Lue Action Group
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ATTACHMENT 5

Review of Bowden's response to multi-agency feedback regarding groundwater in Bowden's July 2021 Amendment Report *(FDP 13 August 2021)*

FDP
Field Development Planning

Review of Bowden's response to multi-agency feedback regarding groundwater in Bowden's July 2021 Amendment Report

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Glossary

Abbreviation	Term	Description
AIP	Aquifer Interference Policy framework	A regulatory approvals framework
MDB	Murray Darling Basin	
TSF	Tailings Storage Facility	Location for potentially acid forming material extracted during mining that may leach hazardous chemicals into the water table
WAL	Water Access Licence	A permit to take water from a specified water source
WRE	Waste Rock Emplacement	Location for potentially acid forming material extracted during mining that may leach hazardous chemicals into the water table

Introduction

Lue Action Group (LAG) engaged Field Development Planning (FDP) to review groundwater related matters in the Bowden's Silver Amendment Report and dated July 2021 (the Report). Groundwater related matters are presented in the Amendment and Updated Appendix 1, 2, 3, 7 and 8 dated June 2021 (Table 2).

Field Development Planning (FDP) is an organisation focussed on communicating technical groundwater-related matters. FDP's staff have previously reviewed technical matters surrounding the proposed Bowden's Silver Mine.

This high level review is constrained by time and budget, with less than one week available for submission. As instructed, specific matters include if, and how well, the Report responds to matters raised in Table 1. As per previous work, a review of groundwater modelling remains outside the scope.

Table 1: Agency Feedback

Agency	Date	Title
EPA (A. Helms)	19 Jul 2020	Bowdens Silver Project – Environmental Impact Statement State Significant Development 5765 – Section 3
DPIE and NRAR (M. Isaacs)	31 Aug 2020	Bowden's Silver Project (SSD 5765) Environmental Impact Statement
DPIE (M. Isaacs)	31 Aug 2020	Bowden's Silver Project (SSD 5765) Environmental Impact Statement Attachment B

Documents Reviewed

The revised documents relevant to groundwater that have been reviewed are shown in Table 2.

Table 2

2021 Report Document	Related 2020 Document	Key Changes
Amendment Report		Inclusion of powerline diversion, noting no new groundwater impacts to the EIS (2020)
Appendix 2	EIS Volume 5	Inclusion of Measure 18 – Seepage Management, one page
Appendix 3 – Groundwater (Jacobs 2021)	EIS Volume 2 Section 5	Inclusion of an additional 142 pages: Additional modelling and 29 pages of responses to DPIE/NRAR feedback
Appendix 7 – Health Risk (EnRiskS 2021)	EIS Volume 3 Part 7	No change
Appendix 8 – TSF Liner and Seepage Monitoring (ATC Williams 2021)	EIS Volume 5 Part 16A	No change

The following documents produced in 2020 for State Significant Development 5765 that are relevant to groundwater have also not been amended in response to the agencies' recommendations:

- Vol 2 Part 6 Surface Water Assessment 2020
- Volume 2 Part 6 Surface Water Assessment Annexures – May 2020
- Volume 3 Part 9A – Biodiversity Assessment
- Volume 3 Part 9B Biodiversity Offset Strategy
- Volume 4 Part 10 Aquatic Ecology May 2020
- Volume 5 Part 16 B Preliminary Design – WRE, Oxide Ore
- Volume 5 Part 16 C Closure Cover Design – May 2020

Review of responses to regulatory queries

Review of response to EPA feedback

The recommendations provided by the EPA under the referral are shown in Table 3. Subsequent columns discuss the nature and location of amendments presented by Bowdens in 2021, notes from FDP and which EPA recommendations are resolved or remaining outstanding.

Table 3

Recommendations – prior to Determination	*Amendment made*	*Location*	*Notes*	**Resolved**	**Outstanding**
The proposed liner is unsuitable: improve barriers to seepage from the TSF • use of in-situ material is unsuitable due to geological variability • consideration must be given to multi barrier seepage management, considering five guidelines	BGM liner over entire impoundment area, where feasible, but dimensions may be reduced if environmental impacts are not exacerbated Construct TSF in accordance with detailed design Consideration of seepage management will be made in a Water Management Plan and a TSF Operations and Maintenance Plan	Amendment 2-45 Appendix 2 A2-6 Amendment & Appendix 2 A2-15	Recommendations do not seem to be addressed the use of 'feasible' implies a return on investment rather than a commitment. Suggest a commitment to applying a bituminous liner to the entire area and monitoring its integrity The two Plans are not provided	• • Consideration has been given to multi barrier seepage management per the amendment note	• As per EPA recommendation
Install groundwater monitoring infrastructure and gather and analyse data before approvals • the additional monitoring bores downgradient of the TSF and between the Lawson Creek and associated alluvials should be drilled before works commence	Monitoring is proposed to be conducted as documented in a Water Management Plan	Appendix 2 A2-5	A detailed Water Management Plan that requires monitoring and analysis of aquifer connectivity between the Mine Site and Lue Village prior to a Determination would be helpful.	•	• Installation, analysis and monitoring of groundwater before Determination

FDP notes that the EPA requested dam infrastructure associated with the tailings storage facility (TSF) to be associated with the ANCOLD (2012) guideline, however, this guideline has been superseded by Revision 1 (ANCOLD 2019) which take into account lessons learnt from recent TSF dam wall failures.

Review of response to DPIE/NRAR feedback

The recommendations provided by the DPIE/NRAR under the referral are shown in Table 4. Subsequent columns discuss the nature and location of amendments presented by Bowdens in 2021, notes from FDP and which DPIE/NRAR recommendations are resolved or remaining outstanding.

Table 4

Recommendations – prior to Determination	*Amendment made*	*Location*	*Notes*	**Resolved**	**Outstanding**
Clarify whether entitlements (Water Access Licences) to the following Groundwater Sources have been secured: a. 907 ML/yr from Lachlan Fold Belt MDB b. 194 ML/yr from Sydney Basin MDB and 12.9 ML/yr from Lawsons Creek Water Source DPIE noted only 165 ML/yr of Sydney Basin MDB entitlements had been secured and that Licences RO12-18-111 and RO13-19-097 may not be within the Sydney Basin MDB (Other) Water Management Zone.	• Bowdens holds 59 ML/a of entitlements but intends to 'refine' licensing obligations once approved • Bowdens would secure necessary water licences prior to Determination of the application. Note that this report states that 136 ML/yr is required from Lawsons Creek (not 12.9 ML/yr) and that up to 2,000 ML/yr can be imported from Ulan Coalfield, with excess diverted to the TSF. • There is currently a moratorium on new WALs – where they are required they would be purchased on the market or via a controlled allocation order • Ulan Coalfield water treatment, including waste disposal, has been assessed and approved • Bowdens have 'access to' approximately 1,066 ML/yr of groundwater entitlements	Appendix 5 336-337 Amendment 2-62 Appendix 3 5-34 Amendment 2-63 Amendment 2-64	• No evidence that sufficient entitlements have been obtained prior to Determination • As Bowdens may be contracted to take 2,000 ML/yr of wastewater from Ulan Coalfields, confirm that the TSF has sufficient capacity to store up to 2,000 ML/yr of water from the Ulan Coalfield. Evidence of approval of Ulan Coalfields waste disposal from treatment is not provided • There is no guarantee of securing sufficient water allocation licences for the proposed development	• Bowdens does not have sufficient water entitlements at present	• Define Water Management Zone for RO12-18-111 and RO13-19-097
Confirm whether a borefield is required and conduct an impact assessment if so under the Water NSW/NRAR process (DPI 2018)	• Jacobs (2020) identified enhanced permeability within fractured rock aquifers near major geological structures • Significant porosity that has the potential to accommodate productive aquifers is present below 600 m • Any prospective borefield would be dependent on successful investigation results and subject to approvals	Amendment 2-64 Appendix 3 5-118	• Respond to Recommendation, including conducting an impact assessment on any proposed borefield • Discuss whether sustainable yields are achievable from the porosity below 600 m	•	• Per DPIE/NRAR Recommendation
Confirm whether the risk of aquifer contamination to receptors such as the down-gradient town water supply utility borefield will be effectively managed, including a. Provide supporting information including piezometric maps b. Substantiating claims that groundwater flow will be reversed from a westward to a south easterly direction, including discussion of	a. Long term post mining water level provided showing groundwater flow to the south b. None	a. Appendix 3 5-134 Fig 47	The post mining piezometric map shows that the Mine Site will not be a sink in all directions. Groundwater seepage will occur to the south from the pit void (lake) and west from the TSF (both down-gradient) a. Several additional piezometric maps would improve the understanding of the directions of seepage	a. A map of post mining groundwater levels is provided	a. Additional maps requested b. Per DPIE/NRAR Recommendation

vertical groundwater flow and inter-aquifer relationships c. Revising the assessment against the Aquifer Interference Policy (AIP) framework if an update is necessary d. Assessing and clearly expressing the groundwater quality impacts on the Sydney Basin MDB Groundwater Source and providing details on how the water quality impact falls within Level 1 minimal impact assessment criteria of the AIP	c. No AIP assessment update d. None	c. Appendix 3 Section 2, Section 7, Annexure 1 p. 5-160, 5-163	c. Unclear whether the allowed take 'secured' refer to peak groundwater entitlements, yet-to-be-confirmed rights to use Ulan Coalfield water or off-peak (staged) entitlements c. AIP 14: there is potential for causing and enhancing hydraulic connections that has not been assessed. c. AIP Table 4 – there are potential quality impacts on nearby licensed groundwater users		c. Per DPIE/NRAR Recommendation d. Per DPIE/NRAR Recommendation
Address model matters to ensure they are not symptomatic of serious model errors a. Structure and complete a standalone numerical groundwater model report according to Chapter 8 in the Australian Groundwater Modelling Guidelines (Barnett, et al. 2012)	• Report restructured and several matters addressed	Appendix 3 Annexure 9 5-263	• Model objectives not stated • Solute transport modules not used	• Report restructured and several matters addressed	• For specialist groundwater modeller review
Provide information on how 'make good' is proposed to be achieved at the impacted bores during operations and post closure as per the Aquifer Interference Policy	• Water table drawdown up to 1 m 1.5-2.2 km from the main open pit ○ GW061475 north of the mine site ○ GW802888 east of the mine site ○ Others within the mine site • 'acid forming water would be captured and processed to ensure any metals that are dissolved cannot percolate into the groundwater' • acceptable contingency measures will be put in place prior to operations intercepting the groundwater table. • a Final Void Management Plan will be put in place prior to completion of mining	Appendix 3 5-128 Appendix 7 7-85 Appendix 2 A 2-4 Appendix 2 A 2-4	• A Final Void Management plan, including make good conditions for impacted bores, would identify how long term risks would be managed prior to a Determination.	•	• Per DPIE/NRAR Recommendation

Review of response to DPIE Attachment B feedback (selected recommendations)

The recommendations provided by DPIE/NRAR's specialist reviewer (Attachment A) under the referral are shown in Table 4. Subsequent columns discuss the nature and location of amendments presented by Bowdens in 2021, notes from FDP and which DPIE/NRAR recommendations are resolved or remaining outstanding.

Table 5

Recommendations – prior to Determination	*Amendment made*	*Location*	*Notes*	**Resolved**	**Outstanding**
Implement Dr Merrick's recommendations	•		Dr Merrick appears to have reviewed Jacobs (2019). Note that the WAL summary (Annexure 3, 2019) has not been provided in 2021. Dr Merrick noted that model calibration had not yet been finalised, including a check of observed/interpolated water table contours (p5-375)	•	• Per DPIE/NRAR Recommendation
Conduct rigorous proofreading and review to avoid degrading confidence in the model and groundwater assessment	• Within 2 years of extraction intercepting the regional groundwater table • Review groundwater model within 2 years of extraction intercepting the regional groundwater table	Amendment A2-6 Appendix 2 A2-6	Clarify whether dewatering bores will interfere with the proposed review.	• Review may occur within 2 years	• Per DPIE/NRAR Recommendation
Discuss whether the guiding principles for the conceptualisation of groundwater systems (Barnett, et al. 2012) have been met, how, and if not, why.	• Considering regional matters are the objective of the model	Appendix 3 5-441	Alternative conceptual models have not been considered nor is there evidence of iterative refinement of the model Modelling objectives unclear / receptors not marked	• Matters such as hydrogeological complexity are presented	• A concise summary of responses to guiding principles
Show conceptual groundwater mounding beneath the Tailing Storage Facility (TSF) and Waste Rock Emplacement (WRE)	•		The TSF clay liner seepage is modelled assuming zero head below the liner (i.e. it is free draining to a lower water table)	•	• Per DPIE/NRAR Recommendation
The conceptual model should include third-party and mine dewatering bores	• The locations of two bores are labelled			• The locations of two bores are labelled	• Per DPIE/NRAR Recommendation
Consider vertical anisotropy and describe the basis for vertical discretisation in layers such as the Shoalhaven Group aquitard	• Discretisation is not required	Appendix 3 5-443	In heterogenous rock, high permeability features may significantly alter the migration of contaminant plumes The modeller notes that insufficient data is available for modelling these matters with acceptable certainty levels	•	• Per DPIE/NRAR Recommendation
Special diagrams are required to show the pre-mining, mining and post-mining hydrological situations in alluvium	•		This matter is important to regional impacts	•	• Per DPIE/NRAR Recommendation

Recommendations – prior to Determination	*Amendment made*	*Location*	*Notes*	Resolved	Outstanding
Shallower groundwater flow direction/s must be discussed further and presented more clearly, including the possibility of perched water tables above the regional groundwater table. Page 67 notes that *'Within the Mine Site, a number of potential GDEs have been identified including springs and seeps, terrestrial vegetation, and river baseflow systems.'* However, the conceptual and numerical models fail to represent these features. The proponent should justify the exclusion of such features or include them in the conceptual and numerical models	• Resolution of cross sections are too coarse to show receptors. Sydney Basin springs unlikely to be impacted by drawdown	Appendix 3 5-439 5-441	Identifying the locations and the relationship between users (including listed species) and water interfering activities should be the objective of an assessment per the AIP. The stated objective is to 'assess regional impacts'.	• Some notes have been made	• Per DPIE/NRAR Recommendation
Enhanced conceptual and numerical modelling of surface water is recommended, especially as Section 5.3.3.3 notes that 'The water balance indicates that, on average, the modelled groundwater system predominantly losses' water to water courses.' Hence, surface water is considered an essential and integral constituent in the modelled hydrogeological system. Varying depths of surface water stage and bottom below the surrounding land level should be considered. Sensitivity analysis of these parameters are also required to be undertaken followed by uncertainty analysis if found necessary.	• This would increase the modelling complexity and is not required	Appendix 3 5-445	Surface water/groundwater interaction is likely to be a key polluting factor	•	• Per DPIE/NRAR Recommendation
Section 5.1.3: drilling results suggest that relatively high groundwater yields can be obtained in the vicinity of the structures. However, these structures are apparently not represented in the numerical model. Explanation or correction is recommended.	• The groundwater model could not be calibrated using these high permeability features	Appendix 3 5-454	The high permeability features (faults/fractures) likely in the variable geology may be the first noted source of pollution. The nature of fluid flow through features between the Mine Site and nearby creeks is particularly relevant.	•	• Per DPIE/NRAR Recommendation
The report argues that unreported earlier versions of the groundwater model showed that the numerical groundwater model is insensitive to evapotranspiration. The proponent is requested to explain the reasoning behind including evapotranspiration in the model where it is not affecting the model. To simplify the model and reduce uncertainty, could evapotranspiration have been left out and compensated for implicitly in the recharge values? If there is evidence that evapotranspiration is not an important process in the Bowdens Silver Mine hydrogeological system, it should be clarified on the conceptual diagrams (Figures 40 and 41).	• ET was retained in the model so as not to have to further modify rainfall recharge and introduce additional calibration runs. ET is also utilised in the recovery model and mine void equilibration.	Appendix 5 5-451	For the mine water mass balance, discharge will be inter-aquifer flow, surface water run-off or ET. Third party groundwater use is also considered on p5-121. As all processes besides ET may be polluting, gathering actual ET / recharge volumes for modelling is critical	• Explanation included	• Use of recharge modifications not adopted

Summary

Of the seven documents associated with groundwater in Bowden's 2021 Amendment, only the Amendment Report (R.W. Corkery & Co. 2021a), Appendix 2 (R.W. Corkery & Co. 2021b) and the Groundwater report (Jacobs 2021) have been updated.

FDPs high level review, that has been constrained by time and budget, indicates that few of the Recommendations provided by EPA and DPIE/NRAR have been resolved, with the majority remaining outstanding.

The water mass balance, including rainfall recharge/evapotranspiration losses and the fate of a possible 2,000 ML/yr from the Ulan Coalfields remains a key uncertainty. Neither entitlements to the maximum required water supply from Groundwater Sources, nor alternatives to the possible Ulan Coalfields water supply, have been obtained.

The mass/year of contaminants within this possible water supply that may be concentrated by reverse osmosis treatment and sent to the TSF is not provided.

Amendments considering the Recommendations for seepage management from the TSF appear to concern plans that would be developed should a positive Determination be received. A predicted groundwater level map inferring groundwater flows 100 years after mining is presented. Modelling of the nature, mass or attenuation of contaminants leaching from the TSF or WRE to the south and west of the Mine Site after 100 years has not been presented.

The clearest responses regard the groundwater modelling and are located at the end of Appendix 3 (Jacobs 2021). A key matter presented is that the objective of the numerical groundwater simulation model was not to consider contamination of local springs or dependent ecosystem health. Regional groundwater level changes are the objective rather than changes to groundwater quality. This review does not consider DPIE's modelling recommendations any rigour, however, at a high level the modelling recommendations remain largely unresolved but the report is significantly restructured to better align with the Australian Groundwater Modelling Guidelines (Barnett, et al. 2012).

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