8-1. RELEVANCE OF PAIRED BORES USED FOR SITE CHARACTERISATION

Concern:
Paired monitoring wells are used to investigate the connectivity between deep and shallow aquifers. In this case, paired wells could be used to understand the relationship between the regional fractured rock aquifer and the shallow alluvial aquifer and leakage from the planned dams.
There are no paired monitoring wells within 1.5 km of Lawson's Creek near Lue village so the degree of impact on riverine ecosystems and shallow bore users is poorly defined. Furthermore, conclusions presented in the EIS from the available data require further consideration.

This concern responds to the following SEARs for SSD 5765:

- A description of the existing environment likely to be affected by the development, using sufficient baseline data;
- Part 3: Any interference with an aquifer caused by the development does not exceed the respective water table, water pressure and water quality requirements specified for item 1 in columns 2, 3 and 4 of Table 1 of the Aquifer Interference Policy for each relevant water source listed in column 1 of that Table.
- Assessment of likely impacts to aquifers; detailed site water balance, management of excess water and reliability
- DRG, Attachment 2A requires rehabilitation methods including
  e) monitoring for rehabilitation
  i) details of triggering intervention
  k) details of post rehabilitation management
  l)i) assessment of rehabilitation techniques against objectives
  l) ii) assessment of potential acid mine drainage
  l) iii) processes to identify and management geochemical risks throughout mine life
  m) iii) groundwater assessment for final water level in any tailing storage facility void
  o) consideration of controls
- DRE/DPE requires a Water Management Strategy that considers
  - the existing surface and groundwater qualities
  - a robust baseline
  - a description of how groundwater and aquatic ecosystems will be monitored, Trigger Action Response Plan and trend identification

DISCUSSION

If the existing hydrogeology is not well understood, predictive tools used to assess impacts such as groundwater models will be unsuitable for decision making. This query relates to the 'paired' bores referred to in the EIS. The EIS uses data from these bores to conceptualise the 'deeper' and 'shallower' aquifer zones across the site, however, the lack of mapping of aquifer and aquitards means that these definitions lack meaning. Modelling assumes a single connected aquifer, with discrete fracture networks. No analysis of hydraulic transmission through faults is presented. Paired wells do not consider connection of alluvium near the Lue Village with the fractured rock aquifer hosting the proposed mine. The lack of monitoring wells between Lawson's Creek near Lue Village and the site (a distance of 1.5 km) precludes identification of any highly transmissive fractured zones in the Coomber Formation between the site and Lue Village.

Various citations (R. W. Corkery & Co. Pty. Limited, 2020) are made regarding the conceptual hydrogeology of the site. The conceptual hydrogeology is what the numerical simulation model (Jacobs 2020) has been based on as well as the basis for many conclusions, suggestions and inferences included in the document (R. W. Corkery & Co. Pty. Limited, 2020, pp. 4-109, 4-110).

Within the information currently available, Jacobs (2020) report that

1. the base of oxidation in the aquifer extends from 1 to 35 m below surface (Jacobs (Australia), 2020, pp. 5-60).
2. The dominant faulting is associated with Blackmans Gully fault “that can be traced for at least two kilometres along Maloneys Road and the low ground east of the Bowdens silver deposit (Jacobs (Australia), 2020, pp. 5-60). The nature of fractures vary widely, with some welded and tight and some showing varying degrees of clayey alteration and the presence of dissolution and precipitation suggesting movement of groundwater (Jacobs (Australia), 2020, pp. 5-62).
3. Shallow groundwater flow will be dominantly northwest toward the Darling River, with local groundwater flows mimicking topography – south to Hawkins and Lawsons Creeks and then northwesterly. Deeper groundwater flow within the Ordovician basement is likely to be structurally controlled, locally inducing groundwater flow to the south (Jacobs (Australia), 2020, pp. 5-63).
4. The hydraulic properties ‘are potentially very broad’ (Jacobs (Australia), 2020).

This raises two questions: are there sufficient investigation and monitoring bores to inform predictions? and how has this uncertainty been reflected in the outcomes of the EIS? Conclusions drawn in the EIS from available paired well data (Figure 1, Figure 2 and Figure 3) are queried below.

Figure 1: Paired well locations – adapted from Figure 23 of (Jacobs (Australia), 2020, pp. 5-88)

The KCN spring area (BGW29/38) shows resistance to flow across the 52 m separating the two screened zones (Table 1).

Table 1: Paired wells (Jacobs (Australia), 2020, pp. 5-94) Table 18

Location	Bore ID	Drilled Depth (mbgl)	Screened Interval (mbgl)	Screened Formation
Pit South	BGW28	6	0-6	Alluvium
	BGW27	90	58-70	Coomber
KCN Spring	BGW29	6.5	1.5-6.5	Volcanic Breccia
	BGW38	100	88-94	Volcanic Breccia
Hawkins Creek (upstream)	BGW53	12	3-9	Alluvium
	BGW52	30	17-23	Coomber
Hawkins Creek (downstream)	BGW48	6	1-6	Alluvium
	BGW47	48	36-42	Rylstone
Hawkins Creek (mid-chainage)	BGW51	12	3-9	Alluvium
	BGW50	28	21-27	Coomber
TSF	BGW61	5	1-5	Alluvium
	BGW60	33	21-33	Rylstone

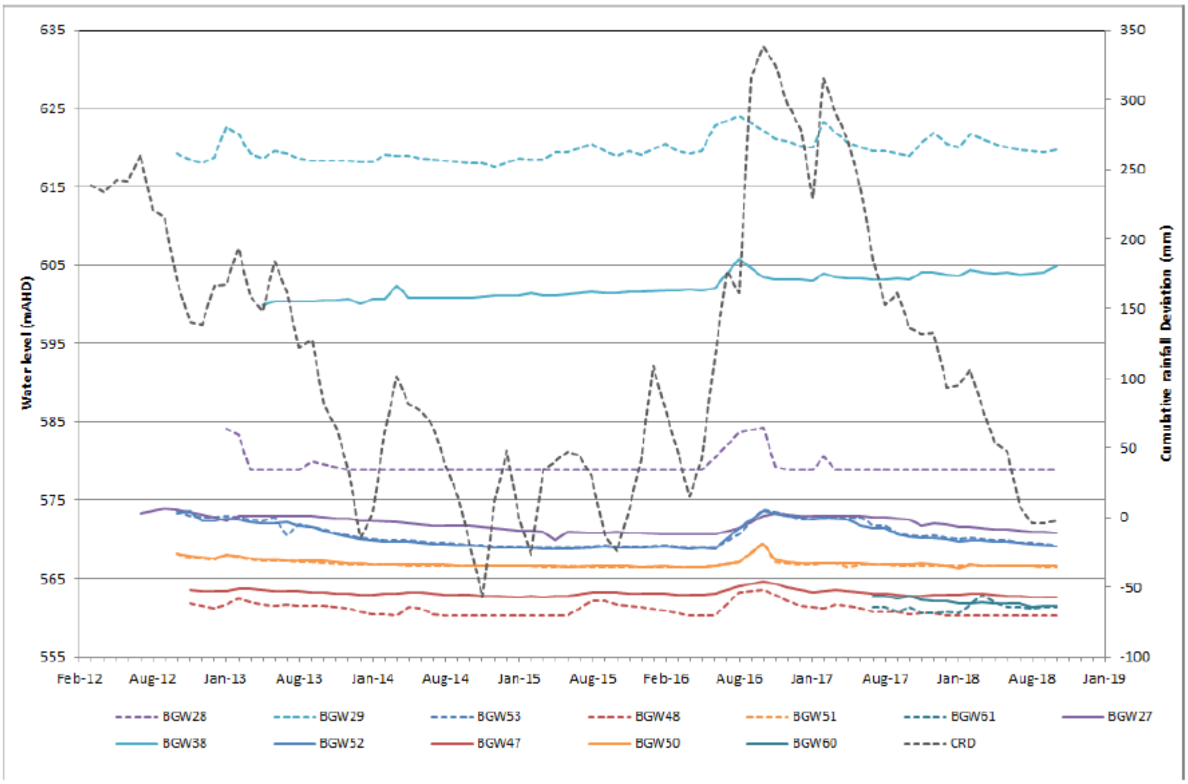

Figure 2: Paired well hydrographs – Figure 27 in (Jacobs (Australia), 2020, pp. 5-94)

From July 2017 to January 2018, BGW60/61 (near the proposed TSF) showed evidence of some barrier to vertical flow. This resistance or barrier is not evident after January 2018.

Further evidence of why BGW47 and BGW48 should be regarded as ‘paired’ should be provided (they are 100 m apart alongside Hawkins Creek). There is no evidence of vertical barriers to flow from the data provided. Following is a brief discussion of the reason for this uncertainty that influences conclusions regarding the impact to Hawkins Creek. BGW47 and BGW48 are at approximately 566 mAHD, despite BGW48 being around 100 m downstream. Upstream from BGW47 (350 m), the ground elevation rapidly drops by approximately 5 m. Groundwater from this escarpment may provide the baseflow for Hawkins Creek. Aside from BGW28/27, there is no evidence of an extensive aquitard separating paired bores. BGW28 (0-6 m in the alluvium) shows a flat trend. On closer inspection of BGW28, (shown as the aqua colour trace on Figure 4), it appears that the lowest groundwater level is at the base of the screened interval (6 mbgl). If the BGW28 bore construction does not allow water to drain from below the screen, then the hydrograph is responding to a well construction artefact (as suggested in (Jacobs (Australia), 2020, pp. 5-95). If the well had been designed to allow water to drain, a drop of over 8 m during dry periods is possible, a level below the static water level (SWL) in BGW27.

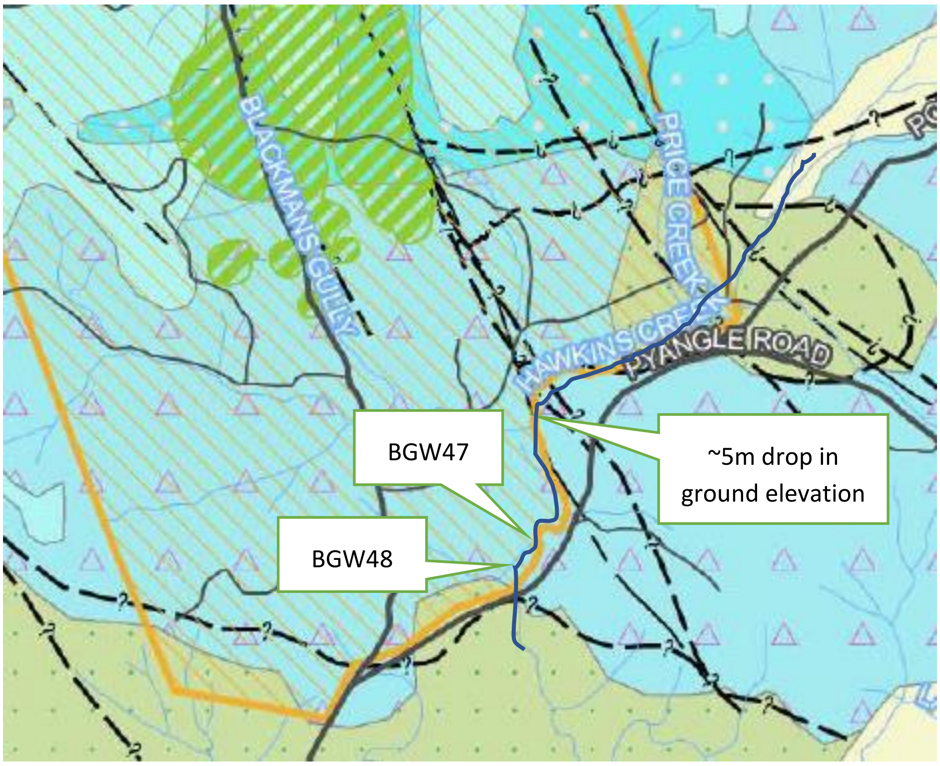

Figure 3: Faults – Figure 11 in (Jacobs (Australia), 2020, pp. 5-57), emphasising Hawkins Creek in dark blue

The Hawkins Creek hydrograph (in mAHD) would need to be compared against BGW48’s hydrograph to clarify whether Hawkins Creek is losing or sustained by groundwater flows either near BGW48 or upstream.

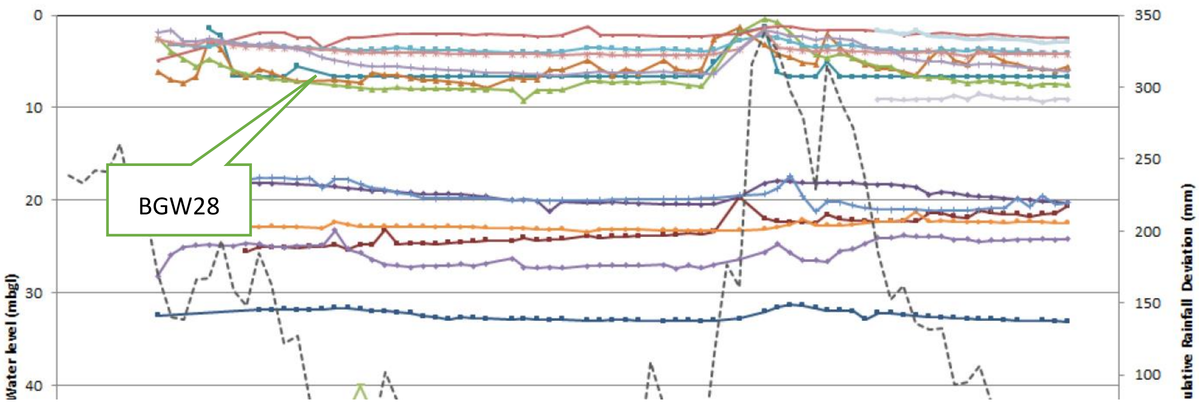

Figure 4: Groundwater hydrographs – adapted from Figure 26d in (Jacobs (Australia), 2020, pp. 5-93)

Considering the above, more lines of evidence are required to strengthen any argument for a significant barrier to vertical flow in the region.

REFERENCES

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