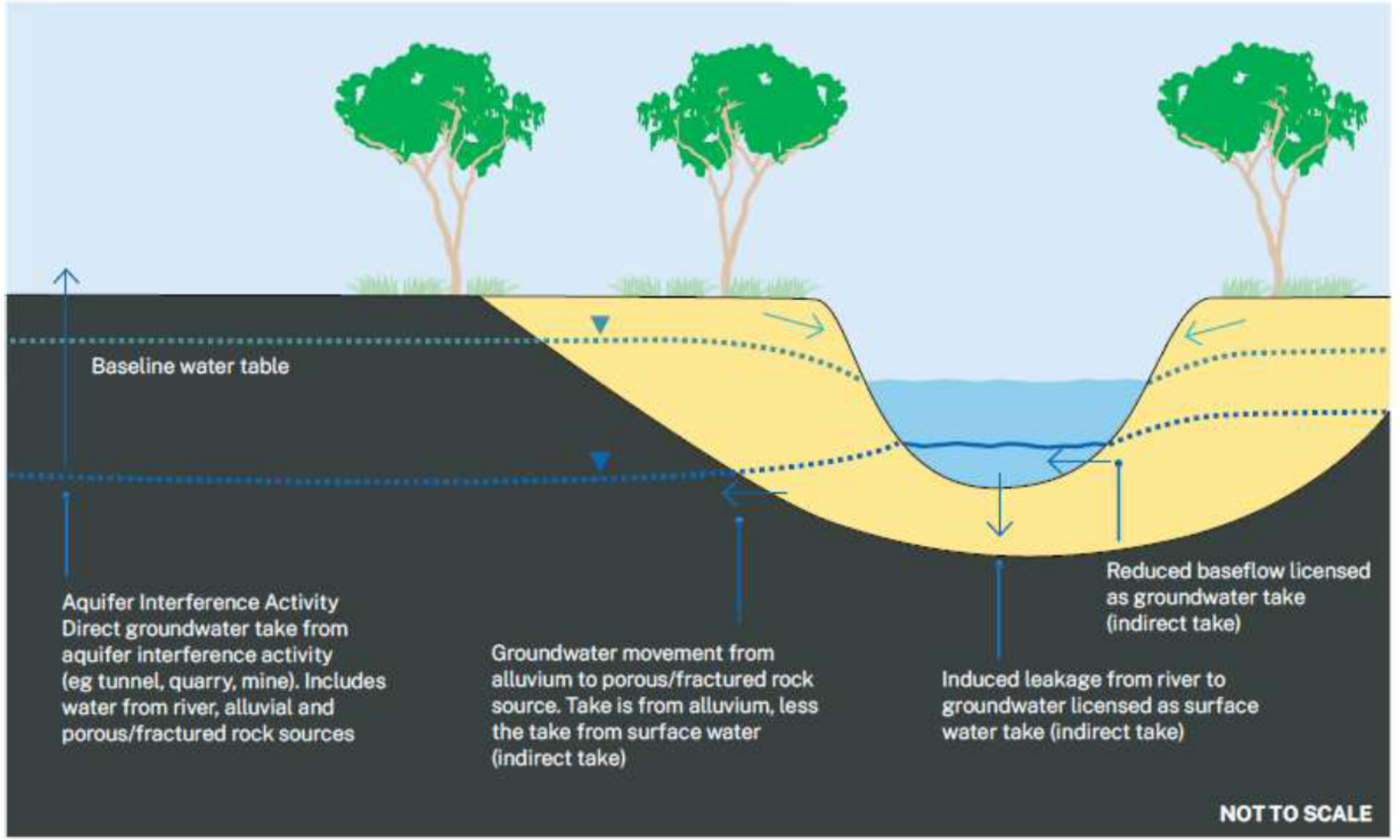
Source: Modified Figure 45 from R. W. Corkery & Co. 2022, p. 5-127

2. Conceptualisation of acid mine drainage

2.2 Lack of clarity around containment of Waste Rock Emplacement and cyanide

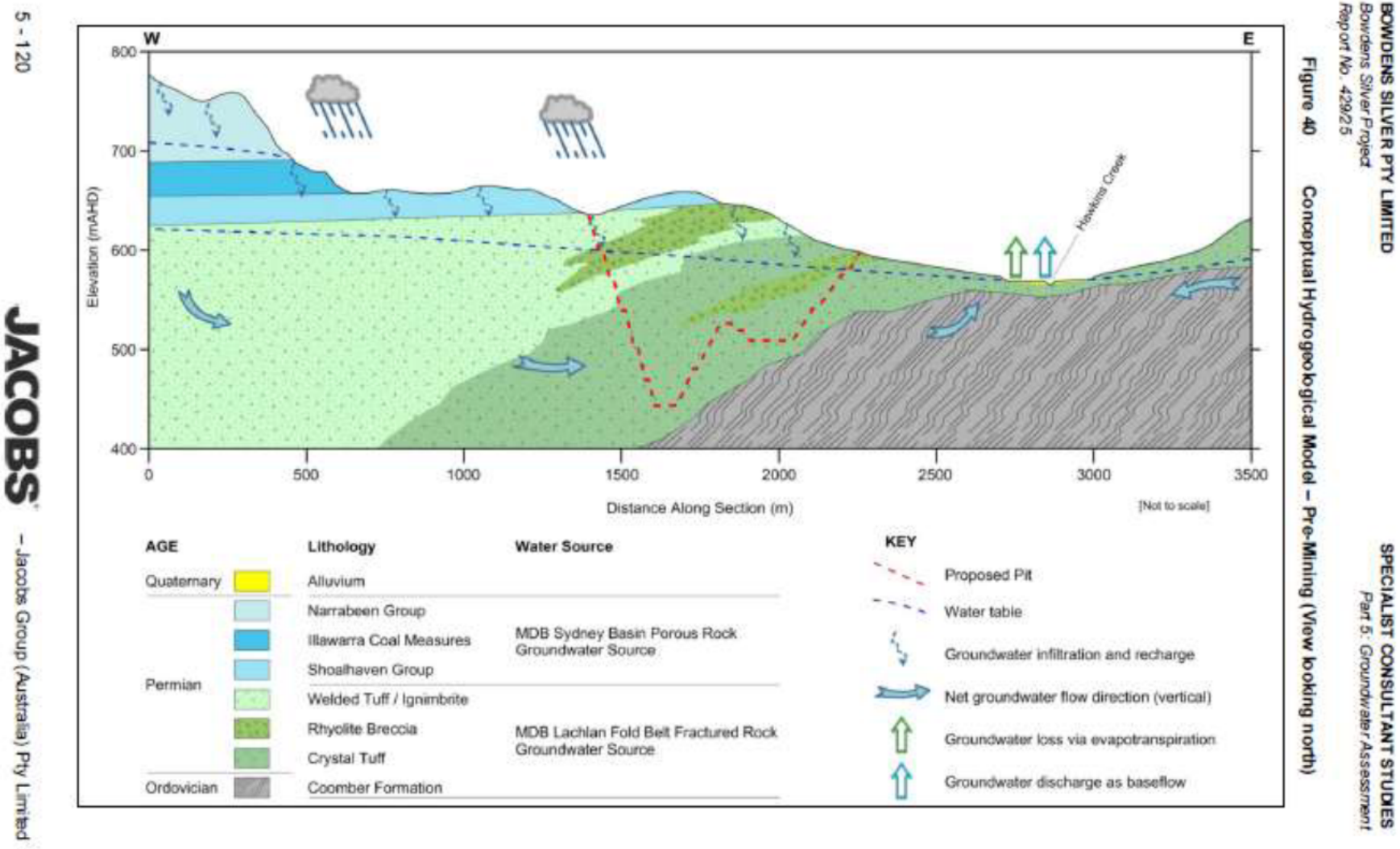
1. Potential seepage is predicted from the TSF and WRE (and Leachate Dam) (Jacobs 2020, 5-125)
2. 200 litres/day of seepage under the (ANCOLD 2012) TSF embankment (ATC Williams, 2020, p.24)
    1. The nature, mass or attenuation of contaminants leaching from the TSF or WRE to the south and west of the site after 100 years has not been provided.
    2. Seepage collection is uncertain in fractured rock aquifers.
    3. Long term management and response has not been specified
3. Amendment 2-45: An *unconditional* commitment to applying a bituminous liner to the entire area *and* monitoring integrity *and* specific response would help limit seepage

Groundwater flowthrough to Hawkins Creek



Aquifer interference diagram from DPE's Draft Guide to Groundwater Management in NSW p.30 Jul. 2022

Groundwater flowthrough to Hawkins Creek



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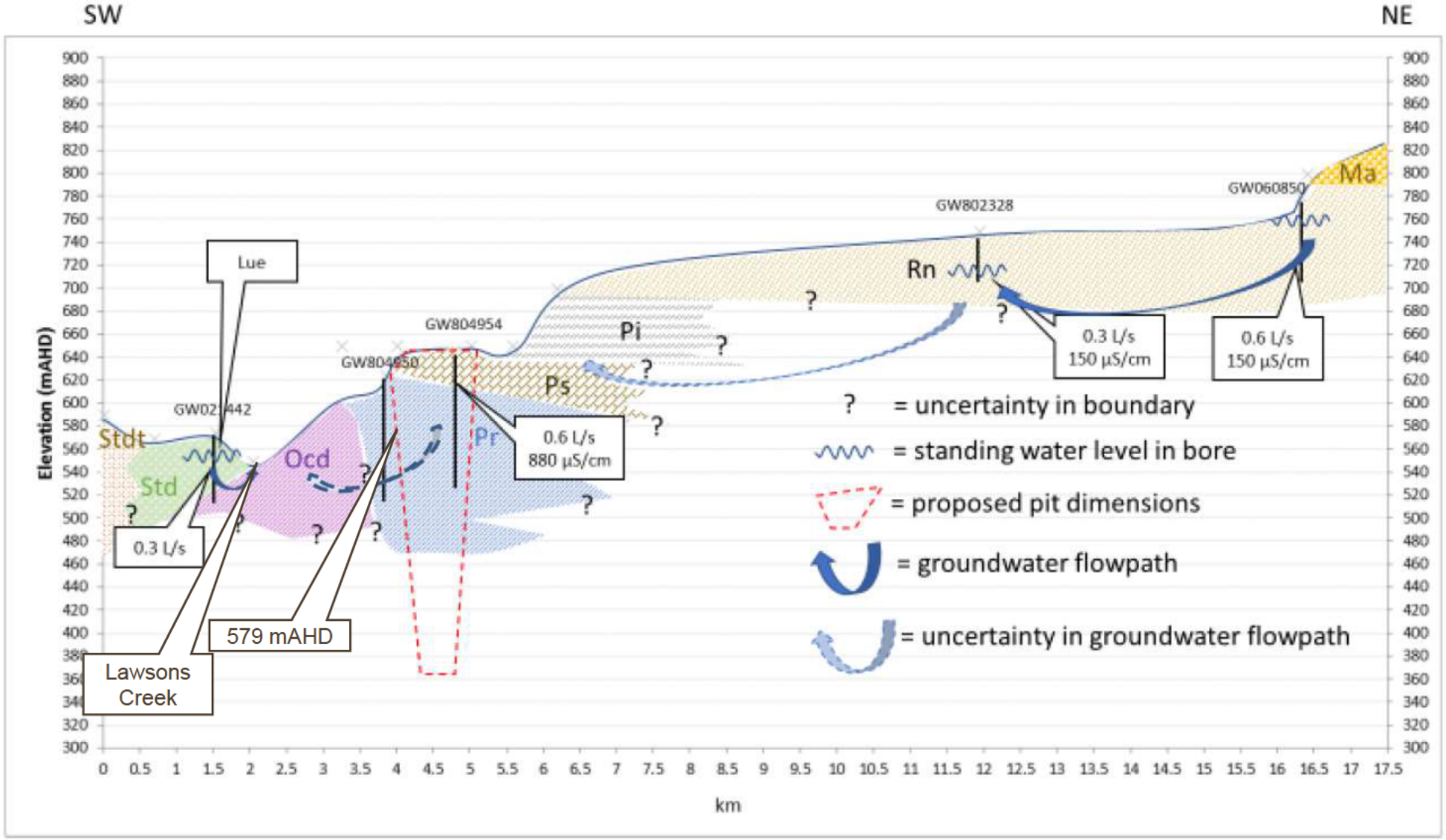
Bowdens Silver Project
Report No. 429/25

Figure 40 Conceptual Hydrogeological Model – Pre-Mining (View looking north)

SPECIALIST CONSULTANT STUDIES
Part 5: Groundwater Assessment

Water source inflows (R. W. Corkery & Co., March 2022b, p. 20)

Natural conditions - 18 km SW-NE Section



Source: LAG report by Australian Water Environments (2018) indicating water salinity and regional impact

3. No formal risk assessment

3.1 Long term / indefinite ‘Take’ from (ground)water resources through evaporation

1. How much Take… and how has Take been calibrated?
    1. Evaporation: 309 ML/yr & groundwater inflow of 102 ML/yr
    (Section 4.7.5.5 R. W. Corkery & Co. Pty. Limited, 2020, pp. 4-161)
    2. Aquifer Interference Assessment submission “anticipates a long term take of 200 ML/yr.”
    (Q11 of Jacobs (2020) p 5-197)
2. Evaporation reduces water availability for ecosystems and people indefinitely (quality and quantity)

3. No formal risk assessment

3.2 Insufficient data for Trigger Action Response Plan or Water Management Plan

1. Investigating significant groundwater dependent ecosystems would enable an effective monitoring plan.
2. No locations, quantities, controls or triggers for monitoring bores are provided (R. W. Corkery & Co., 2022d, pp. 5-149),
4. A peer reviewed AS/NZS ISO 31000:2009 Risk Assessment would assist

The likelihood of contamination from the final void lake warrants a source-pathway-receptor assessment

Adapted from HydroGeoLogic, 10 Dec 22 p.11 & 26

Review against Objectives

- Does the proposal demonstrate leading practice?
  - 2017 National Groundwater Strategic Framework objectives:
    - Sustainable extraction and optimal use
    - Investment confidence through improved regulation
    - Planning and managing now and for the future
  - Indefinitely evaporating high quality water from year 16 could be replaced by backfilling, rehabilitation, sustainable water treatment and managed aquifer recharge

Leading Groundwater Practice (Source: USGS)

Review against Objectives

- Is there a demonstrable link between the activity, environment and human health?
  - Multiple authors and revisions lead to poorly referenced conclusions
  - No evidence that local perched and non-perched springs will not be drained or polluted
  - Water dependent habitat for critically endangered species that rely on water
  - Scant evidence of a collaborative partnership in NSW to showcase a behavioural change

Review against Objectives

- Does the proposal align with WaterNSW strategy and principles for sustainable development?

> *'making our lives healthier and more productive and our communities more attractive and amenable places to live.'*

(WaterNSW strategy, 2022)

- Sustainable development is challenged by this proposal

> *'If we contaminate our groundwater, it is extremely difficult… to clean up.'*

(modified from the WaterNSW strategy – GWM Guide 2022 p.18)

Specific LAG queries

- Hydrogeological model layering
  - Modelling of fractured rock has high uncertainty. Layering is not explained, thicknesses are not provided and geometry does not honour geology or faults
    (HydroGeoLogic Dec 2022)

- Fault impact
  - Fault behaviour is highly uncertain and may activate during subsidence induced by removal of overburden, blasting or dewatering

Specific LAG queries

- Final pit void flows and quality
  - Estimates of evaporation are uncertain
  - Hydrogeochemical investigations and hydraulic connectivity studies required
  - Experts note the present likelihood of discharge of contaminated water to the south and west (Earth Systems Dec 2022, HydroGeoLogic Dec 2022).

- Leak detection and mitigation – No specific details provided for assessment (Earth Systems Dec 2022, HydroGeoLogic Dec 2022).

Summary

Three key concerns amongst many:

1. An unclear definition of groundwater users is influencing risk conceptualisation and conclusions
2. Conceptualisation of acid mine drainage should be improved
3. No formal risk assessment

Summary

- Proposal is **unclear** on groundwater-:
  - **Movement;** especially from year 16
  - **Quality**: concentration, migration, attenuation and fate of contaminated seepage
  - **Users**: identity of water users at risk and the activity, pathway, likelihood & consequence

- Hence plans to monitor and control risks for groundwater users are unclear
  - A thorough, referenced and peer reviewed risk assessment would enable decision making

Recommendations

- A Conditions of Consent approvals ‘roadmap’ is not particularly collaborative nor transparent for NSW in 2023

- Provide all SEAR information *before* decision-making to clarify the risks of the project to the satisfaction of all parties

Further Detail on Concerns Presented

DPIE Major Projects Portal – Organisation Submissions, page 2:

LAG Attachment 4: AWE Aquifer Connectivity Study, June 2018

- Hydrogeological cross sections, GDEs, conceptual modelling

LAG Attachment 3: FDP Key Hydrogeological Concerns, July 2020

- Detail on all concerns investigated, as well as a summary of the response to the SEARs

LAG Attachment 5: FDP Review Combined 13 August 2021

- Review of Bowdens response to multi-agency feedback

LAG submission to DPIE (not on Portal):

FDP Review of Bowden's Response to Groundwater Questions July 2022

- Identifies which subconsultant reports were updated in 2022, the key changes and suggestions for responsible hydrogeological investigations

References

R. W. Corkery & Co. (2020). *EIS Volume 2 Part 5 Groundwater Assessment - Jacobs.* Sydney: R. W. Corkery & Co.

R. W. Corkery & Co. (2022d). *Appendix 4 - Part 5 - Updated groundwater assessment.* Sydney: R. W. Corkery & Co.

R. W. Corkery & Co. (March 2022b). *Water supply amendment report.* Sydney: R.W. Corkery & Co.

R.W. Corkery & Co. (2021a). *Amendment Report for the Bowdens Silver Project.* Sydney: Bowdens Silver Pty Limited.

R.W. Corkery & Co. (2021b). *Appendix 2 - Updated summary of environmental management and monitoring measures.* Sydney: Bowdens Silver Pty Limited.

R.W. Corkery & Co. (March 2022). *Amendment submissions report.* Sydney: R. W. Corkery & Co.

R.W. Corkery & Co. (March 2022c). *Appendix 1 - Amended Project Description.* Sydney: R. W. Corkery & Co. Pty. Limited.