Appendix I Groundwater Impact Assessment and Modelling Report (ELA 2026)

Lei Lithium

Groundwater Impact Assessment and Model Report

EcOz Environmental Consultants

ecological AUSTRALIA
A TETRA TECH COMPANY

Document Tracking

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Abbreviations

Abbreviation	Description
ANZECC	Australia and New Zealand Environment and Conservation Council
DENR	Department of Environment and Natural Resources
GIS	geographical information system
GL	gigalitre (109 litres)
HSU	Hydro stratigraphic Unit
kL	kilolitre (103 litres)
km	kilometre
km2	square kilometre
L/s	litres per second
LOM	Life Of Mine
m2/d	metres squared per day
m^2/d	metres squared per day
m3	cubic metre
m3/d	cubic metres per day
m3/s	cubic metres per second
ML	megalitre (10^6 litres)
ML/a	megalitre per year
mAHD	metres above Australian Height Datum
mbgl	metres below ground level
mm	millimetre
mm/d	millimetre per day
NAFRPA	Northern Australian Fractured Rock Province Aquifer
pF	log scale for representing soil matric potential
RMS	root mean square
ROM	Run of mine
SRMS	scaled root mean square
SOCS	Sites of Conservation Significance
SRTM	Shuttle Radar Topographic Mission
t	tonne
T	Transmissivity (metres squared per day)

Executive Summary

Overview

Lithium Plus Mineral Ltd propose to develop an underground lithium mine located within the Northern Territory known as the Lei Lithium Project (the Project). This report is an impact assessment prepared to support the Lei Lithium Project Supplementary Environmental Report that aims to establish a current understanding of the area's groundwater system and potential impacts resulting from the proposed mining operation.

Environmental setting

The Project is located within a tropical climate that experiences clear wet and dry seasons. The Project Area is surrounded and transected by tributaries associated with the adjacent Charlotte River, which flows into the Byone Harbour. Charlotte River is tidally influenced and lined with mangroves up to the closest mining lease boundary within 200 m of the creek. Ephemeral tributaries of Charlotte River cross the low-lying topography of the Project Area feeding into the creek at various points along its path. The surface water quality (electrical conductivity) aligns with its tidal influence where sampling locations closer to the main channel experiences higher salinity compared to fresher upstream sites showing sporadic saltwater ingress. pH across freshwater sites is within ANZECC (Australia and New Zealand Environment and Conservation Council) 2000 guideline values. The creek is lined in alluvial sediments that contain acid sulfate soils up to the tidal/freshwater barrier. This influences Zinc (Zn), Aluminum (Al) and Arsenic (As) levels throughout the sites both fresh and tidal due to increased flushing and mobilization of sediment.

The main geological unit in the is the early Proterozoic Burrell Creek Formation, which is made up of a succession of shale, siltstone, sandstone and strongly foliated phyllite with lenses of quartz pebble conglomerate. The formation spans the Project Area and hosts key lithium ore deposits. The hydrogeology of the Project Area is closely related to its geological characteristics with an alluvial aquifer sitting within the top 4 mbgl in soils and sandy clay units. From approximately 4 mbgl to deepest drilled bore of 109 mbgl sits the Northern Australian Fractured Rock Province Aquifer (NAFRPA). This aquifer is made up of two distinct geological units, a weathered brown schist with firm claystones and a lower fresh hard grey schist that is highly fractured. Based on recent groundwater drilling onsite and in surrounding projects of BP33 to the north the NAFRPA experiences overall groundwater depths up to 16 mbgl, low yields of less than 0.5 L/s with hydraulic conductivity rates of approximately 0.27 to 2.6 m/day within fractured sections and 0.0003 to 0.08 m/day in fresh sections.

Groundwater levels also indicate that flow becomes shallower within the fresh NAFRPA with a higher piezometric pressure towards the tributaries. This corresponds to possible groundwater discharge between the tributaries and Charlotte River, with groundwater flowing in a south-westerly direction across the Project Area towards Charlotte River. Vertical groundwater gradients remain largely unknown as there is only one nested bore pair, from this there is evidence of the movement of groundwater between the fresh and fractured rock lithologies. There are no bores within the alluvial aquifer with the degree of vertical groundwater movement between the alluvial and NAFRPA unknown.

Groundwater quality is mildly acidic by generally fresh. Al. As, and Zn concentrations are indicative of influence from the acid sulfate soils in the shallow bore and the wet and dry cycling of the water table within the region with some months experiencing sampling outliers. GDEs are mapped within a 5 km radius of the Project Area with moderate potential for the Charlotte River and moderate potential Eucalypt Woodland.

Groundwater impact assessment

Groundwater modelling was undertaken with two scenarios; one being box cut and the other being cut and covering tunnel scenarios. Results under both scenarios indicate localized drawdown around the Project Area. With an overall reduction in groundwater inflows under the cut and cover tunnel modelling scenario only if a liner is installed as part of the tunnel design to inhibit groundwater ingress.

Across both the box-cut and cut-and-cover tunnel scenarios, RN043915 (LG2) within the footprint is predicted to experience the greatest drawdown, at approximately 172 m, while RN043918 (LG1-S) which is closer to Charlotte River is substantially lower at approximately 7 m. The cut-and-cover tunnel design is predicted to reduce groundwater ingress to the underground workings compared to the box-cut design, but it does not materially alter the broader drawdown footprint or the overall cumulative interpretation.

Under the reasonable worst-case cumulative scenario, in which other mining operations in the area (Grants, BP33 and Lei) operate concurrently, drawdown at the Lei observation bores (LG1-S, LG1-D, LG2, LG3, LG4 and LG5) increases slightly, with an average increase of approximately 1 m compared with the Lei-only operational case. Some drawdown is also expected along Charlotte River, and if acid sulfate soils are present within the alluvial corridor there is potential for exposure and oxidation of these soils, with associated risks of acidification and mobilisation of metals.

Risk assessment and mitigation

With proposed mitigation, residual risks are generally assessed as Minor for most receptors. However, two substantive risks remain:

1. Saline water intrusion to deep flow pathways and operational inflows (potentially reduced under the cut-and-cover tunnel scenario when compared to box-cut design), and
2. Localized lowering of the water table (areas >5 m drawdown) that has the potential to affect vegetation depending on rooting depth / exposure of acid sulfate soils in the alluvial corridor.

It is recommended that:

- A groundwater and surface water monitoring program with site specific trigger levels be developed and that further testing be conducted around the presence of acid sulphate soils and if necessary, a management plan be developed.
- Additional inflow studies be completed to determine the level of risk and monitoring required to manage inflows to mining operations and the level of which saline water may flow into underground workings
- If a cut and cover tunnel mining method is preferred an assessment of suitable tunnel liners is undertaken to determine the effect this will have on inflows and allow installation of a liner that would meet operational requirements.

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1. Introduction

1.1. Background

1.1.1. Overview

Lithium Plus Minerals Ltd (Lithium Plus) proposes to develop the Lei Lithium Project the Project), an underground lithium mine located on the Cox Peninsula in the Northern Territory, approximately 30 km south of Darwin. The Project is situated within the Bynoe Pegmatite Field, a prospective lithium province stretching approximately 80 km north south, starting 15 km south of Darwin. The Lei deposit is hosted within the Burrell Creek Formation, a fractured and weathered metasedimentary rock unit that forms a marginal regional aquifer. Approximately 3.10 MT of high grade spodumene ore is proposed to be extracted at the Lei Lithium project, this assessment considers two mine designs, 1) a surface box cut and portal; and 2) a cut and cover tunnel arrangement providing access to an underground decline. Groundwater modelling conducted by CloudGMS is presented in Appendix A, the surface box cut scenario in A-1 and the cut and cover scenario in A-2.

The Project lies within the Charlotte River sub-catchment, which drains to Bynoe Harbour, within the Darwin Rural Adelaide River Water Control District (DRARWCD). The sub-catchment supports riparian vegetation, estuarine environments, and mangrove communities downstream of the catchment. Charlotte River is ephemeral in its upper reaches and transitions to tidally influenced conditions downstream of the Project Area, with estuarine conditions mapped approximately 300 m south-west of the Lei deposit. These surface water features, together with mapped and potential groundwater-dependent ecosystems (GDEs), represent key environmental values within the Project Area.

1.1.2. Supplementary Environmental Report

The Northern Territory Environment Protection Authority (NT EPA) has determined that the Project requires environmental impact assessment by Supplementary Environmental Report (SER) under the *Environment Protection Act 2019*. The SER deemed necessary due to uncertainty in relation to groundwater drawdown magnitude and extent; groundwater-surface water connectivity (including with the Charlotte River); potential impacts to GDEs; and potential for cumulative impacts with nearby mining developments (NT EPA, 2025).

1.2. Purpose, Scope and Relationship to the SER

This impact assessment report has been prepared to support the Lei Lithium Project SER by addressing the following objectives:

- establish and document the current conceptual understanding of the groundwater system relevant to the Project;
- identify and characterise GDE receptors within and adjacent to the Project Area, and evaluate their potential sensitivity to groundwater level changes;
- assess the magnitude, extent, duration and recovery of groundwater drawdown associated with Project dewatering activities;
- interpret numerical groundwater model outputs in the context of site-specific hydrogeology, surface water features, and environmental receptors;

- evaluate potential impacts to GDEs, surface water features (including the Charlotte River), and declared beneficial uses;
- assess whether predicted groundwater drawdown could result in secondary impacts to GDEs via exposure and oxidation of potential acid sulfate soils (ASS) within estuarine or alluvial sediments;
- assess cumulative groundwater impacts in combination with the Grants Lithium Project and BP33 underground mine; and
- identify key uncertainties, assumptions, and residual risks relevant to regulatory decision-making.

1.3. Regulatory Context

This report has been prepared to inform the NT EPA's assessment of the Project against the relevant NT EPA Environmental Factors and Objectives (NT EPA, 2025), with particular emphasis on:

- Hydrological Processes – protection of groundwater and surface water regimes so that environmental values are maintained;
- Inland Water Environmental Quality – protection of groundwater and surface water quality; and
- Aquatic Ecosystems – protection of aquatic habitats and ecosystem functioning.

The impact assessment has been undertaken in recognition of the precautionary principle and the requirement under the *Environment Protection Act 2019* to consider cumulative impacts and uncertainty when determining the likelihood of significant environmental impact. The report does not assume that impacts are acceptable in the absence of complete certainty, and aims to identify where additional data, monitoring, or management responses may be required.

The Burrell Creek Formation (BCF) is not currently managed under a declared Water Allocation Plan (WAP), the assessment has been undertaken with regard to the Northern Territory Water Allocation Planning Framework (Department of Environment and Natural Resources, 2020), which generally considers up to 20% of long-term average annual recharge to be available for consumptive use. Retaining the remaining recharge to support groundwater-dependent ecosystems, streamflow and other environmental values.

1.4. Scope and Limitations

This assessment is based on the information available at the time of report preparation, including existing groundwater investigations, monitoring data, hydrogeological studies, and numerical groundwater modelling outputs provided by the specialist modeller.

The numerical groundwater model provides a predictive framework for assessing the predicted magnitude and extent of groundwater drawdown, mine inflows and groundwater recovery, but also the confidence associated with those predictions. The model outputs are inherently dependent on conceptual assumptions, parameterisation, and data availability. Predicted drawdown magnitudes are evaluated relative to observed seasonal climatic and groundwater fluctuations to contextualise ecological significance. This report therefore focuses not only on predicted outcomes, but also on:

- the confidence associated with those predictions;

- the sensitivity of outcomes to key assumptions; and
- the implications of uncertainty for environmental risk and regulatory decision-making.

This report does not replace the numerical groundwater modelling report, see Appendix A. Rather, it provides the interpretive and impact assessment layer required to translate modelling outputs into conclusions that can be relied upon for the SER and subsequent regulatory assessment. Considering both the regional groundwater balance and the local hydrogeological response to mining.

Table 1-1 Summary of SER water issues addressed in this report

Topic	Comment	Additional Information Required	Section
Hydrological processes	**Extent of groundwater drawdown** The referral provides an indicative zone of influence (ZOI) of 2 km around the proposed action, based on groundwater modelling of the Core Lithium BP33 mine. The referral states that a site-specific groundwater model will be developed. The model is required to determine the potential for significant impacts from groundwater extraction. The BP33 underground mine is also < 3 km from the Lei Lithium Project, it is unclear what the cumulative ZOI is predicted to be in the event both mines operate concurrently.	7. Provide a groundwater model that includes, as a minimum: • descriptions of groundwater dependent ecosystems and understanding of their interconnectivity and water dependence • predictions based on the relevant site-specific characteristics such as: o groundwater drawdown levels, spatial extent and recovery time o alterations to recharge and subsequent effect on anticipated recovery time o impacts to declared beneficial uses of the water within the Fog Bay Area and Darwin Rural Adelaide River Water Control District • modelling using appropriate precautionary scenarios, and accounting for different proposal stages, such as initial conditions (baseline) and relevant intervals in construction, operation, care and maintenance, and closure phases (including post closure). Future predicted climatic conditions must also be considered. • assumptions and parameters used in the predictive model and justification for their use, including a description of how the predictions would change in the event critical assumptions (including transmissivity, hydraulic conductivity and porosity) were found to be incorrect. • overall water balance of the target groundwater system, including inputs and outputs, and feasibility assessment to demonstrate that groundwater abstraction to facilitate mining	Groundwater model Appendix A Section 2.8 Appendix A , Sections 5.4 and 6.4.2 Appendix A, Sections 4.5 and 6 Sections 2.7 and 6 Appendix A Appendix A, Section 5.2 Appendix A

Topic	Comment	Additional Information Required	Section
		will not result in adverse impacts to the environment, and current and future groundwater users.	Section 6
		8. Identify, describe and assess potential direct and indirect impacts and risks of the predicted groundwater extraction, including likely effects to groundwater dependent ecosystems including springs, wetlands, vegetation, connected surface water systems, declared beneficial uses and other groundwater users.	Section 6.5
		9. Describe the avoidance and mitigation measures to manage the impacts and risks of groundwater extraction identified by item **8**.	Section 7
		10. Describe any uncertainties and further work required to increase understanding of potential impacts, and the plan for completing further work.	
		11. Quantify the significance and extent of impacts at the project level and cumulatively. Quantify the significance of proposal impacts using: • the latest draft of the Northern Territory Water Allocation Planning Framework • Relevant guideline thresholds.	Section 6 Section 6
Inland water environmental quality	**Surface and groundwater quality** The referral identifies: • elevated aluminium, arsenic and zinc in groundwater • enrichment of arsenic in waste rock and process residues • elevated arsenic in water extracts and peroxide extracts.	12. Detail the chemical and physical characteristics of surface waters and groundwater within the predicted ZOI, through the collection of an appropriate baseline dataset. Identify any water quality standards and guidelines that would be used to describe the ecological values and health of surface water environments. 13. Identify the quantity, quality (including anions, cations, pH, EC, metals, arsenic and nutrients) and location of all potential discharges of water and wastewater by the proposal, to groundwater and surface water, whether as point sources (such as controlled discharges from regulated dams) or diffuse sources	Section 2.6.2 and 2.5.4

Topic	Comment	Additional Information Required	Section
	Seepage and run off from waste rock and ore stockpiles, and discharge of groundwater through dewatering operations has the potential to, directly and cumulatively, significantly impact on: • surface water quality from the fate of metals, metalloids (particularly arsenic) and nutrients present in the groundwater and geology of the area, • groundwater quality from the fate of metals and metalloids present in waste rock and ore stockpiles the ecological health of the Charlotte River from the migration of mine impacted water through the shallow alluvial aquifer.	(such as seepage from waste rock dumps/ ore stockpiles or irrigation to land of wastewater). 14. Demonstrate how water would be managed and treated to achieve a quality that provides for the protection of aquatic ecosystems prior to discharge. Provide a tabulated comparison of the predicted water quality and the standards and guidelines identified in item **12**. 15. Identify, describe and assess the potential impacts of any discharges on the quality and quantity of receiving waters taking into consideration cumulative impacts from other proposals and the practices and procedures that would be used to avoid or minimise impacts. 16. Describe the avoidance and mitigation measures to manage the impacts and risks of water discharges on the receiving environment identified by item **15**. 17. Provide details of a monitoring program, including trigger thresholds and response (corrective) actions.	Recommendations provided in Section 6.5 and 7
	Groundwater drawdown The referral identifies that groundwater extraction may result in saline intrusion in the freshwater reaches of the Charlotte River, and the oxidation of subsurface acid sulfate soils leading to potential significant impacts to surface and groundwater quality.	18. Identify, describe and assess direct and indirect impacts of implementing the proposal, and cumulative impacts, on groundwater and surface water quality. This must include (at a minimum) consideration of impacts associated with: • disturbance / exposure of acid sulfate soils through groundwater extraction or removal of overburden • changes to the saltwater – freshwater interface for all waterways within the ZOI, including the Charlotte River • salinisation of groundwater aquifers from encroachment of seawater 19. Describe the avoidance and mitigation measures to manage the impacts and risks of groundwater extraction identified by item **18**.	Section 6 Section 5.4 Section 6 Section 6 Section 6.5

2. Existing Environment

2.1. Location

The Lithium Plus Minerals Ltd (Lithium Plus) propose to expand mining activities into the Lei Lithium Project (ML33874). The Project is located within the Cox Peninsula approximately 28 km west of Berry Springs, along Cox Peninsula Road and to the west of Fog Bay Road (Figure 2-1). The mining lease covers 296 ha of the crown land with the proposed project disturbance area extending to 64.89 ha within the mining lease area.

2.2. Climate

Climate patterns such as temperature, precipitation, humidity, evaporation, and other atmospheric conditions play a key role in driving regional hydrogeological and hydrological processes affecting the water environments at the Project Area. The Project is located within climate zone 6 (of 6), characterised by hot humid summers and warm winters.

Temperature measurements were obtained from the BoM Kangaroo Flats (Defence) weather station (Figure 2-2 gauge 14982), located at 12.79 °S and 130.85 °E (BoM, 2025), which is approximately 8 km from the Project Area. Temperature data show an average maximum temperature ranging from 42.5 °C in October to 36.4 °C in July.

Using the Long Paddock SILO climate database, long term (25 years) temperature and pan evaporation data can be obtained within the extent of the of the Project Area (-12.75°S and 130.8 °E) (Queensland Government, 2025). The SILO data temperature ranges from 22.4 °C to 33.3 °C; with the highest evaporation is experienced in October on average (Figure 2-2).

The nearest observed rainfall data were obtained from the BoM at Berry Springs Rangers (Figure 2-3, gauge 14215), located approximately 34 km from project (12.70 °S, 131.00 °E) (BoM, 2025) and Southport (Figure 2-3, gauge 14206), located approximately 31.5 km from the project (12.73° S, 130.95 °E) (BoM, 2025). Based on a review of historical rainfall data from 2006 to 2022 at Southport, the annual mean rainfall was 1796.4 mm, and for Berry Springs Rangers annual mean rainfall data was 1681.5 mm. A review of the annual mean rainfall (Table 2-1) indicates the wettest months are typically between November and March and the driest months being April to October.

Using the Long Paddock SILO climate database, long term rainfall can be obtained with the extent of the Project Area, Figure 2-3. The long-term rainfall for the area follows the wet season (November to April) and dry season (May to October) with maximum monthly rainfall highest in January at 493 mm and lowest in July at 0.3 mm. The average daily rainfall shows June and September as the lowest at 0.2 mm and December the highest at 281.4 mm.

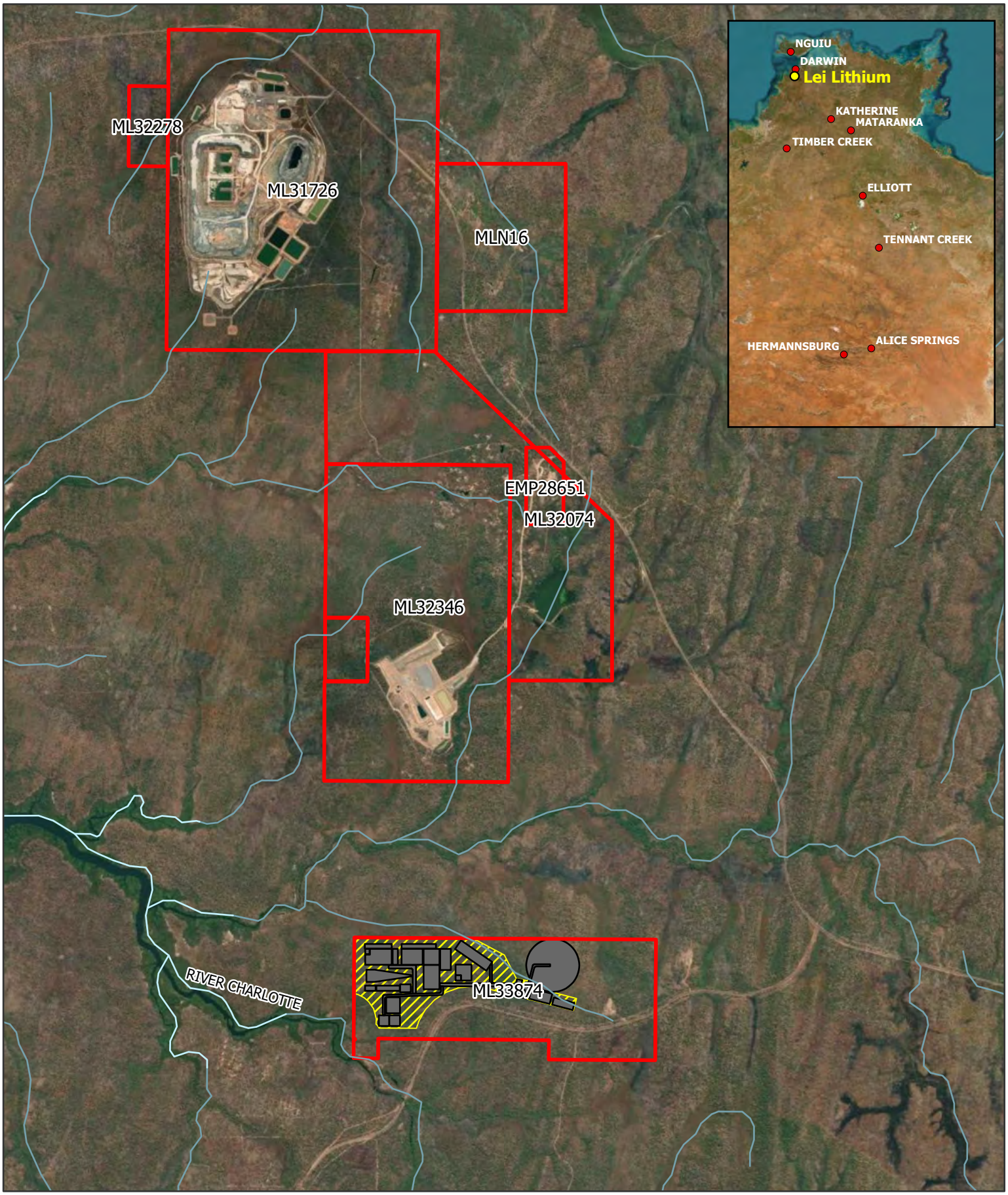


Figure 2-1 Location of Lei Lithium Project

Legend

- Lei Lithium Proposed Distrurbance Footprint
- Lei Lithium Infrastructure Layout
- Mining Lease

Watercourses

- Non-perennial
- Perennial

0 500 1,000 1,500 2,000

Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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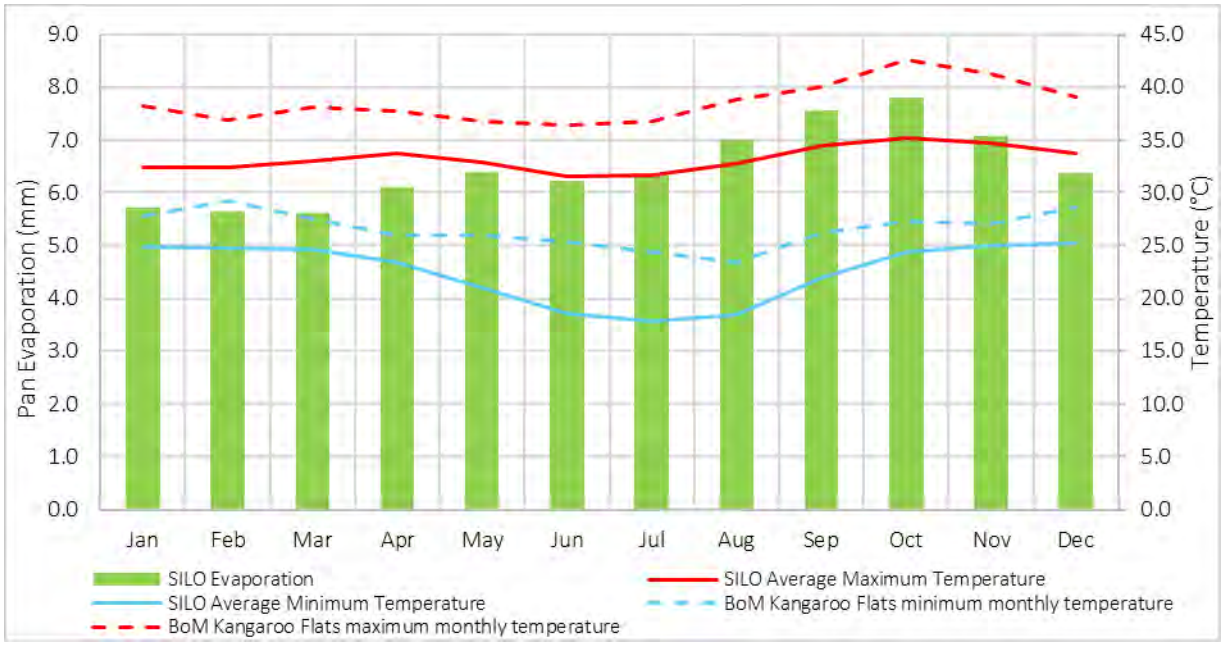


Figure 2-2 Average evaporation, minimum and maximum temperature from 2000 to 2025 (Queensland Government, 2025)

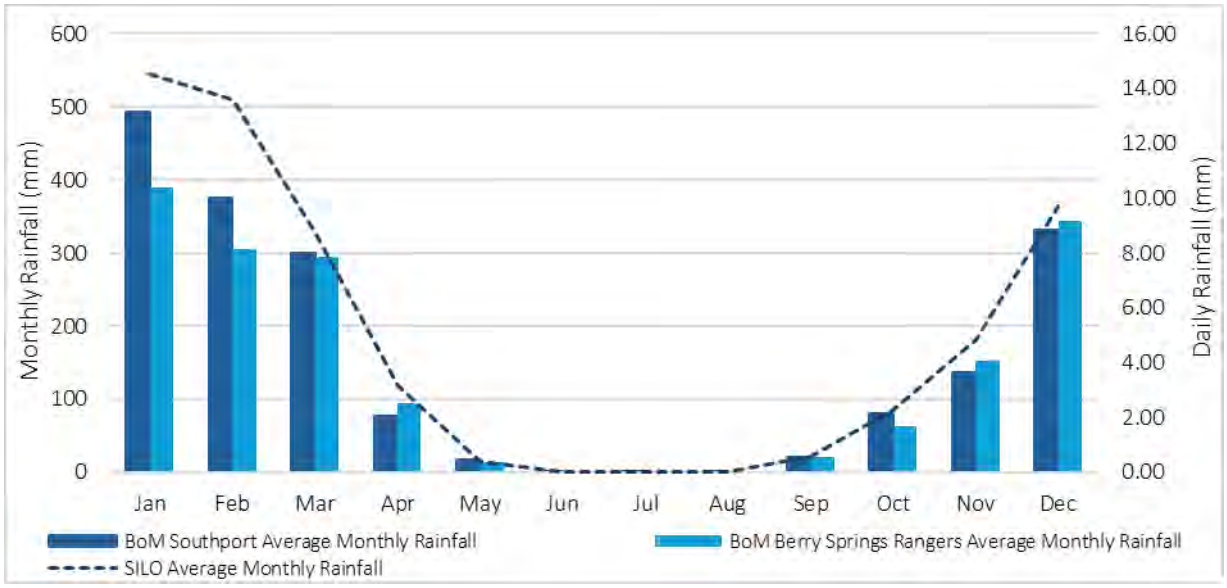


Figure 2-3 Maximum Monthly Rainfall and Average Daily Rainfall (Queensland Government,2025)

Table 2-1 Mean monthly rainfall for BoM stations 14215 (Berry Springs Rangers) and 14206 (Southport) (BoM, 2025)

Rainfall (mm)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Southport	493.1	376	300.5	77.4	16.4	0.3	2.2	0.2	20.9	80.7	136.4	332.1	1796.4
Berry Springs Rangers	388.8	305.5	294.5	94.6	14.6	0.1	0.6	1.6	20.2	63.6	153.1	344.3	1681.5

2.3. Geology

2.3.1. Overview

The geology of the region and Project Area is described in the Darwin Geological map sheet (Pietsch, 1986). The Project Area and surrounds is within the geological event known as the Pine Creek Orogen that spans approximately 47,500 km^2 from Darwin to Katherine in the south. The orogen records a complex tectonic history involving rifting, basin development, regional metamorphosis, and multiple deformation events. Overall, it consists of a thick succession of Paleoproterozoic sedimentary and volcanic rocks deposited between 2.50 and 1.86 billion years ago that overlies the neoarchaean granitic and gneissic basement. Within the Project Area the main geological unit is the early Proterozoic BCF which forms the western margin of the Pine Creek Orogen. It is made up of a succession of shale, siltstone, sandstone and strongly foliated phyllite with lenses of quartz pebble conglomerate. The Charlotte River and associated floodplain is a succession of Quaternary estuarine and deltaic deposits of sand, silts and fluvial deposits of gravel sized weathered lithic clasts and sandy silts (Qe and Qa). Figure 2-4 is a conceptual geological model of the Project Area and Figure 2-5 shows the surface geology of the Project Area.

2.3.2. Geological structure

The are two major fault structures within the area surrounding Darwin and the Project Area, they are

- the Tom Turners Fault (Figure 2-5) which is a Cenozoic thrust fault sitting north-east to southwest in orientation approximately 28 km to the west of the Project Area; and
- the Giants Reef Fault, which Geoscience Australia (2025) shows as a fault running north-east to south-west orientation through the Project Area. This fault separates the Pine Creek Orogeny from the Litchfield and Central sub basins, creating a wedge-shaped embayment of sedimentary rocks where the Project Area and surrounding mines sit.

2.3.3. Observed geology

Bore records obtained through Northern Territory Government (2025) and Pietsch (1986) provide a description the geology and lithology found beneath the site. Table 2-2 presents a summary of these records as well as integration with drilling observations (CDM Smith, 2024).

Table 2-2 Lithological summary

Depth (mbgl)	Description
0 to 4	Soil, sandy clay, and alluvium; estuarine/floodplain influence; local thin regolith
4 to 20	Highly weathered brown/red schist -phyllite with clays and claystones.
20 to 35	Moderately weathered schist/phyllite with increasing quartz veining; transitional saprolite - bedrock zone.
35 to 45	Hard grey schist with quartz bands; occasional sandstone reported regionally.
> 45	Fresh grey to dark grey schist/phyllite with quartz and pegmatite; minor fractures in deeper intervals.

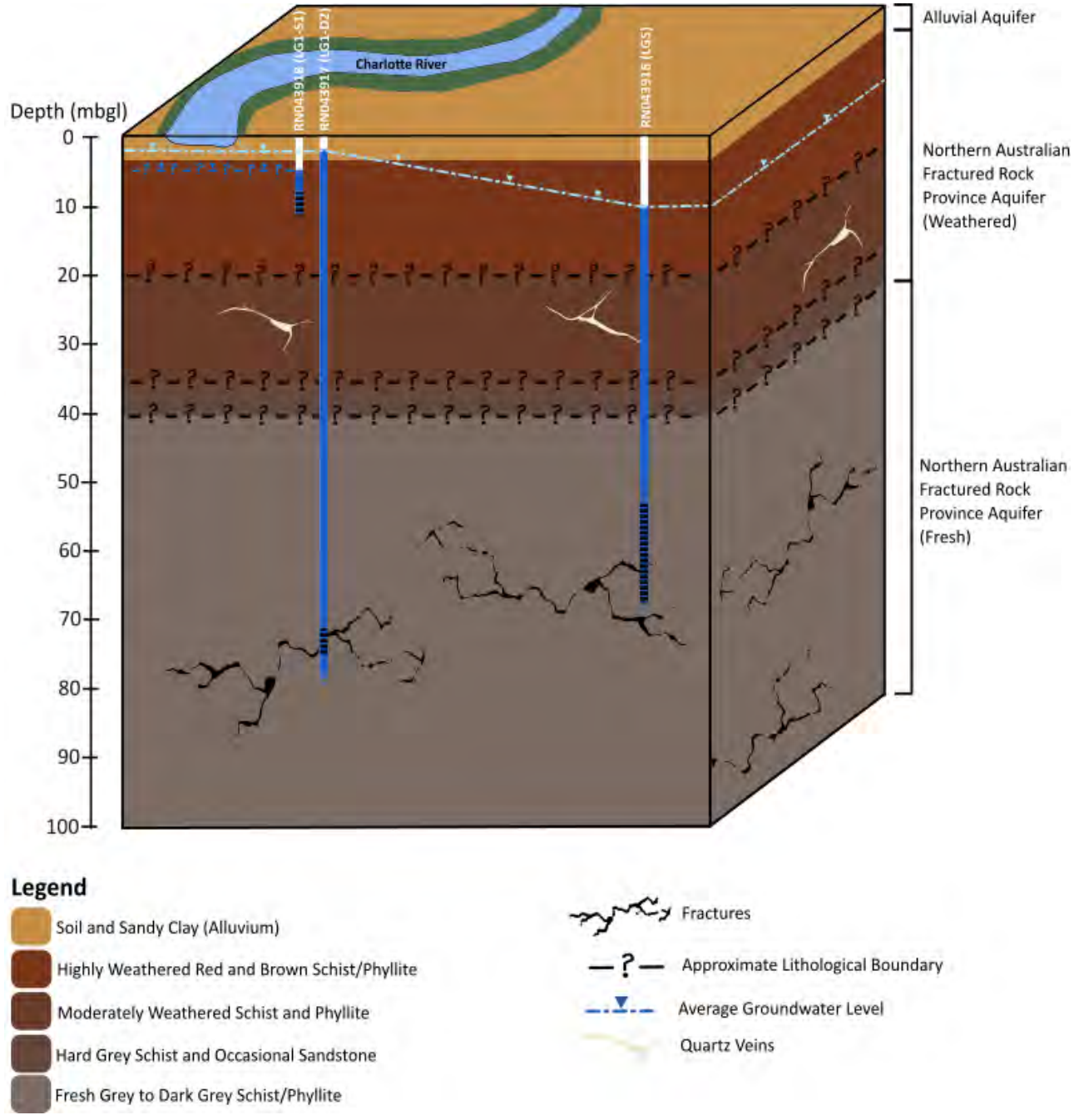


Figure 2-4 Conceptual Model of the Project Area.

Table 2-3 Observed geology within a 2 km radius of Project Area

Bore ID	Easting (GDA94 Z52)	Northing (GDA94 Z52)	Total Depth (mAHD)	Drilled Date	General Lithology
RN43840	692461	8590393	79	28/09/2023	Weathered brown and red schist into unweathered grey schist and phyllite.
RN43913 (LG3)	693979	8591294	60.1	15/11/2023	Weathered brown and red schist into unweathered grey schist and phyllite.
RN43914 (LG4)	693746	8591403	73	17/11/2023	Weathered brown and red schist into unweathered grey schist and fractured sandstone.
RN43915 (LG2)	693746	8591201	73	21/11/2023	Weathered brown and red schist into unweathered grey schist and phyllite.
RN43916 (LG5)	693653	8591237	69.5	23/11/2023	Weathered brown and red schist into unweathered grey schist and phyllite with occasional quartz bands.
RN43917 (LG1-D)	693615	8590960	79	1/12/2023	Weathered brown and red schist into unweathered grey phyllite with occasional quartz bands.
RN43918 (LG1-S2)	693615	8590957	12	1/12/2023	Weathered brown and red schist.
RN041993	694502	8588795	42	17/11/2020	Brown clays into firm unweathered claystone.
RN041798	693991	8593098	53.5	7/09/2020	Yellow sandy clays moving into brown and grey schist.
RN041797	693991	8593098	7	5/09/2020	Yellow sandy clays into weathered brown schist.
RN041832	694477	8593425	35.4	13/09/2020	Yellow sandy clays into weathered brown schist.
RN041831	694486	8593422	109	12/09/2020	Yellow sandy clays into weathered brown schist and fresh grey schist.
RN041830	694497	8593425	8	9/09/2020	Yellow sandy clays into weathered brown schist.

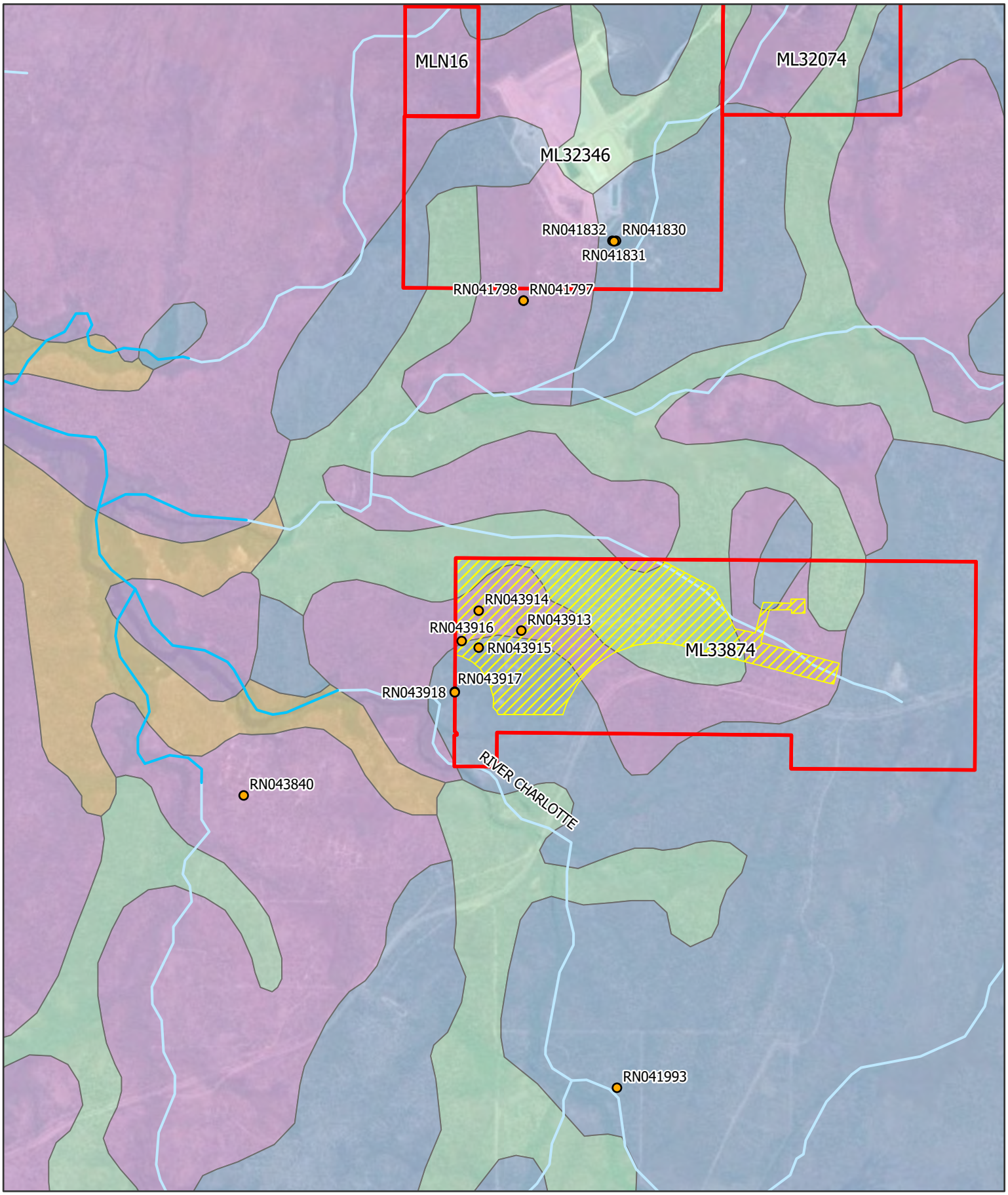


Figure 2-5 Surface Geology

Lei Lithium Proposed Distrurbance Footprint
Mining Lease
Groundwater Bores

Watercourses
Non-perennial
Perennial

Geological Formation (Geoscience NT, 1988)
Burrell Creek Formation

Alluvium (Geoscience NT, 1988)
Gravel, sand; silt
Mud; silt; clay
Sandy and gravelly soils:

0 250 500 1,000
Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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2.4. Soils

2.4.1. Overview

The Project Area is located within the Bustard Land System, characterised by lithosols, shallow yellow massive earths and earthy sand (EcOz Environmental Consultants, 2024b, Table 2.2). Land unit mapping confirms that the disturbance footprint is dominated by upland rises and gentle slopes developed over weathered metasedimentary rocks of the Burrell Creek Formation (BCF). Soil erosion risk is moderate with slope gradients greater than 2% comprising approximately 43% of the proposed disturbance footprint. Soil characteristics influence infiltration, runoff generation and recharge processes that contribute to groundwater dynamics within the Project Area.

Figure 2-6 presents the Australian Soil Classification mapping for the Project Area (Geoscience Australia, 2025). The mapping indicates that the disturbance footprint is dominated by upland soil units associated with shallow weathered bedrock and well-drained slopes. These soils occur on elevated terrain above the Charlotte River drainage system and are generally characterised by shallow profiles and moderate permeability.

The soil units mapped within the disturbance footprint are primarily associated with upland rises and gentle slopes developed over weathered BCF. These landforms are typically well-drained and are not associated with estuarine or floodplain depositional environments where acid sulfate soils are more likely to occur.

2.4.2. Acid sulphate soils (ASS)

Desktop mapping indicates the Project disturbance footprint does not intersect mapped ASS or potential acid sulphate soils (PASS) areas (Northern Territory Government, 2025). The Charlotte River alluvial corridor contains mapped PASS, including areas where PASS is present within the upper 1 metre (m) of soil profile (Figure 2-6). Localised areas of known ASS are mapped within the broader Charlotte River tidal reach. These areas are confined to low-lying alluvial and tidal sediments associated with the Charlotte River. Figure 2-7 provides further information on ASS soil descriptions and coastal habitat classes with the following present within a 5 km radius of the Project Area:

- Aa = Subaqueous materials (high probability),
- Ab = Intertidal flats (high probability),
- Am = Hydrosols (high probability), and
- An = Dermosols (high probability).

Based on Section 2.5.4.3 it has been identified that there is potential that ASS is contributing to increased levels of Al, As and Zn through mobilisation within suspended sediment in tidal zones. This creates levels that are above guideline values with discussion and recommendations for this in Section 6.3.1.1 and Section 6.5.

Hydrological observations presented in Section 2.3 indicate upstream tributaries of the Charlotte River within the Project Area are generally ephemeral, with limited dry-season flow. Surface water permanence analysis indicates that permanent water occurs primarily within the main Charlotte River channel further downstream. This suggests that groundwater discharge to upstream tributaries is limited and that water levels within the shallow alluvial sediments are already seasonally variable.

Overall the proposed disturbance area is located on elevated terrain outside these mapped ASS/PASS areas. Consequently, direct disturbance or excavation of ASS/PASS material from Project construction activities is considered unlikely to occur.

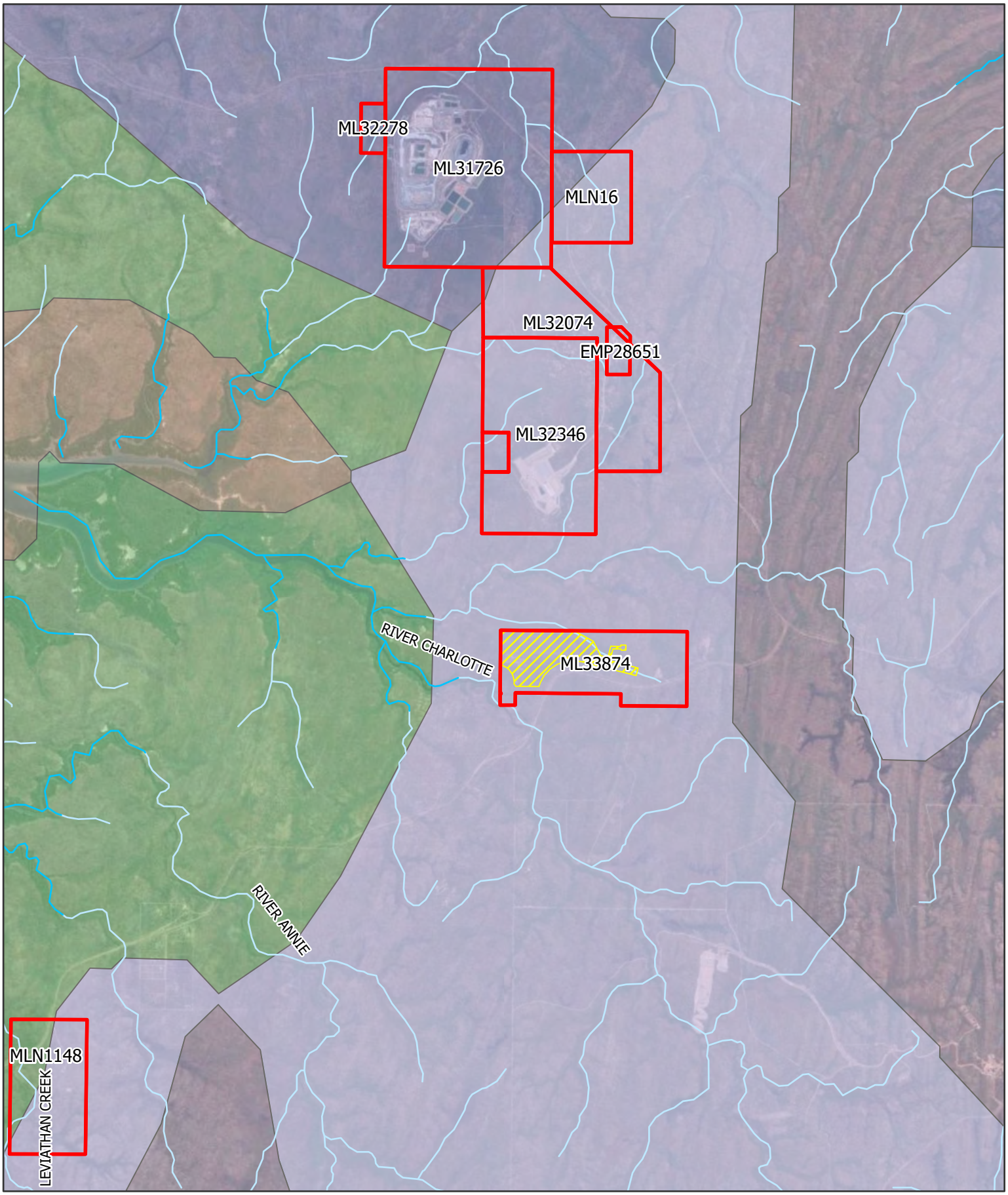


Figure 2-6 Soil Classification (CSIRO & National Resource Information Centre , 1991)

Lei Lithium Proposed Distrurbance Footprint
Mining Lease

Watercourses
Non-perennial
Perennial

Australian Soil Classification
Jw1
LK22
LK24
Mr8
Tb134

0 1,500 3,000
Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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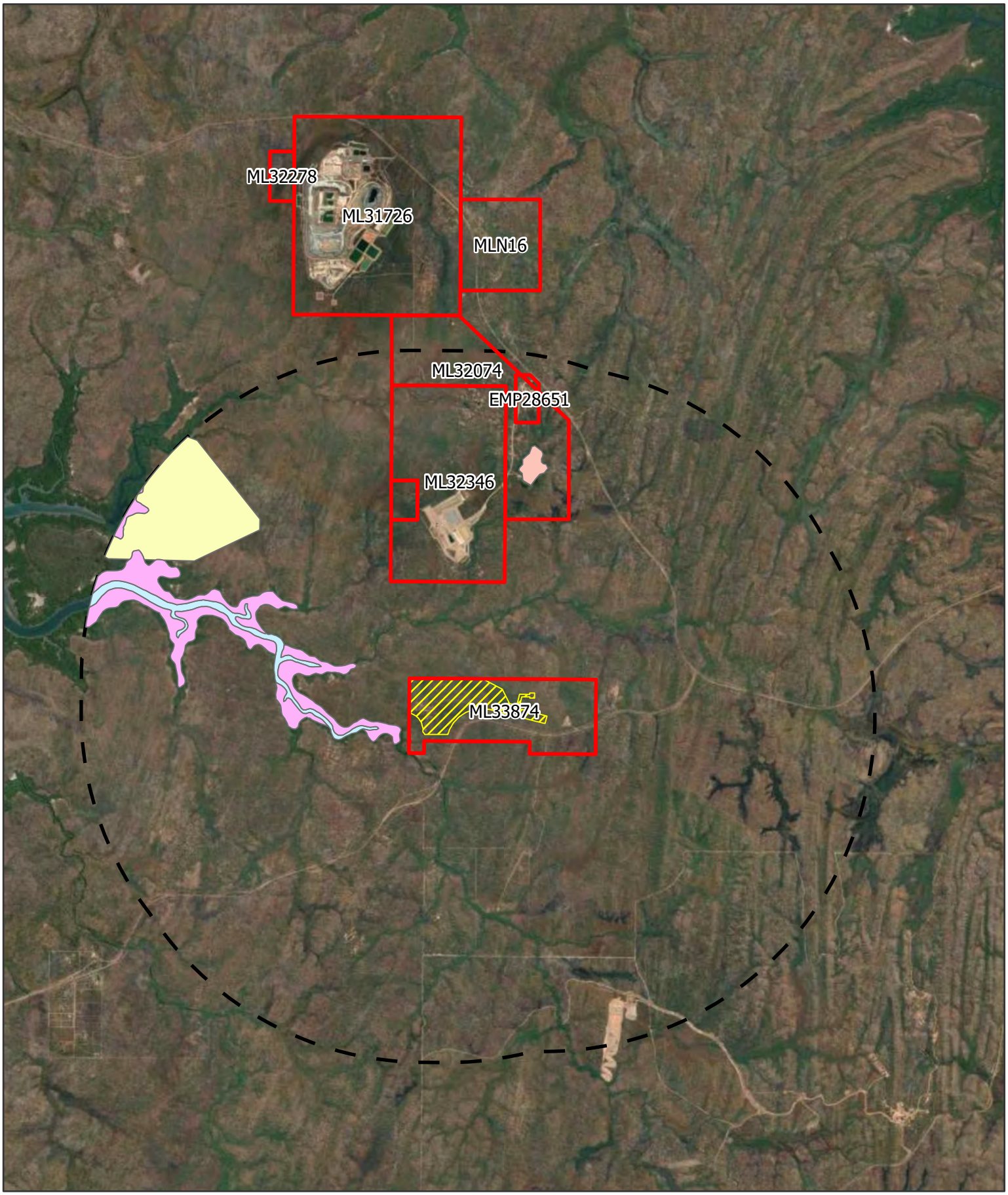


Figure 2-7 Acid Sulfate Soils - High Probability of Occurrence (Northern Territory Gov, 2025)

Mining Lease
Lei Lithium Proposed Distrurbance Footprint
5km Buffer

Acid Sulfate Soil Class
Aa(p4)
Ab(p4)
Am(p4)
An(p4)

0 750 1,500 3,000
Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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2.5. Topography and Drainage

2.5.1. Elevation

The ML33874 area has a low relief with the elevation within the Project Area ranging from 38 m Australian Height Datum (AHD) to the east gradually decreasing in elevation towards the western boundary of 14 mAHD. The highest elevation surrounding the area is 86 mAHD which is located 2 km southeast. Figure 2-8 shows the topography and drainage features of the Project Area.

2.5.2. Surface water features

The Charlotte River is located 36 km south of Darwin, feeds into the Bynoe Harbour, an estuary system part of the Timor Sea Basin. It has a classification that is non-perennial dominated by wet season rainfall when majority of the high flow events occur. The river is a single channel in its lower reaches that leads into the gulf entrance 8 km from the Project Area. There are multiple tributaries that run within the 5 km radius from the Project Area with one ephemeral tributary bisecting the Project Area. The River Style Framework (Brierley and Fryirs, 2005) classifies the Charlotte River as a lowland meandering river with a discontinuous floodplain.

Darwin Rural Adelaide River Water Control District spans across the Project Area. Its western boundary flows to the southern boundary of the Charlotte River catchment area but is not covered by the Adelaide River Water Allocation Plan (Northern Territory Government, 2024). There is a lake, named Observation Hill Dam, registered within ML32074 along a tributary of Charlotte River.

2.5.3. Surface water permanence

Geoscience Australia Observations (2025) shows the multiyear compilation of aerial images depicting the percentage of water detected since 1987, see Figure 2-9. Charlotte River to the south of the Project Area shows that there was water detected in 80% of observations within the main channel ~1 km downstream of the ML boundary.

Drainages bordering and crossing the site appear to be ephemeral. The tributaries crossing the site show no water permanence while the section of Charlotte River closet to the mine lease boundary shows recorded water in less than 1% of observations see Figure 2-9 (Geoscience Australia, 1986). . The surface water flows are seasonally driven within tributaries; observations in the main water body of the Charlotte River indicate a presence of permanent water that may be sustained by groundwater discharge or influenced by tidal flows from the Bynoe Harbour. Overall, this indicates that permanent water occurs primarily within the main Charlotte River channel. Suggesting that groundwater discharge to upstream tributaries is limited and that water levels within the shallow alluvial sediments are already seasonally variable.

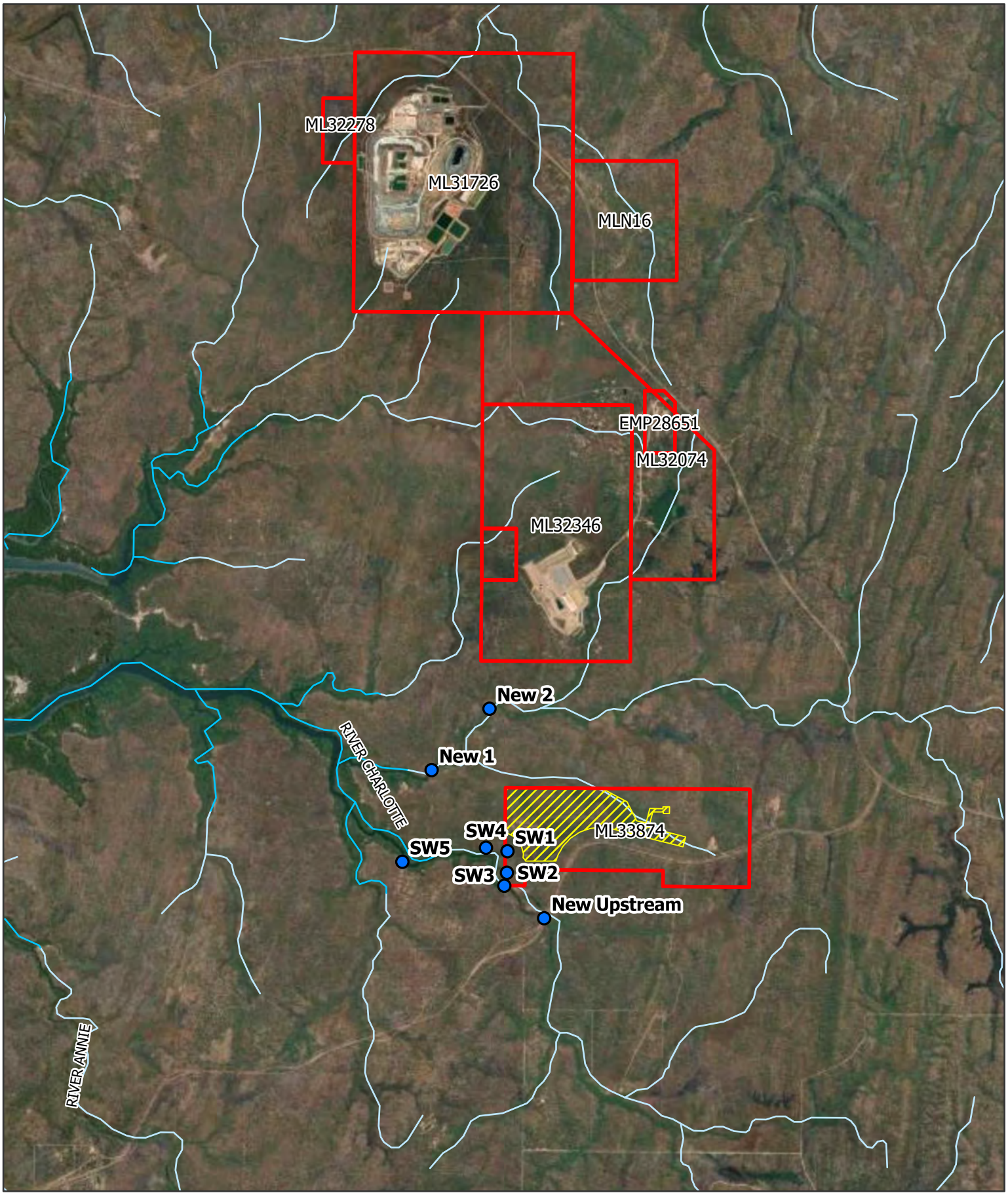


Figure 2-8 Topography and Drainage

Legend

- Lei Lithium Proposed Distrurbance Footprint
- Mining Lease

Watercourses

- Non-perennial
- Perennial
- Surface Water Monitoring Sites

0 500 1,000 2,000
Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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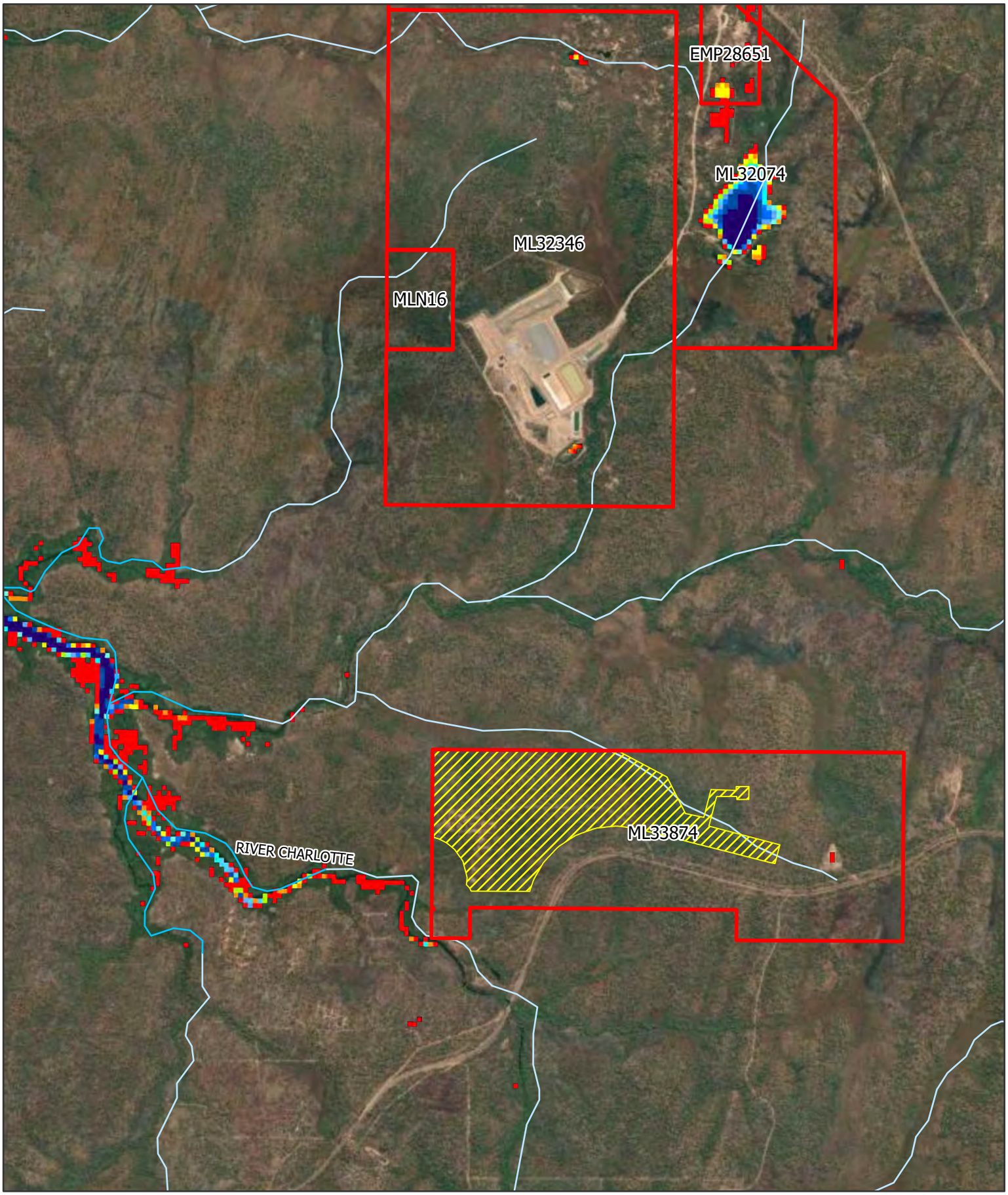


Figure 2-9 Surface Water Permanence

Lei Lithium Proposed Distrurbance Footprint

Mining Lease

Watercourses

Non-perennial

Perennial

DEA Water Observations Multi Year (%)

0.001 - 0.005

0.006 - 0.05

0.051 - 0.1

0.11 - 0.2

0.21 - 0.3

0.31 - 0.4

0.41 - 0.5

0.51- 0.6

0.61 - 0.7

0.71 - 0.8

0.81 - 0.9

0.91- 1

0 500 1,000

Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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2.5.4. Surface water quality

2.5.4.1. Fluvial setting

Surface water quality within the Charlotte River and associated tributaries is strongly influenced by tidal fluctuations. Monitoring sites are located both in fresh tributaries as well as tidal fluvial zones, making water quality and associated trigger levels more complex. The sites were divided into tidal and freshwater zones based on typical salinity levels presented and are presented in Table 2-4 and Figure 2-10. Note all sites are connected to the marine environment and show some level of elevated salinity.

Table 2-4 Fluvial setting of surface water monitoring site ID

Surface water monitoring site ID	Fluvial setting	Easting	Northing
New1	Tidal	692759.27	8591894.85
SW2	Tidal	693636.13	8590699.40
SW3	Tidal	693605.66	8590548.09
SW5	Tidal	692418.17	8590826.92
New Upstream	Freshwater	694069.62	8590169.91
SW1	Freshwater	693642.36	8590950.10
SW4	Freshwater	693392.32	8590990.66
New2	Freshwater	693433.07	8592609.60

2.5.4.2. pH and electrical conductivity

The freshwater monitoring sites have pH ranging from 5.57 to 8.81, with the majority sitting within the ANZECC (2000) tropical lowland river pH limits for the area (Figure 2-11). The New Upstream site has more variability likely due to location within the upper tributaries of the Charlotte River. The Electrical Conductivity (EC) of the freshwater sites ranged from 15.80 to 37,462µS/cm, with majority of the samples sitting within an acceptable range based on the ANZECC (2000).and representative of freshwater, with some samples showing elevated EC consistent with mixing with marine or other saline water sources. The New2 and New Upstream site has some spikes in data potentially indicating peak tidal range or groundwater intrusion.

The tidally influenced sites (Table 2-4) have no guideline marine values associated with them, making it important to outline baseline conditions for the sites. pH for the tidal monitoring sites ranged from 5.69 to 9.92, which is considered slightly alkaline (Figure 2-12). EC ranged from 17.90 to 62,360 µS/cm, representing a typical range for tidal sites. The relatively lower EC values were recorded at SW3, located the furthest upstream and subject to tidal flushes depending on cyclic variations rather than daily patterns.

Figure 2-13 clearly shows that pH has a wide range of values throughout the report period with Q1 2024, Q3 2024 and Q1 2025 all showing more than one outlier. The broad range in pH values is likely to be natural variation due to the tidal influence and this should be considered when reviewing monitoring data during (and post) mining operations.

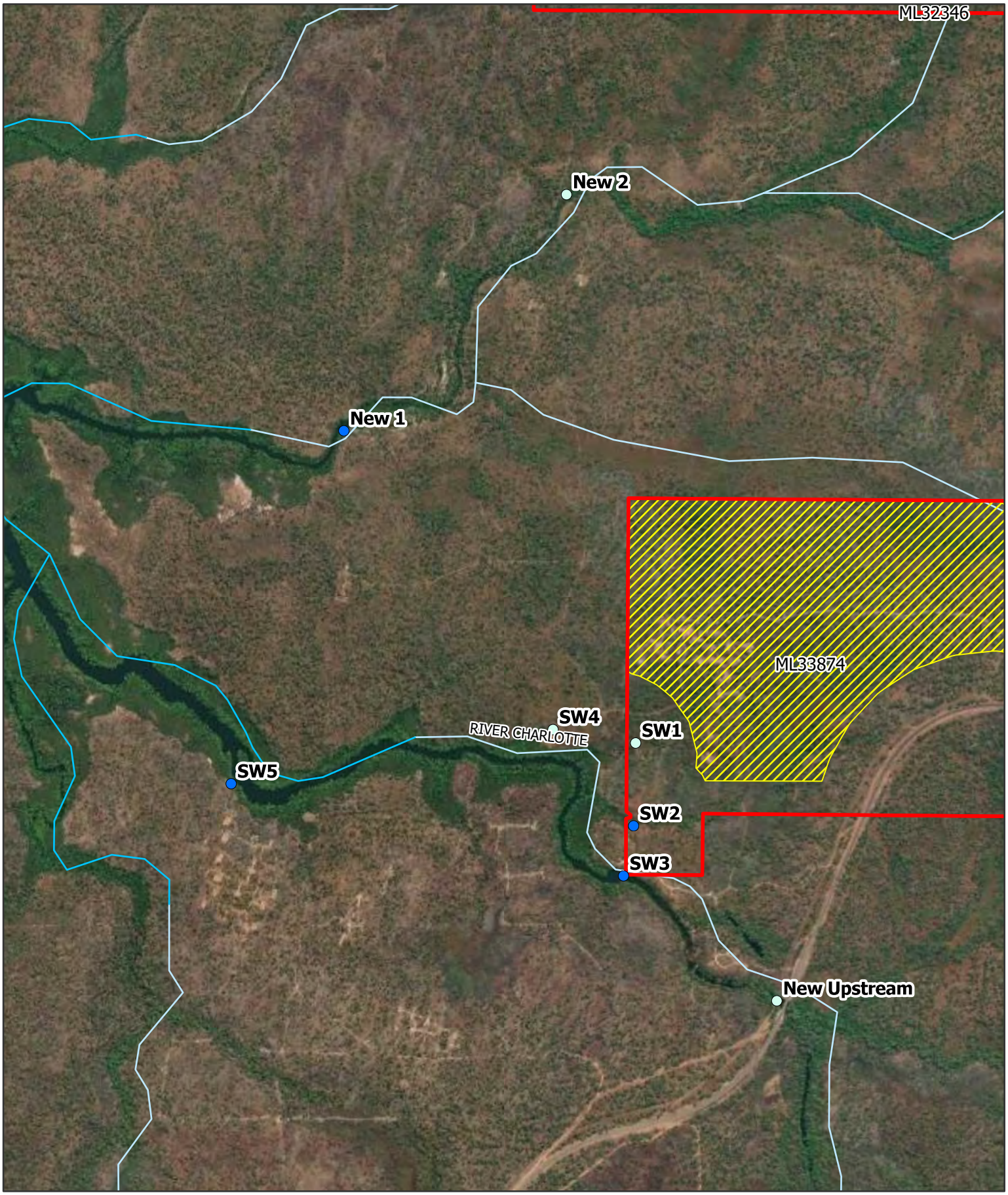


Figure 2-10 Surface Water Monitoring Sites

Legend

- Lei Lithium Proposed Distrurbance Footprint
- Mining Lease

Watercourses

- Non-perennial
- Perennial

Surface Water Monitoring Sites

- Freshwater
- Tidal

0 125 250 500
Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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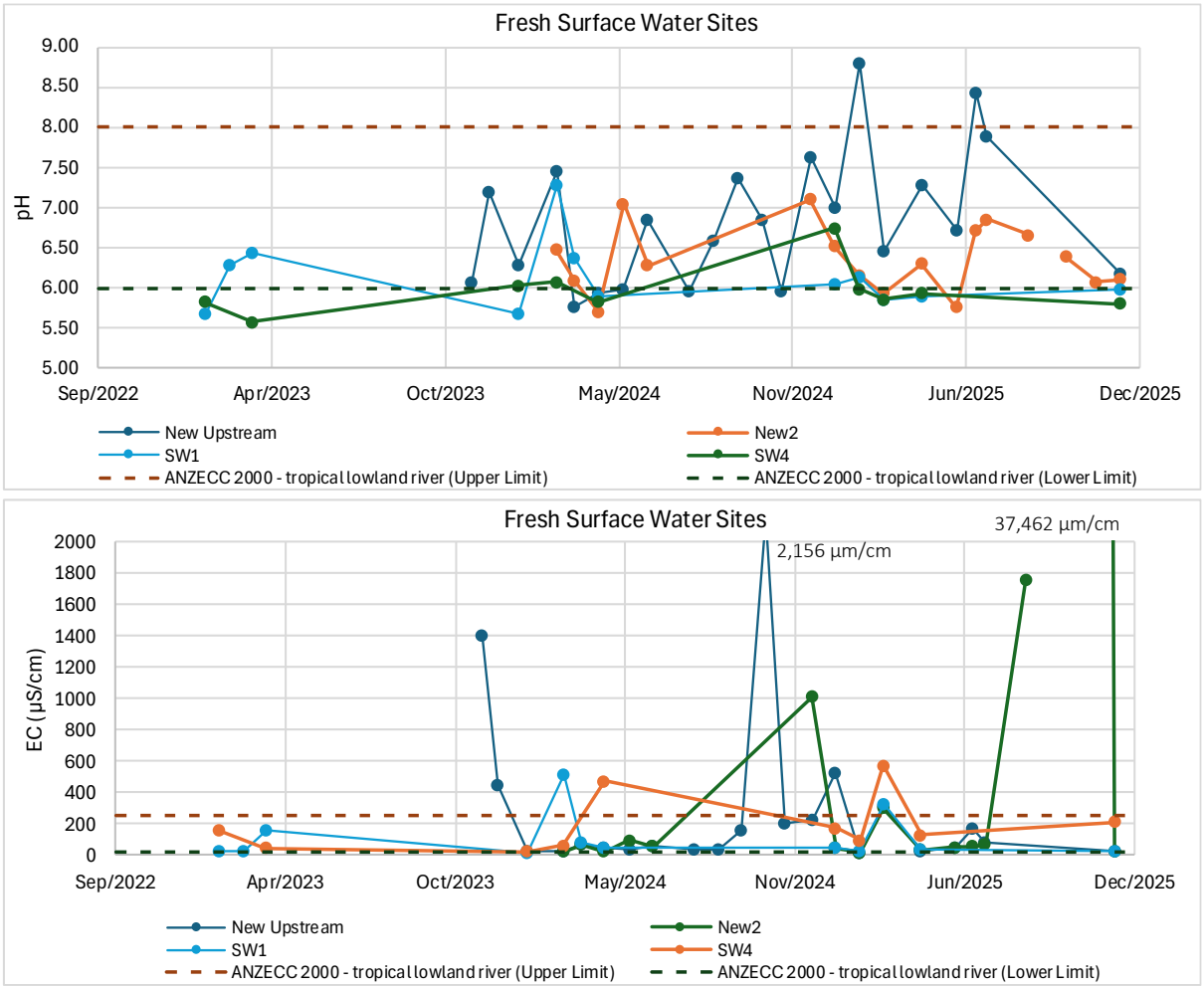


Figure 2-11 Freshwater surface water sites pH and EC note: sea water typically 50,000 -60,000 µm/cm

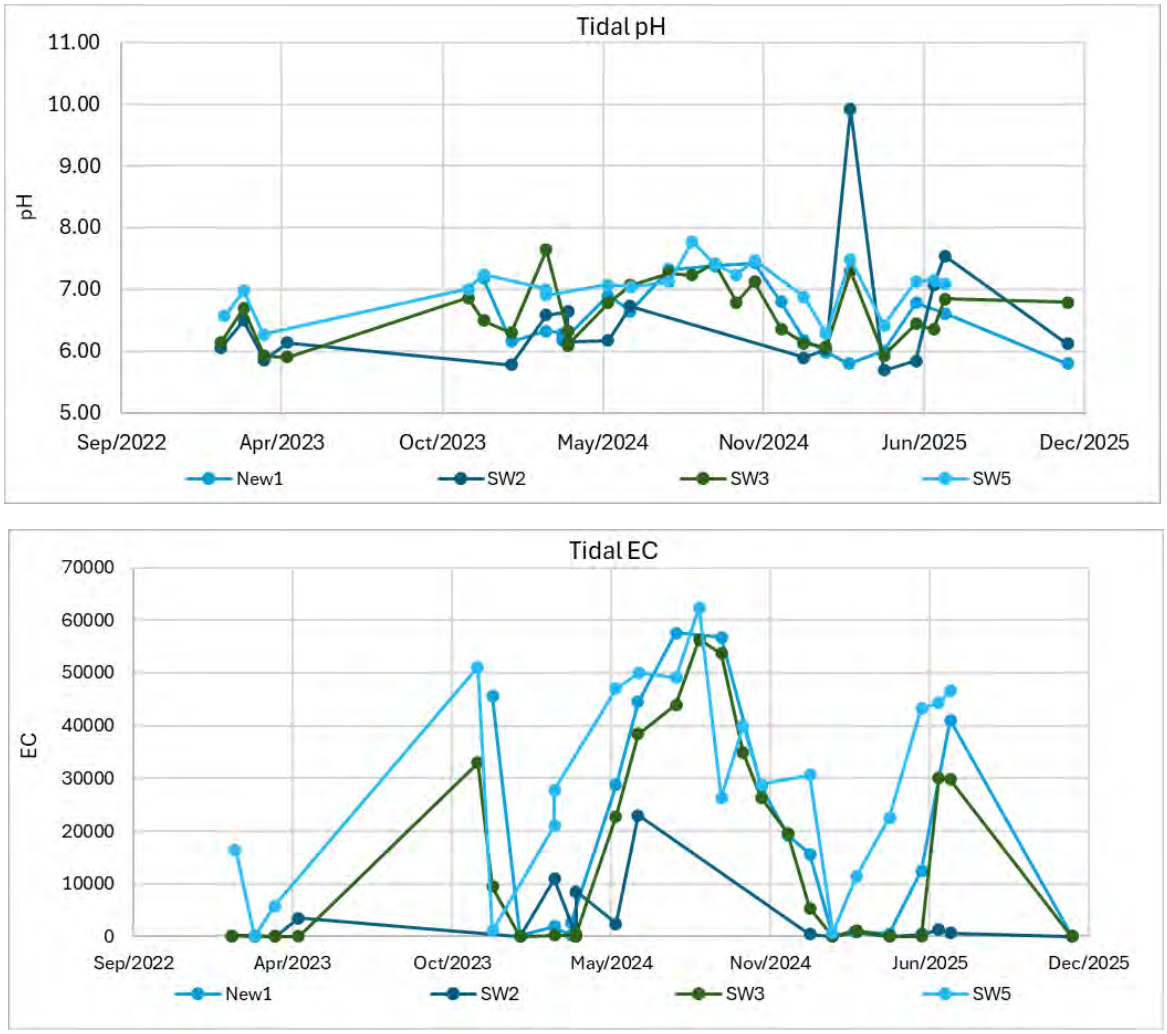


Figure 2-12 Tidal surface water sites pH and EC

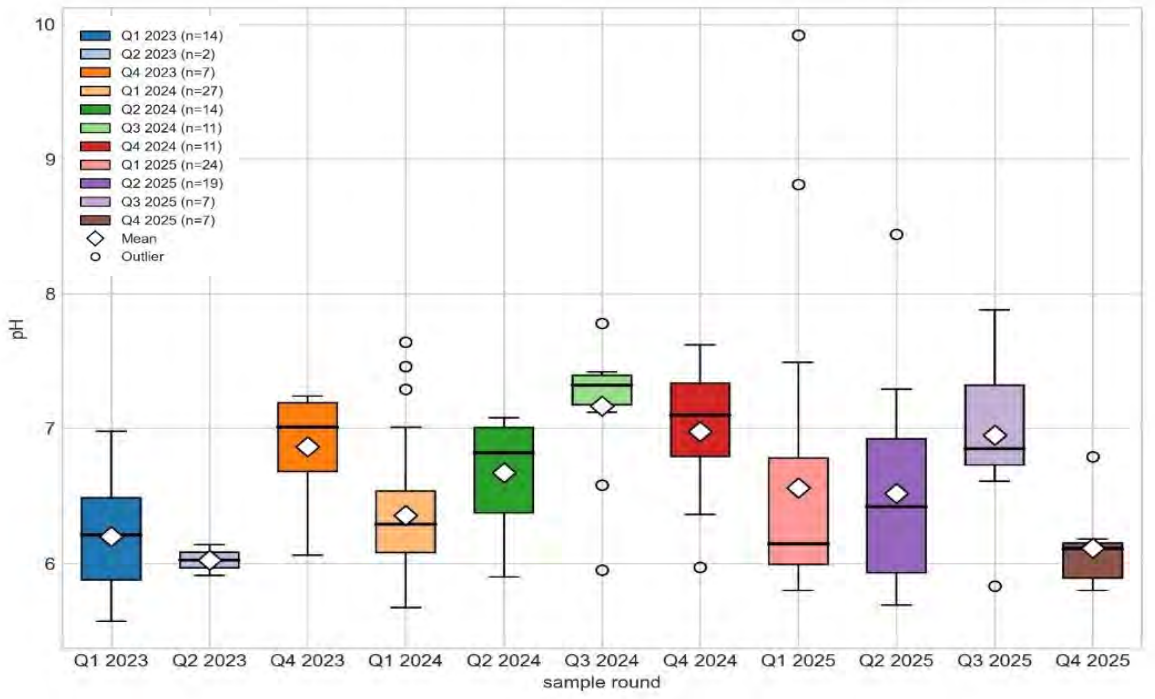


Figure 2-13 Surface water pH 2023 – 2025

2.5.4.3. NT EPA Environmental Factors and Objectives analytes

Based on the NT EPA Environmental Factors and Objectives (Table 1-1) considerations of Zinc (Zn), Aluminium (Al) and Arsenic (As) have been assessed in relation to guidelines required for the area. Sites were divided into tidal and freshwater monitoring locations due to default guideline values differing for marine and freshwater environments.

All sites across dissolved and total Zn fluctuate to near trigger level concentrations (0.008 mg/L, freshwater - 95% species protection, 0.015 mg/L marine - 95% species protection). and below reporting limit (0.005 mg/L), see Figure 2-14 and Figure 2-17.These fluctuations occur in both tidal and freshwater sample locations and are not well correlated temporally or spatially.

Total Al within the freshwater monitoring locations is variable (Figure 2-15) with SW4 and New 2 sites seeing the largest spikes in data, with some observations above trigger levels. Concentrations of Al at New Upstream have remained consistently below ANZECC (2000) freshwater guidelines (0.008 mg/L, freshwater - 95% species protection), while SW1 peaks slightly above the guideline value.

Concentrations of total and dissolved As were reported below the DGVs for AS (III) and As (V) for all samples across the sites measured (Figure 2-16) and are considered to be consistent spatially and temporally.

It is possible these erratic results are a result of a reaction from acid sulfate soils (ASS) that line the creek combining with a low pH to allow mobilisation and release of metals from sediments however there is no clear correlation between samples elevated metals and lower than expected pH results and there is no clear correlation between elevated metals and sample sites located in high risk ASS areas as mapped in Figure 2-1. Therefore it is unlikely that ASS is the main driver for the elevated metals.

Weathering of the creek line is also evidenced by tidal fluxes in turbidity, with observations ranging from 0 to 20 NTU across the reporting period.

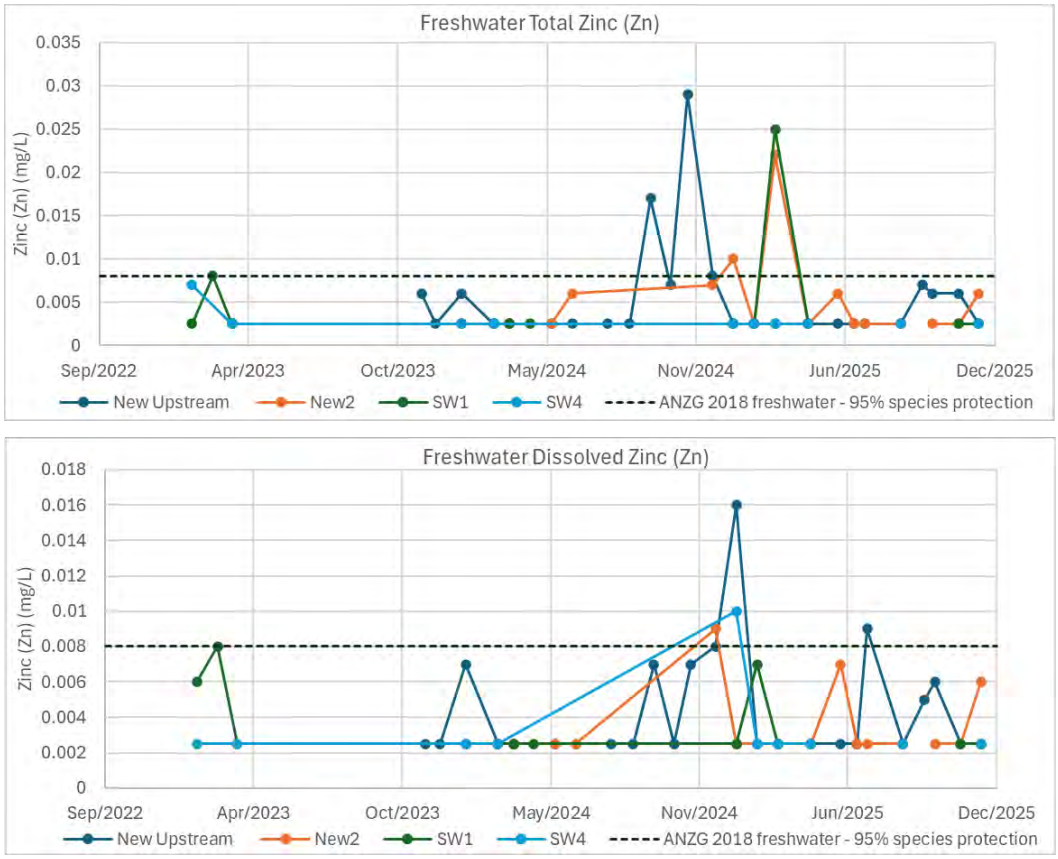


Figure 2-14 Fresh Surface Water Sites total and dissolved Zinc (Zn)

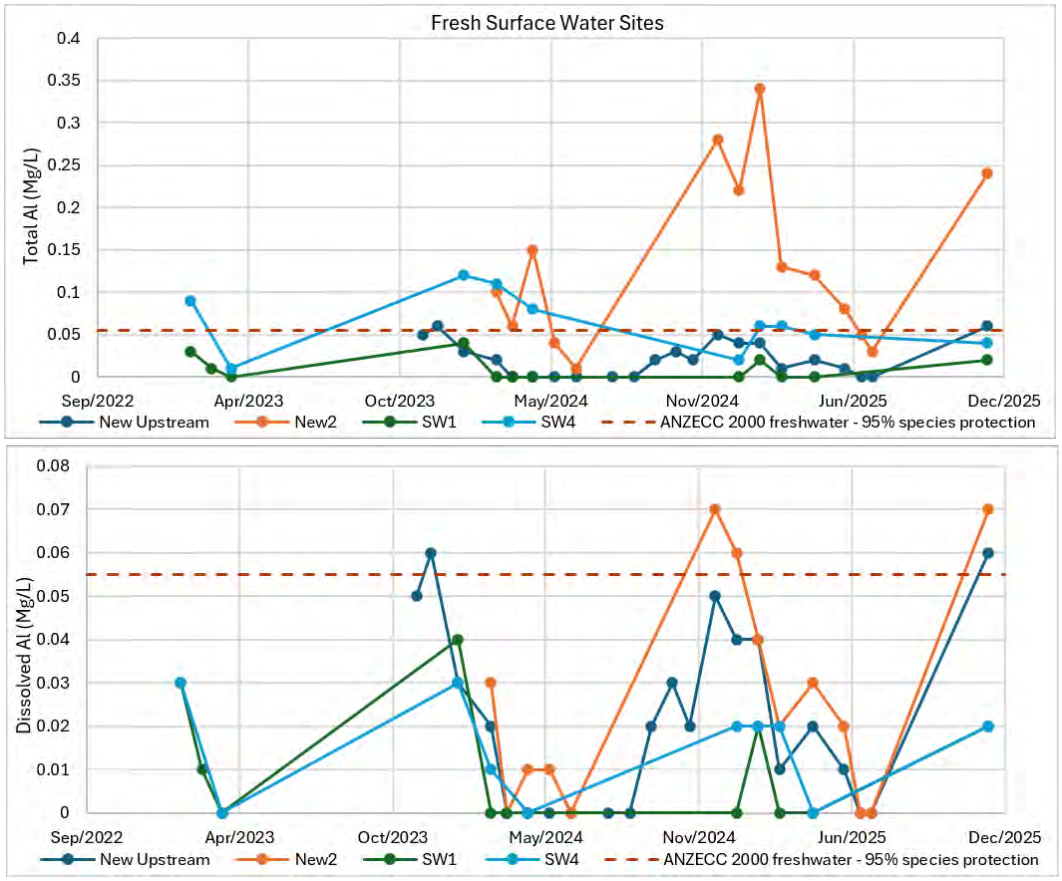


Figure 2-15 Fresh Surface Water Sites total and dissolved Aluminium (Al)

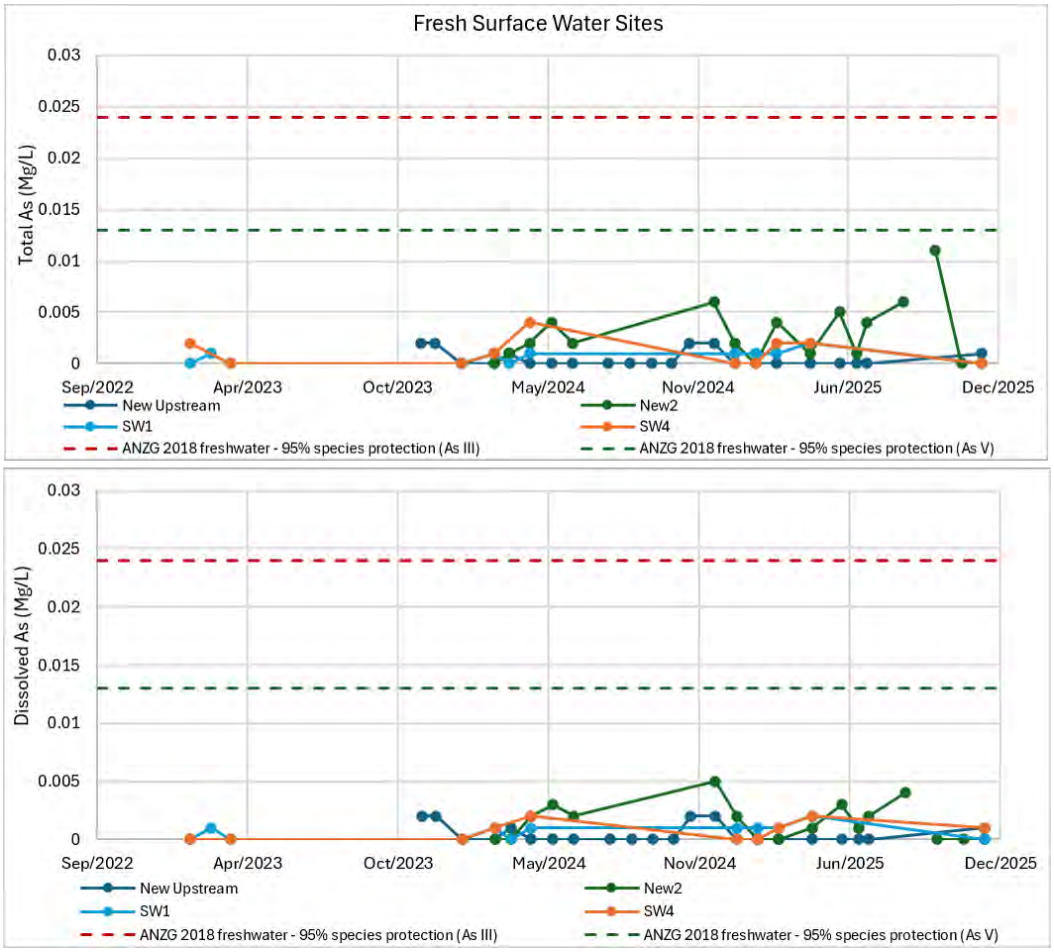


Figure 2-16 Fresh Surface Water Sites total and dissolved Arsenic (As)

Zn levels at tidal monitoring sites for total and dissolved are presented in Figure 2-17. Most data points are below the ANZG (2018) marine trigger level. With total Zn concentrations fluctuating sharply in September 2024 and February in 2022 at SW2 and SW5, respectively. This may be a result of increased fresh and marine water mixing allowing for sediment transport of Zn and is also related to Fe/Mn oxide cycling.

Al levels for tidal sites (Figure 2-18) don't have triggers associated with them, but majority of the reported values sit below reporting limit. SW2 and SW5 sites shows sharp peaks in February and September 2024 for total Al and in February in 2022 for SW5. Similarly to Fresh monitoring site observations, ASS are unlikely to be the main driver for these fluctuations. As levels for all marine sites (Figure 2-19) are sporadic in both the total and dissolved concentrations, fluctuating between reportable values and values below reporting limit. Tidal sediment resuspension and associated changes in salinity with tidal flows are likely to contribute to variable data.



Figure 2-17 Tidal Surface Water Sites total and dissolved Zinc (Zn)

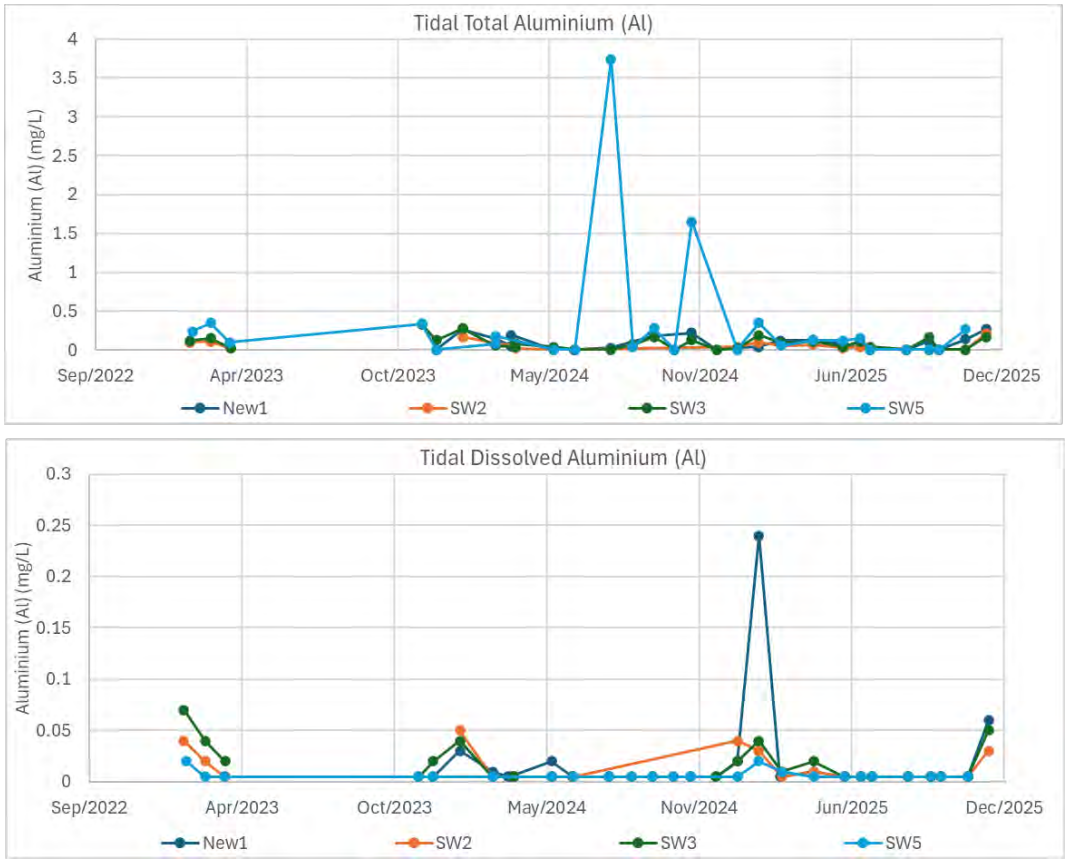


Figure 2-18 Tidal Surface Water Sites total and dissolved Aluminium (Al)

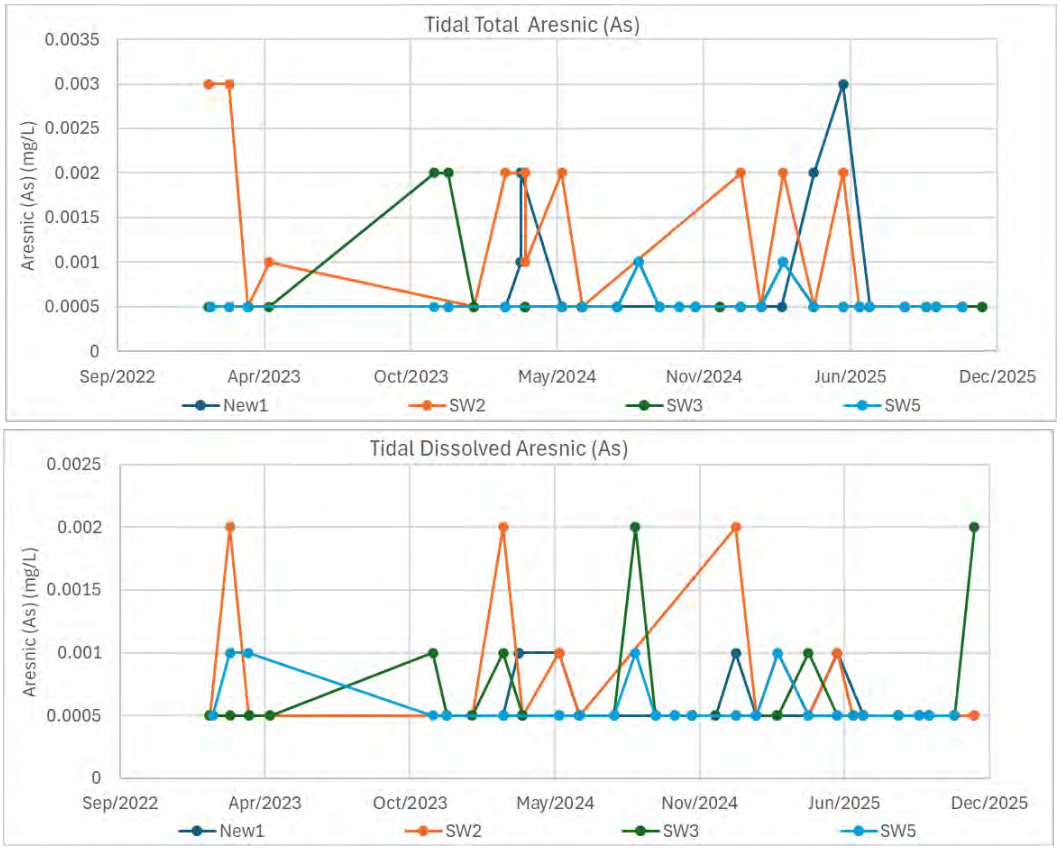


Figure 2-19 Tidal Surface Water Sites total and dissolved Arsenic (As)

2.6. Hydrogeology

2.6.1. Overview

The hydrogeological setting of the Project Area and surroundings is the Northern Australian Fractured Rock Province (NAFRP) aquifer with pockets of porous aquifers that surround Berry Springs to the east and to the north to the end of the Cox Peninsula. The BCF forms the NAFRP in the Project Area with shallow alluvial aquifers in Cenozoic deposits in areas with thicker deposits commonly along alluvial lines.

2.6.2. Previous studies

Previous studies for the Project Area include the Preliminary Groundwater Assessment and the Drilling Report Conducted in 2023 and 2024 as appendices to the Lei Lithium Referral under the Environmental protection act 2019. The key finding from these reports includes (Groundwater Enterprises, 2023) (CDM Smith, 2024):

- Groundwater near the Lei deposit occurs entirely within the BCF, a fractured rock aquifer that is present at shallow depth or outcrops across the Project Area. No shallow alluvial aquifers were intersected in drilling.
- A consistent stratigraphy is present across the Project Area: 0-4 m soil/sandy clay, 1-40 m weathered red/brown schist, 40-65 m grey schist/phyllite with quartz bands and fractures, and 65-75 m fractured grey phyllite and occasional sandstone/pegmatite.

- Low yields from shallow bores (< 0.5 L/s) reflect limited porosity and fracturing in the weathered zone, while higher yields (1-3 L/s) occur where deeper fractures or quartz veins are intercepted, typically between 50-80 m.
- Hydraulic conductivity in fractured intervals ranges 0.1-3.8 m/day, while fresh or weathered rock without fractures is significantly less permeable (0.003-0.08 m/day).
- Water levels across the BCF are generally shallow (< 15 mbgl) with local evidence of upward vertical gradients from nested bores. Depth to water decreases down-gradient toward the Charlotte River.
- Groundwater is predominantly fresh, with EC values typically between 19-930 µS/cm.
- pH in regional groundwater is mildly acidic (4.4-7.0), but Project Area bores have recorded a broader range (5.81-10.47).
- Underlying Pegmatite is likely non-aquiferous except where fractured.
- Alluvial deposits along the Charlotte River may host small, seasonal aquifers supporting riparian ecosystems. Groundwater flow likely follows topography toward the Charlotte River.

There have been previous groundwater modelling studies within the peninsula for the surrounding mining activities to the north of the Lei Lithium Project Area within this assessment. These are the following:

- 2018 (CloudGMS, 2018)- was developed to assess the impact of proposed mining at the Grants Lithium Project (GLP) on the surrounding aquifer system to support their EIS.
- 2021 (CloudGMS, 2021)- conducted modelling for the BP33 activities for Finnis Lithium, this model included the GLP (CloudGMS, 2018) to support their EIS.

2.6.3. Hydrostratigraphic units

The key hydrostratigraphic units within the Project Area is shown in Table 2-5. These units reflect the weathering profile of the BCF and form the basis for the conceptual hydrogeological model and subsequent numerical groundwater modelling. The shallowest unit comprises of Quaternary alluvial sediments associated with drainage features. These sediments typically consist of sandy clays and gravels and form a thin, discontinuous alluvial aquifer. Drilling undertaken during the investigation program indicates that these deposits are generally limited in thickness within the Project Area and were intersected at depths of approximately 0 to 4 mbgl.

Table 2-5 Hydrostratigraphic unit summaries

Age	Name	Lithology	Aquifer	Depths (mbgl)
Quaternary	Alluvial Sediment	Sandy clays and gravels	Alluvial Aquifer	0 to 4
Proterozoic	Weathered BCF	Red and brown schists and minor clays lenses	NAFRP aquifer	4 to 40
Proterozoic	Fresh BCF	Grey schists and phyllite	NAFRP aquifer	40 to 75 +

Beneath the alluvium, the BCF exhibits a weathering profile that is hydrogeologically significant. The upper portion of the formation consists of weathered schists with clay lenses and iron oxide staining. This unit forms a weathered fractured rock aquifer with limited permeability and storage, consistent with the Northern Australian Fractured Rock Province (NAFRP) aquifer classification.

At greater depths, the BCF transitions into slightly weathered to fresh phyllite and schist. Groundwater within this unit occurs primarily along discrete fractures and quartz veining, and overall

hydraulic conductivity is generally low except where localised fracture zones are intersected. For the purposes of hydrogeological assessment and numerical modelling, the weathered and fresh BCF units are treated as components of the fractured rock aquifer system.

2.6.1. Aquifer hydraulic properties

Prior to the 2024 Groundwater Bore Drilling Report (CDM Smith, 2024) there have been no aquifer hydraulic studies conducted within the Project Area. Adjacent studies at BP33 to the North indicate that the predominant aquifer within the region is the BCF with overall low yields (< 0.5 L/s) with the resource being of limited potential due to low primary porosity and minimal open fractures. There are however higher yields within fracture zones and quartz veins. With groundwater level typically seen at the base of the weathering zone of the BCF. Bores within the BP33 Project Area to the north of the Project Area have recorded hydraulic conductivity rates of 0.27-2.6 m/day within fractured sections and 0.0003-0.08 m/day in fresh rock with no fractures.

2.6.2. Depth to Groundwater, Fluctuation and Groundwater Flow Direction

Groundwater levels within the bores recently drilled in the Project Area indicate a relatively shallow aquifer with levels up to 16 mbgl see Figure 2-20. Groundwater levels in mAHD and over time are provided in Figure 2-21 and Figure 2-22. Through Groundwater Enterprises (2023) report groundwater level and water fluctuations groundwater flow at BP33 and Grants deposits generally follows surface topography water level data collected in the groundwater monitoring bores around the Project Area suggest local groundwater flows follow this pattern flowing towards the Charlotte River Figure 2-24.

Although the available dataset is not continuous across each month, groundwater levels are typically at the lowest point towards the end of the dry season (September) and their peak at the end of the wet (March), consistent with the conceptual model of recharge in the area. Seasonal groundwater level increases following wet season rainfall indicate that recharge occurs primarily through diffuse infiltration of rainfall during the monsoonal wet season, see Figure 2-21. However, there is significant variation between bores and years in the fluctuations between wet and dry periods and not all bores show this trend in every year (Figure 2-22), LG1s has significantly lower hydraulic head due to its proximity to Charlotte River and the shallow screen depth.

Groundwater level and flow directions on a regional scale are presented in Figure 2-24.

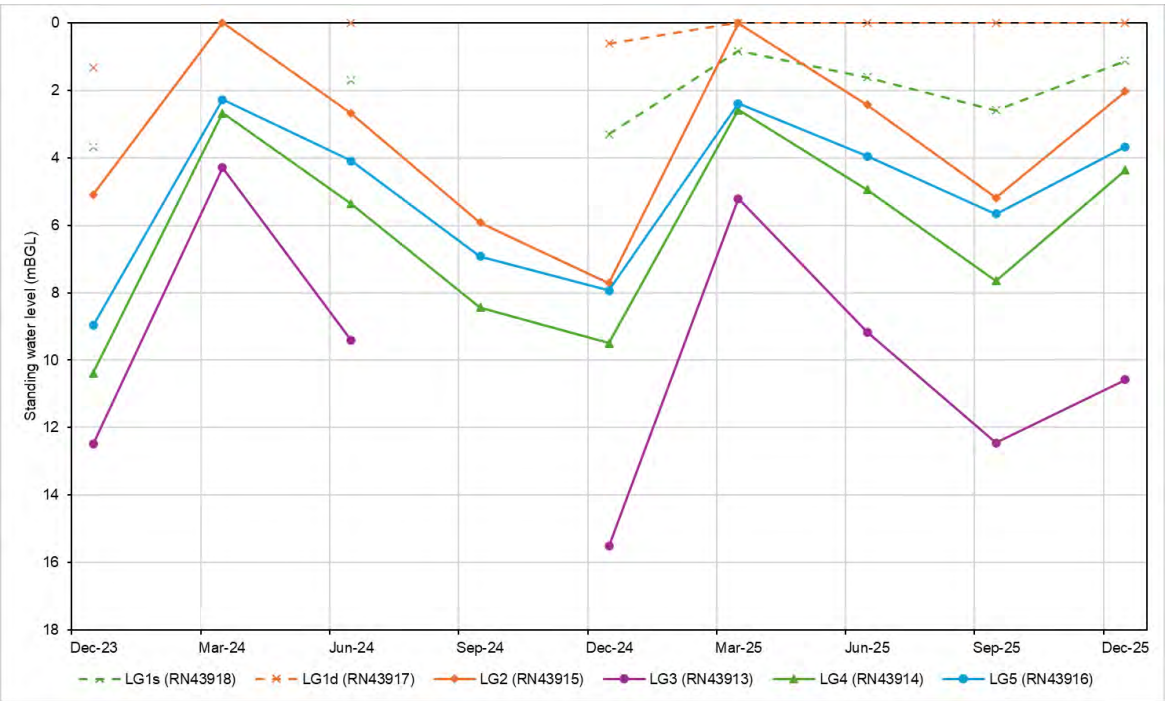


Figure 2-20 Standing water level (mbgl)

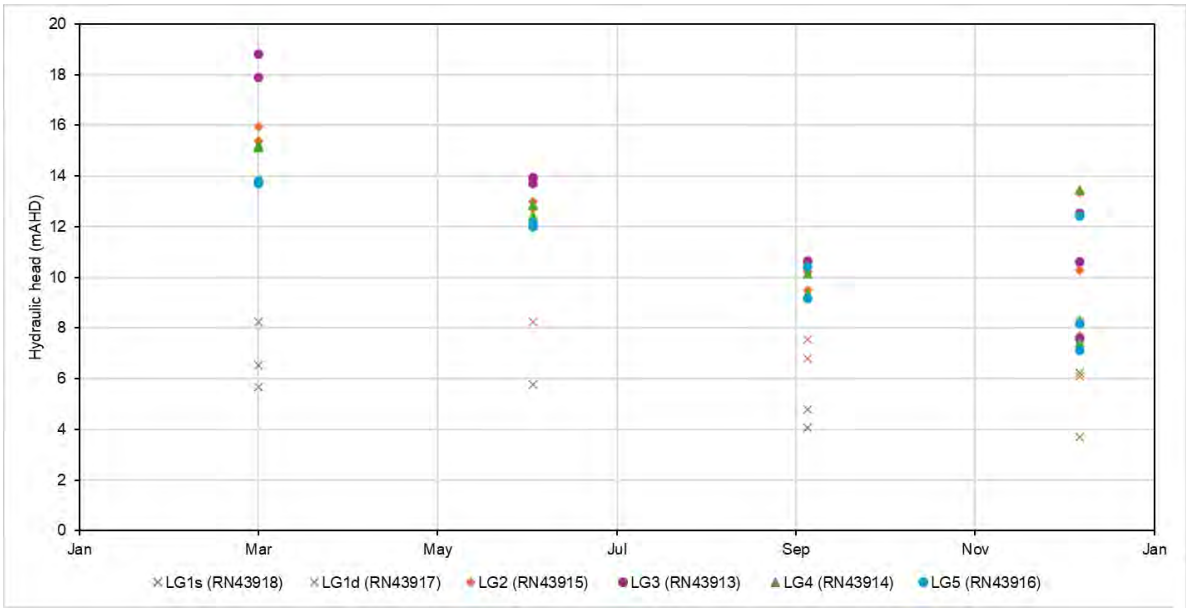


Figure 2-21 Range of standing water levels during each month (mAHD)

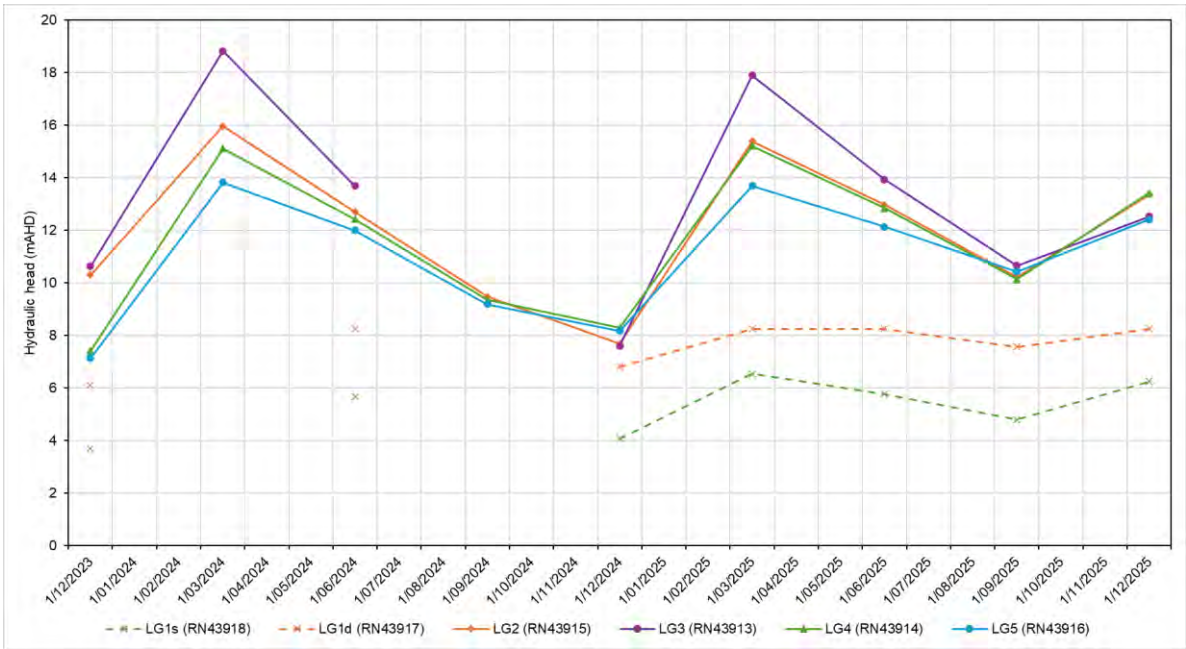


Figure 2-22 Groundwater level (mAHD) over time

2.6.1. Vertical groundwater gradients

Vertical groundwater gradients are presented in Figure 2-23. There is one nested pair of bores targeting the upper and lower portions of the BCF. In each case where water levels were collected from both bores, LG1d, the deeper bore, recorded a higher standing water level than the shallow bore, LG1s. This difference indicates an upward hydraulic gradient in the BCF in the area likely driven by the weathered unit of the formation confining the lower portions of the formation. The vertical difference ranges from approximately 3 m throughout each comparable month with March in 2025 and 2026 being approximately 2 m.

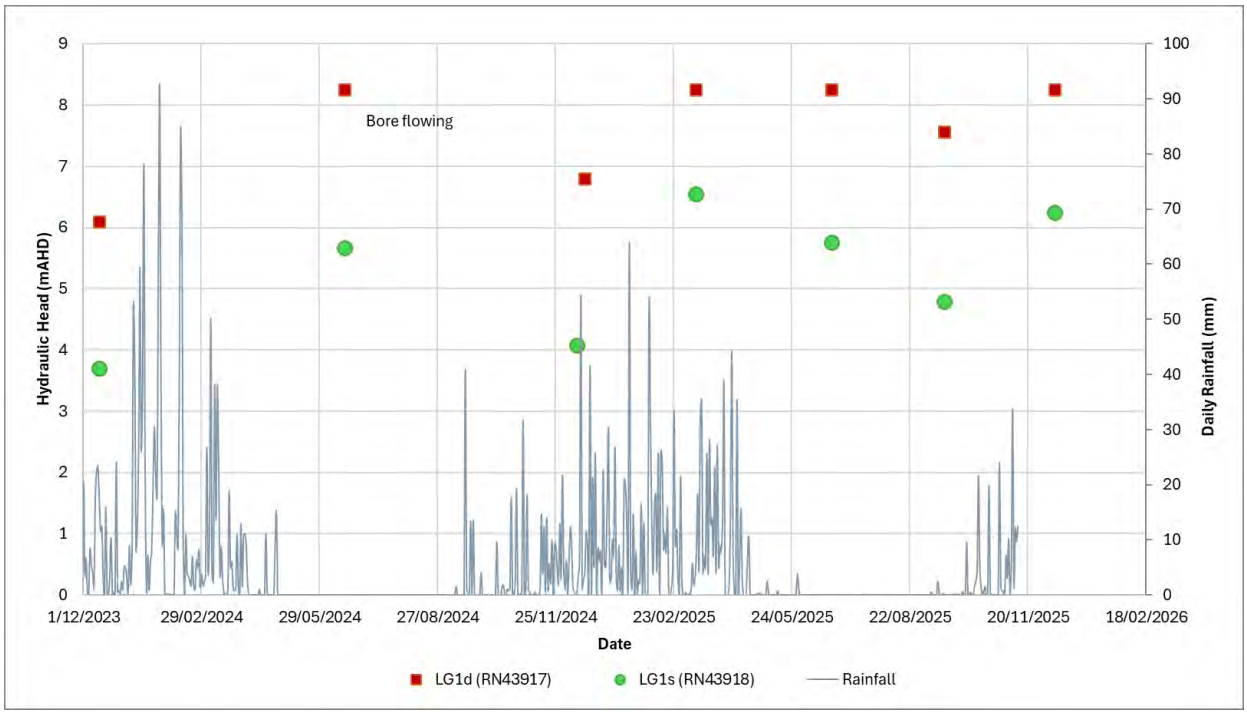


Figure 2-23 Standing Water Level (mAHD) vertical gradients

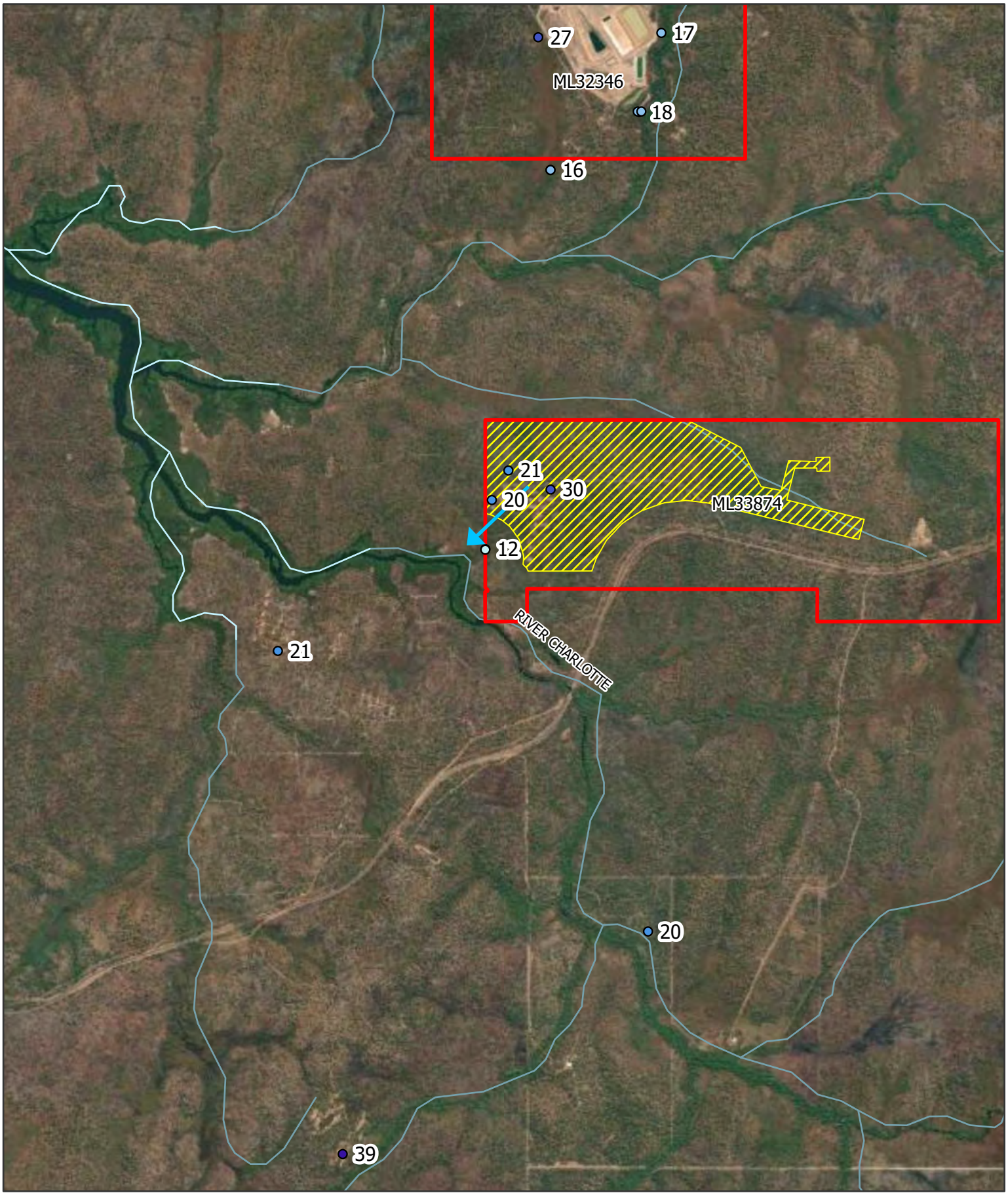


Figure 2-24 Groundwater Level and Flow Direction

Lei Lithium Proposed Distrurbance Footprint
Mining Lease

Watercourses
Non-perennial
Perennial
Approximate Groundwater Flow direction

Groundwater Level (mAHD)
11.0 - 12.0
12.0 - 18.0
18.0 - 23.0
23.0 - 33.0
33.0 - 46.0

0 250 500 1,000
Metres

Datum/Projection:
GCS GDA 1994

Project: 25ADL10829 Date: 23/06/2026

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2.6.2. Groundwater quality

2.6.2.1. pH and Electrical Conductivity

Groundwater pH is presented in Figure 2-25. Data show pH ranging from 5.81 to 10.47 which is considered moderately acidic to highly alkaline. Groundwater EC values are presented in Figure 2-26. EC values range from 19.6 µS/cm to 930 µS/cm which indicates the aquifer within the area is generally fresh. This profile is slightly different to the neighbouring Project Areas (e.g. BP33 Groundwater Enterprises (2023)). Groundwater quality within the BCF at BP33 ranges between pH 4.4 to 7.0 and is generally fresh, ranging from 60 to 330 µS/cm.

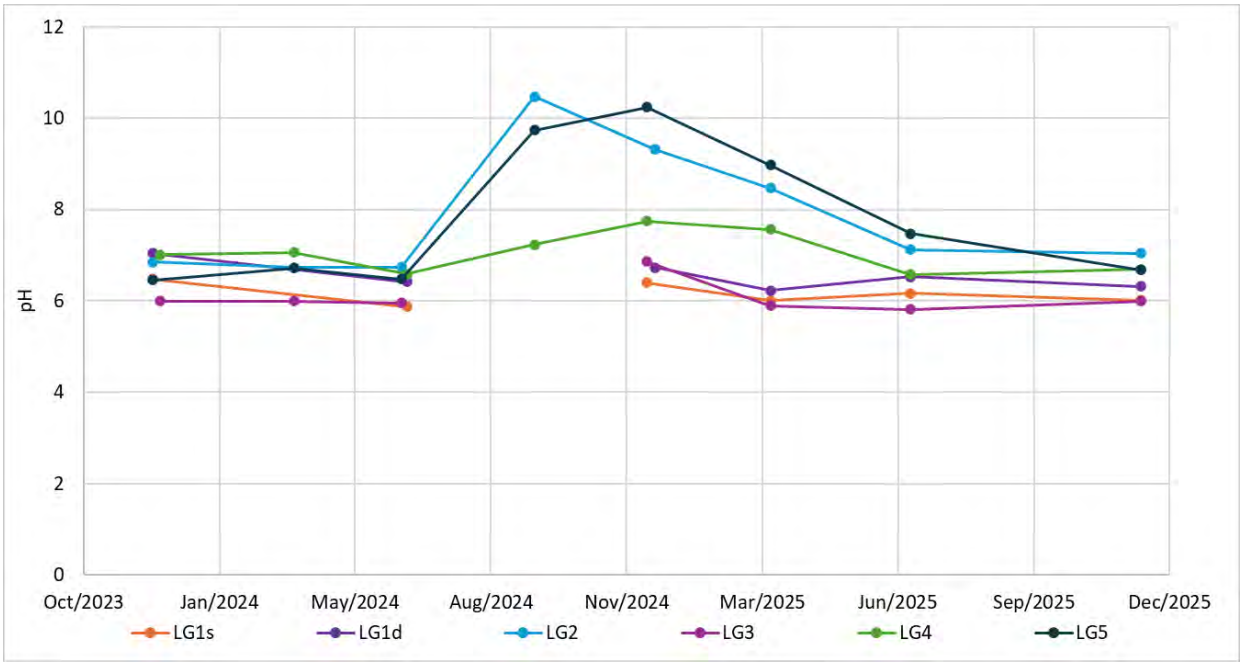


Figure 2-25 Groundwater pH values

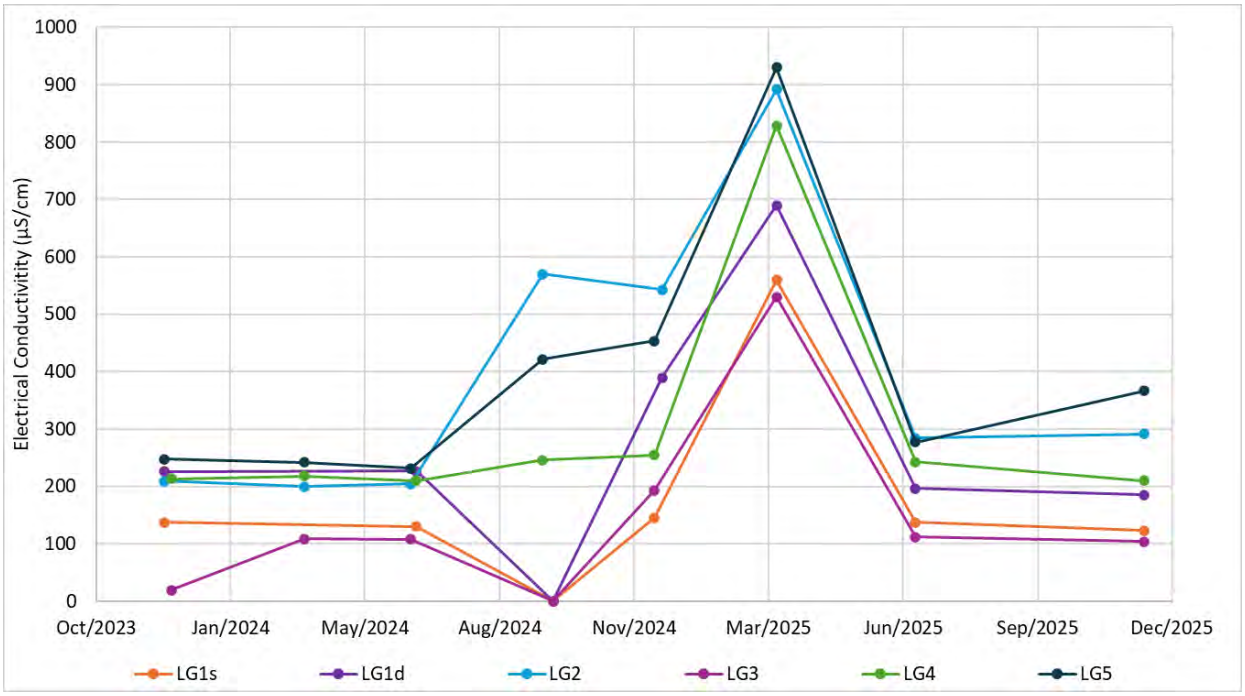


Figure 2-26 Groundwater EC values

2.6.2.2. Arsenic and Metal Mobilisation

Groundwater quality data for Al, As and Zn are shown in Figure 2-27, total and dissolved concentrations are plotted against the relevant water guidelines for the area (2000 ANZECC guideline levels for freshwater and 2018 ANZG guideline for marine water). It was determined that the 95% species protection trigger values for freshwater and marine water were an appropriate level of protection based on criteria (ANZECC, 2000 and ANZG, 2018). The Project Area is therefore considered as a slightly to moderately disturbed system with the overall ecosystem of the Project Area in its baseline state has been adversely affected by a relatively small but measurable degree of human activity remaining in a healthy condition. The NT EPA Environmental Factors and Objectives identified in Table 1-1 highlights Al, As and Zn as key groundwater quality parameters.

The monitoring results show that As, Al and Zn behave in ways that reflect a naturally variable fractured rock aquifer. The majority of the samples tested contained less than the detection limit for dissolved Al, while total Al was often elevated. Broadly the bores can be split into three categories, LG1d, and LG4 sit below or at the guideline value (0.055 mg/L), LG2 and LG3 are often elevated and LG1s and LG5 are generally significantly elevated (seen in Figure 2-27b). There is no clear seasonal trend or corresponding drop in pH.

Groundwater concentrations for As are presented in, Figure 2-28. At all sites total and dissolved As are similar throughout the reporting period, indicating that As is mainly present in dissolved form and responds to redox shifts rather than sediment mobilisation. Levels of As are elevated across the site particularly at LG4 and LG5. However while all bores show elevated As levels above the guideline values, they do not exhibit distinct peaks of elevated As levels seasonally or corresponding to any pH change. It is reasonable to assume that these are naturally elevated levels and site specific trigger levels should be developed.

Groundwater Zn concentrations are presented in Figure 2-29. LG1s and LG3 fluctuate throughout the reporting period both following somewhat similar trends, these bores are identified as not having any outliers within Figure 2-29b. This indicates that there is variability within the environment in both deeper and shallower bores across the fractured rock aquifer. The elevated Zn likely reflects natural geochemical processes such as weathering, redox cycling, and dissolution of Fe/Mn oxides within the tropical subsurface environment.

Overall, the results indicate a dynamic groundwater system where natural fluctuations in redox state, pH, fracture connectivity and host rock are likely to govern metal mobility and levels in groundwater rather than any anthropogenic inputs. A rigorous baseline sample set and site specific trigger levels should be applied to monitor this system.

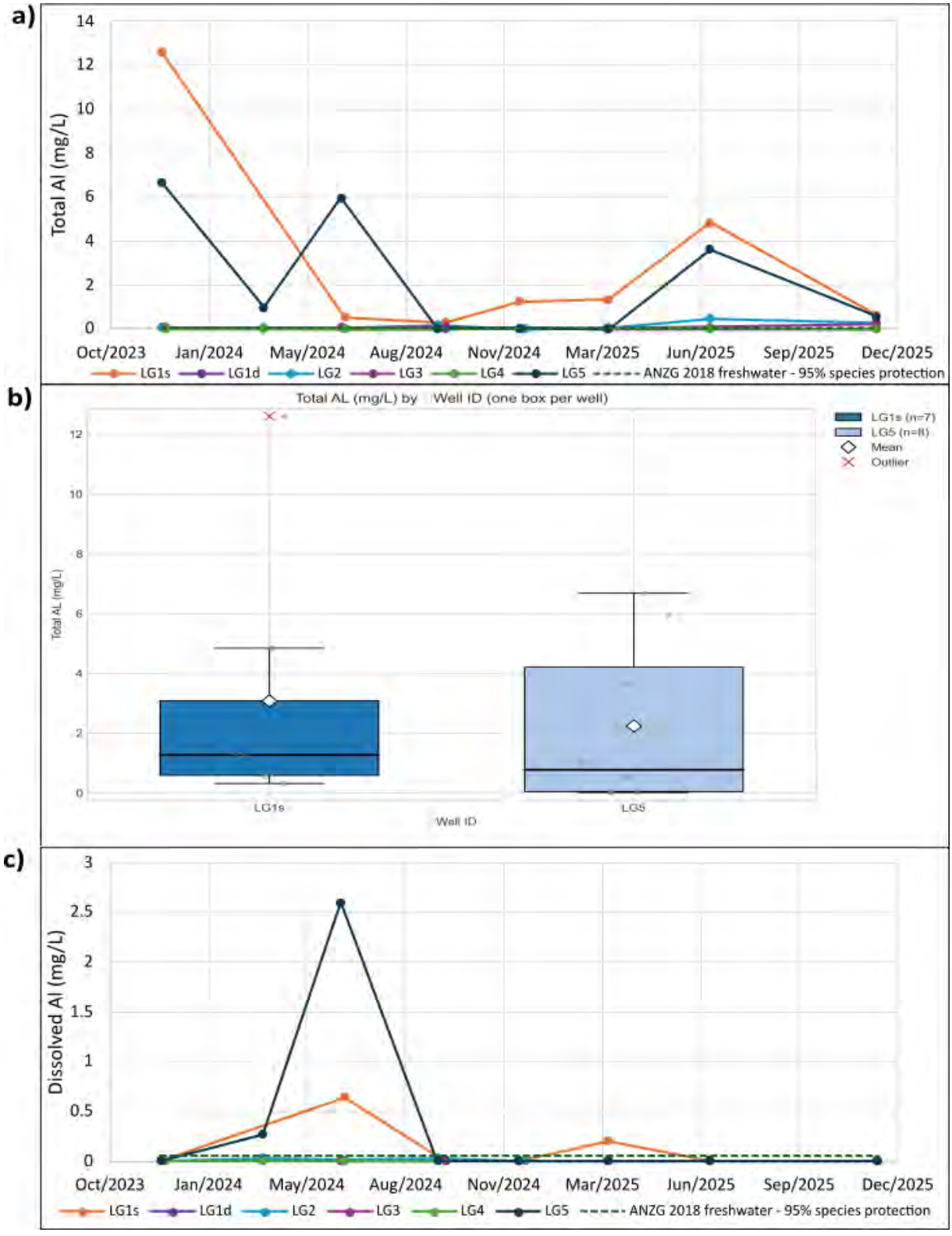


Figure 2-27 Groundwater Quality Aluminium (Al) a) Total Al, b) Box Plot for total Al identifying outliers, c) Dissolved Al

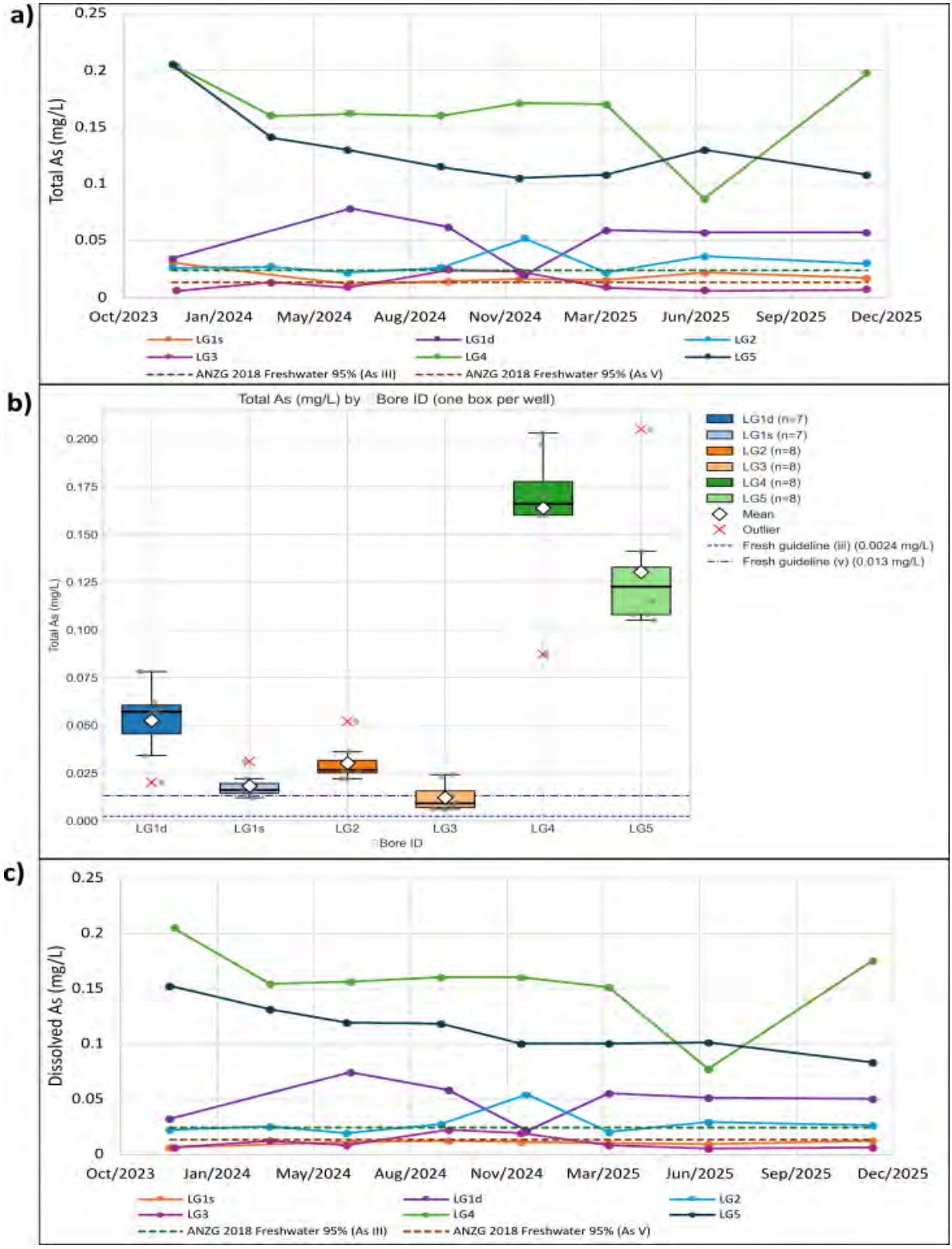


Figure 2-28 Groundwater Quality Arsenic (As) a) Total As, b) Box Plot for total As identifying outliers, c) Dissolved As

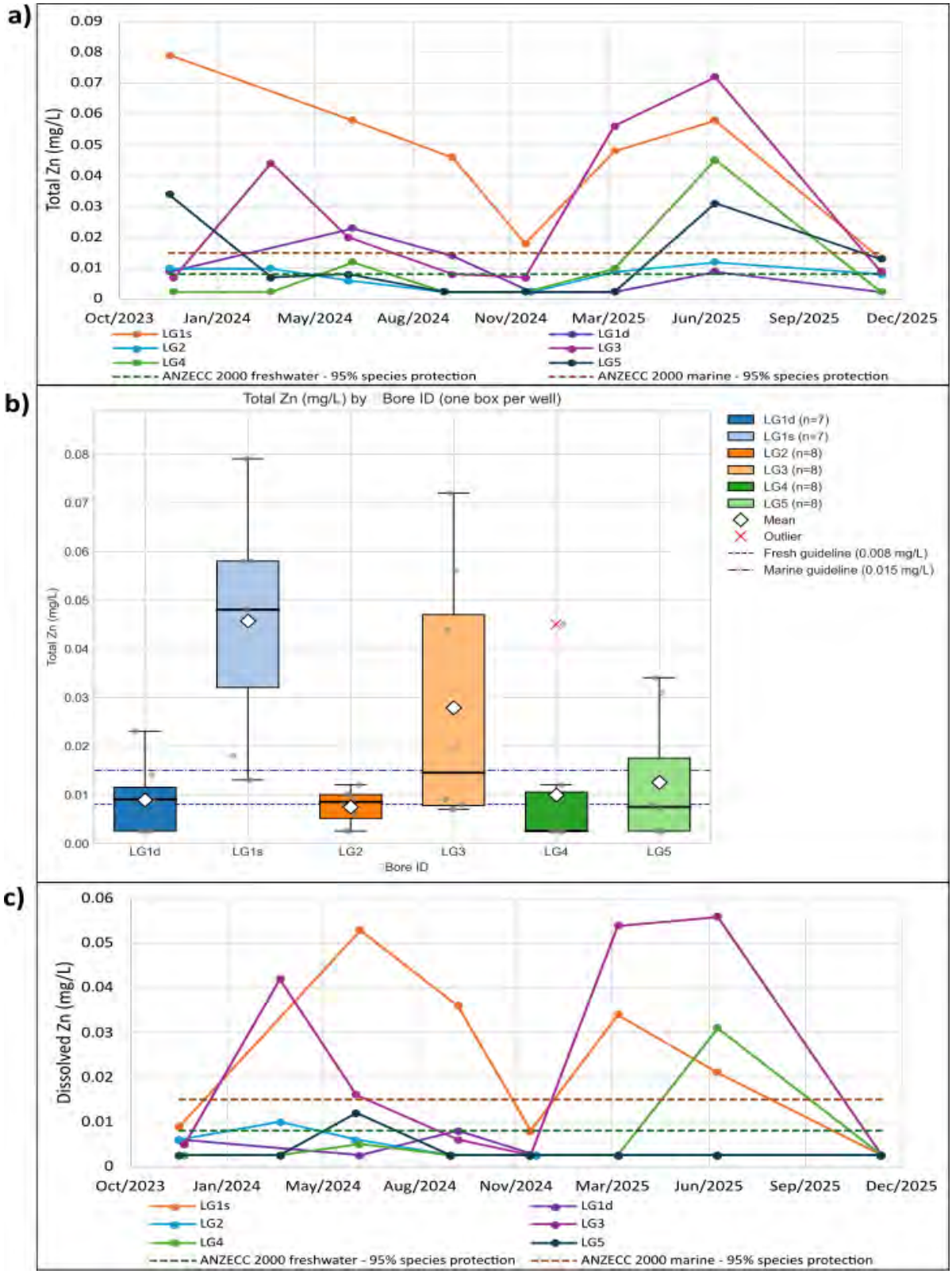


Figure 2-29 Groundwater Quality Zinc (Zn) a) Total Zn, b) Box Plot for total Zn identifying outliers, c) Dissolved Zn

2.6.2.3. Seawater vs Groundwater Gradient

The Na/Cl relationship indicates that groundwater in the Project Area shows no significant evidence of mixing with saline or marine water. All samples plot well below the 1:1 Na/Cl line, demonstrating that chloride concentrations are significantly lower than sodium and therefore not consistent with the ionic signature of seawater intrusion or tidal influence, see Figure 2-30. However when the surface water and groundwater sample sites are plotted together (Figure 2-33) on a piper plot some mixing is evident in the surfacewater samples although there does not appear to be a stong seasonal trend.

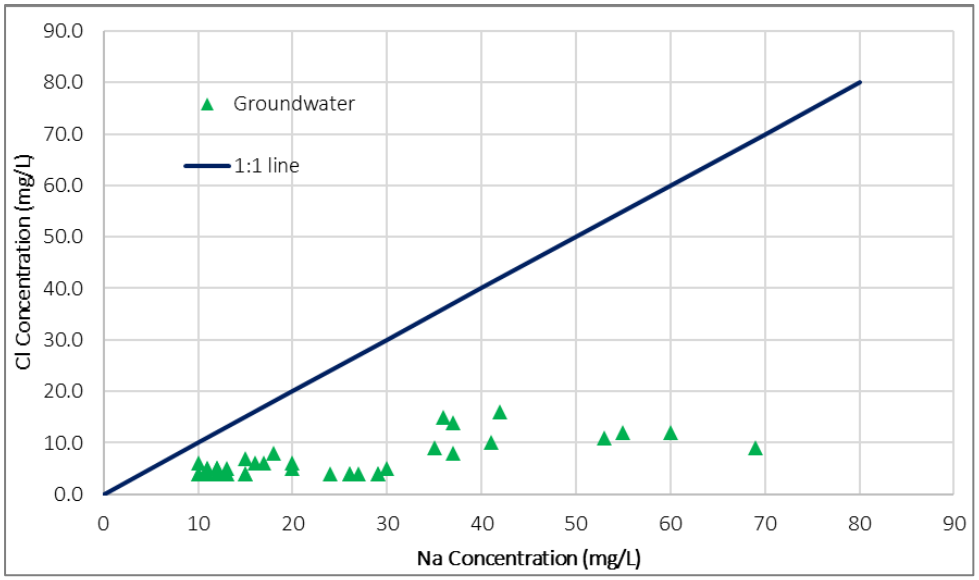


Figure 2-30: Na Cl ratio in groundwater samples

2.6.2.4. Oxidising Environment

Dissolved total iron ration is close to 1:1. A cluster of 5 samples, taken from 3 bores on two sampling rounds (13/12/2023 and 23/06/2025), shown in Figure 2-31, do not fit this pattern. The relationship between total and dissolved iron indicates that most iron occurs as precipitated or particulate phases rather than dissolved form, demonstrating groundwater is predominantly oxidising.

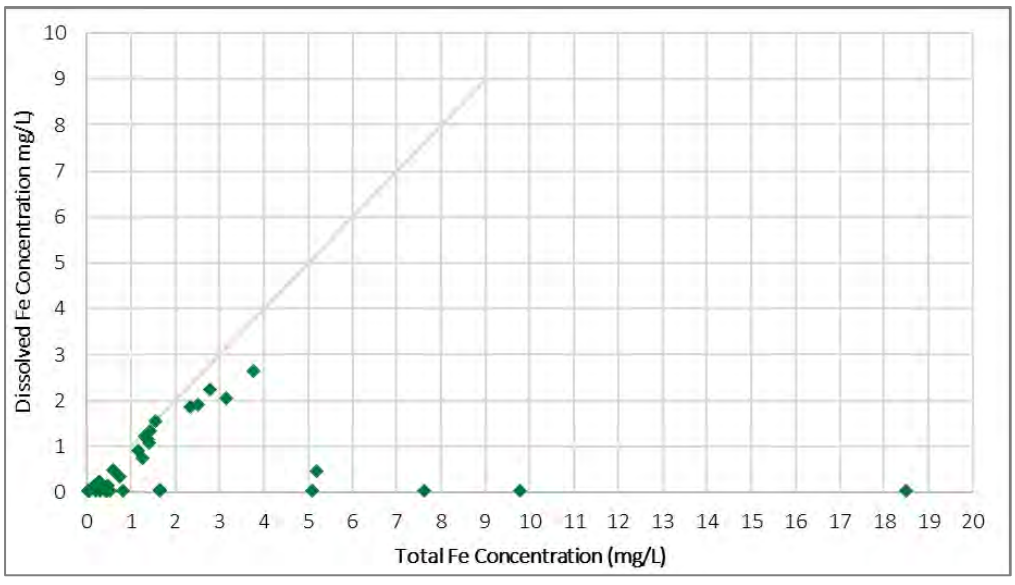


Figure 2-31: Groundwater Dissolved Fe to Total Fe

2.6.2.5. Groundwater Recharge

Groundwater is bicarbonate dominant with mixed dominant cations depending on sample site, see Figure 2-32. This reflects active flushing, low salinity, and no evidence of seawater intrusion. The dominance of HCO_3^- is typical of tropical weathering environments and confirms that the system is governed primarily by natural CO_2-driven dissolution processes rather than evaporative concentration or coastal influence. Figure 2-33 shows a piper plot of groundwater and surface water sample site in the wet and dry season. Although there does not appear to be a distinct seasonal trend in either group there is a number of samples taken from surface water sites that show more similarity to the groundwater samples. However this similarity is not considered to be likely to be due to direct mixing (of groundwater into surface water) but rather that these samples are fresher due to their distance from the estuarine environment and rainfall and runoff.

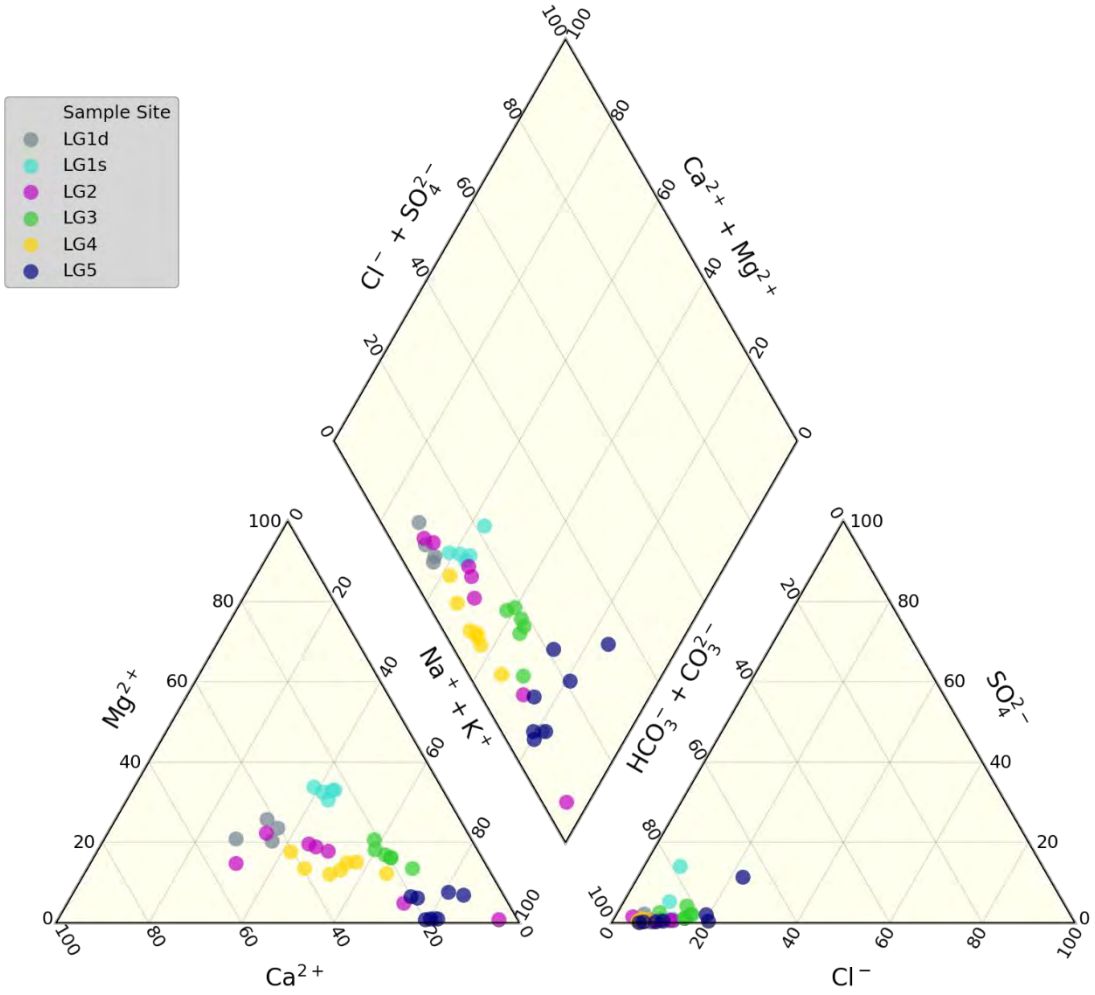


Figure 2-32: Piper Plot Groundwater

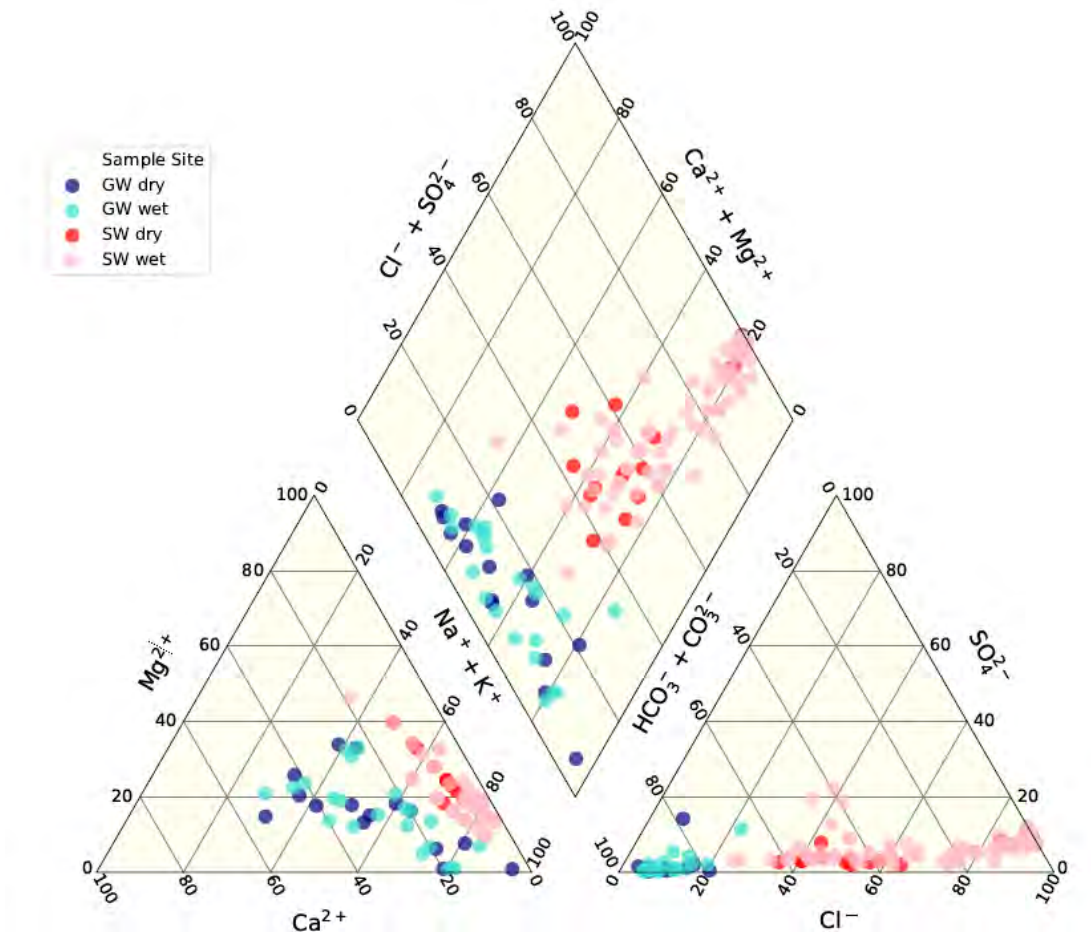


Figure 2-33: Seasonal surface and groundwater piper plot

2.7. Existing Groundwater Users

2.7.1. Groundwater bores

There are 13 groundwater bores within a 2 km radius of the Project Area, mainly drilled for the purpose of exploration and monitoring (Table 2-6). The bores were drilled recently within the last 5 years indicating increased reliability and accuracy of data.

Table 2-6 Groundwater bores within a 2 km radius of the Project Area.

Bore ID	Total Depth (m)	Drilled Date	Groundwater level (mbgl)	Yield (L/s)	Screen Interval (m)	Screen Lithology	Aquifer	Status
RN43840	79	28/09/2023	-	10	65-75	Fractured grey sandstone / phyllite with some quartz	NAFRP aquifer	Current
RN43913 (LG3)	60.1	15/11/2023	15	1	53-59.5	Fractured grey phyllite and quartz	NAFRP aquifer	Current
RN43914 (LG4)	73	17/11/2023	8	3	66-72.5	Grey Sandstone, small fractures every 1 m	NAFRP aquifer	Historical
RN43915 (LG2)	73	21/11/2023	8	1.5	65-72.5	Small fractures in grey phyllite	NAFRP aquifer	Current

Bore ID	Total Depth (m)	Drilled Date	Groundwater level (mbgl)	Yield (L/s)	Screen Interval (m)	Screen Lithology	Aquifer	Status
RN43916 (LG5)	69.5	23/11/2023	8	0.35	61-69	Grey schist quartz and mica	NAFRP aquifer	Current
RN43918 (LG1-D2)	79	1/12/2023	2	1	71-78.5	Fractured Grey phyllite	NAFRP aquifer	Current
RN43917 (LG1-S1)	12	1/12/2023	3	-	7-12	Weathered brown and red schist	NAFRP aquifer	Current
RN041993	42	17/11/2020	9	7	23-35	Soft + broken claystone	NAFRP aquifer	Current
RN041798	53.5	7/09/2020	4	0.5	46-52	Hard grey schist small quartz bands	NAFRP aquifer	Current
RN041797	7	5/09/2020	4.2	-	4-7	Brown Schist	NAFRP aquifer	Current
RN041832	35.4	13/09/2020	3.8	-	28.4-34.4	Weathered brown schist	NAFRP aquifer	Current
RN041831	109	12/09/2020	3.3	7	-	-	NAFRP aquifer	Current
RN041830	8	9/09/2020	3.6	10	5-8	Brown Schist	NAFRP aquifer	Current

2.7.2. Mining operations

Table 2-7 summarises the mining operations in the study area. Two companies operate the three mining operations in the Finniss/Bynoe mining district (Northern Territory Government, 2025). The NT EPA is assessing these mines collectively for cumulative groundwater and ecological impacts. The Grants and BP33 operations currently on hold due to Lithium price decrease, with Core Lithium seeking reinstating operations from the middle of 2026 (Core Lithium, 2026). Lei Mine is the only mining lease in application stage within the area with many surrounding tenements within exploration phase. The Grants and BP33 mines are currently considered as the only surrounding mining groundwater users.

Table 2-7 Summary of Lithium/mine operations within the study area

Mine	Company	Subsidiary	Project Name	Target deposit	Notes
Lei Mine	Lithium Plus Minerals Ltd	-	Lei Lithium Project	Lei Pegmatite Deposits (Lei-1 and Lei-2)	Located immediately south of Core's leases and within the same Bynoe Pegmatite Field. (Lithium Plus Minerals, 2026)
Grants Open Cut Mine	Core Lithium	Lithium Developments (Grants NT) Pty Ltd	Finniss Lithium Project	Grants Deposit	Operations on hold (Core Lithium, 2026)
BP33 Underground Mine	Core Lithium	Lithium Developments (Grants NT) Pty Ltd	Finniss Lithium Project	BP33 Pegmatite Deposit	Operations on hold (Core Lithium, 2026)

2.8. Environmental Receptors

2.8.1. Sites of Conservation Significance

There are no Sites of Conservation Significance (SOCS) in or adjacent to the project area, nor is the project in the headwaters for a SOCS. The closest SOCS is Darwin harbour which lies 12 Km northwest of the Lei deposit. It is not considered plausible that the project has any effect on these areas and they are not considered further in this assessment.

2.8.2. Charlotte River Catchment

The Charlotte River catchment covers approximately 119 km^2 and falls within the Fog Bay area for declared beneficial users. The river is also included within the Darwin Rural Adelaide River Water Control District for which the river is a partial boundary.

The Charlotte River includes perennial, estuarine zones downstream in the catchment, and non-perennial tributaries upstream. The Project footprint covers around 2.4% of the catchment and overlaps a minor non-perennial tributary. A second non-perennial tributary is located immediately adjacent to the southeast corner of the lease.

2.8.3. Bynoe Harbour

Bynoe Harbour lies 8 km downstream of the Project area and is used for both recreational and commercial activities. The harbour and its estuaries contain significant mangrove communities supported by numerous small tidal creeks and extend upstream along the Charlotte River toward the western boundary of ML33874. Detailed mapping of mangrove communities was produced by the Northern Territory Government at a scale of 1:10,000 (DEPWS, 2024a) and (EcOz Environmental Consultants, 2024)

2.8.4. Groundwater Dependant Ecosystems

An assessment of the surrounding GDEs was undertaken using the publicly available GDE Atlas (The Bureau of Meterology, 2026). Charlotte River is registered as a moderate potential aquatic GDE within 5 km from the project. The proposed disturbance area is approximately within 300 m of the river's moderate status mapping.

Mangroves are mapped along the river up within 200 m west of the Project Area as shown in the inset of Figure 2-34. While groundwater flows from the aquifer to the river may sustain aquatic vegetation to some degree, it is unlikely that the mangroves would be considered dependant on groundwater. The groundwater levels show a seasonal trend (see Figure 2-21, Figure 2-22 and Figure 2-24) and upstream surface water sampling sites (particularly SW1 and SW4) are frequently not flowing or dry in the dry season. Mapping of surface water permanence (see Section 2.5.3), shows that the higher reaches of the drainages are generally not permanent water sources indicating little to no base flow to the rivers from the groundwater during dry periods.

Terrestrial GDEs of moderate potential are registered across majority of the Project Area and the area of disturbance according to the GDE Atlas. The ecosystem type identified is Eucalypt Woodland. There is additionally a low potential terrestrial GDE identified in the south-western corner of the disturbance area and Project Area. The ecosystem type is identified as drainage open woodland. This species is also seen within the northern section of the 5 km Project Area radius.

On-ground validation through vegetation mapping was conducted by EcOz. The survey did not record mangrove species in the drainages within the Project Area. Most of the Project Area is

covered with Woodland or Open Woodland with smaller areas of Open Forest and Grassland (EcOz Environmental Consultants, 2024). It is likely that many of the species present have sufficient root depth to intersect the water table. However, as water level data suggest significant seasonal fluctuations the groundwater level may not be a reliable source of water for vegetation all year.

2.8.5. Declared beneficial uses

The declared beneficial uses for marine waters in the Fog Bay area are aquatic ecosystem protection and recreation water quality (map provided in 0) (Northern Territory Government, 1998). Surface and Groundwater resources in the Darwin Rural Adelaide River Water Control District have the following beneficial uses (Appendix B) (Northern Territory Government, 2024):

- Agriculture
- Aquaculture
- Public water supply
- Cultural
- Industry
- Rural stock and domestic
- Mining activity
- Petroleum activity

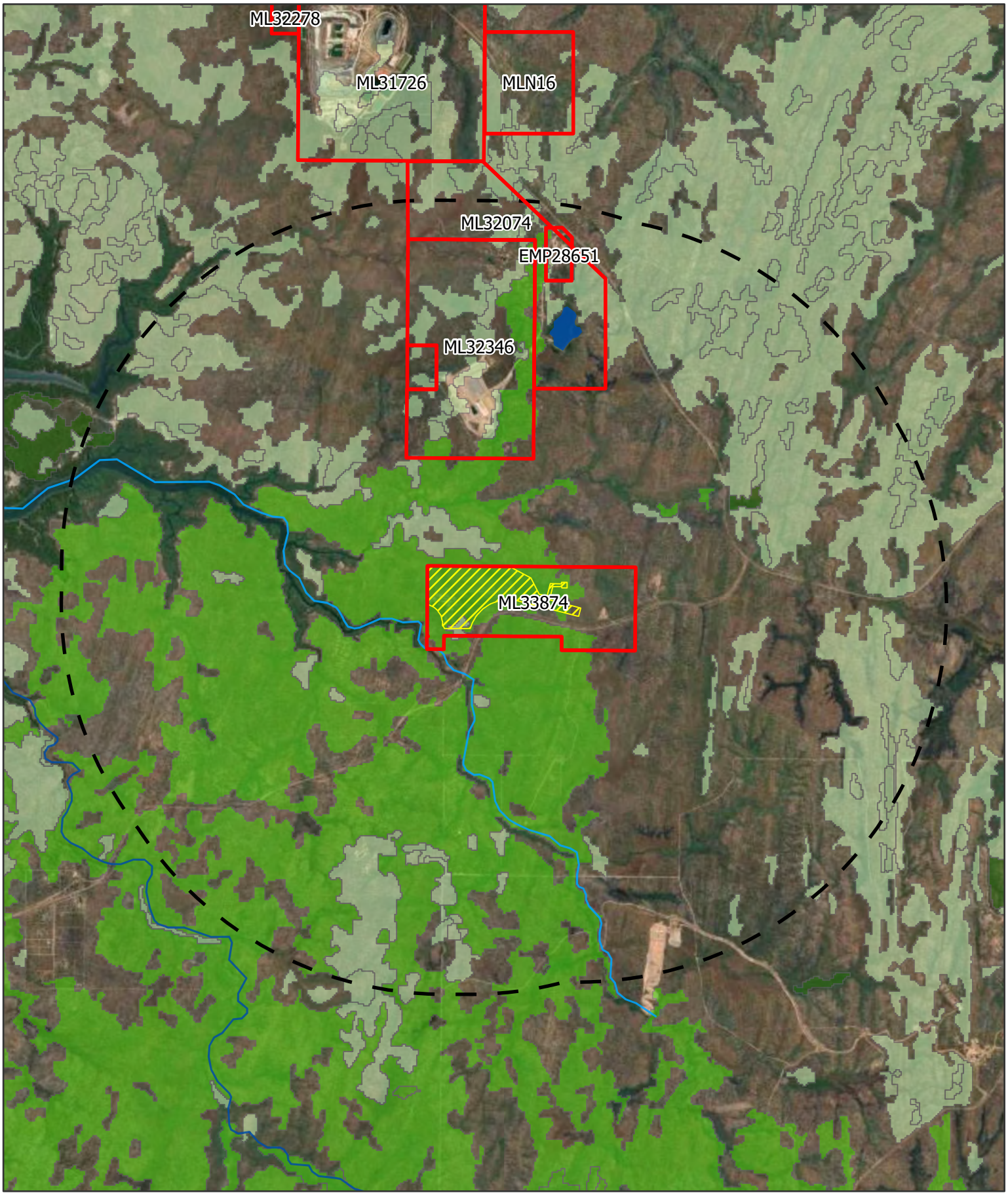


Figure 2-34 Groundwater Dependent Ecosystems

Lei Lithium Proposed Distrurbance Footprint
Mining Lease
5km Buffer

Aquatic
Known GDE - from regional studies
High potential GDE - from national assessment
Moderate potential GDE - from national assessment
Low potential GDE - from national assessment

Terrestrial
Known GDE - from regional studies
High potential GDE - from national assessment
Moderate potential GDE - from national assessment
Low potential GDE - from national assessment

0 500 1,000 2,000
Metres

Datum/Projection:
GDA2020 MGA Zone 52

Project: 25ADL10829 Date: 23/06/2026

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3. Proposed mining activities

3.1. Option 1 - Box-cut and underground mine description

A surface box cut will be completed to 50 mbgl to access geotechnically stable fresh material for construction of the portal and underground decline. A perimeter safety bund, constructed in accordance with relevant guidelines, will be installed to prevent surface-water ingress and to restrict access. A sump, pumps and a pipeline network will be established at the base of the box cut to manage dewatering of rainfall and groundwater inflows; intercepted water will be retained on-site in MWD1 for use in dust suppression (Lithium Plus, 2024). Further details on this design scenario are in Appendix A A1:.

A portal will be established within the box cut to provide access to a spiralling decline developed between the two pegmatite bodies; ore will be extracted via long-hole open-stoping methods to a total depth of 700 m designs specify multiple production levels, each incorporating stope access, sump and drainage infrastructure, ventilation circuits, and a turning/stockpile bay. Water collected in the underground sumps will be pumped to the box-cut sump and dewatered to MWD1 for reuse. (Lithium Plus, 2024)

3.2. Option 2 – Cut and cover tunnel and underground mine description

A cut and cover tunnel would provide access to the underground mine working and associated infrastructure. Underground workings including stope access, sump and drainage infrastructure, ventilation circuits, and a turning/stockpile bay are expected to be the same as Option 1 detailed above. For more details including a conceptual cut and cover tunnel design see Appendix A A2: a nominal tunnel liner has been assumed for comparison purposes. Stockpiling and waste

The stockpiling and waste remain largely unchanged between the two scenario options. Under the box cut a raised ROM pad with a 110,000-t capacity will be constructed with the material excavated from the box cut. Drainage from the pad will be directed to MWD1. Two waste dumps will be constructed one for the surface box cut (LWD1) and one for the underground decline (LWD2). The waste rock stored in these facilities will be used to backfill the underground workings and the box cut on closure of the mine. Waste rock from the box cut may also be utilised for the construction of the box cut safety bund, raising of the ROM pad and RWD wall pending geotechnical assessment.

The cut and cover tunnel changes the type of surface access to a cut and cover tunnel excavation, with two waste dumps will be constructed at the same locations. One at the surface of the cut and cover tunnel and one for underground decline. With waste rock still stored in these facilities for backfill on closure of the mine.

3.3. Mining and underground development schedule

The Project under both scenarios has a 12-month construction phase, a 68-month operations phase, and a 6-month closure reinstatement period followed by ongoing monitoring until lease relinquishment requirements are met, giving a total Life of Mine (LOM) of approximately 7 years with continuous operations. (Lithium Plus, 2024)

4. Conceptual hydrogeological model

4.1. Overview

The conceptual hydrogeological model describes the hydrogeological framework of the study area and provides the basis for numerical model development. Conceptualisation is a critical step in groundwater modelling as it defines the dominant processes, hydrostratigraphic structure and boundary conditions of the groundwater system (Barnett, et al., 2012).

The conceptual model for the Lei Project has been developed using regional geological and hydrogeological mapping of the Cox Peninsula (Pietsch, 1986; NRETA, 2008), site-specific groundwater investigations undertaken at the nearby Grants deposit (GHD, 2017), and numerical modelling completed for the Grants and BP33 deposits.

The conceptual model is intended to represent the dominant hydrogeological processes controlling groundwater occurrence and movement in the BCF within the Project Area.

4.2. Groundwater system extents

The Lei Project is located within the BCF of the Pine Creek Orogen. The BCF forms a regionally extensive fractured rock aquifer across the Cox Peninsula (NRETA, 2008). Similar geological and hydrogeological conditions extend well beyond the immediate Project Area.

Groundwater system extents are therefore conceptualised primarily with reference to hydrological and topographic controls rather than lithological limits. The groundwater system is bounded laterally by regional topographic divides and drainage features that approximate groundwater divides. This approach is consistent with conceptual models developed for the Grants and BP33 deposits.

4.3. Hydraulic characteristics

Groundwater occurs predominantly within the weathered and fractured BCF. The formation has low primary porosity, and permeability is controlled largely by secondary fracturing.

The hydrostratigraphic framework adopted for the conceptual and numerical model is based on the weathering profile of the BCF. Three hydrostratigraphic units (HSUs) are recognised:

- HSU1 – Laterite / highly weathered zone: This unit includes lateritic soils, alluvial sediments and highly weathered bedrock materials. Permeability is generally higher than the underlying units where saturated, but the saturated thickness is typically limited.
- HSU2 – Moderately weathered saprolite: This unit consists of highly weathered phyllite and siltstone retaining original rock fabric. Hydraulic conductivity is generally low, and groundwater storage is limited.
- HSU3 – Slightly weathered to fresh BCF: This unit consists of fractured phyllite and siltstone. Permeability is generally low but locally higher where discrete fracture zones occur.

Hydraulic testing at the Grants deposit indicates hydraulic conductivity values typically in the range of approximately 0.003 to 0.16 m/day in slightly weathered to fresh BCF, with higher values observed in shallow lateritic materials (GHD, 2017). These values are consistent with a low transmissivity fractured rock aquifer.

Groundwater quality in the BCF is generally fresh to slightly brackish, with electrical conductivity values typically less than 300 µS/cm in deeper weathered zones. Shallow groundwater within lateritic materials may be significantly fresher where direct hydraulic connectivity with rainfall recharge occurs.

Alluvial sediments along drainage lines are generally thin and discontinuous (Pietsch, 1986). Although these sediments may be locally more permeable than underlying bedrock, their limited saturated thickness restricts their hydraulic significance at a regional scale.

4.4. Groundwater flow dynamics

Groundwater flow within the study area is controlled primarily by topography. The groundwater surface is generally a subdued reflection of the land surface, resulting in flow from elevated terrain toward lower lying drainage features. This behaviour has been documented in nearby deposits across the Finniss Lithium Project Area (CloudGMS, 2018). Regionally, groundwater is inferred to move toward the Charlotte River drainage system and associated coastal catchments. Locally, groundwater flow occurs from areas of higher topography toward drainage features and low-lying terrain.

Seasonal water level fluctuations occur in response to wet season rainfall recharge. Observations at nearby monitoring sites indicate groundwater level changes of several metres between wet and dry seasons. Flow direction does not vary significantly between seasons.

Vertical gradients within the aquifer appear to vary spatially. Nested monitoring bores at the LG1 site indicate an upward hydraulic gradient between deeper and shallow screened intervals. This may reflect local stratigraphic controls or semi-confining behaviour within the weathered profile.

4.5. Recharge

Recharge to the BCF aquifer occurs primarily through diffuse infiltration of rainfall during the wet season. Recharge rates estimated using the water table fluctuation method at nearby deposits suggest long-term recharge in the order of approximately 30 to 160 mm/year (CloudGMS, 2018) . These estimates are consistent with recharge rates reported for similar woodland systems in northern Australia (Cook et al., 1998). Recharge is highly seasonal, with the majority occurring during the monsoonal wet season when rainfall exceeds evapotranspiration.

Recharge is influenced by soil permeability, vegetation evapotranspiration and fracture permeability within the weathered zone. In tropical environments such as the Cox Peninsula, rejected recharge may also occur where rainfall intensity exceeds infiltration capacity.

Climate variability can affect groundwater recharge rates in conjunction with proposed mining activities. Activities such as clearing of land and establishment of hardstands such as roads can effect evapotranspiration rates reduce infiltration. Therefore the net change in infiltration surrounding the project area will be dependent on final mine layout, surface water management systems, and the performance of engineered containment systems. These activities have been accounted for in the impact assessment’s uncertainty analysis through the application of a recharge scaling factor. The impact of potential climate change variations is considered to be secondary to the natural inter-annual variation given the relatively short operational and recovery period considered.

4.6. Groundwater Discharge

Natural groundwater discharge occurs primarily through evapotranspiration from shallow water tables, diffuse discharge to drainage features, and regional groundwater throughflow toward the Charlotte River and downstream coastal systems. The Charlotte River is considered the principal potential downgradient receptor for groundwater flow in the vicinity of the project. However, observations of limited dry-season flow in upper reaches suggest that groundwater discharge to the river may be spatially variable and relatively small in magnitude, see Section 2.6.2.5.

Evapotranspiration is likely to represent a significant component of the groundwater balance where water tables are shallow. Studies of woodland evapotranspiration in northern Australia indicate annual evapotranspiration rates exceeding 1000 mm/year (Cook et al., 1998).

Given the relatively low hydraulic conductivity of the BCF, groundwater discharge to streams is expected to occur as low-magnitude seepage rather than sustained high-volume baseflow.

During mining operations, groundwater discharge will increase due to dewatering of underground workings and associated infrastructure. Dewatering will induce a localised cone of depression and alter hydraulic gradients in the vicinity of the mine.

Following cessation of mining and backfilling of underground workings, groundwater rebound will occur as recharge replenishes aquifer storage. If a residual void remains below equilibrium groundwater levels, groundwater inflow to the void may persist and the void may function as a groundwater sink.

4.7. Conceptual water budget

The saturated groundwater balance (Barnett, et al., 2012) can be expressed conceptually as:

$$REg - \Delta Ly - \Delta D - EVT - A = \Delta S$$

where recharge (REg) is balanced by lateral groundwater fluxes (ΔLy), discharge to surface water (ΔD), evapotranspiration (EVT), groundwater abstraction (A) and changes in aquifer storage (ΔS)

Under baseline conditions, recharge is balanced primarily by evapotranspiration and diffuse discharge. During mining operations, groundwater abstraction associated with dewatering will represent an additional discharge component and will result in a temporary decline in groundwater storage. Following cessation of dewatering, groundwater levels are expected to recover progressively as recharge replenishes storage.

5. Numerical groundwater modelling

5.1. Model development

A groundwater flow model was constructed by Cloud GMS, for the project using FEFLOW v10.0.5 (DHI-WASY), an industry-standard finite-element code. The following chapter summarises the development and results of this model for the full model report see Appendix A. The initial model development and Option 1 Mine design (Box Cut) is discussed in Appendix A-1. Option 2 Cut and Cover design is discussed in Appendix A-2 the cut and cover design modelling addendum.

The three-dimensional model domain (≈193.6 km^2) is centred on the Lithium Plus and Core Lithium mining activities and has a refined mesh within the Grants Pit, BP33 and Lei mine footprints. The mesh comprises 31,913 elements per layer and 19 layers. The cut-and-cover tunnel scenario retains the same model framework, domain and numerical platform as the original assessment, with the underground access representation updated to reflect the revised design.

Boundary conditions implemented include:

- zero-flux (no-flow) external boundaries
- seepage-face specified-head boundaries to represent the Charlotte River and other tidal inlets, the ground surface, and the pit/underground excavations (allowing discharge but preventing inflow)
- well boundaries for local injection/abstraction.

Areal fluxes (recharge and ET) are applied via parameter expressions linked to time-varying recharge distributions and ET extinction depths; recharge time series were generated using the LUMPREM utility with SILO rainfall and potential evaporation inputs.

Pit behaviour during mining and after closure is explicitly represented. Dewatering of the Grants Pit is simulated by sequentially activated seepage-face boundaries so that pit inflow is an emergent model output; the pit reference elevations follow planned pit progression. Post-closure pit-lake evolution is modelled using the IfmLake plug-in, which computes dynamic lake levels and horizontal extent from groundwater and external fluxes (rainfall/evaporation) and applies appropriate lake groundwater boundary constraints and lake volume level functions.

The transient model was constructed for parameter estimation over 01/01/2012 to 01/01/2018, with a numerical configuration using an Adams Bashforth/Trapezoid predictor corrector time stepping and a preconditioned conjugate-gradient solver. Numerical settings include an RMS error tolerance of 5×10^{-3} and a maximum of 12 iterations per time step. Initial heads for the transient runs were obtained from an 11.25-year warm-up simulation beginning 01/01/2010 (ending 1/3/2021 in the supplied text). Vertical discretisation comprises three principal layers representing the weathered horizons and fresh basement, with additional slices in the fresh rock to represent underground stope horizons.

5.2. Parameter estimation

Calibration was undertaken to develop a set of model parameters, boundary conditions, and stresses to produce simulated heads and fluxes matching field measurements within a predefined error range. Calibration provides confidence that the model represents the physical system. The process adjusts key parameters (e.g., hydraulic conductivity, specific yield, recharge and boundary conditions) within realistic limits, the final calibrated model parameters are shown in Table 5-1

This approach is adequate based on the model revisions made to adjust from the box-cut scenario to the cut and cover tunnel scenario because the revised design changes local hydraulic connection around the tunnel but does not alter the regional groundwater system conceptualisation.

Table 5-1 Final calibrated model parameters

Layer	Hydrostratigraphic Unit	Horizontal hydraulic conductivity (m/d)	Vertical hydraulic conductivity (m/d)	Specific yield	Layer
1	HSU 1 laterite / completely weathered rocks	0.5	0.05	0.015	1
2	HSU 2 extremely / highly / moderately weathered rocks	0.05	0.002	0.015	2
3	HSU 3 slightly weathered to fresh rocks	0.002	0.001	0.01	3

5.2.1. Parameter uncertainty

Final calibrated model parameters are within the expected ranges based on typical values and hydraulic testing and the model performance is within an acceptable range (see Section 5.3) Monte Carlo analysis was used (through PESTPP-IES (Parameter ESTimation using iterative ensemble smoother) to assess the parameter sensitivity to ensure the forecasts reflects natural variability parameter uncertainty. 100 realisations were run with parameters based on expected ranges ("prior or "Iter 0") and 100 based on the post calibration parameters ("post" or "Iter 2"). Histagrams for HSU 2 parameters are presented in Figure 5-1, Figure 5-2 and Figure 5-3. Full parameter sets for each HSU are presented in Appendix A1: Section 8.

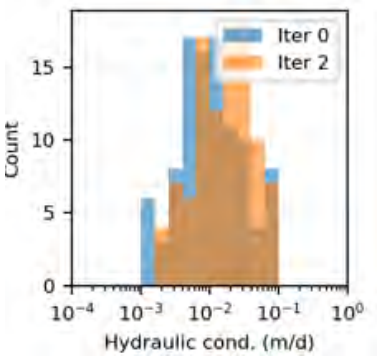


Figure 5-1: HSU2 Horizontal hydraulic conductivity range

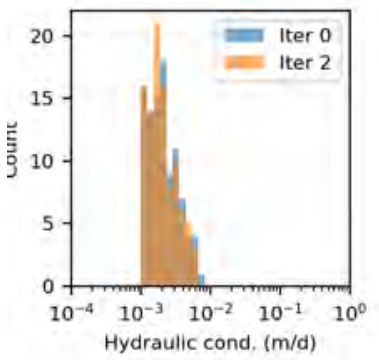


Figure 5-2:HSU2 Vertical hydraulic conductivity range

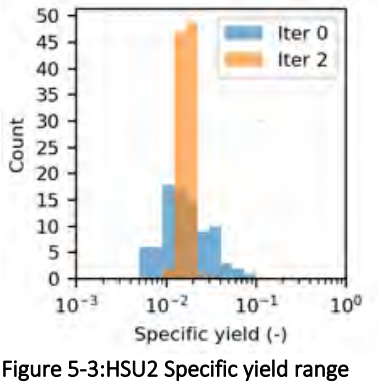


Figure 5-3:HSU2 Specific yield range

The groundwater level results of the Iter 0 set of parameters median and interquartile range for the Lei Project bores are presented in Figure 5-5, Figure 5-6, Figure 5-7, Figure 5-8, Figure 5-9 and Figure 5-10. While the impact of changes to the parameters varies between the bores the groundwater elevations are shown to return to pre-mining levels within a reasonable timeframe. The maximum drawdown for each bore varies considerably between the bores (Figure 5-4) however they remain reasonable under the 25th percentile and the 75th percentile parameter groups.

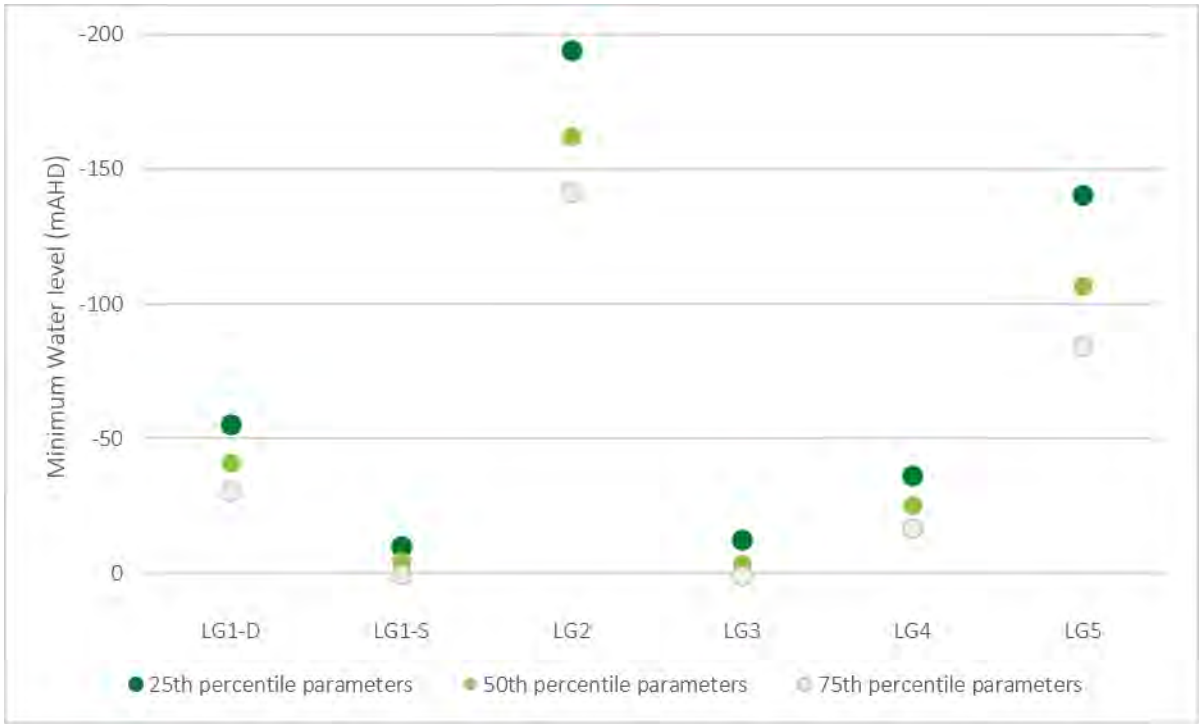


Figure 5-4: Minimum water level at observation bores for each parameter set

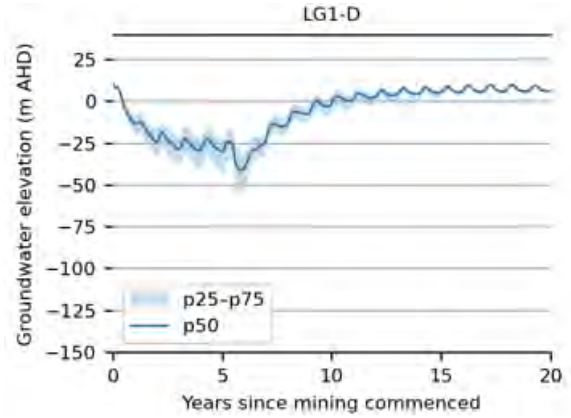


Figure 5-5: LG1-D range of groundwater elevation response with Iter 0 parameter set

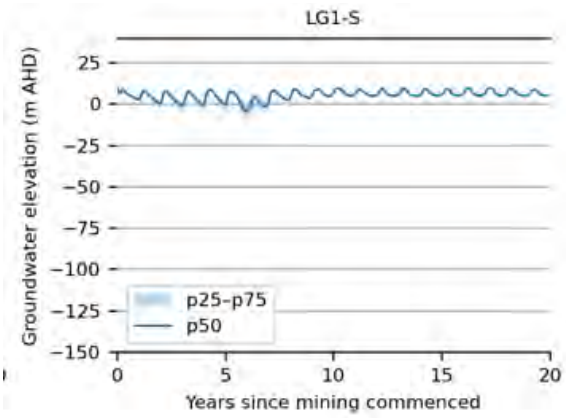


Figure 5-6:LG1-S range of groundwater elevation response with Iter 0 parameter set

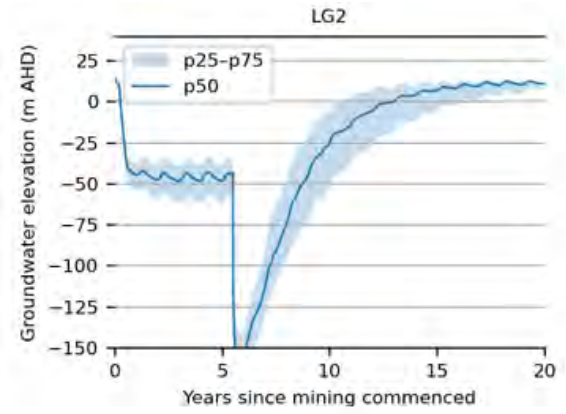


Figure 5-7: LG2 range of groundwater elevation response with Iter 0 parameter set

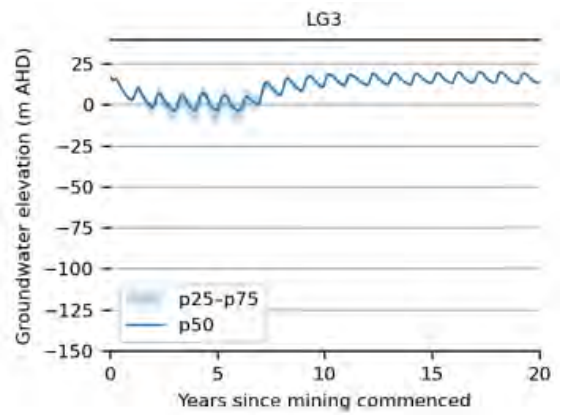


Figure 5-8:LG3 range of groundwater elevation response with Iter 0 parameter set

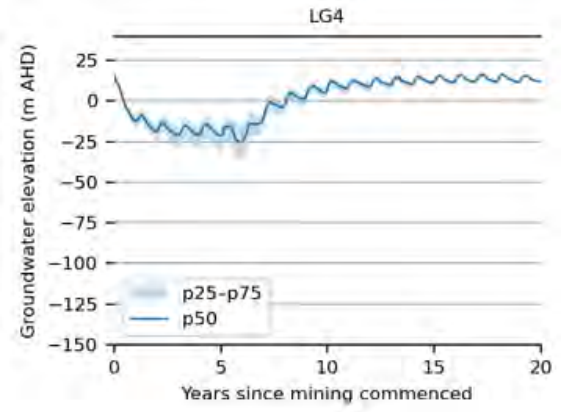


Figure 5-9: LG4 range of groundwater elevation response with Iter 0 parameter set

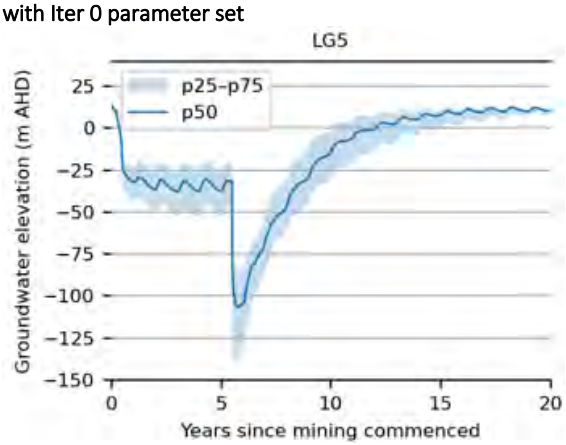


Figure 5-10: LG5 range of groundwater elevation response with Iter 0 parameter set

5.3. Model performance

The model performance is within an acceptable range, as shown in Figure 5-11. The plots show measured vs modelled heads and is consistent for both modelled scenarios. All timesteps converged to a value less than the error criteria, the water balance showed less than 0.01 % imbalance and the scaled root mean square error after parameterisation was 8.2 %. Although this is above the target of 5 % it is considered acceptable as the modelled groundwater levels are driven by the SRTM-derived groundwater levels which contain considerable uncertainty (<15 m). For further information regarding observed and measured heads and model performance see Appendix A.

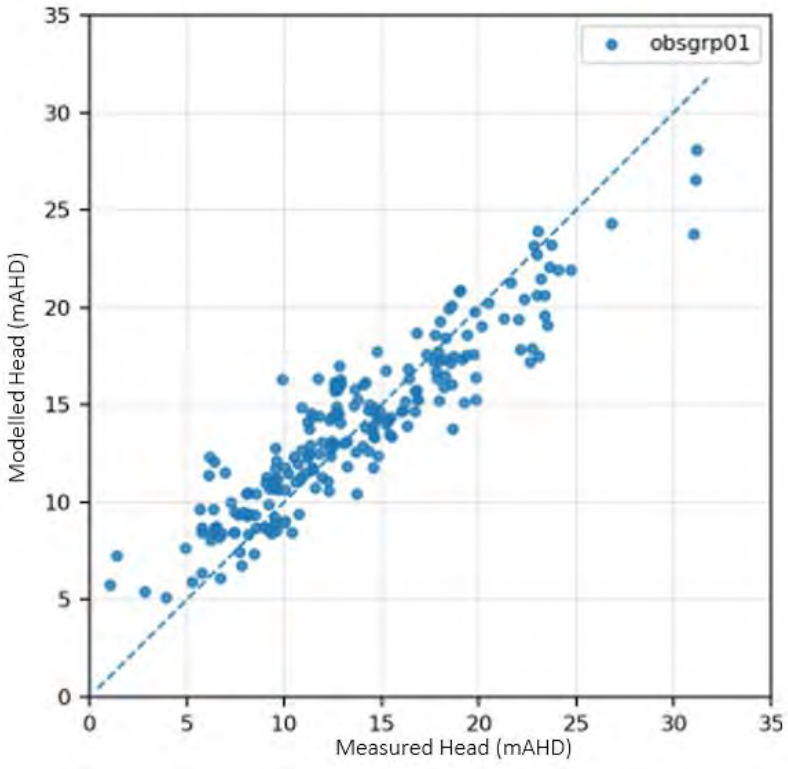


Figure 5-11 Modelled vs measured heads

5.4. Model results

For each mining method (Box-cut and Cut and Cover), three scenarios were modelled:

1. Natural conditions (s00);
2. Lei mining operations only (s01); and
3. Cumulative impacts (s02) with Lei Lithium, BP33 and GLP operations running concurrently.

The natural conditions scenario (s00) was modelled for the same time period as s01 and s02 with the same climate input data (precipitation and evaporation) used as an initial condition to define the extent of drawdown.

Under scenario s01 expected drawdown of 0.1 m is predicted to extend approximately 2 km from the site under either mining method, while drawdowns of more than 10 m are contained to the mining lease. Predicted drawdown varies significantly between the observation bores with their distance from the mining area and their screened zone. The predicted drawdown at each monitoring bore can be used as a basis for a monitoring trigger level.

5.4.1. Box-Cut Scenario

5.4.1.1. Predicted groundwater effects

Under Lei Lithium operations only (s01) the maximum drawdown at the existing monitoring bores ranges from 8 m at LG1S (LG1-D 36 m) to 177 m at LG2. The area of drawdown is shown to be concentrated around the mine workings and extends up to approximately 1.5 km to the South and West from the ML boundary. Post closure all water levels are expected to return to baseline, 9 years

post mining the residual drawdown is ~ 0.1 m, in approximately 200 m radius around the pit, as shown in Figure 5-12 and Figure 5-13, for further detail see Section 6 of Appendix A.

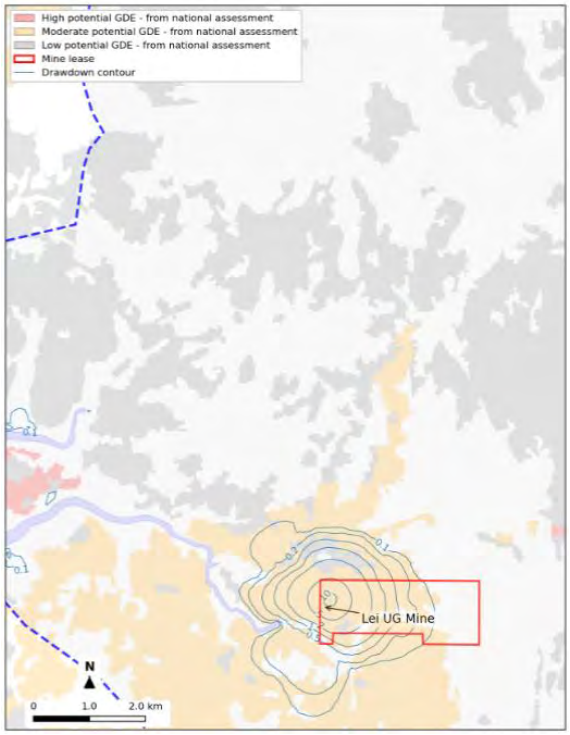


Figure 5-12: Predicted drawdown contours after 6 years since the start of mining at the Lei Lithium project (Box Cut)

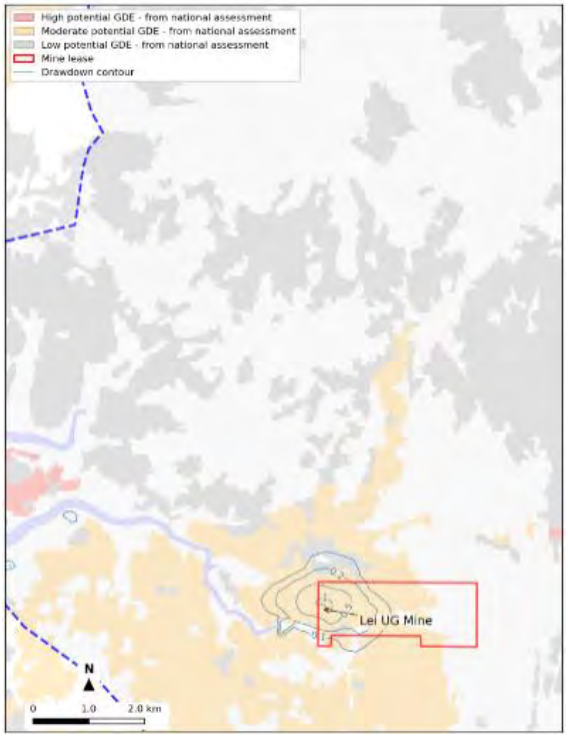


Figure 5-13: Predicted drawdown contours after 4 years of recovery 10 years since the start of mining at the Lei Lithium project (Box cut)

5.4.1.2. Predicted cumulative groundwater effects (Scenario s02)

It is considered that a reasonable worst-case scenario for cumulative effects to groundwater is if BP33, GLP and Lei are running simultaneously in both scenarios. They were both run with all operations commencing on the same day BP33 running for 5 years, GLP running for 4 years and Lei running for 6 years, drawdown in the Lei observation bores under this scenario is shown in Figure 5-14.

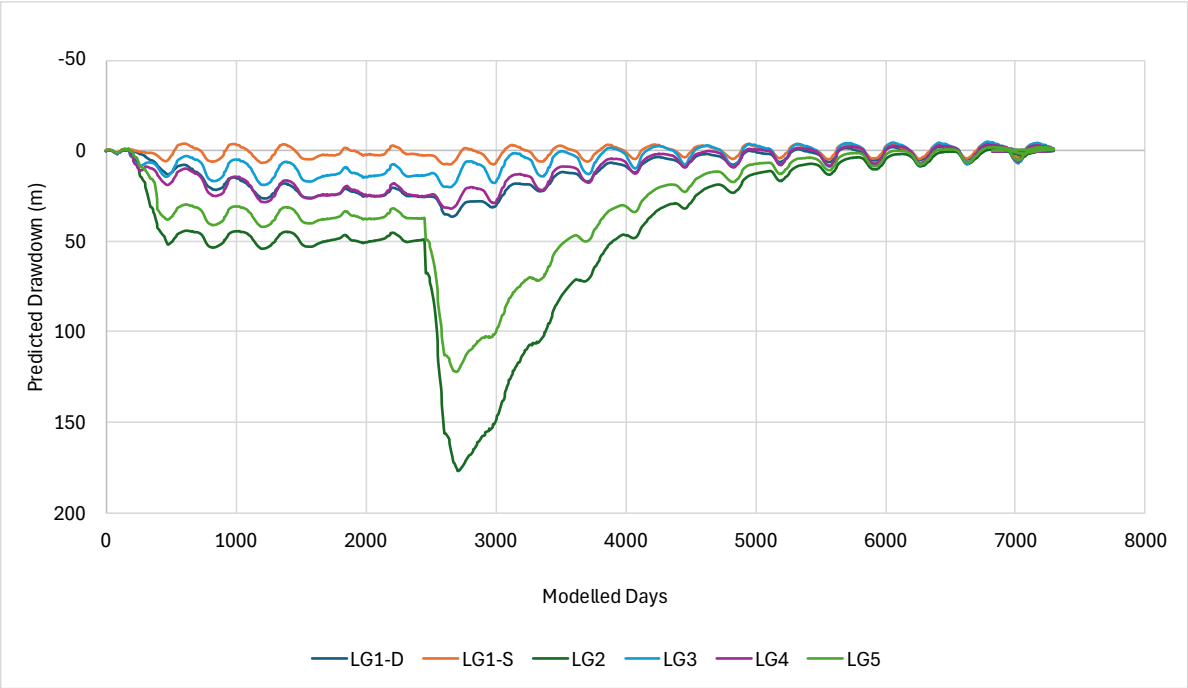


Figure 5-14 Predicted drawdown in Lei Observation bores (m)

Under these conditions the maximum drawdown increases slightly when compared to the single mine scenario(S1 lei only) for the box cut scenario in each of the Lei Observation bores as shown in Table 5-2.

Table 5-2 Predicted maximum drawdown in Lei observation bores under singular and cumulative scenarios

Bore ID	S1 Lei Only		S2 (cumulative impact)		Increase in drawdown (m)
	Max Drawdown (m)	Min water level (mAHD)	Max Drawdown (m)	Min water level (mAHD)	
LG1-D	35.5	-26	36.4	-26.9	0.9
LG1-S	6.8	1	7.9	-0.1	1.1
LG2	175.9	-162	176.8	-162.9	0.9
LG3	18.5	-3	20.2	-4.7	1.7
LG4	30.5	-18	32.3	-19.8	1.8
LG5	121.6	-108	122.6	-109	1

5.4.1.3. Predicted groundwater drawdown effects at Charlotte River alluvial corridor

Upstream of the tidal zone where the Charlotte River riparian zone crosses the ML boundary, groundwater levels are expected to draw down by several meters because of proposed mining operations. This change in water level may affect water availability for vegetation species depending on species rooting depth. Areas effected are typically “Open Forest” or “Tall Woodland”. It is considered that the reduction in the water table would not be sufficient for it to fall beyond the capacity of larger trees to reach however smaller understory species may be impacted.

High probability of ASS Subaqueous materials and Intertidal flats are present within predicted drawdown levels. Drawdown from dewatering operations may exacerbate natural chemical process

present when these soils are affected by changes in water content from tidal and seasonal groundwater discharge to the river.

The tidal zone of the Charlotte River is modelled approximately 1 km from the western boundary of the ML. It is possible that this reduction in water level will reduce the water table to below sea level and locally reverse the groundwater gradient to allow saline water further inland.

5.4.1.4. Predicted seawater intrusion effects

Numerical modelling random walk particle tracking was utilised to estimate the extent of seawater intrusion under the influence of the dewatering activities in both scenarios. Results suggest that seawater may migrate inland from tidal zones of Charlotte River because of dewatering operations. Under the most conservative aquifer parameters and seawater intrusion conditions (lower effective porosity and higher dispersity), sea water was able to migrate inland by approximately 400 m under the Charlotte River. Deeper particles estimate that seawater was able to migrate by up to approximately 1 km into the mine workings. This simulation suggests that saline water has the potential to discharge into mine workings and interact with the Project's dewatering infrastructure. Saline intrusion, and the potential change of dewatering water quality will likely need to be managed via mining dewatering strategies. Additional sampling and testing could refine the expected range of key parameters (porosity and dispersity) and reduce the uncertainty.

5.4.2. Cut and Cover Scenario

5.4.2.1. Predicted groundwater effects

Predictive simulations for the cut-and-cover tunnel scenario indicate groundwater impacts and post-closure recovery broadly consistent with those predicted for the box-cut scenario. There are no significant difference between the box cut and basic cut and cover scenario, with differences in minimum water level between 0.2 and 2.3 m, see Table 5-3. Likewise there is no significant difference in drawdown contours between the two mining scenarios either during mining (Figure 5-12 and Figure 5-15) or in recovery (Figure 5-13 and Figure 5-16) However when a nominal tunnel liner is included there is a significant decrease in the modelled inflows, see Table 5-4.

Table 5-3: Difference in minimum water level (mAHD) under mining scenarios

Observation Bores	Box Cut (min water level (mAHD)	Cut and Cover (min water level (mAHD)	Difference (m)
LG1-D	-26	-26	-0.2
LG1-S	1	3	-1.2
LG2	-162	-163	1.0
LG3	-3	-1	-1.3
LG4	-18	-16	-2.3
LG5	-108	-109	1.0

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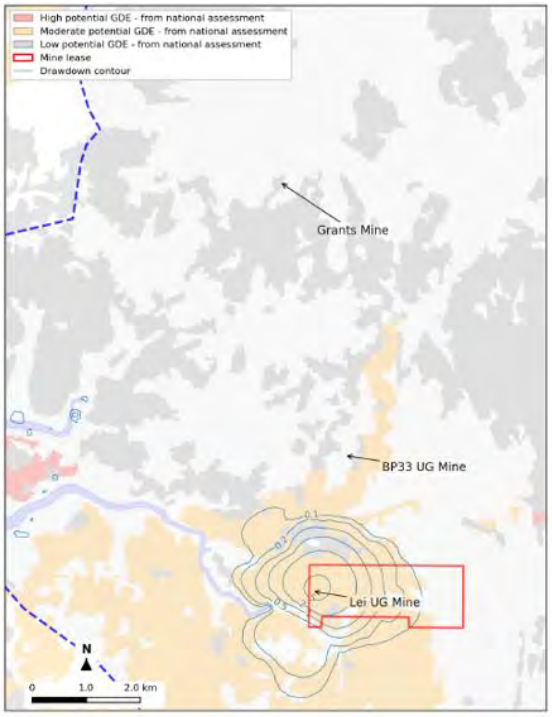


Figure 5-15: Predicted drawdown contours after 6 years since the start of mining at the Lei Lithium project (Cut and Cover)

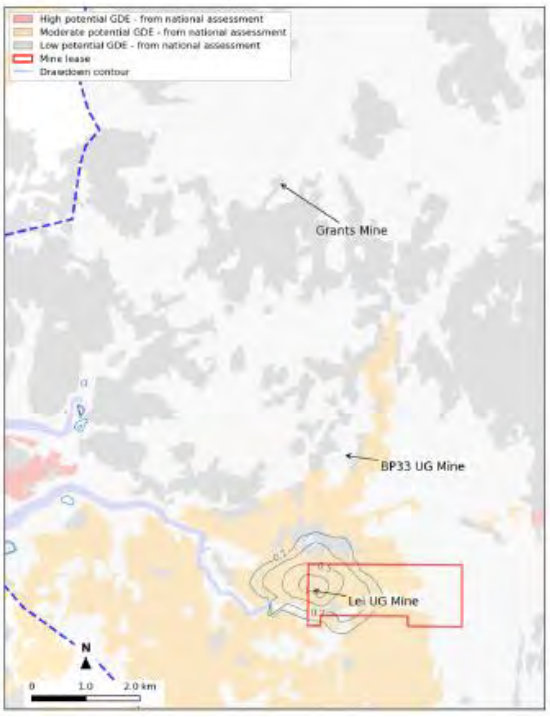


Figure 5-16: Predicted drawdown contours after 4 years of recovery 10 years since the start of mining at the Lei Lithium project (Cut and Cover)

5.4.2.2. Predicted cumulative groundwater effects

Cumulative groundwater impact predictions for the cut-and-cover tunnel scenario are also consistent with those of the box-cut scenario. During mining, overlapping drawdown cones develop within the surrounding BCF groundwater system, but predicted drawdown extents, impacts beneath ephemeral drainage lines and post-closure recovery remain effectively unchanged.

5.4.2.3. Predicted groundwater drawdown effects at Charlotte River alluvial corridor

The predicted drawdown extent, potential impacts to terrestrial GDEs, and the absence of impacts to existing groundwater users remail largely unchanged under this scenario with the key difference being reduction in inflows. To the west of Lei mine the 0.1,0.2 and 0.5m drawdown contours approach the upstream end of the tidal section of Charlotte River and is likely to intersect the river but is constrained by the specified head boundary conditions representing the river. This results in no change to predicted drawdown effects at Charlotte River within the alluvial corridor, with particle tracking results confirming the original effects which is limited inland migration from the tidal reach under most parameter combinations. The particle tracks overall indicates that water originating from Charlotte River migrates less than 500 m inland from the river. Post -closure particle tracking results in the re-establishment of natural hydraulic gradients towards Charlotte River to the west.

5.4.2.4. Predicted seawater intrusion effects

Particle migration is seen after 6, 10, 14 and 20 years from the start of mining. With the results for cut and cover tunnel consistent with results under the box cut scenario both having a low possibility of saline groundwater ingress to the underground mine. There is still the possibility of saline inflows

to the underground mine (modelled under the S01 Lei only scenario) with discharge water may require blending with fresher groundwater prior to release.

5.4.3. Inflow comparison between the two modelled scenarios

Comparison of the annual inflows (Table 5-4) shows that the cut-and-cover tunnel scenario does not produce significantly different inflow volumes to the box cut scenario until a tunnel liner is considered. When a nominal tunnel liner, which reduces the horizontal permeability of the formation in the immediate area surrounding the tunnel, is introduced the inflows to the tunnel are reduced by 25-50%. This reduces the overall inflows by 10-20% in any given year, However these figures are nominal and reflect a conceptual tunnel liner, rather than a specific material or complete engineered design or solution. It is likely that if a liner was implemented the conductivity would be reduced further and inflows would be reduced more than what is presented here.

Table 5-4 Comparison between scenarios and modelled inflow volumes

Year	Combined box cut and UG mine	Combined cut-and-cover tunnel and UG mine	Combined cut-and-cover tunnel and UG mine (with nominal Tunnel liner)
	ML/year	ML/year	ML/year
1	119	120	97
2	318	318	265
3	412	412	362
4	465	465	415
5	512	512	455
6	501	501	450

6. Impact Assessment for Modelled Scenarios

6.1. Overview

The two modelled scenarios of the box-cut and cut and cover tunnel has had minimal impact to overall receptors, pathways and receptors. The key difference is a reduction in groundwater inflows associated with the tunnel liner, which is captured within Section 6.2 and 6.3, in corresponding model scenario sections. During operations drawdown of 0.1m is expected to extend beyond the mine lease by 1-2km, North, South and west and is expected to reach the upstream tidal zone of the charlotte river and intersect areas of moderate GDE potential. Significant drawdowns of greater than 10 m are confined to the mine lease and within 4 years of the cessation of mining drawdown of 1m are confined to the mine lease. Inflows to the mine workings are expected to peak at 608 ML/year, or about 2.1% of the modelled annual recharge for the modelled domain, significantly below the 20% generally allowable under the Water Allocation Framework (Department of Environment and Natural Resources, 2020) .

6.2. Receptors

Preliminary risk of groundwater and surface water impacts from the Project has been assessed using a risk assessment based on characterisation of the groundwater environment and consideration of groundwater use at and surrounding the Project Area. Receptors identified closely align with current beneficial users for the area, with the Charlotte River and associated tributaries being a key receptor within 5 km of the Project Area. Darwin Rural Adelaide River Water Control District (Appendix B) include Agriculture and Aquaculture; Public water supply; Cultural; Industry; Rural stock and domestic; Mining and petroleum activity; and Ecosystem protection.

6.2.1. Surface water

The assessment characterised the existing hydrological environmental features and has identified several potentially sensitive surface water receptors that may be impacted by Project activities. The Mine lease borders the Charlotte River on its Southwest corner, five tributaries run through the disturbance area footprint. These rivers flow out to Bynoe Harbour which is approximately 15 km to the west with majority of the Charlotte River being within the tidal zone with field observations of mangroves lining the creek up to the closest Project Area extent. Beneficial uses for the Fog Bay area are aquatic ecosystem protection and recreation water quality (Northern Territory Government, 1998) refer to Appendix B.

6.2.2. Groundwater

Potential nearby users of groundwater include domestic, agricultural and pastoral bores, irrigation abstraction points, and mining-related abstraction for Lei, Grants and BP33 operation, are indirect groundwater receptors and maybe impacted by operations. There is a potential groundwater receptor within a tributary of Charlotte River in the form of a noted lake, this is within the BP33 operation mining lease and is identified as a high potential aquatic GDE.

6.2.3. Groundwater Dependent Ecosystems

The lake mapped as a high potential Aquatic GDE is with in the 5 km buffer however it is upstream of the Project Area and unlikely to be impacted, this is supported by modelling results.

Tributaries of the Charlotte River may be fed by ground water particularly during the wet season when the water table is higher however mapping of water permanence indicates that this base flow is not continually maintained and therefore not a source of water for ecosystems during dry periods. However, the water table is sufficiently shallow to potentially support vegetation during the dry season. It is likely that larger tree species such as eucalypt trees (mapped as GDEs) are utilising groundwater.

Areas where the drawdown is greater than 10 m are likely to affect the groundwater available for most species. Further studies int root depth of species present or other methods maybe required to assess the vegetation dependence on groundwater.

6.3. Potential Sources and pathways

6.3.1. Box-Cut Scenario

6.3.1.1. Surface water impact sources and pathways

Source and pathway linkages that may result in impacts to identified surface water receptors from Project activities include:

- Direct impacts to flow paths from excavation and/or construction of proposed infrastructure
- Indirect impact from increased sedimentation, causing a change in groundwater or surface water quality within wetlands from increased turbidity, salinity and/or nutrient loading.
- Indirect impact from changes to surface water quantity, including interruption of drainages or flow paths that discharge to potential wetland areas.
- Reduction in surface water quality at and/or downstream of the Project Area from:
    - vegetation clearing, installation and maintenance of access tracks.
    - siltation from mobilisation of plant and equipment.
    - sedimentation or siltation from uncontrolled stockpile runoff.
    - uncontrolled spills and infiltration of hazardous materials.
    - stormwater and wastewater discharge.
    - exposing ASS to oxidation release metals into the surface and groundwater.
- Changes to surface water quantity at and/or downstream of the Project Area from:
    - interruption of drainages or changes to flow regime.
    - stormwater and wastewater discharge.
    - reduction in groundwater discharge to the Charlotte River.

6.3.1.2. Groundwater impact sources and pathways

The Project related source and pathway of potential impacts to shallow groundwater quality and GDE communities, as well as the Tertiary aquifer and associated identified receptors arise from:

- Direct impacts to groundwater quality from:
    - siltation from mobilisation of plant and equipment.
    - sedimentation or siltation from uncontrolled stockpile runoff.

- uncontrolled spills and infiltration of hazardous materials.
- Saline water intrusion
- Metal mobilisation due to oxidation of ASS during construction or operations.

- Direct impacts to groundwater quantity from abstraction for Project activities.
- Indirect impacts to human-health or livestock users from consumption or irrigation of consumed crops with reduced groundwater quality.
- Indirect impact from interaction with reduced groundwater quality or quantity, including vegetation health.
- Metal mobilisation due to oxidation of ASS due to groundwater level changes from dewatering activities.

6.3.2. Cut and Cover Tunnel Design

6.3.2.1. Surface water impact sources and pathways

The cut-and-cover tunnel design does not materially change these source-pathway linkages, although the reduced hydraulic connection to the underground access may slightly reduce the volume of groundwater requiring management at the excavation.

Source and pathway linkages that may result in impacts to identified surface water receptors from Project activities include:

- Direct impacts to flow paths from excavation and/or construction of proposed infrastructure
- Indirect impact from increased sedimentation, causing a change in groundwater or surface water quality within wetlands from increased turbidity, salinity and/or nutrient loading.
- Indirect impact from changes to surface water quantity, including interruption of drainages or flow paths that discharge to potential wetland areas.
- Reduction in surface water quality at and/or downstream of the Project Area from:
  - vegetation clearing, installation and maintenance of access tracks.
  - siltation from mobilisation of plant and equipment.
  - sedimentation or siltation from uncontrolled stockpile runoff.
  - uncontrolled spills and infiltration of hazardous materials.
  - stormwater and wastewater discharge.
  - exposing ASS to oxidation release metals into the surface and groundwater.
- Changes to surface water quantity at and/or downstream of the Project Area from:
  - interruption of drainages or changes to flow regime.
  - stormwater and wastewater discharge.
  - reduction in groundwater discharge to the Charlotte River.

6.3.2.2. Groundwater impact sources and pathways

The Project related source and pathway of potential impacts to shallow groundwater quality and GDE communities, as well as the Tertiary aquifer and associated identified receptors arise from:

- Direct impacts to groundwater quality from:
  - siltation from mobilisation of plant and equipment.
  - sedimentation or siltation from uncontrolled stockpile runoff.
  - uncontrolled spills and infiltration of hazardous materials.
  - Saline water intrusion
  - Metal mobilisation due to oxidation of ASS during construction or operations.
- Direct impacts to groundwater quantity from abstraction for Project activities.
- Indirect impacts to human-health or livestock users from consumption or irrigation of consumed crops with reduced groundwater quality.
- Indirect impact from interaction with reduced groundwater quality or quantity, including vegetation health.
- Metal mobilisation due to oxidation of ASS due to groundwater level changes from dewatering activities.
- Cumulative groundwater impacts associated with interaction between the cut-and-cover tunnel scenario and the BP33 underground mine and Grants Lithium Project, including overlapping drawdown cones and recovery interaction.

The cut-and-cover tunnel design does not materially change the identified groundwater source-pathway-receptor linkages. The principal amendment is a reduction in hydraulic connection between the underground access and the surrounding groundwater system, resulting in lower predicted inflows to the excavation compared with the box-cut scenario.

6.4. Preliminary Impact assessment

6.4.1. Risk-based impact assessment framework

The following definitions have been adopted for the purposes of this risk-based SWGA. Note, the Assessment undertaken is not a Risk Assessment, but rather a Risk of Impact Assessment based on assessment of potentially complete source-pathway-receptor linkages as defined below and discussed in subsequent sections of this report. This is in consideration of both modelled scenarios, the box-cut and cut and cover tunnel designs.

- Consequence: The most significant possible outcome of an event impacting an asset, value, or use. The consequence ratings as they relate to surface water and groundwater are defined thus:
  - Negligible: Minimal or negligible change in water quality, quantity or dynamics. For example, a small, temporary withdrawal of surface water or change in groundwater level that does not cause measurable harm to aquatic ecosystems or affect water availability is considered to have a negligible consequence.
  - Low: Small, but measurable, change in water quality, quantity or system dynamics. An example would be limited temporary sediment runoff into a waterway caused by a construction project that temporarily affects aquatic ecosystem health, but where the ecosystem can recover quickly following cessation of construction activities.

  - **Moderate:** A noticeable and measurable change in water quality, quantity and/or dynamics. For example, discharge of treated wastewater into a designated waterway in compliance with regulatory standards may increase nutrient levels, affecting aquatic ecosystem health from potential algal blooms or reduction in oxygen levels to a degree that may recover, but require intervention to avoid long-term damage.
  - **High:** Significant, widespread and potentially long-last effect on water quality, quantity and/or system dynamics. An example of a major consequence is a large chemical spill which discharges into a designated waterway and infiltrates into the groundwater table, causing contamination and long-term harm to a degree requiring remediation but ultimately resulting in ongoing risks to ecological and/or human health receptors.
  - **Extreme:** Severe, widespread and potentially irreversible damage to water quality, quantity and/or water system dynamics. E.g. a mine tailings dam breach or failure resulting in release of large quantities of contaminated water causing destruction of downstream ecosystems and/or displacement of human populations and long-term economic, environmental and social damage.
- **Likelihood**: The probability of an event occurring, defined as follows:
  - **Unlikely**: Low possibility of occurrence in any given year. An example is a storm event with a total rainfall approximately equivalent to the 1% AEP scenario.
  - **Possible**: May occur at some time throughout the Project's life. E.g. trench excavation for replacement of underground infrastructure such as internal transmission lines.
  - **Likely**: May occur in any given year. E.g. discharge of stormwater from the Project Area in accordance with operational procedures or routine grading of internal access tracks.
  - **Almost certain**: Expected to occur under most circumstances and at least once per year.
- **Risk of Impact**: The potential for a negative change concerning specific assets, values, or uses, determined by the combination of consequence and likelihood. This is further categorised into the following potential outcomes:
  - **Insignificant**: An event that is generally improbable, but if it occurs, results in an impact of negligible magnitude, extent and scale.
  - **Minor**: An event that is generally improbable, but if it occurs, results in an impact ranging from negligible to relatively low magnitude, extent and scale.
  - **Intermediate**: An event that is likely to occur, with the severity of the impact considered limited in magnitude, extent and scale.
  - **Elevated:** An event that is highly likely to occur, with the severity of the impact considered limited in magnitude, extent and scale.
  - **Extreme**: An event that is highly likely to almost certain to occur, resulting in an impact that is severe in magnitude, extent and scale.

The possible risk of impact ratings resulting from assessment of likelihood and consequence of a potential impact occurring is summarised in Table 6-1. These definitions have been utilised throughout the Impact Assessment.

Table 6-1 Risk based screening impact assessment matrix

		Consequence				
		Negligible	low	Moderate	High	Extreme
Likelihood	Unlikely	Insignificant	Insignificant	Minor	Intermediate	Intermediate
	Possible	Insignificant	Minor	Minor	Elevated	Elevated
	Likely	Insignificant	Minor	Intermediate	Elevated	Extreme
	Almost certain	Minor	Intermediate	Elevated	Extreme	Extreme

6.4.2. Assessment of Impacts

6.4.2.1. Box-Cut Scenario

Preliminary risk of groundwater, surface water and GDE impacts from the Project was deemed to be intermediate which reflects the uncertainly around the following;

- likelihood of saline water intrusion
- consequence of interactions with ASS and,
- degree of impact of drawdown on potential GDEs surrounding the Project

This section comprises a risk of impact assessment following a SPR approach based on characterisation of the water environments at the Project Area and the assessment undertaken.

The consequence of a potential impact is consistent regardless of the Project phase. Initial ratings are based on unmitigated risk of impact. Residual risk ratings assuming implementation of mitigation measures outlined in Section 6.6. Table 6-2 detailed the impact assessment for the Box Cut scenario.

6.4.2.2. Cut and Cover Tunnel Design

The overall source-pathway-receptor linkages remain broadly unchanged therefore the assessment of impacts largely remains the same as detailed in section 6.3.2.1The potential for groundwater ingress to the underground access is reduced however due to the tunnel liner and associated reduction in hydraulic connection, this has the possibility of:

- less seepage into the cut-and-cover tunnel
- lower groundwater inflows that need to be pumped or managed
- less draw on surrounding groundwater immediately next to the excavation
- potentially less local lowering of groundwater levels near the tunnel

Therefore, the project under the cut and cover tunnel design is also deemed as intermediate as detailed in Table 6-3.

Table 6-2: SPR Impact Assessment Box Cut (option 1)

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
GW1	Groundwater quality	Reduction from contact during excavation	Moderate	Possible	Excavation will occur during the construction phase and has potential to result in a measurable change in water quality requiring intervention; therefore, the consequence is classified as moderate and likelihood is possible.	Minor
		Reduction from siltation resulting from vegetation clearing, grading, mobilisation of plant and/or uncontrolled stockpile runoff	Low	Likely	A small, but measurable, change in groundwater quality may result from siltation via the identified pathways, resulting in a minor consequence.	Minor
		Reduction from uncontrolled spills and infiltration of hazardous materials	Moderate	Possible	A hazardous materials spill (chemical, fuel, firefighting foam, etc.) may occur and may result in a measurable change to groundwater quality (contamination) requiring intervention. Therefore, the SPR linkage consequence is classified as moderate and likelihood is considered possible.	Minor
		Reduction from the oxidation of ASS, on the ML as a result of construction or operational activities	Moderate	Unlikely	The SPR linkage between Project activities and ASS on site is considered unlikely as ASS have not been identified with in the ML boundary.	Minor
		Reduction from the oxidation of ASS, beyond the ML as a result of dewatering activities	Moderate	Likely	Up to 2m of drawdown is expected along the Charlotte River where high probability of ASS has been mapped. Therefor it is considered likely that oxidation of ASS may occur in this area. However, these soils exist in an area that undergoes periodic wetting and drying cycles. It is recommended that site specific testing be conducted to determine the degree on impact.	Intermediate
		Reduction from the intrusion of saline water from marine sources	High	Likely	Particle tracing modelling has identified some degree of saline water intrusion is likely because of dewatering activities. Further sampling and refinement of the model could reduce the uncertainty	Elevated
GW2	Groundwater quantity	Reduction from abstraction	Moderate	Almost certain	Dewatering will reduce the groundwater table in the vicinity of the pit and mine workings. Drawdown of 10m or more are expected to be confined to the ML boundary and 1 km away are less than 1m. This is a moderate impact considering the area covered and the expectation that drawdown reduces to 1m or less within 4 years.	Elevated

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
GW3	Aquatic GDEs	Reduction in quality or quantity in shallow soils and perched groundwater systems	Moderate	Unlikely	The SPR linkage between Project activities and Aquatic GDEs is considered unlikely as no Aquatic GDEs have been identified at the Site. If unidentified Aquatic GDEs do exist at the Site, any impacts resulting from changes to groundwater quality or quantity from Project activities are likely to resolve without further intervention.	Minor
GW4	Terrestrial GDEs	Deterioration in health of GDEs due to reduction in groundwater levels or quality	Moderate	Almost certain	Dewatering activities will reduce the availability of water for terrestrial GDEs surrounding the mine workings. These are expected to be confined to areas where the drawdown reduces the water table to a level below the rooting depth of the vegetation. Areas where this is almost certain to occur are within the disturbance footprint. However, it is likely/possible as drawdown decreases away from the site off the ML.	Elevated
GW5	Subterranean GDEs	Deterioration in health of GDEs due to reduction in groundwater levels or quality	Moderate	Unlikely	The SPR linkage between Project activities and subterranean GDEs is considered unlikely as no subterranean GDEs have been identified at the Site. If unidentified subterranean GDEs do exist at the Site, any impacts resulting from changes to groundwater quality or quantity from Project activities are likely to resolve without further intervention.	Minor
SW1	Surface water quality	Reduction from sedimentation resulting from vegetation clearing, grading, mobilisation of plant and/or uncontrolled stockpile runoff	Moderate	Possible	Excavation, vegetation and land cover clearance is likely to impact surface water quality due to increased sedimentation and nutrient loading however, consequences are considered to be moderate but localised and long-term deleterious effects are improbable.	Minor
		Reduction from uncontrolled spills and infiltration of hazardous material	Moderate	Possible	A hazardous materials spill (chemical, fuel, firefighting foam, etc.) could occur and may result in a measurable change to surface water quality requiring intervention. Therefore, the SPR linkage consequence is classified as moderate and likelihood is considered possible.	Minor
		Reduction from stormwater and/or wastewater discharge	Low	Possible	Discharge of stormwater and wastewater has potential to impact water quality such that although likely to recover without aid, intervention may be required to avoid long-term damage.	Minor
		Reduction from increased saline intrusion	High	Likely	Particle tracing modelling has identified some degree of saline water intrusion is likely as a result of dewatering	Elevated

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
					activities. Further sampling and refinement of the model could reduce the uncertainly. Should saline water reach mine workings the overall salinity of the water should be considered when managing discharge.	
SW2	Surface water quantity	Change to flow regime from proposed layout	Negligible	Almost certain	The proposed layout of the site intersects with an unnamed drainage it is assumed that this drainage line will be diverted around the disturbance area, resulting in change to the flow regime. It is considered that a minor diversion of a 1st order stream constitutes a negligible impact.	Minor
		Change to flow regime from stormwater and/or wastewater discharge	Low	Possible	Discharge of stormwater and wastewater has potential to impact the flow regime such that although likely to recover without aid, intervention may be required to avoid long-term damage.	Minor
		Reduction from the oxidation of ASS, on the ML as a result of construction or operational activities	Moderate	Unlikely	The SPR linkage between Project activities and ASS on site is considered unlikely as ASS have not been identified with in the ML boundary.	Minor
		Reduction from the oxidation of ASS, beyond the ML as a result of dewatering activities	Moderate	Likely	Up to 2m of drawdown is expected along the Charlotte River where high probability of ASS has been mapped. Therefor it is considered likely that oxidation of ASS may occur in this area. However, these soils exist in an area that undergoes periodic wetting and drying cycles. It is recommended that site specific testing be conducted t determine the degree on impact.	Intermediate

Table 6-3: SPR Impact Assessment Cut and Cover (option 2)

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
GW1	Groundwater quality	Reduction from contact during excavation	Moderate	Possible	Excavation will occur during the construction phase and has potential to result in a measurable change in water quality requiring intervention; therefore, the consequence is classified as moderate and likelihood is possible.	Minor
		Reduction from siltation resulting from vegetation clearing, grading, mobilisation of plant and/or uncontrolled stockpile runoff	Low	Likely	A small, but measurable, change in groundwater quality may result from siltation via the identified pathways, resulting in a minor consequence.	Minor
		Reduction from uncontrolled spills and infiltration of hazardous materials	Moderate	Possible	A hazardous materials spill (chemical, fuel, firefighting foam, etc.) may occur and may result in a measurable change to groundwater	Minor

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
					quality (contamination) requiring intervention. Therefore, the SPR linkage consequence is classified as moderate and likelihood is considered possible.	
		Reduction from the oxidation of ASS, on the ML as a result of construction or operational activities	Moderate	Unlikely	The SPR linkage between Project activities and ASS on site is considered unlikely as ASS have not been identified with in the ML boundary.	Minor
		Reduction from the oxidation of ASS, beyond the ML as a result of dewatering activities	Moderate	Likely	Up to 2m of drawdown is expected along the Charlotte River where high probability of ASS has been mapped. Therefor it is considered likely that oxidation of ASS may occur in this area. However, these soils exist in an area that undergoes periodic wetting and drying cycles. It is recommended that site specific testing be conducted to determine the degree on impact.	Intermediate
		Reduction from the intrusion of saline water from marine sources	High	Likely	Particle tracing modelling has identified some degree of saline water intrusion is likely because of dewatering activities. Further sampling and refinement of the model could reduce the uncertainty	Elevated
GW2	Groundwater quantity	Reduction from abstraction	Moderate	Almost certain	Dewatering will reduce the groundwater table in the vicinity of the pit and mine workings. Drawdown of 10m or more are expected to be confined to the ML boundary and 1 km away are less than 1m. This is a moderate impact considering the area covered and the expectation that drawdown reduces to 1m or less within 4 years.	Elevated
GW3	Aquatic GDEs	Reduction in quality or quantity in shallow soils and perched groundwater systems	Moderate	Unlikely	The SPR linkage between Project activities and Aquatic GDEs is considered unlikely as no Aquatic GDEs have been identified at the Site. If unidentified Aquatic GDEs do exist at the Site, any impacts resulting from changes to groundwater quality or quantity from Project activities are likely to resolve without further intervention.	Minor
GW4	Terrestrial GDEs	Deterioration in health of GDEs due to reduction in groundwater levels or quality	Moderate	Almost certain	Dewatering activities will reduce the availability of water for terrestrial GDEs surrounding the mine workings. These are expected to be confined to areas where the drawdown reduces the water table to a level below the rooting depth of the vegetation. Areas where this is almost certain to occur are within the disturbance footprint. However, it is likely/possible as drawdown decreases away from the site off the ML.	Elevated

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
GW5	Subterranean GDEs	Deterioration in health of GDEs due to reduction in groundwater levels or quality	Moderate	Unlikely	The SPR linkage between Project activities and subterranean GDEs is considered unlikely as no subterranean GDEs have been identified at the Site. If unidentified subterranean GDEs do exist at the Site, any impacts resulting from changes to groundwater quality or quantity from Project activities are likely to resolve without further intervention.	Minor
SW1	Surface water quality	Reduction from sedimentation resulting from vegetation clearing, grading, mobilisation of plant and/or uncontrolled stockpile runoff	Moderate	Possible	Excavation, vegetation and land cover clearance is likely to impact surface water quality due to increased sedimentation and nutrient loading however, consequences are considered to be moderate but localised and long-term deleterious effects are improbable.	Minor
		Reduction from uncontrolled spills and infiltration of hazardous material	Moderate	Possible	A hazardous materials spill (chemical, fuel, firefighting foam, etc.) could occur and may result in a measurable change to surface water quality requiring intervention. Therefore, the SPR linkage consequence is classified as moderate and likelihood is considered possible.	Minor
		Reduction from stormwater and/or wastewater discharge	Low	Possible	Discharge of stormwater and wastewater has potential to impact water quality such that although likely to recover without aid, intervention may be required to avoid long-term damage.	Minor
		Reduction from increased saline intrusion	High	Likely	Particle tracing modelling has identified some degree of saline water intrusion is likely as a result of dewatering activities. Further sampling and refinement of the model could reduce the uncertainly. Should saline water reach mine workings the overall salinity of the water should be considered when managing discharge.	Elevated
SW2	Surface water quantity	Change to flow regime from proposed layout	Negligible	Almost certain	The proposed layout of the site intersects with an unnamed drainage it is assumed that this drainage line will be diverted around the disturbance area, resulting in change to the flow regime. It is considered that a minor diversion of a 1st order stream constitutes a negligible impact.	Minor
		Change to flow regime from stormwater and/or wastewater discharge	Low	Possible	Discharge of stormwater and wastewater has potential to impact the flow regime such that although likely to recover without aid, intervention may be required to avoid long-term damage.	Minor
		Reduction from the oxidation of ASS, on the ML as a result of construction or operational activities	Moderate	Unlikely	The SPR linkage between Project activities and ASS on site is considered unlikely as ASS have not been identified with in the ML boundary.	Minor

Potential impact ID	Receptor	Source/Pathway	Consequence	Likelihood	Justification	Risk of impact
		Reduction from the oxidation of ASS, beyond the ML as a result of dewatering activities	Moderate	Likely	Up to 2m of drawdown is expected along the Charlotte River where high probability of ASS has been mapped. Therefor it is considered likely that oxidation of ASS may occur in this area. However, these soils exist in an area that undergoes periodic wetting and drying cycles. It is recommended that site specific testing be conducted t determine the degree on impact.	Intermediate

6.5. Potential mitigation measures

6.5.1. Overview

Mitigation measures are mostly the same for each of the two scenarios, with the exception of the tunnel liner, which has been show to theoretically reduce groundwater inflows to the mine workings.

6.5.2. Avoidance measures

Design measures relevant to mitigation of potential impacts to groundwater and surface water environments at the Project Area include:

- Where practicable establish and maintain buffer zones around natural drainage lines, to minimise potential construction and operational impacts.
- Spill prevention measures for hazardous materials including fuels and lubricants used during construction activities to prevent contamination.
- Utilisation of appropriately sized culverts and/or floodways where proposed access tracks intersect waterways.
- In the case of the cut and cover mining method, lining the tunnel has the potential to reduce inflows, and therefore impacts to groundwater quality and quantity measures, to the underground workings. The extent of impact mitigation will be dependent on the efficacy of the liner from restricting or reducing the volume of inflows to the underground workings. A nominal liner design has been presented in this study to indicate the potential for a liner to influence inflows.

6.5.3. Management measures

Management measures that should be incorporated into Construction Environmental Management Plans (CEMPs) and implemented include:

- Utilisation of low impact construction techniques, such as limiting works to the immediate construction area and using designated laydown areas, to minimise soil disturbance.
- Appropriate stockpile management and earthworks, including designation of laydown areas, utilisation of bunding, silt fences and/or erosion control blankets to minimise sediment transport in event of rainfall and surface water runoff.
- Implementation of a comprehensive Stormwater Management Plan for the Project Area based on final detailed and operational design to adequately control runoff and reduce sediment loads that may affect potential receptors within and hydraulically downgradient of the Project Area. Including the consideration of the following:
    - Sediment and erosion control measures, such as silt fences, bunding and/or sediment traps, upstream and downstream of structure construction locations to intercept external flows, prevent siltation of shallow groundwater and prevent sedimentation in designated downstream waterways.
    - Stormwater and wastewater management measurements including separation of clean and dirty surface water areas to avoid and minimise potential downstream impacts from discharges within the development Project Area:

- implementation of drainage systems to reduce potentially impacted stormwater infiltration into groundwater
- use of permeable surfaces where possible (i.e. access tracks, substation) to promote natural infiltration of clean surface water.

- Management of temporary sewage systems in accordance with Industry Standard to prevent and respond to potential spills or overflows.
- Re-vegetation of disturbed areas to stabilise soil and minimise potential erosion and sedimentation.
- Utilisation of retention ponds, bioswales or other stormwater management infrastructure to manage peak flows and mitigate potential impacts to water quality.
- Ongoing monitoring of groundwater surface water and vegetation to identify and address potential impacts.

6.5.4. Offsets

Where impacts are practicably unavoidable in localised areas offsets maybe considered as a mitigation strategy for the overall impact of Project Area operations. This maybe the case for impacts to the moderate potential Terrestrial GDEs surrounding the Project Area, further study into rooting depth of mapped species could be used to inform the extent of impact and thus offset required.

6.6. Residual impact assessment

The residual risk of groundwater, surface water and GDE impacts from the Project in both scenarios was deemed to be minor assuming appropriate mitigation and management measures are implemented, and monitoring is conducted to ensure effectiveness.

The residual impact assessment is presented in Table 6-4.

6.7. Cumulative GDE impact assessment

The Project Area is located within the Bynoe Pegmatite Field, currently there are two other lithium projects in the area, the BP33 project (BP33) and the Grants Lithium project (GLP). BP33 is located 2 km to the north and GLP 6 km north. The cumulative impacts of these projects were considered in the Lei Lithium Project Groundwater model report Appendix A (CloudGMS, 2026). Under the model scenarios the three projects (BP33, GLP and Lei Lithium) stated operations on the same day, this was a reasonable worst-case scenario, based on the available information at the time of model development. The drawdown contours are expected to overlap between BP33 and the Project area, however the area affected is localised around the northern edge of the Lei drawdown contours (0.1 - 0.2 m drawdown) recovers well following closure, this additional drawdown represents are small proportion of the annual recharge to the model. In the event that mining methods and schedules change for any of the projects considered there is potential for the outcome of the cumulative impact assessment to change. For further detail of the modelling scenarios see Section 7 of Appendix A.

6.7.1.1. Box-Cut Scenario

Drawdown at the Lei Lithium mine is not expected to be significantly greater under the cumulative scenario. The average drawdown across the monitoring bores is an additional 1.2 m, see Section

5.4.1.2, under the worst-case scenario. This additional drawdown is unlikely to increase the impacts of the project in a significant way due to the small proportion of the overall drawdown.

Under the cumulative scenario the area of drawdown for the lei and BP33 mines do intersect, see Figure 6-1 showing cumulative scenario with all three operations after 6 years of mining. While there is additional area covered by the drawdown contours when compared to Figure 5-12, the additional area is relatively small and shows drawdown on 0.1 or 0.2 m which is unlikely to impact vegetation communities that may be reliant on groundwater. Recovery at the Lei Lithium Project Area is not expected to be delayed significantly by the cumulative impact of the BP33 and GLP projects operating at the same time. In Figure 6-2 the drawdown contours can be seen for BP33 and GLP however the drawdown contours for the Lei Project Area are comparable to the contours in Section 5.4, where only Lei was operational.

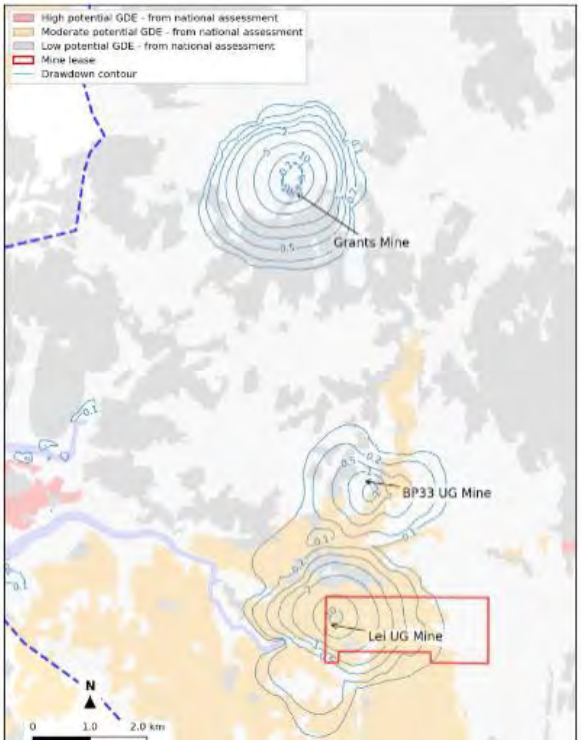


Figure 6-1:Predicted drawdown contours after 6 years with all three mines operational

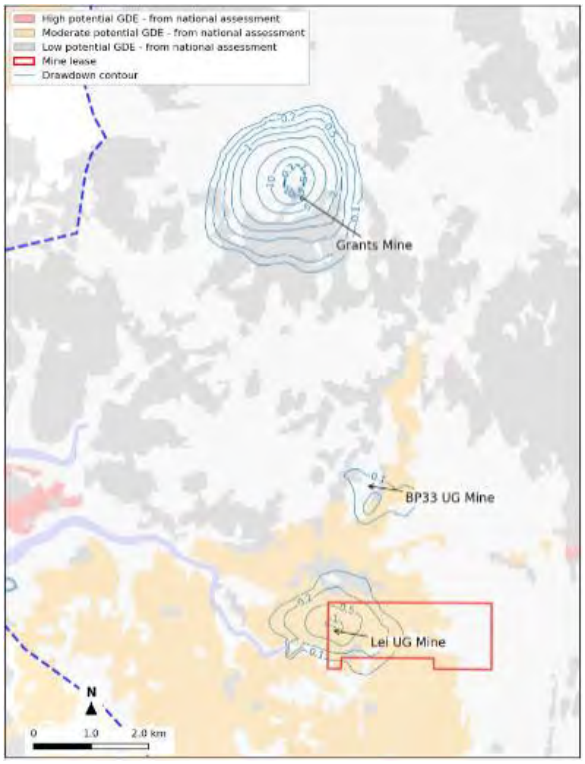


Figure 6-2: Predicted drawdown contours after 4 years of recovery, 10 years since the start of mining at the three projects

6.7.1.2. Cut and Cover Tunnel Design

Cumulative impacts to GDEs associated with the cut-and-cover tunnel scenario remain broadly consistent with those predicted for the Box cut scenario for both s01 and s02 scenarios (see Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4). The forecast drawdown at the end of underground mining and during post-closure recovery indicates that the cumulative drawdown cone continues to extend beyond the mining lease boundary to the north, west and south, approaches the eastern lease boundary, and extends toward the tidal reach of the Charlotte River. Due to the underground access being represented as a cut-and-cover tunnel, modelled groundwater inflows are lower than in the box-cut scenario due to the reduced hydraulic connection provided by the tunnel liner; however, the

overall spatial extent of drawdown and the recovery behaviour remain effectively unchanged. Drawdown also extends below areas identified as having moderate potential for terrestrial GDEs. Particle tracking results remain consistent with the original assessment, indicating that saline groundwater from the tidal reach of the Charlotte River may still migrate toward the underground workings. Inland migration is limited under most parameter combinations and impacts to shallow groundwater-dependent ecosystems remain unlikely outside of the immediate development area. Accordingly, cumulative GDE impacts remain of similar significance to those assessed for the box-cut scenario. Monitoring adjacent to the Charlotte River remains appropriate to better characterise salinity stratification and groundwater–surface water interaction in the tidal reach.

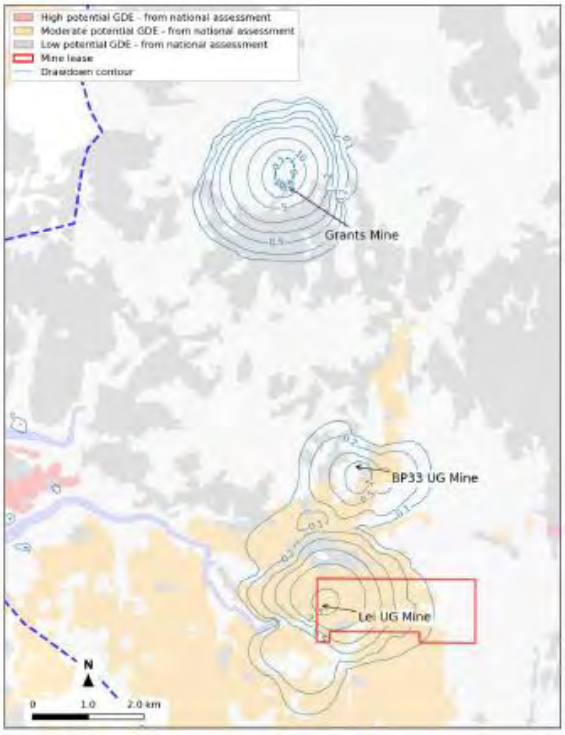


Figure 6-3: Predicted drawdown contours after 6 years with all three mines operational (cut and cover)

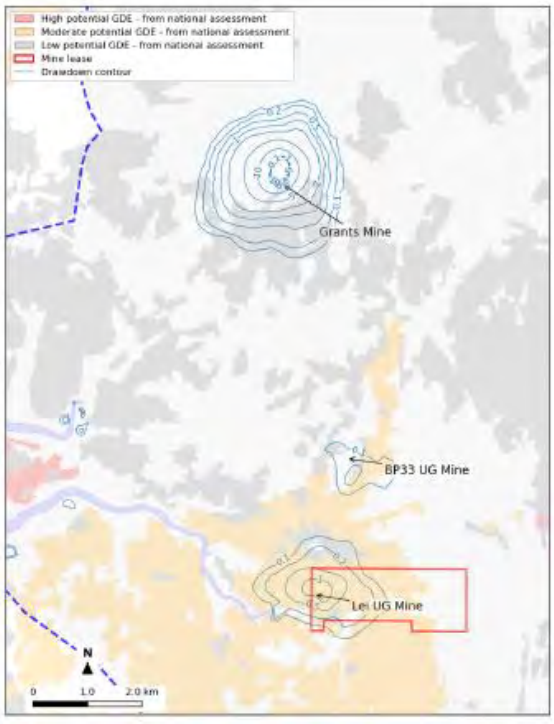


Figure 6-4:Predicted drawdown contours after 4 years of recovery, 10 years since the start of mining at the three projects

Table 6-4 Residual Impact Assessment merged for both the box-cut and cut and cover tunnel scenario

Potential impact ID	Description	Justification	Risk of impact	Mitigation measure	Residual		
					Consequence	Likelihood	Impact Rating
GW1 Groundwater quality	Groundwater Quality Reduction from contact during excavation	Excavation will occur during the construction phase and has potential to result in a measurable change in water quality requiring intervention; therefore, the consequence is classified as moderate and likelihood is possible. Under the cut-and-cover tunnel scenario, this pathway remains applicable during construction, although predicted groundwater ingress to the excavation is lower than for the box-cut design.	Minor	Implementation of an appropriate stormwater management strategies including erosion control measures, silt fences and barriers during construction activities. Implementation of a groundwater and surface water monitoring plan, including comparison to relevant livestock and human-health drinking water guidelines.	Moderate	Unlikely	Minor
	Reduction from siltation resulting from vegetation clearing, grading, mobilisation of plant and/or uncontrolled stockpile runoff	A small, but measurable, change in groundwater quality may result from siltation via the identified pathways, resulting in a minor consequence. The cut-and-cover tunnel scenario does not materially change the siltation pathway, as this remains driven by surface disturbance, vegetation clearing, grading and stockpile runoff.	Minor		Low	Possible	Minor
	Reduction from uncontrolled spills and infiltration of hazardous materials	A hazardous materials spill (chemical, fuel, firefighting foam, etc.) may occur and may result in a measurable change to groundwater quality (contamination) requiring intervention. Therefore, the SPR linkage consequence is classified as moderate and likelihood is considered possible.	Minor		Moderate	Unlikely	Minor
	Reduction from the oxidation of ASS, on the ML because of construction or operational activities	The SPR linkage between Project activities and ASS on site is considered unlikely as ASS have not been identified with in the ML boundary. The cut-and-cover tunnel design does not materially change this pathway, as ASS remain unlikely within the ML boundary.	Minor	Sampling to determine presence of acid sulphate soils. Development of a management plan if acid sulphate soils are confirmed.	Low	Unlikely	Insignificant
	Reduction from the oxidation of ASS, beyond the ML because of dewatering activities	Up to 2m of drawdown is expected along the Charlotte River where high probability of ASS has been mapped. Therefore, it is considered likely that oxidation of ASS may occur in this area.	Intermediate	Sampling to determine presence of acid sulphate soils. Development of a management plan if acid	Moderate	Unlikely	Minor

Potential impact ID	Description	Justification	Risk of impact	Mitigation measure	Residual		
					Consequence	Likelihood	Impact Rating
				sulphate soils are confirmed.			
	Reduction from the intrusion of saline water from marine sources	Particle tracking identified some degree of saline water intrusion is likely because of dewatering activities. Further sampling and refinement of the model could reduce uncertainly. Particle tracking results for the cut-and-cover tunnel scenario remain broadly consistent with the box-cut scenario, indicating that saline groundwater may still migrate toward the underground workings, although predicted inflows are lower.	Elevated	Testing to inform porosity and dispersity values to reduce particle tracking uncertainty.	High	Likely	Elevated
GW2 Groundwater quantity	Reduction from abstraction	Dewatering will reduce the groundwater table in the vicinity of the pit and my workings. Drawdown of 10m or more are expected to be confined to the ML boundary and 1 km away are less than 1m. This is a moderate impact considering the area covered and the expectation that drawdown reduces to 1m or less within 4 years following the cessation of mining. The cut-and-cover tunnel is expected to reduce groundwater ingress relative to the box-cut scenario, if a tunnel liner is utilised. but the overall drawdown and recovery pattern remains broadly similar.	Elevated	Ongoing groundwater monitoring to establish a better understanding of groundwater levels at the Site. Where the water table is intersected by excavations, monitoring should be undertaken to ensure appropriate management of impacts. Offsets maybe implemented where impacts are unavoidable. Further investigation into tunnel liners may reduce uncertainty around inflow quantities.	Negligible	Almost Certain	Minor
GW3 Aquatic GDEs	Reduction in quality or quantity in shallow soils and perched groundwater systems	The SPR linkage between Project activities and Aquatic GDEs is considered unlikely as no Aquatic GDEs have been identified at the Site. If unidentified Aquatic GDEs do exist at the Site, any impacts resulting from changes to groundwater	Minor	Groundwater monitoring to identify potential risk to receptors.	Moderate	Unlikely	Minor

Potential impact ID	Description	Justification	Risk of impact	Mitigation measure	Residual		
					Consequence	Likelihood	Impact Rating
		quality or quantity from Project activities are likely to resolve without further intervention.					
GW4 Terrestrial GDEs	Deterioration in health of GDEs due to reduction in groundwater levels or quality	Dewatering activities will reduce the availability of water for terrestrial GDEs surrounding the mine workings. These are expected to be confined to areas where the drawdown reduces the water table to a level below the rooting depth of the vegetation. Areas where this is almost certain to occur are within the disturbance footprint. However, it is likely/possible as drawdown decreases away from the site off the ML.	Elevated	Ongoing groundwater monitoring to establish a better understanding of groundwater levels at the Site. Where the water table is intersected by excavations, monitoring should be undertaken to ensure appropriate management of impacts. Offsets maybe implemented where impacts are unavoidable	Negligible	Almost Certain	Minor
GW5 Terrestrial GDEs	Deterioration in health of GDEs due to reduction in groundwater levels or quality	The SPR linkage between Project activities and subterranean GDEs is considered unlikely as none have been identified at the Site. If unidentified subterranean GDEs do exist at the Site, any impacts resulting from changes to groundwater quality or quantity from Project activities are likely to resolve without further intervention.	Minor	Groundwater monitoring to identify potential risk to receptors.	Moderate	Unlikely	Minor
SW1 Surface water quality	Reduction from sedimentation resulting from vegetation clearing, grading, mobilisation of plant and/or uncontrolled stockpile runoff	Excavation, vegetation and land cover clearance is likely to impact surface water quality due to increased sedimentation and nutrient loading however, consequences are moderate. Localised, long-term deleterious effects are improbable.	Minor	Implement stormwater management and monitoring plan, including comparison to relevant guideline values	Moderate	Unlikely	Minor
	Reduction from uncontrolled spills and infiltration of hazardous material	A hazardous materials spill (chemical, fuel, firefighting foam, etc.) could occur and may result in a measurable change to surface water quality requiring intervention. Therefore, the SPR linkage consequence is classified as moderate and likelihood is considered possible.	Minor	Implementation of an appropriate waste management and monitoring plan, including comparison to relevant guideline values	Moderate	Unlikely	Minor
	Reduction from stormwater and/or wastewater discharge	Discharge of stormwater and wastewater has potential to impact water quality such that although likely to recover without aid,	Minor	Implementation of an appropriate stormwater management and	Low	Unlikely	Insignificant

Potential impact ID	Description	Justification	Risk of impact	Mitigation measure	Residual		
					Consequence	Likelihood	Impact Rating
		intervention may be required to avoid long-term damage.		monitoring plan, including comparison to relevant guideline values			
	Reduction from increased saline intrusion	Particle tracing modelling has identified some degree of saline water intrusion is likely because of dewatering activities. Further sampling and refinement of the model could reduce the uncertainly. Should saline water reach mine workings the overall salinity of the water should be considered when managing discharge. The cut-and-cover tunnel scenario remains broadly consistent with the original assessment, with saline intrusion still identified as a potential pathway from the tidal Charlotte River.	Elevated	Further testing to inform porosity and dispersity values to reduce uncertainty in particle tracking modelling.	High	Possible	Elevated
SW2 Surface water quantity	Change to flow regime from proposed layout	The proposed layout of the site intersects with an unnamed drainage it is assumed that this drainage line will be diverted around the disturbance area, resulting in change to the flow regime. It is considered that a minor diversion of a 1st order stream constitutes a negligible impact.	Minor	Implementation of an appropriate stormwater management and monitoring plan, including comparison to relevant guideline values	Negligible	Almost certain	Minor
	Change to flow regime from stormwater and/or wastewater discharge	Discharge of stormwater and wastewater has potential to impact the flow regime such that although likely to recover without aid, intervention may be required to avoid long-term damage.	Minor	Implementation of an appropriate stormwater management and monitoring plan, including comparison to relevant guideline values	Low	Unlikely	Insignificant
	Reduction from the oxidation of ASS, on the ML because of construction or operational activities	The SPR linkage between Project activities and ASS on site is considered unlikely as ASS have been identified with in the ML boundary.	Minor	Sampling to determine presence of acid sulphate soils. Development of a management plan if acid sulphate soils are confirmed.	Low	Unlikely	Insignificant
	Reduction from the oxidation of ASS, beyond the ML because of dewatering activities	Up to 2m of drawdown is expected along the Charlotte River where high probability of ASS has been mapped. Therefor it is considered likely that oxidation of ASS may occur in this area. The cut-	Intermediate	Sampling to determine presence of acid sulphate soils. Development of a	Low	Likely	Minor

Potential impact ID	Description	Justification	Risk of impact	Mitigation measure	Residual		
					Consequence	Likelihood	Impact Rating
		and-cover tunnel scenario remains broadly consistent with the original drawdown pathway, so the potential for ASS oxidation in the Charlotte River corridor remains relevant.		management plan if acid sulphate soils are confirmed.			

7. Uncertainties and Recommendations

7.1. Overview

Numerical groundwater modelling results and impact assessment suggests that the overall residual risk to groundwater, surface water and GDEs is considered to be Minor. However, there remain significant risks associated with the Lei Lithium Project from effects such as the potential for saline water intrusion, and the localised reduction in the water table to the environment.

7.2. Groundwater dependent ecosystems

Groundwater drawdown of more than 5 m extends beyond the ML boundary and has the potential to impact water availability for vegetation community's dependant on groundwater resources. This degree of impact is highly dependent on rooting depth and individual species tolerance. An assessment of the rooting depth of key species could be conducted to determine the likely area and reduce the uncertainty regarding the degree of impact.

7.3. Acid sulfate soils

High probability acid sulfate soils have been mapped within the predicted drawdown area. However, these areas are generally considered to be under tidal influence and/or a seasonally present groundwater table. It is likely that these soils naturally undergo periodic wetting and drying cycles and the degree of impact that the drawdown will have is unclear. Project Area specific soil testing and the development of Project Area specific trigger levels could reduce the uncertainty.

7.4. Model Parameters

Uncertainty is inherent in any application of modelling, with model parameters determined based on the data available at the time of model development. Field observations and typical values found in literature were used as a basis for the model parameter which were then refined using industry standard uncertainty analysis software (PESTPP-IES). This is a necessary simplification of a real-world system which is likely to contain much greater variability than is presented in the model. Specifically, it is likely that deeper fresh rock has lower hydraulic conductivity and storage properties than the upper layers which are generally more weathered. This model therefore represents a conservative parameter calibration whereby the inflows to the mine workings at depth may be reduced in comparison to that predicted from the model. Parameter sensitivity analysis was undertaken and results can be found in Appendix A1: Section 8. The results show the effect of varying parameter sets on the drawdown at each observation bore. As there is no site-specific data available for at depth this is considered to be the most robust methodology.

The model has been calibrated against observation data from onsite bores between late 2023 and mid 2025, as this data set expends and more operational information become available is it advisable to update the model where necessary. Initial operational data from Grants and BP33 has been made available between the development of the Lei Lithium Groundwater model and the finalisation of this report. As data are collected at site over time, it is important to undertake model validation and re-calibration (where required) to reduce the predictive uncertainly.

7.5. Saline water intrusion

There is significant uncertainly regarding the parameters for the partial tracking modelling. Refining these parameters though testing and/or further modelling could provide additional information to assess the degree of risk associated with saline water intrusion. More refined modelling could be used to inform design and management processes for the dewatering process to manage saline water intrusion and mitigate potential damage to mining infrastructure due to the lowering of water quality interacting with operations. Should sufficient Project Area specific data be obtained, solute transport modelling with a density component could provide the most robust method for determining the degree of risk associated with saline water intrusion. Currently the modelling suggests this risk is greatest at depth and therefor poses and operational risk but due to the upward gradient of the groundwater and potential dewatering disposal pathways also poses a risk to GDEs and the Environment. An additional monitoring bore, or nested bores in the vicinity of the tidal section of the Charlotte River could provide information on the salinity profile below the river and be utilised as an observation bore.

7.6. Monitoring plan

The development of and internal monitoring plan with QAQC guidelines and site-specific trigger levels is recommended to provide a robust water quality database to assess impacts against. The surface water monitoring sites in particular are subject to high variation in salinity due to the tidal influence which can impact the reliability of field measurements, QAQC guidelines should include actions for retesting and calibration when readings outside the normal range are detected in the field to improve reliability in these circumstances.

The existing monitoring record is relatively short and the therefore the baseline conditions may not have captured the true natural minimum of the natural variation. Therefore the predicted water levels derived from s00 should be utilised as a basis for the natural groundwater level variation in conjunction with the observed data set as it expands. This approach is consistent with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

Consider the use of the drawdown extent from numerical groundwater modelling to inform the development of site specific trigger levels if required with an additional buffer to account for all uncertainties, modelling (spatial and level extent) and natural variation. An adaptive management plan with initial, early warning, trigger levels could be developed to provide a trigger for investigation before an exceedance became reportable.

7.7. Mining Method

While there is no significant difference in the impacts predicted between the two mining methods presented the installation of a tunnel liner has the potential to significantly reduce the inflows to the mine workings. However the magnitude of this reduction has not been quantified at this time and represents an area of uncertainty. The reduction in conductivity and related inflows are conservative and not based on a specific material or design. It is likely that a well-designed liner could be more effective. If the cut and cover tunnel method is selected further investigation into a liner its effectiveness and impact on inflows be conducted, liners typically have a design permeability that can be reviewed against the model results. The modelled scenarios assume that post mining the void

will remain with no back filling, this is considered to be a conservative approach and should backfilling occur the recovery time is likely to decrease.

The mining methods and schedules of the surrounding projects have been modelled with the best available data at the time of model development, to represent a reasonable worst case scenario where the three projects commence at the same time. Under the modelled scenario there is minimal cumulative impact however should there be changes to the mining schedules and methods these changes have the potential to materially change the cumulative impacts assessment.

8. References

ANZECC & ARMCANZ (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra), 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* [Online]
Available at: https://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000

Australian and New Zealand Environmental and Conservation Council (ANZECC), 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* [Online]
Available at: https://www.waterquality.gov.au/sites/default/files/documents/anzecc-armcanz-2000-guidelines-vol1.pdf

Australian and New Zealand Governments and Australian state and territory governments (ANZG), 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* [Online]
Available at: https://www.waterquality.gov.au/anz-guidelines

Barnett, et al., 2012. *Australian Groundwater Modelling Guidelines,* Canberra: s.n.

Bureau of Meterology , 2025. *Bureau of Meterology Climate Data Online.* [Online]
Available at: https://www.bom.gov.au/climate/data/
[Accessed 2025].

Bureau of Mineral Resources, Geology and Geophysics, NT, 1988. *Darwin, Northern Territory : geological sheet SD5204.* s.l.:s.n.

CDM Smith, 2024. Drilling Report Lei Lithium Groundwater Bore Drilling.

CloudGMS, 2018. *Development of a Groundwater Model for the Grants Lithium Project,* s.l.: unpublished.

CloudGMS, 2026. *Lei Lithum Project Groundwater Model Report,* s.l.: s.n.

Cook, P. G., Hatton, T. J., Eamus, D., Hutley, L. and Pidsley, D, 1998. Hydrological Investigation at Howard East. *N.T. CSIRO Land and Water, Technical Report 41/98.*

Core Lithium, 2026. *Finniss Lithium Operation.* [Online]
Available at: https://www.corelithium.com.au/assets/finniss-lithium-operation

CSIRO & National Resource Information Centre , 1991. *Atlas of Australian Soils.* [Online]
Available at: https://doi.org/10.25919/5f1632a855c17
[Accessed 2025].

Department of ENVIRONMENT AND NATURAL RESOURCES , 2020. *Northern Territory Water Allocation Planning Framework.* 1.1 ed. s.l.:Northern Territory Government.

Department of Lands, Planning and Environment, 2019. *Environmental Protection Act.* [Online]
Available at: https://legislation.nt.gov.au/en/Legislation/ENVIRONMENT-PROTECTION-ACT-2019
[Accessed 2025].

Department of Lands, P. a. E., 2000. *Bores sites in the Northern Territory.* Darwin: NR Maps.

EcOz Environmental Consultants, 2024. Ecological Assessment of EL31091 Lithium Plus.

Geoscience Australia, 1986. *Water Observation Mutli Year Frequency Statistics.* [Online]
Available at: https://maps.dea.ga.gov.au/

Geoscience Australia, 2025. [Online]
Available at: https://portal.ga.gov.au/

GHD, 2017. *Finniss Lithium Project Groundwater Investigation Report. Unpublished,* s.l.: s.n.

Groundwater Enterprises, 2023. Lei Lithium Prospoect Preliminary Groundwater Assessment. September.

Lithium Plus Minerals, 2026. *Lithium Plus Mineral Projects Overview.* [Online]
Available at: https://lithiumplus.com.au/projects/

Lithium Plus, 2024. Referal under the Environmental protection Act 2019 (NT) Lei Lithium Project.

Northern Territory Department of Natural Resources, the Environment and the Arts (NRETA), 2008. *Groundwater Supply Prospects and Hydrogeology of the Cox.* s.l.:s.n.

Northern Territory Government , 1998. NT Government Gazette No. 20. 27 5.

Northern Territory Government , 2025. *Darwin Rural Adelaide River Water Control District.* [Online]
Available at: https://nt.gov.au/environment/water/management-security/water-plan/water-control-districts/darwin-rural

Northern Territory Government, 1998. NT Government gazette No. 9. 11 03.

Northern Territory Government, 2024. *Adelaide River Water Allocation Plan - Plan in Progress.* [Online]
Available at:
file:///C:/Users/erica.holt/Downloads/Darwin%20Rural%20Adelaide%20River%20Water%20Control%20District%20Map.pdf

Northern Territory Government, 2024. Government Gazette No. G13. 20 06.

Northern Territory Government, 2025. *Natural Resources Maps.* [Online]
Available at: https://nrmaps.nt.gov.au/nrmaps.html

NT EPA, 2025. *Notice of decision and statement of reasons - EP2024/038,* s.l.: s.n.

NT EPA, 2025. *NT EPA Environmental factors and objectives,* s.l.: s.n.

Pietsch, B. A., 1986. *1:100 000 Geological Map Series Explanatory Notes - Bynoe 5072.,* s.l.: Northern Territory Geological Survey.

Queensland Government, 2026. *LongPaddock SILO.* [Online]
Available at: https://www.longpaddock.qld.gov.au/silo/

The Bureau of Meterology, 2026. *Groundwater Dependent Ecosystems Atlas.* [Online]
Available at: https://www.bom.gov.au/water/groundwater/gde/map.shtml
[Accessed 2026].

The National Committee on Soil and Terrain (NCST) , 2021. *The Australian Soil Classification.* s.l.:CSIRO Publishing.

Appendix A Cloud GMS Groundwater Modelling

A1: Cloud GMS Modelling Report

Lei Lithium Project Groundwater Model Report

Draft Version 0.4

PREPARED FOR LITHIUM PLUS MINERALS LTD
BY CLOUDGMS

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Abbreviations and acronyms

AHD	Australian Height Datum
BCF	Burrell Creek Formation
BOM	Bureau of Meteorology
BC	Boundary Condition
DEM	Digital Elevation Model
DEPWS	Department of Environment, Parks and Water Security
DIPE	Department of Infrastructure, Planning and Environment
DLRM	Department of Land Resource Management
DSO	Direct Shipping Ore
EC	Electrical Conductivity
EIS	Environmental Impact Statement
ET	Evapotranspiration
FEFLOW	Finite Element subsurface FLOW and transport system
GDA94	Geocentric Datum of Australia 1994
GDE	Groundwater-Dependent Ecosystem
GLP	Grants Lithium Project
HSU	Hydrostratigraphic Unit
LHOS	Long-Hole Open Stoping
Li_2O	Lithium Oxide
LoM	Life of Mine
ML	Mineral Lease
MWD1	Mine Water Dam 1
ne	Effective porosity
NRETA	Natural Resources, Environment, The Arts and Sport
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
pH	Potential of Hydrogen
Qa	Quaternary Alluvium
Qe	Quaternary Estuarine Deposits
RAR	Return Air Raise
ROM	Run of Mine
RMS	Root Mean Square
RWPT	Random-Walk Particle Tracking
SER	Supplementary Environmental Report
SILO	Scientific Information for Land Owners climate database
SOCS	Sites of Conservation Significance
SRTM	Shuttle Radar Topography Mission
SWL	Standing Water Level
WRD	Waste Rock Dump
WTFM	Water Table Fluctuation Method
ZOI	Zone of Influence

Units

GL	gigalitre (10^9 litres)
kL	kilolitre (10^3 litres)
km	kilometre
km^2	square kilometre
kt	Kilotonnes
ktpa	Kilotonnes per annum
L/s	litres per second
m^2/d	metres squared per day
m^2/d	metres squared per day
m^3	cubic metre
m^3/d	cubic metres per day
m^3/s	cubic metres per second
ML	megalitre (10^6 litres)
m AHD	metres above Australian Height Datum
mBGL	metres Below Ground Level
mm	millimetre
mm/d	millimetre per day
Mt	Million tonnes

1 Introduction

1.1. Background

Lithium Plus Minerals Ltd (Lithium Plus) proposes to develop the Lei Lithium Project, an underground lithium mine located on the Cox Peninsula in the Northern Territory, about 30 km south of Darwin within mineral lease application ML 33874. The Project is situated on vacant Crown land and is accessed via Fog Bay Road. The nearest township is Berry Springs, located about 25 km east of the Project area (Figure 1-1).

The Project is located within the Bynoe Pegmatite Field, with mineralisation hosted in the Burrell Creek Formation, a fractured and weathered metasedimentary unit that forms a marginal regional aquifer. About 3.10 Mt of high-grade spodumene ore is proposed to be extracted from the Lei deposit using underground mining methods. Current mine planning includes a surface box cut and portal providing access to a spiralling underground decline located east of the pegmatite orebody. Ore will be crushed and screened on site to produce Direct Shipping Ore (DSO) at a peak production rate of about 600 kt per year.

The DSO will be transported by road to Darwin Port for export. No on-site processing or tailings storage facilities are required. Waste rock is considered chemically benign and will be temporarily stored on the surface before being used to backfill the box cut and underground workings at closure. The proposed Life of Mine is about seven years, including construction and closure, with a total disturbance footprint of less than 100 ha.

The Project lies within the Charlotte River sub-catchment, which drains to Bynoe Harbour and supports riparian vegetation, estuarine environments and downstream mangrove communities. The Charlotte River is ephemeral in its upper reaches but becomes tidally influenced downstream of the Project area. These surface water features, together with mapped and potential groundwater-dependent ecosystems (GDEs), represent key environmental receptors that may be sensitive to groundwater drawdown or changes in groundwater quality associated with mine dewatering.

The Lei Lithium Project is also located near other current and former mining operations within the Bynoe Pegmatite Field, including the Grants Lithium Project (open pit) and the BP33 underground mine. Groundwater abstraction and drawdown associated with these developments occur within the same hydrogeological system. As such, potential groundwater impacts from the Lei Lithium Project must be assessed in the context of cumulative groundwater extraction within the region.

The Northern Territory Environment Protection Authority (NT EPA) has determined that the Project requires environmental impact assessment by Supplementary Environmental Report (SER) under the Environment Protection Act 2019. The key matters requiring assessment include the magnitude and extent of groundwater drawdown, groundwater–surface water connectivity (including interactions with the Charlotte River), potential impacts on groundwater-dependent ecosystems, and cumulative groundwater impacts associated with nearby mining developments (NT EPA, 2025).

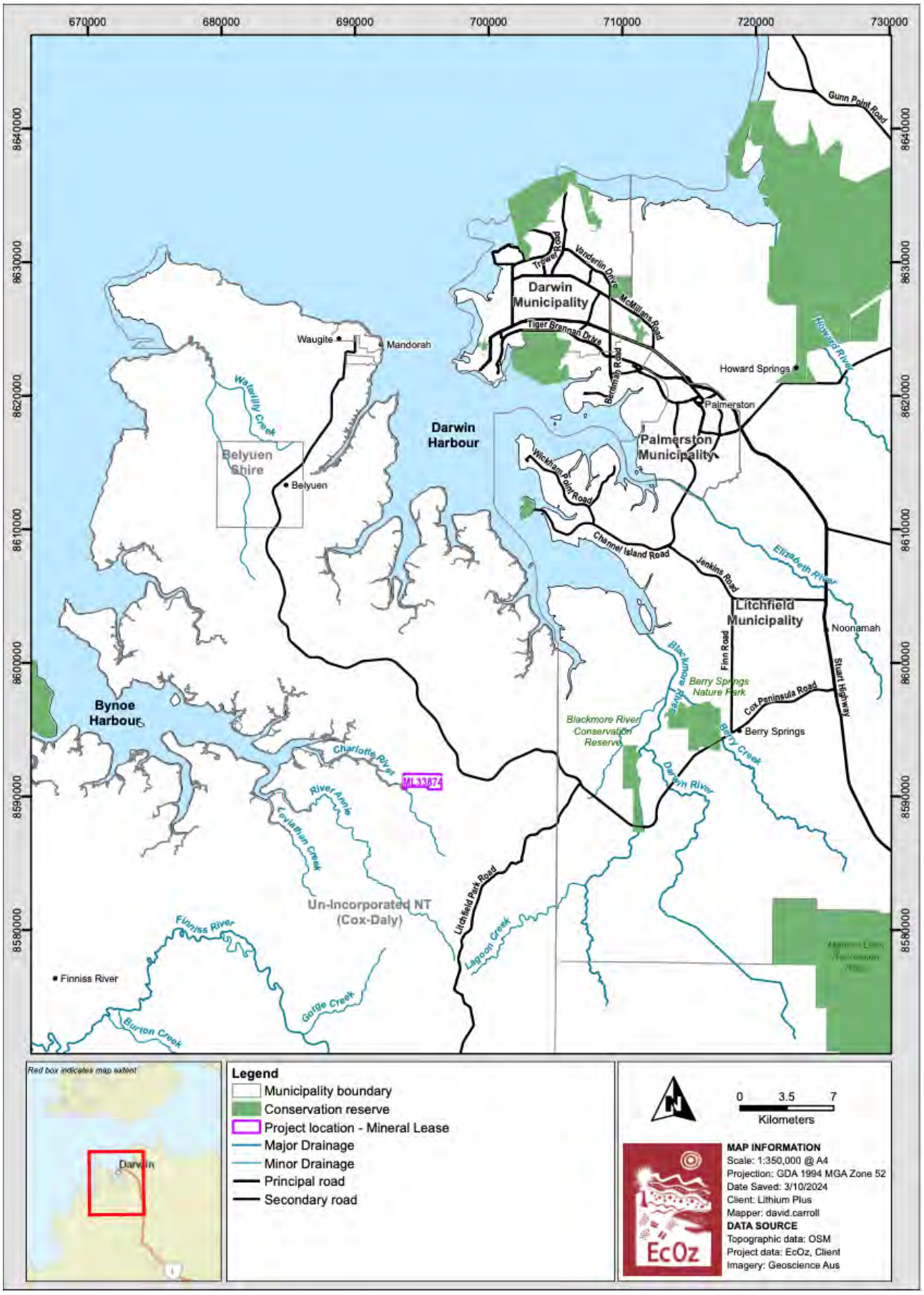


Figure 1-1 Location of the Lei Lithium Project ML 33874.

1.2. Purpose and scope

This groundwater modelling report has been prepared to support the groundwater impact assessment for the Lei Lithium Project being undertaken by Eco Logical Australia as part of the Supplementary Environmental Report (SER) under the *Environment Protection Act 2019*. It provides the technical basis for the assessment through the development and application of a numerical groundwater flow model.

The report documents the current conceptual understanding of the groundwater system, the development and calibration of the numerical model, and the predicted groundwater responses to proposed mine dewatering. The modelling provides a quantitative basis for assessing the magnitude, spatial extent, duration and recovery of groundwater level changes associated with the Project.

The model predictions are used by Eco Logical Australia to evaluate the potential significance of groundwater impacts on identified environmental receptors. These include groundwater-dependent ecosystems (GDEs) and surface water features, such as the Charlotte River and its associated riparian and estuarine environments. The groundwater modelling therefore supports the broader groundwater impact assessment but does not constitute the impact assessment itself.

The specific objectives of the groundwater modelling are to:

- Document the current conceptual understanding of the groundwater system relevant to the Lei Lithium Project.
- Assess the magnitude, spatial extent, duration and recovery of groundwater drawdown associated with Project dewatering.
- Assess cumulative groundwater impacts associated with dewatering at the Lei Lithium Project, Grants Lithium Project and BP33 underground mine, including the potential overlap of drawdown cones and interactions during groundwater recovery.
- Interpret the model outputs in the context of site-specific hydrogeology, surface water features and environmental receptors.
- Identify the key uncertainties, assumptions and residual risks relevant to regulatory decision-making.

1.3. Regulatory Context

This report has been prepared to inform the Northern Territory Environment Protection Authority's (NT EPA) assessment of the Project against the relevant NT EPA Environmental Factors and Objectives (NT EPA, 2025), with particular emphasis on:

- Hydrological Processes, protecting groundwater and surface water regimes, including groundwater availability and recharge processes, so that environmental values are maintained.
- Inland Water Environmental Quality, protecting groundwater and surface water quality.
- Aquatic Ecosystems, protecting aquatic habitats and ecosystem functioning.

The assessment has been undertaken in accordance with the requirements of the *Environment Protection Act 2019*, recognising the precautionary principle and the need to consider cumulative

impacts, uncertainty and the likelihood of significant environmental impacts. Accordingly, the groundwater modelling has been used to assess not only the predicted magnitude and extent of groundwater drawdown, mine inflows and groundwater recovery, but also the confidence associated with those predictions through calibration, sensitivity testing and uncertainty analysis. Where uncertainty remains, the report identifies opportunities for additional data collection, monitoring and adaptive management.

The Project is located within the Darwin Rural Adelaide River Water Control District (DRARWCD). While the Burrell Creek Formation (BCF) is not currently managed under a declared Water Allocation Plan (WAP), the assessment has been undertaken with regard to the Northern Territory Water Allocation Planning Framework, which adopts a precautionary approach to groundwater resource management. In the absence of more detailed local hydrogeological investigations, the framework generally considers up to 20% of long-term average annual recharge to be available for consumptive use, with the remaining recharge retained to support groundwater-dependent ecosystems, streamflow and other environmental values. Although this planning benchmark is not used as a project-specific environmental impact criterion, it provides useful regional context for assessing the scale of predicted groundwater abstraction relative to the renewable groundwater resource and the potential implications for the beneficial uses of groundwater.

Accordingly, the assessment considers both the regional groundwater balance and the local hydrogeological response to mining. The significance of potential impacts has been evaluated using model predictions of groundwater drawdown, groundwater recovery, mine inflows, groundwater flow paths and cumulative groundwater abstraction, together with consideration of groundwater users, groundwater-dependent ecosystems and other sensitive environmental receptors. The report does not assume that impacts are acceptable in the absence of complete certainty, and explicitly identifies where further data, monitoring or management responses may be required.

Table 1-1 Summary of SER water issues addressed in the groundwater modelling report

Topic	Comment	Additional information item	Report location	Response / action
Hydrological processes	Extent of groundwater drawdown. The referral provides an indicative zone of influence (ZOI) of 2 km around the proposed action, based on groundwater modelling of the Core Lithium BP33 mine.	Descriptions of groundwater-dependent ecosystems, interconnectivity and water dependence.	Sections 2.9.4, 3.4-3.7, 6.4, 6.5, 7.3	Predicted groundwater drawdown is assessed in relation to groundwater-dependent ecosystems through the conceptual hydrogeological model and receptor-specific impact assessment. Section 7.3 considers the cumulative effects of concurrent mining.
	The referral states that a site-specific groundwater model will be developed. The model is required to determine the potential for significant impacts from groundwater extraction.	Groundwater drawdown levels, spatial extent and recovery time.	Sections 6.2.1-6.3.2, 6.5, 7.2.1-7.3, 8.4, 9.1-9.4	Groundwater levels, drawdown, recovery and cumulative groundwater responses are predicted using the calibrated groundwater model. Results indicate that drawdown remains localised and groundwater levels recover progressively following mine closure. Section 6.2.4 presents preliminary groundwater-level investigation threshold ranges for the existing monitoring bores, providing a framework for model verification and adaptive groundwater management during mine operations.
	The BP33 underground mine is also < 3 km from the Lei Lithium Project, it is unclear what the cumulative ZOI is predicted to be in the event both mines operate concurrently.	Alterations to recharge and subsequent effect on recovery.	Sections 3.5, 5.2.1, 5.3, 7.3, 8.1	Recharge uncertainty is assessed using a ±20% recharge scaling factor. Localised changes to recharge associated with mining are expected to be negligible at the catchment scale because the mining lease occupies only about 2% of the model catchment area. Consequently, groundwater recovery is controlled primarily by regional recharge processes rather than localised changes in recharge within the Project area.
		Impacts to declared beneficial uses within the Fog Bay Area and Darwin Rural Adelaide River Water Control District.	Sections 2.2, 2.9, 6.4, 6.5, 7.3, 9.2, 9.4	Maximum cumulative groundwater extraction represents about 14% of calibrated annual recharge, providing regional context relative to the Darwin Rural Adelaide River Water Control District allocation framework. The significance of impacts to beneficial uses is assessed using predicted drawdown, groundwater recovery and receptor response rather than recharge comparisons alone.
		Precautionary scenarios including baseline, construction, operation, closure, post-closure and future climate	Sections 4.4, 6.1, 6.3, 7.1, 8.1	The assessment includes calibrated baseline conditions together with operational, cumulative and post-closure scenarios. The uncertainty analysis adopts a conservative ±20% recharge range and justifies the use of historical climate data over the relatively short 20-year assessment period.
		Assumptions, parameter justification and consequences if assumptions are incorrect	Sections 5.1, 5.2, 6.2.4, 8.2, 8.3, 8.4, 8.5	Model assumptions, calibration parameters and uncertainty are documented, with sensitivity analyses demonstrating how variations in recharge, hydraulic conductivity and storage influence predicted inflows and groundwater drawdown.

Topic	Comment	Additional information item	Report location	Response / action
		Overall groundwater water balance, inputs, outputs and feasibility of groundwater abstraction	Sections 5.3, 6.2.6, 7.3, 9.2	The regional groundwater balance is quantified and compared with predicted cumulative groundwater abstraction. Maximum annual extraction is compared with calibrated recharge to provide regional context while recognising that environmental significance is determined from predicted groundwater responses.
		Direct and indirect impacts to GDEs, springs, wetlands, vegetation, connected surface water, beneficial uses and other groundwater users	Sections 2.9, 6.4, 6.5, 7.3, 9.1-9.4	The groundwater model provides the technical assessment of predicted groundwater responses, including groundwater drawdown, groundwater recovery and groundwater flow paths resulting from cumulative groundwater abstraction. These results inform the overarching impact assessment, where the significance of potential impacts is evaluated in conjunction with ecological, hydrological and water quality investigations.
		Describe uncertainties, further work and plan to reduce uncertainty	Sections 8.1-8.5, 9.4	Model uncertainty is evaluated through sensitivity and uncertainty analyses, with recommendations for additional monitoring and data collection to improve confidence in future model predictions.
		Quantify project and cumulative significance using the NT Water Allocation Planning Framework and relevant thresholds	Sections 1.3, 7.3, 9.2	Project and cumulative groundwater abstraction are compared with calibrated annual recharge to provide regional management context. The Northern Territory Water Allocation Planning Framework is used as supporting context rather than as a project-specific environmental impact threshold.
Inland water environmental quality	The referral identifies that groundwater extraction may result in saline intrusion in the freshwater reaches of the Charlotte River, and the oxidation of subsurface acid sulfate soils leading to potential significant impacts to surface and groundwater quality.	Groundwater and surface-water quality, including salinisation from seawater intrusion	Sections 2.2, 6.4, 6.5, 7.3, 9.1-9.2	Seawater intrusion is considered unlikely due to the localised extent of drawdown, the Project's upstream location relative to the tidal reaches, and the persistence of regional hydraulic gradients towards the Charlotte River estuary and Bynoe Harbour. Potential impacts associated with acid sulfate soils and groundwater and surface water quality are addressed in the overarching impact assessment using the groundwater modelling results together with geochemical and water quality investigations.
		Avoidance and mitigation measures	Sections 6.2.4, 6.5, 7.3, 9.3, 9.4	The groundwater model provides the technical basis for monitoring, adaptive management and verification of model predictions. Detailed mitigation measures are presented within the Supplementary Environmental Report and associated Water Management Plan. Section 6.2.4 presents preliminary operational groundwater-level investigation thresholds for the existing monitoring bores that provide the basis for operational monitoring, adaptive management and progressive verification of groundwater model predictions.

1.4. Limitations

The groundwater modelling study presented herein is based on the information available at the time of report preparation, including existing groundwater investigations, monitoring data, hydrogeological studies, and previous numerical groundwater modelling.

The numerical groundwater model provides the predictive framework used to estimate groundwater drawdown and recovery associated with the Project. Model outputs are inherently dependent on conceptual assumptions, parameterisation and the availability of hydrogeological data. Predicted drawdown magnitudes are therefore interpreted in the context of observed seasonal groundwater fluctuations to assist in evaluating the potential ecological significance of groundwater level changes.

Accordingly, this assessment considers not only the predicted outcomes from the numerical groundwater modelling, but also:

- the confidence associated with those predictions
- the sensitivity of outcomes to key model assumptions
- the implications of uncertainty for environmental risk and regulatory decision-making.

The groundwater modelling report provides the quantitative basis for the impact assessment by defining the predicted magnitude, spatial extent, duration and recovery of groundwater drawdown associated with the Project. The report presents and interprets these modelling outputs in the context of site hydrogeology, surface water features and environmental receptors to evaluate the potential significance of groundwater impacts relevant to the Supplementary Environmental Report (SER).

2 Site characterisation

2.1. Climate

The region of the project area experiences a tropical climate with a distinct Dry season (May to October) and Wet season (November to April). Typically, for this region, humidity, maximum and minimum temperatures are highest in the Wet season, and annual evaporation far exceeds annual rainfall.

Climate statistics for the Darwin Airport (Site number: 014015) from 1941 to current (July 2024) show an average annual rainfall of 1729.5 mm, of which 93% of it falls during the wet season. The mean annual maximum temperature is 32.1 °C and minimum temperature is 23.2 °C (BOM 2024).

Wind direction is predominately from the north through west most of the year (August to March) and particularly during the wet season (September to March). During the dry months (April to July) winds come predominately from the east.

Climate data for the Lei groundwater modelling study has been sourced from SILO data drill (https://www.longpaddock.qld.gov.au/silo), a national scale database of climate records for 14 Australia. The SILO data set has been used in preference to individual weather stations in the Darwin area because it provides a continuous rainfall and evaporation record for the study. The SILO data site was located at Latitude, Longitude: -12.70 130.80 (Decimal Degrees).

The SILO data has an average annual rainfall of 1,530 mm and average annual potential evaporation of 2,280 mm. Average maximum temperature ranges from 34.4 degrees Celsius (°C) in October to 30.9°C in June and July (Figure 2-2a). July is the coolest month with an average minimum temperature of 17.9°C. Rainfall is concentrated in the wet season with around 90% of precipitation occurring between November and March. January is the wettest month with an average rainfall total of 382 mm. Peak potential evaporation occurs between September and October, with potential evaporation being lowest during February and March (Figure 2-2b). Average monthly rainfall only exceeds potential evaporation during the wettest months (December-March). The rainfall data is presented in Figure 2-3 as annual totals with a trace of the cumulative rainfall residual which shows long-term trends in the rainfall record.

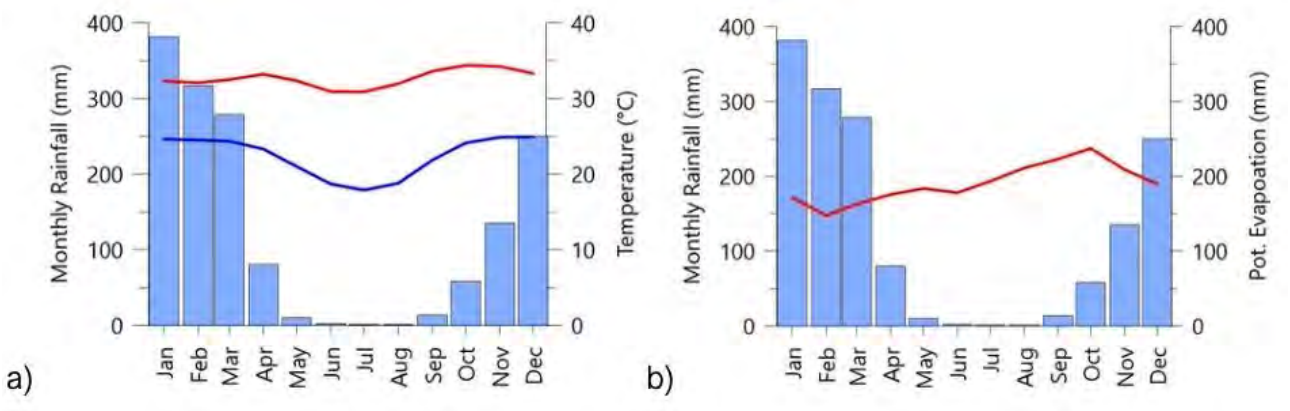


Figure 2-1 (a) Average monthly rainfall compared to average max and min temperatures and (b) average monthly rainfall compared to monthly potential evaporation for the period 1900-2020 (SILO Data Drill).

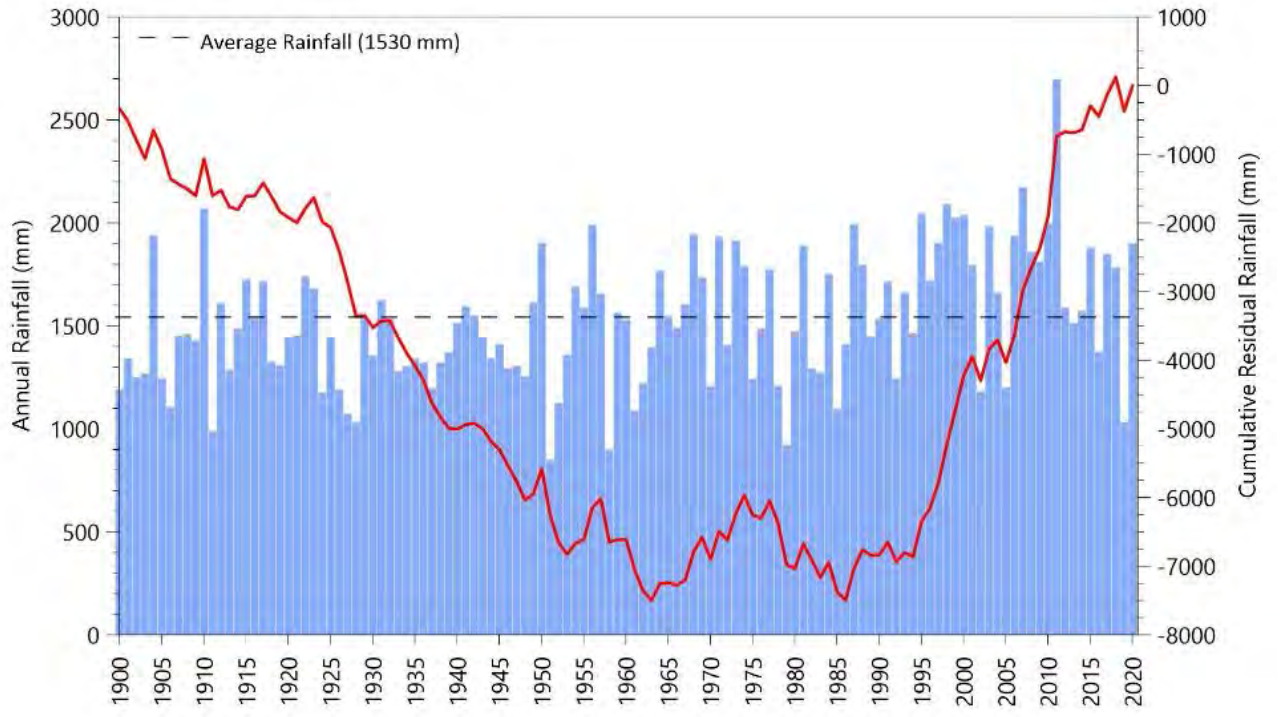


Figure 2-2 Annual rainfall totals with a trace of mass residual rainfall (1900-2020).

2.2. Topography and hydrology

The Project area is characterised by low relief, with ground elevations ranging from about 38 m Australian Height Datum (AHD) in the east, gradually decreasing to about 14 m AHD at the western boundary. The highest elevations in the surrounding region occur outside the Project area, including terrain reaching about 86 m AHD about 2 km southeast within the Kangaroo Flats Training Area (Australian Army facility). About 7 km south of the Project area, Mt Peel reaches about 83 m AHD and represents the highest point within a longitudinal sand belt that transects the region from north to south. Figure 2-3 shows the topography and drainage features of the Project area.

The Project is regionally within the Finniss River drainage basin and falls within the Charlotte River sub-catchment of Bynoe Harbour. The sub-catchment is approximately 170 km^2, with surface water flows following the topography gradient of the drainage lines, trending towards the north-west via the Charlotte River, flowing into the tidal inlet of the Bynoe Harbour, approximately 8 km Northwest of the Project area to the western boundary of ML 33874).

The Project area is located adjacent to the Charlotte River within 200 m on the western boundary. The Charlotte River feeds into the Bynoe Harbour an estuary system apart of the Timor Sea Basin and is located 36 km south of Darwin. It has a classification that is non-perennial dominated by wet season rainfall when majority of the high flow events occur. The river is a single thread, meandering in its lower reaches into the gulf entrance 8 km from the Project area. There are multiple tributaries that run within the 5 km radius from the Project area with one tributary bisecting the site. The tributaries are only utilised in wet season allowing for drainage of the landscape into Charlotte River and the Basin. The Project area sits within the floodplain of the river and has an ephemeral tributary of the Charlotte River running southeast to northwest through the Project area. The Project area sits within the Darwin Rural Adelaide River Water Control District,

its western boundary flows the southern boundary of the Charlotte River catchment area but is not covered by the Adelaide River Water Allocation Plan (Northern Territory Government, 2024). There is a lake registered within ML 32074 this is known as Observation Hill Dam sitting along a tributary of Charlotte River.

Eco Logical (2026), using Geoscience Australia Water Observations from Space data (Geoscience Australia, 2025), analysed a multi-year compilation of aerial imagery showing the percentage of time water has been detected since 1987. Along the Charlotte River south of the Project area, water was detected in about 80% of observations within the main channel about 1 km downstream of the ML boundary. In contrast, less than 1% of observations recorded water in the upper tributaries closer to the Project area.

These observations indicate that surface water flows within the tributaries are strongly seasonal and primarily driven by wet season rainfall. In contrast, the higher frequency of water detection in the main channel of the Charlotte River suggests the presence of more persistent water, likely influenced by tidal conditions from Bynoe Harbour, although some contribution from groundwater discharge cannot be ruled out.

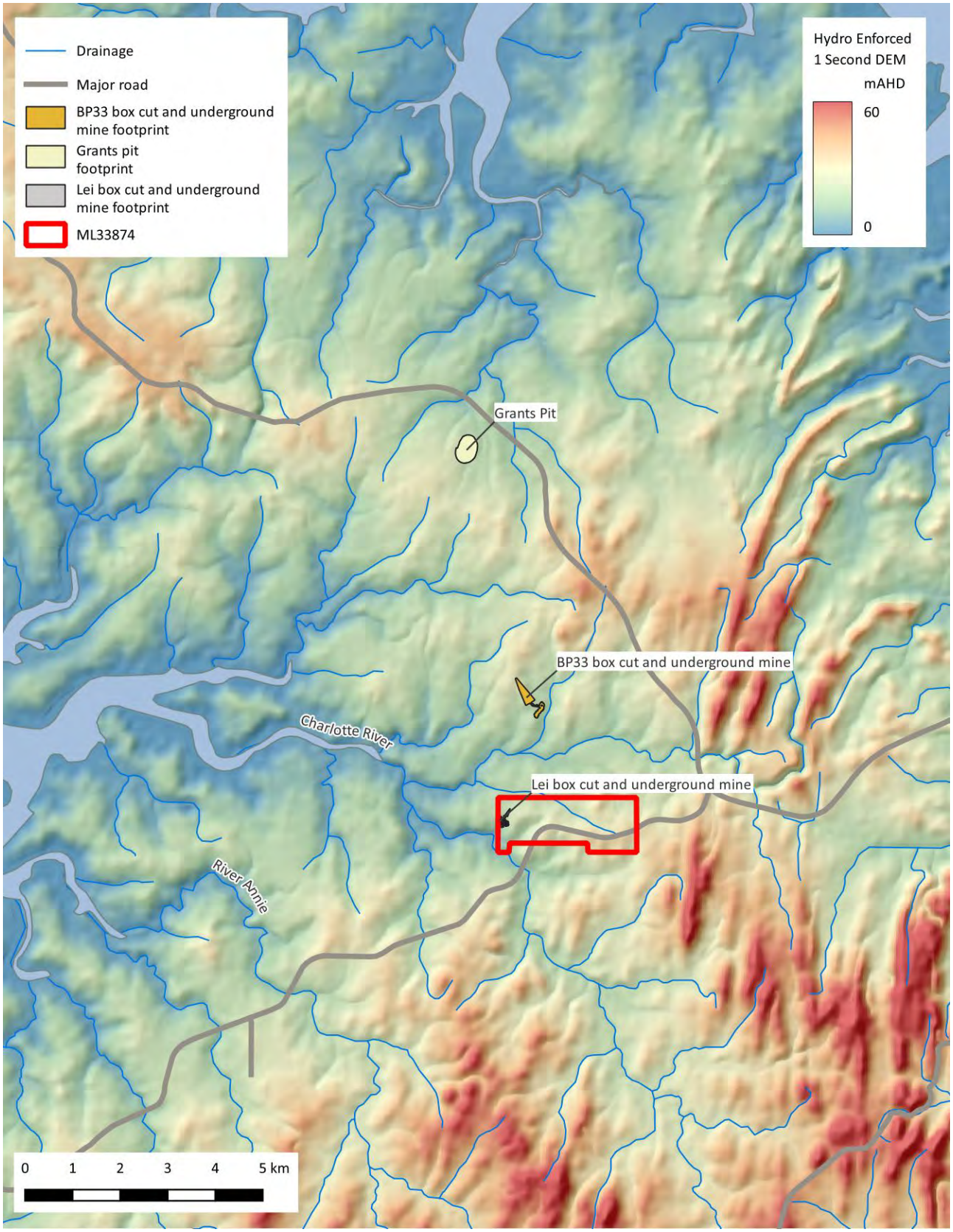


Figure 2-3 Topography of the study area showing surface water drainage and the locations of the Grants Pit, BP33 box cut and underground mine, and the proposed Lei box cut and underground mine.

2.3. Geology

Lei is located in the north-west of the Pine Creek Geosyncline that spans approximately 47,500 km^2 from Darwin to Katherine in the south, a thick sequence of Proterozoic metasediments that overlies Archean basement rocks and underwent complex tectonic history involving rifting, basin development, regional metamorphosis, and multiple deformation events around 1,800 million years ago. After a long hiatus during which significant weathering and erosion occurred a drape of flat bedded Cretaceous and Cainozoic sedimentary formations were deposited over the Proterozoic rocks.

The lithium prospect at Lei is hosted in a pegmatite, which is one of a swarm of complex zoned rare element pegmatites forming the 55 km long by 10 km wide West Arm–Mt Finniss pegmatite belt. The Finniss pegmatites are intruded into the early Proterozoic Burrell Creek Formation (BCF) which is distributed along the northwest margin of the Pine Creek Geosyncline. The Lei lithium deposit is hosted in one discrete pegmatite in the order of 15-20 m wide, 240 m long and dipping steeply to the east.

The BCF is comprised of shale, siltstone, sandstone and strongly foliated phyllite with lenses of quartz pebble conglomerate. The formation is extensively weathered at surface where it often forms a laterite horizon. The underlying shale and phyllite is typically heavily weathered and decomposed into mottled clay. Exploration drilling at BP33 indicates the weathered zone is on average 60 m thick with the upper 30 m typically showing extensive weathering and the bottom 30 m showing moderate to slight weathering.

Where the BCF is not exposed it subcrops beneath a thin veneer of Tertiary and Quaternary aged sediments. These include alluvial deposits (Qa) along the drainage lines as well as colluvium (Cz) and laterite formed by in-situ weathering of the BCF. The colluvium comprises ferruginous clayey, sandy and gravelly soils. Both the colluvium and laterite deposits are typically less than 4 m in thickness (Pietsch, 1986).

The Charlotte River and associated floodplain is a succession of Quaternary estuarine and deltaic deposits of sand, silts and fluvial deposits of gravel sized weathered material and sandy silts (Qe and Qa).

The alluvial deposits centre around active drainage lines and can extend up to several kilometres in length and up to 200-300 m in width (Frater, 2005). They are typically less than 4 m in thickness but can exceed 6 m in the southern sections of the Booths drainage (Mollemans and Hatcher, 1988) - Booths is the drainage line running south from Observation Hill dam to the immediate east of the BP33 mine site. Mollemans and Hatcher (1988) describes the following three sedimentary layers in alluvial deposits around BP33/Observation Hill area:

- A-layer: Less than 0.5 m thick and may contain a thin band of pebbles (5–10 mm wide) at its base. It is essentially un-mineralised and is capped by an organic clay layer.

- B-layer. A minor gravel layer up to 1 m thick, directly overlying the C-layer or separated from it by thin bands of clayey sand.

- C-layer. This earliest layer consists of basal clayey sand or gravel up to 2.5 m thick, containing sub-angular quartz and siltstone clasts up to 200 mm in length.

Mollemans and Hatcher (1988) note that in some areas the alluvial deposits have been completely reworked with black soil, and that the bedrock under the main alluvial channel is typically heavily

weathered. The 1:250 000 scale surface geology for the study area and surrounding region is presented in Figure 2-4.

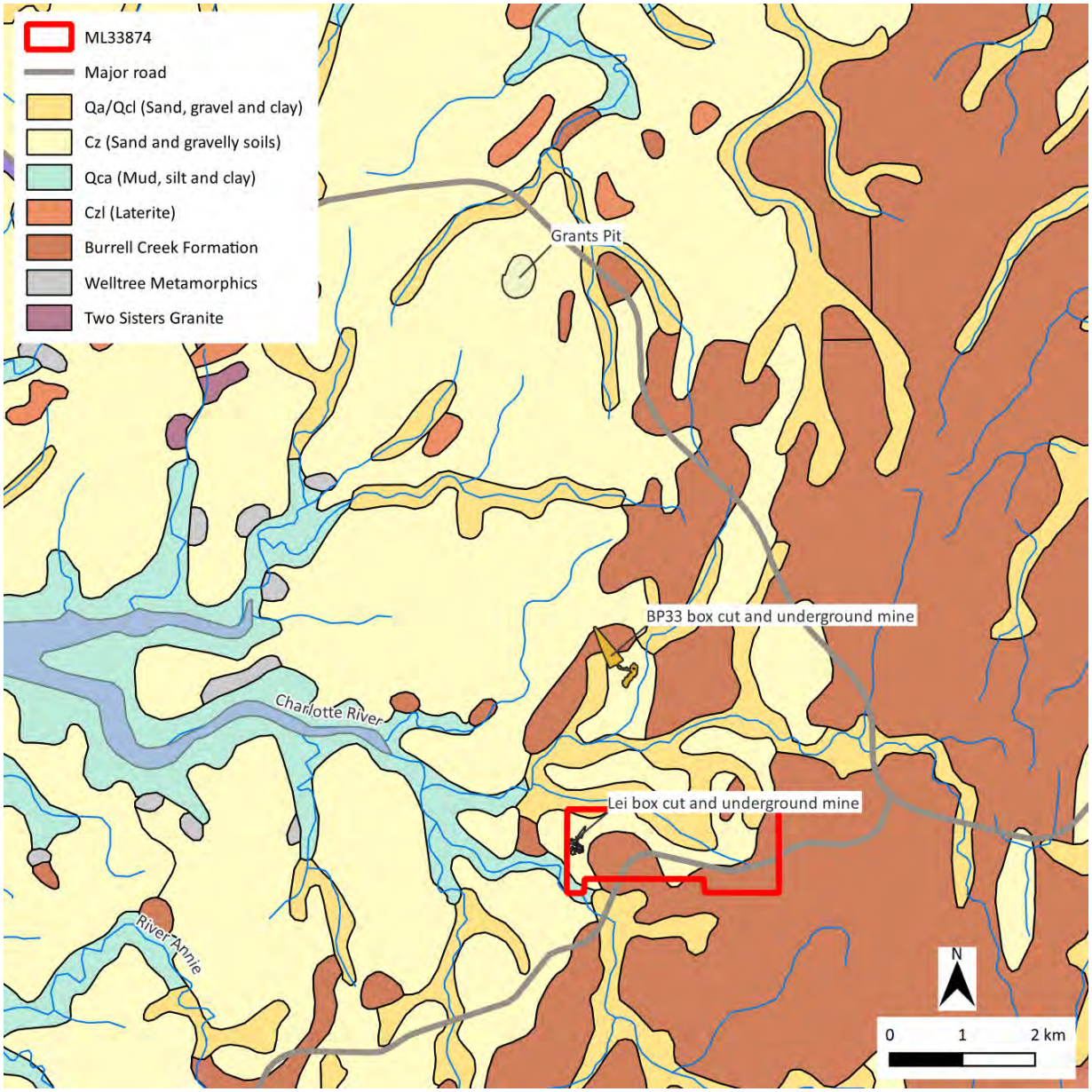


Figure 2-4 Surface geology derived from the 1:250000 scale geology coverage (after Pietcsh, 1986).

2.3.1. Geological structure

The are two major fault structures within the area surrounding Darwin and the Project area, they are the Tom Turners Fault, which is a Cenozoic thrust fault sitting north-east to southwest in orientation approximately 28 km to the west of the Project area. The Geoscience Australia Major Crustal Boundaries of Australia map (2024) shows a fault running north-east to south-west orientation about 37 km to the southeast of the Project is known as the Giants Reef Fault. This fault separates the Pine Creek Orogeny from the Litchfield and Central sub basins, creating a wedge-shaped embayment of sedimentary rocks where the Project area and surrounding mines sit.

Phyllite is a foliated rock, and the foliation is striking approximately North-South (~010-015°). Based on bedding trends mapped in outcropping BCF in regional geological maps (Figure 2-4).

A review of the Bynoe 1:100 000 surface geology (Pietsch, 1986) did not reveal any mapped faults or significant geological structures in the vicinity of the Lei project area.

2.3.2. Observed geology

From bore records obtained through NR maps (2025) the general observed geology can be understood. Table 2-1 describes the general bore information as well as a summary of the lithology. The bores within the Project area have the following general lithological trend:

- 0 – 4 m - Soil, sandy clay, and alluvium; estuarine/floodplain influence; local thin regolith.
- 4 – 20 m- Highly weathered brown/red schist -phyllite with clays and claystones.
- 20 – 35 m -Moderately weathered schist/phyllite with increasing quartz veining; transitional saprolite - bedrock zone.
- 35 – 45 m - Hard grey schist with quartz bands; occasional sandstone reported regionally.
- > 45 m- Fresh grey to dark grey schist/phyllite with quartz and pegmatite; minor fractures in deeper intervals.

For bores within a 2 km radius, mainly located north and south of the Project area within estuarine wetlands and floodplains the lithology increases in clay following the general trend of:

- 0 – 4 m - Soil and sandy clays
- 4 – 35 m - weathered brown schist with fluvial settings showing firm clays and claystones
- 35 - 42 m – hard grey schist with quartz bands and occasional sandstone.

Table 2-1 Observed geology within a 2 km radius of Project area

Bore ID	Easting (GDA94 Z52)	Northing (GDA94 Z52)	Total Depth (m)	Drilled Date	General Lithology
RN43840	692461	8590393	79	28/09/2023	Weathered brown and red schist into unweathered grey schist and phyllite.
RN43913	693979	8591294	60.1	15/11/2023	Weathered brown and red schist into unweathered grey schist and phyllite.
RN43914	693746	8591403	73	17/11/2023	Weathered brown and red schist into unweathered grey schist and fractured sandstone.
RN43915	693746	8591201	73	21/11/2023	Weathered brown and red schist into unweathered grey schist and phyllite.
RN43916	693653	8591237	69.5	23/11/2023	Weathered brown and red schist into unweathered grey schist and phyllite with occasional quartz bands.
RN43917	693615	8590960	79	1/12/2023	Weathered brown and red schist into unweathered grey phyllite with occasional quartz bands.
RN43918	693615	8590957	12	1/12/2023	Weathered brown and red schist.
RN041993	694502	8588795	42	17/11/2020	Brown clays into firm unweathered claystone.
RN041798	693991	8593098	53.5	7/09/2020	Yellow sandy clays moving into brown and grey schist.
RN041797	693991	8593098	7	5/09/2020	Yellow sandy clays into weathered brown schist.
RN041832	694477	8593425	35.4	13/09/2020	Yellow sandy clays into weathered brown schist.
RN041831	694486	8593422	109	12/09/2020	Yellow sandy clays into weathered brown schist and fresh grey schist.
RN041830	694497	8593425	8	9/09/2020	Yellow sandy clays into weathered brown schist.
RN043918 LG1-S1 (shallow)	693616.3	8590978.4	12	01/12/2023	Alluvium over heavily weathered phyllite/schist.
RN043917 LG1-D2 (deep)	693616.9	8590981.6	79	01/12/2023	Alluvium over weathered schist/phyllite with quartz; minor fractures at depth.
RN043915 LG2	693746.9	8591199.6	73	01/12/2023	Weathered phyllite and schist with quartz and pegmatite veins.
RN043913 LG3	693979.3	8591289.8	60.6	16/11/2023	Alluvium over weathered schist with quartz lenses.
RN043914 LG4	693743	8591399.5	73	18/11/2023	Weathered phyllite and schist, transitioning to grey schist/siltstone.
RN043916 LG5	693650.1	8591238.3	59.5	23/11/2023	Highly weathered phyllite/schist with deeper pegmatite.

2.4. Hydrogeology

The Project area is underlain predominantly by the Burrell Creek Formation (BCF), apart from shallow alluvial deposits associated with the Charlotte River. Groundwater within the BCF occurs mainly in fractures, quartz veins and the transition between weathered and fresh rock. The formation has limited primary porosity and is generally weakly fractured, resulting in a marginal fractured-rock aquifer with typical bore yields of less than 0.5 L/s. Higher yields may occur where drilling intersects fracture zones or quartz veins.

The BCF is generally fine-grained and characteristically weathers to clay. Where intensely weathered, it may be less permeable than fractured fresh rock because fractures are less likely to remain open within the clay-rich weathered material (Groundwater Enterprises, 2023). Groundwater is commonly encountered near the base of the weathering profile or within fractured intervals in the underlying fresh BCF.

Groundwater development within the BCF is limited, with little use for domestic, stock or agricultural supply. Available hydrogeological information indicates that groundwater movement is controlled by localised secondary porosity within an otherwise relatively low-permeability rock mass. These characteristics are expected to limit the propagation of drawdown caused by mine dewatering, although the magnitude and extent of drawdown are assessed through the numerical modelling presented in this report.

The Berry Springs Dolostone aquifer and associated Water Allocation Plan area are located around 16 km east of the Project area. Groundwater extraction from this aquifer is managed under the Berry Springs Water Allocation Plan 2016–2026 (DLRM, 2016), and concerns have been raised regarding over-extraction. Available regional investigations indicate that the BCF beneath the Project area is not hydraulically connected to the Berry Springs Dolostone aquifer (Verma, 1994; Verma, 2002). Consequently, the Project is not expected to affect the Berry Springs Dolostone aquifer, and it is not considered further in this report.

2.4.1. Previous studies

The Lei Project falls within regional hydrogeological and water resource mapping completed by the Water Resources Division on the Bynoe 1:100 000 map sheet in 2004 and the Cox Peninsula in 2008 (DIPE, 2004; NRETA, 2008).

Previous studies for the site include the Preliminary Groundwater Assessment and the Drilling Report Conducted in 2023 and 2024, respectively, which were submitted as appendices to the Lei Lithium Project referral under the Environmental Protection Act 2019.

In addition, several groundwater investigations undertaken across the Greater Darwin region provide context for groundwater occurrence within the BCF. These studies include:

- Karp (2010) - In 2010 the current DEPWS Water Resources Division reported on results from investigation drilling conducted in the BCF near the proposed city of Weddell (Karp, 2010). They report a yield range of < 0.1 – 2 L/s (median 0.3 L/s) from seven investigation bores constructed in the BCF. All bores encountered groundwater within fractured and weathered rocks at the base of the weathering zone. Although two bores recorded yields of 2 L/s, Karp (2010) suggests that 0.5 L/s is more characteristic of the longer-term yield for bores constructed in the BCF.
- Karp (2009) – Water Resources Division completed a groundwater investigation in the suburbs of Johnston and Zuccoli to assess water potential in the area. Six bores were drilled targeting a quartz ridge within the BCF (shown as Acacia Gap Quartzite on the geology maps), airlift yields ranged from < 0.1 – 9 L/s. The investigation identified a narrow aquifer associated with the fractured quartz ridge, elsewhere only minor and localised aquifers were intersected in siltstones of the BCF.
- Verma (1982) – Water Resources Division completed a groundwater investigation on the Cox Peninsula to the north-west of the Lei site between 1979 and 1982. The study involved a geophysics and investigation drilling program. Two minor aquifers were identified: a shallow

aquifer in the Bathurst Island Formation (Cretaceous) which extended into the weathering zone of the underlying Proterozoic rocks and a deep structurally controlled aquifer in the Proterozoic Formations. Bore yields ranged from 0.1 – 1.5 L/s indicating the aquifers have poor water supply potential. The marginal nature of the aquifers is consistent with groundwater drilling observations from Proterozoic rocks (BCF) at the Lei site.

- Inpex EIS Hydrology and Hydrogeology of Blaydin Point (2009) – URS completed detailed groundwater investigations on the Inpex Gas site at Blaydin point and drilled around 10 investigation bores into the BCF. All bores were constructed to screen the shallower Cenozoic and Cretaceous sediments so hydraulic testing and monitoring results have limited application to the Lei site.
- BP33 groundwater investigation two phases of groundwater drilling have been undertaken at the GLP. A preliminary groundwater investigation was undertaken by GHD in 2017 (GHD, 2017). The investigation program involved the drilling and construction of six monitoring bore hydraulic testing (recovery and slug tests) and water quality sampling.
- Groundwater Enterprises (2020a) The investigation involved the installation of 13 dedicated monitoring bores at seven locations around BP33. Nested bores were constructed at five sites to investigate the occurrence of shallow groundwater within alluvial deposits and the weathered top of the BCF, and its connection to the deeper, fractured rock aquifer in the BCF.
- Groundwater Enterprises, (2020b) In 2020, five additional monitoring bores were installed at GLP in accordance with requirements under the environmental approvals process.

The key finding from these reports include (Groundwater Enterprises, 2023) (CDM Smith, 2024):

- Groundwater near the Lei deposit occurs entirely within the BCF, a fractured rock aquifer that is present at shallow depth or outcrops across the site. No shallow alluvial aquifers were intersected in drilling.
- A consistent stratigraphy is present across the site: 0-4 m soil/sandy clay, 1-40 m weathered red–brown schist, 40-65 m grey schist/phyllite with quartz bands and fractures, and 65-75+ m fractured grey phyllite and occasional sandstone/pegmatite.
- Low yields from shallow bores (<0.5 L/s) reflect limited porosity and fracturing in the weathered zone, while higher yields (1-3 L/s) occur where deeper fractures or quartz veins are intercepted, typically between 50-80 m.
- Hydraulic conductivity in fractured intervals ranges 0.1-3.8 m/day, while fresh or weathered rock without fractures is significantly less permeable (0.003-0.08 m/day).
- Water levels across the BCF are generally shallow (<16 m bgl) with local evidence of upward vertical gradients from nested bores. Depth to water decreases down-gradient toward the Charlotte River.
- Groundwater is predominantly fresh, with EC values typically between 19-930 µS/cm.
- pH in regional groundwater is mildly acidic (4.4-7.0), but site bores have recorded a broader range (5.81-10.47).
- Underlying Pegmatite is likely to be an aquitard except where fractured.

- Alluvial deposits along the Charlotte River may host small, seasonal aquifers supporting riparian ecosystems.
- Groundwater flow likely follows topography toward the Charlotte River.

2.4.2. Previous groundwater modelling studies

There have been previous groundwater modelling studies within the peninsula for the surrounding mining activities to the north of the Lei Lithium Project area within this assessment. These are the following:

- CloudGMS (2018) - was developed to assess the impact of proposed mining at the Grants Lithium Project (GLP) on the surrounding aquifer system to support their EIS.
- CloudGMS (2021) - conducted modelling for the CORE Lithium BP33 activities for Finnis Lithium, this model included the cumulative impacts associated with GLP (CloudGMS, 2018) to support their EIS.

No other published groundwater modelling studies have been identified that cover the project area.

2.4.3. Aquifer hydraulic properties

CDM Smith (2024) conducted a series of slug tests to estimate the hydraulic properties of the aquifer in the immediate vicinity of the monitoring bores installed at the site. Results from five bores within the Lei Project area indicate hydraulic conductivity values of about 6.8 m/day within weathered rock containing fractures and 0.05 to 3.8 m/day within weathered rock where fractures were not documented (CDM Smith, 2024). Prior to this investigation, no aquifer hydraulic testing had been undertaken within the Project area.

Adjacent studies at BP33 to the North indicate that the predominant aquifer within the region is the BCF with overall low yields (<0.5 L/s) with the resource being of limited potential due to low primary porosity and minimal open fractures. There are however higher yields within fracture zones and quartz veins. With groundwater level typically seen at the base of the weathering zone of the BCF.

The test results from the two sites reveal that the permeability of the BCF is dependent on secondary porosity (i.e., fracture and joint development). Fresh and weathered BCF with negligible fracturing displayed a hydraulic conductivity range of 0.003 – 0.08 m/day. Bores that intersected fractured BCF (fresh or weathered) showed a hydraulic conductivity two orders of magnitude higher with a range from 0.27 to 6.8 m/day. The alluvial sediments (silty sand) tested with a hydraulic conductivity in the order of 0.4 m/day (CloudGMS, 2021).

Specific yield represents the volume of water that will drain under gravity from a unit volume of rock over time. Ideally, specific yield is estimated from the response to long-term pumping tests or dewatering activities, however, no such information is available for the BCF in the Project area. For the purposes of assessment, values typical of weathered and fractured rocks have been adopted (0.01 to 0.02), these are consistent with values adopted. Thes values are consistent with those

applied in numerical modelling of the Mt Todd Gold Project (GHD, 2013), which is also located in the Pine Creek Geosyncline and models the BCF.

2.4.4. Lei Groundwater level fluctuations

Groundwater levels within the bores recently drilled in the project area indicate a relatively shallow aquifer with depth to water up to 16 m Figure 2-5.

Although the available dataset is not continuous across each month, groundwater levels are typically at the lowest point towards the end of the dry season (September) and their peak at the end of the wet (March), consistent with the conceptual model of recharge in the area. LG1-D does not follow that trend and LG1-S has significantly lower standing water level (Figure 2-6). The standing water level being lower in LG1-S can be explained by its proximity to Charlotte River and the shallow screen depth.

Through Groundwater Enterprises (2023) report groundwater level and water fluctuations groundwater flow at BP33 and Grants deposits generally follows surface topography water level data collected in the groundwater monitoring bores around the site suggest local groundwater flows follow this pattern flowing towards the Charlotte River.

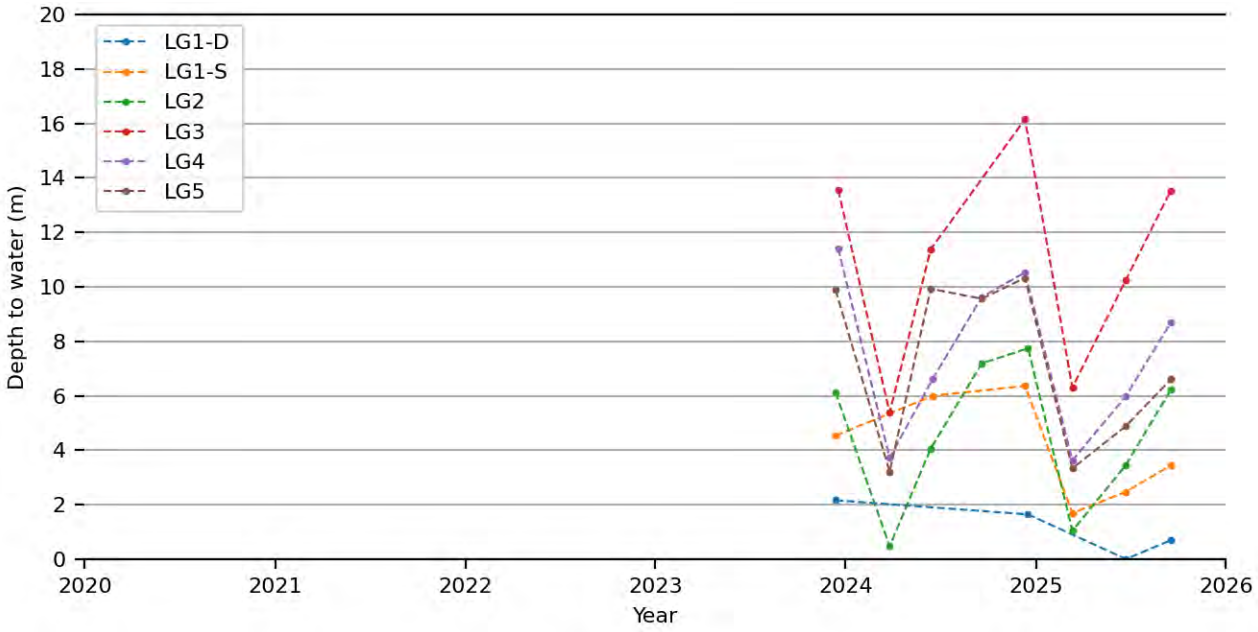


Figure 2-5 Lei depth to water (m).

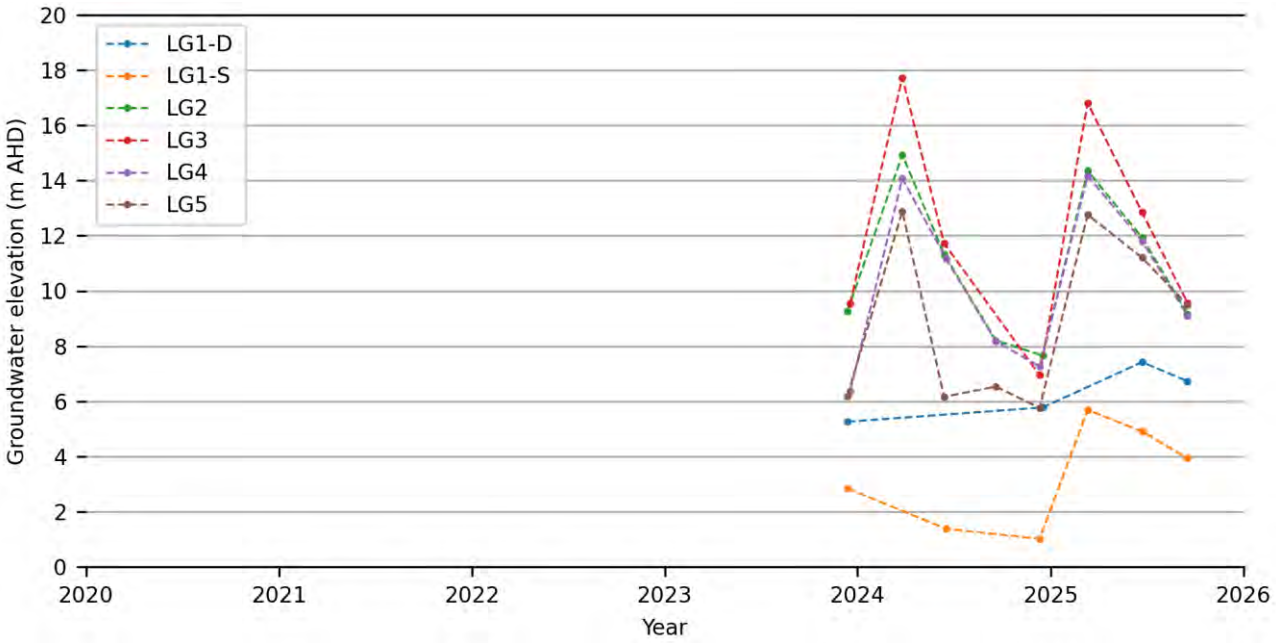


Figure 2-6 Lei standing water levels (m AHD).

2.4.5. Vertical groundwater gradients

There is one nested bore pair targeting the upper and lower portions of the Burrell Creek Formation. Where water levels were recorded in both bores, the deeper bore, LG1-D, consistently showed a higher standing water level than the shallow bore, LG1-S (Figure 2-7). This indicates an upward hydraulic gradient within the BCF in this area, likely reflecting partial confinement of the deeper section of the formation by the overlying weathered unit. The vertical head difference was about 2 m in December 2023 and July 2025, increasing to about 5 m in December 2024.

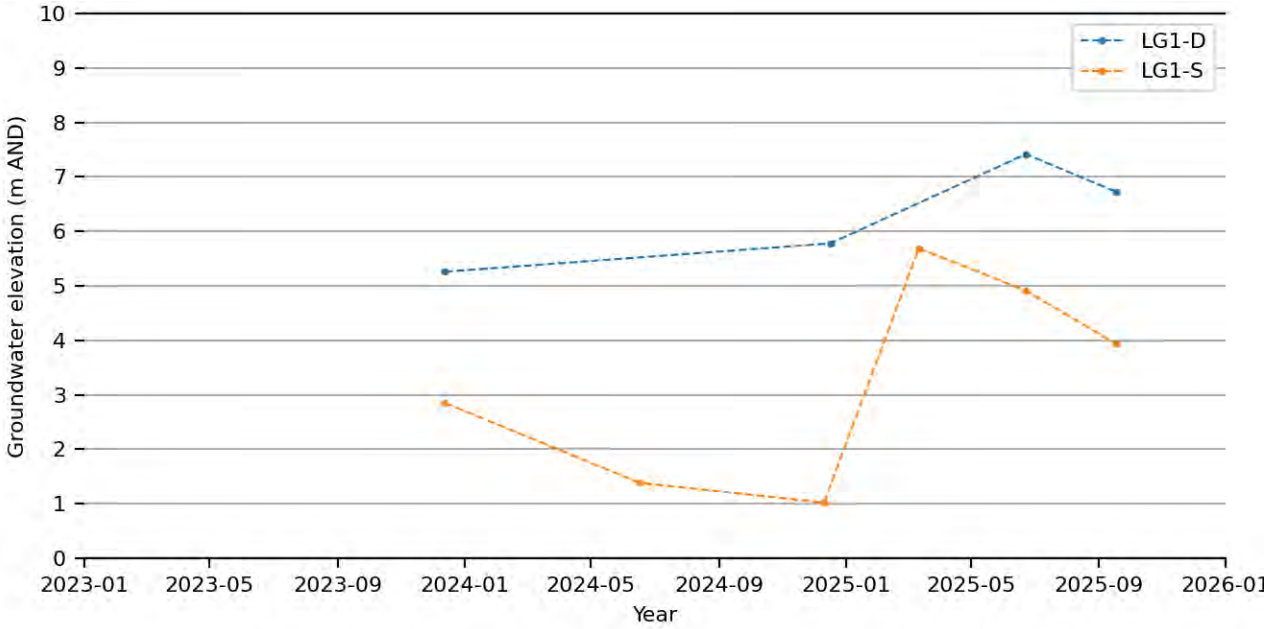


Figure 2-7 Groundwater differences at LG1-S and LG1-D indicating the gradient between shallow aquifer material and deeper weathered Burrel Creek Formation.

2.4.6. GLP and BP33 groundwater levels

To augment the calibration dataset publicly available groundwater levels were obtained from the GLP and BP33 projects. The groundwater levels as m AHD compared to the simulated groundwater levels are presented in Section 5.4.3.

2.4.7. Hydrostratigraphic units

The geological formations within the study area have been combined into three hydrostratigraphic units (HSU) for inclusion in the groundwater model. An HSU is a geological formation or part of a formation with similar hydrogeological properties or characteristics.

The key hydrostratigraphic units within the Project area are consistent with the previous modelling studies in the area and are shown in Table 2-2. The HSUs have been incorporated into a hydrostratigraphic model which forms the basis of FEFLOW model grid geometry, this is discussed further in Section 4.3.

Table 2-2 Hydrostratigraphic unit summaries

HSU	Age	Name	Lithology	Aquifer	Depths (m)
1	Quaternary / Proterozoic	Alluvial Sediment / Weathered BCF	Sandy clays and gravels	Alluvial, Weathered BCF Aquifer	0 to 30
2	Proterozoic	Slightly weathered BCF	Red and brown schists and minor clays lenses	Weathered and fractured BCF aquifer	30 – 60
3	Proterozoic	Fresh BCF	Grey schists and phyllite	Fractured fresh BCF aquifer	60 – 75 +

2.5. Lithium Plus Lei Project mining activities

Lithium Plus propose to develop an underground mine at the Project, located in the Northern Territory, 30 km south of Darwin, within ML 33874 on Fog Bay Road. The tenement forms part of the Bynoe Pegmatite Field located on the Cox Peninsula in the Northern Territory, approximately 2 km south of the Lithium Developments (Grants NT) Pty Ltd (Lithium Developments), Finniss Lithium Project BP33 underground mine.

The Lei deposit, located within the Project area, is one of a series of discrete, lithium yielding pegmatite deposits located in the West Arm–Mt Finniss pegmatite belt. The Lei deposit is estimated to contain 4.09 million tonnes (Mt) at 1.43% Li2O from which 3.10 Mt (at equivalent grade) is proposed to be recovered from underground mining methods. Fresh pegmatite at the Project is composed of spodumene, quartz, albite, microcline and muscovite (in decreasing order of abundance). The Lei lithium deposit is hosted in one discrete pegmatite in the order of 15-20 m wide, 240 m long and dipping steeply to the east. Preliminary mine plans include a surface box cut with a portal providing access to a spiralling decline located east of the pegmatite body.

The key components of the Project are summarised below:

- Mining of the pegmatite deposit containing spodumene ore using box cut and portal entry with underground decline.
- Total depth of the underground workings is approximately 700 m.
- Life of Mine (LOM) is approximately 7 years (inclusive of 12 months of construction, 68 months of operation and 6 months of rehabilitation and closure).
- Transfer of mined material to a Run of Mine (ROM) Pad located adjacent to the box cut/underground portal.
- Crushing and screening to produce Direct Shipping Ore (DSO) at an estimated peak production rate of 600 kilotonnes per annum (ktpa). Feasibility Studies are currently being undertaken to optimise operation for a 750 ktpa production capacity at peak production. The ore production is proposed as a DSO therefore no processing and tailings production will occur on site.
- Establishment of surface Waste Rock Dumps (WRDs) for temporary disposal of chemically benign waste rock prior to being used for backfill underground, and backfill of the box cut on closure.
- Transport spodumene as DSO and/or beneficiated product to Darwin Port by road for export overseas.
- Site infrastructure components include: Site access road, administration offices, employee facilities, laydown and storage areas, workshop, fuel storage and refuelling areas, internal haul roads, water storages, pumps and pipelines; drainage and sediment basins, run of mine pad, stockpiling areas, waste rock dumps, box cut and safety bund, portal and decline, ventilation, return air raise (RAR), and explosives storage.

2.5.1. Box cut

A surface box cut will be constructed to 50 m depth (3.1 ha) to gain access to geotechnical stable fresh material for construction of the portal and underground decline.

A safety bund will be constructed around the perimeter of the box cut to prevent surface water from ingress into the box cut and restrict access. The bund will be constructed in accordance with relevant guidelines.

Sump, pump and pipeline network will be constructed in the base of the box cut for dewatering of rainfall and groundwater inflows. The water intercepted will be retained on-site within the MWD1 for dust suppression use.

2.5.2. Portal and decline

A portal will be constructed within the box cut to provide access to the underground mine. A spiralling decline will be developed between the two pegmatite bodies, with ore extraction undertaken using long-hole open stoping methods. The underground workings are expected to extend to a depth of about 700 m. Preliminary designs include a series of production levels incorporating stope access, sump drainage, ventilation infrastructure, and turning and stockpile bays. Water collected in underground sumps will be pumped to the box cut sump and then transferred to the mine water storage dam for reuse.

Ventilation raises and return air raises (RARs) will provide fresh air circulation throughout the underground mine. Supporting mine infrastructure, including air, water and power services, together with the power station and backup generator, will be located adjacent to the box cut. The conceptual life-of-mine underground design, including the annual development of the decline and stopes and the relationship between major mine components, is shown in Figure 2-8.

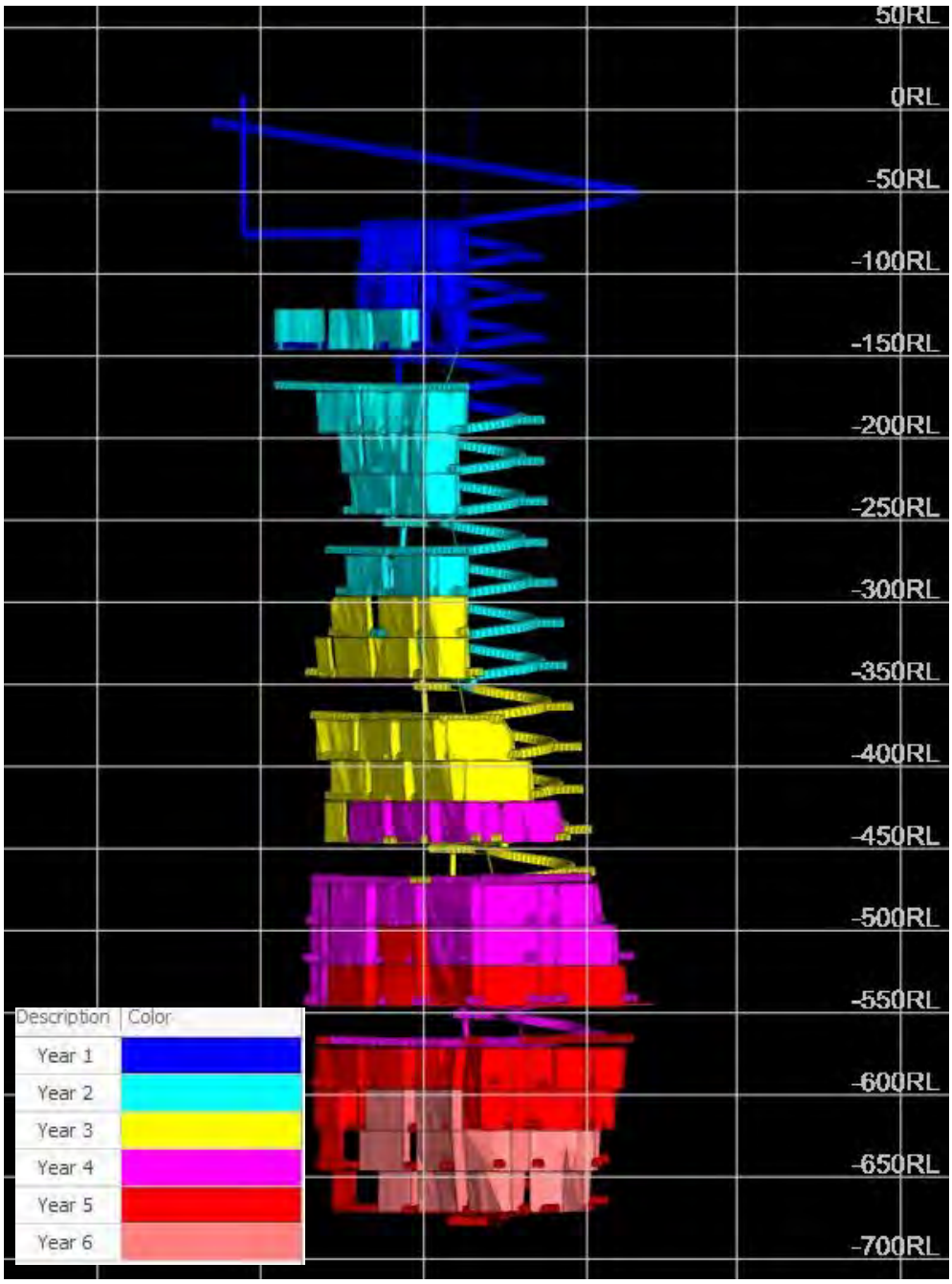


Figure 2-8 Lei conceptual underground design for Life of Mine showing the annual development of the decline and stopes.

2.5.3. Waste dumps

There will be two temporary waste dumps, one for the oxide waste rock from the surface box cut (LWD1) and the other for the fresh waste rock from the underground decline development

(LWD2). The mine will be waste negative, and the material will be backfilled underground (fresh waste) and the box cut with the oxide waste on closure.

• The volume of waste rock for LWD1 is about 400 kt.

• The volume of waste rock for LWD2 is about 1,130 kt.

The oxide waste from the box cut may also be used construction of surface works such as the box cut safety bund, raising of the ROM pad, RWD wall (the latter pending suitability from geotechnical assessment). The waste dumps are located north of the box cut.

2.6. CORE Lithium mining activities

CORE Lithium currently has two mines approved in the vicinity of the Lei underground mine, the Grants Pit about 8 km to the north and BP33 underground mine about 2.5 km to the north. These projects are described in the following sections.

2.6.1. Final Grants Pit shell geometry

Core are proposing to mine the lithium ore via an open cut mine. The approximate dimensions of the final pit are 600m x 400m x 180m (L x W x D), with a projected a planar area of 14 Ha.

The Life of Mine (LoM) is expected to be 2-3 years. A preliminary top down mine schedule has the pit being mined over a period of 25 months (refer Figure 2-9). Ore is expected to be intercepted at month eight in the schedule. Mining will occur in three phases:

• The Pre-strip months 1-7 removal of oxide waste and oxidised pegmatite waste

• Operation: months 8-25 Mining of pegmatite ore body and adjacent ‘fresh’ waste and processing / transport of product.

• Rehabilitation & closure: months 26-30 Rehabilitation & closure at the end of the life of the mine the pit will left intact to form a pit lake.

2.6.2. Grants Pit excavation schedule

The schedule for the Grants Pit is taken from the Grants Lithium EIS groundwater impact assessment and EIS supplement (CloudGMS, 2018; 2019). The Grants Pit schedule is detailed in Table 2-3.

Table 2-3 Grants Pit excavation schedule in days since mining commenced.

Time from mine commencement (days)	Pit floor elevation (mAHD)
0	21.6
30	20.4
61	5.3
92	0.2
122	-11.3
153	-12.0
183	-12.0
214	-12.0
245	-12.0
273	-12.1
304	-15.7
334	-25.0
365	-35.0
395	-40.0
426	-50.3
457	-64.2
487	-75.0
518	-86.3
548	-96.5
579	-106.5
610	-115.0
639	-115.4
670	-125.0
700	-128.9
731	-135.0
761	-145.0
792	-151.1
823	-159.9
853	-170.0
884	-185.0

2.6.3. BP33 underground development

The proposed BP33 underground mine design, as described in the Core Lithium Environmental Impact Statement (EIS), comprises several key components that will interact with the groundwater system, including the box cut, decline, stopes and return air raise (RAR). The relationship between these mine components is shown in Figure 2-8.

Mining will be undertaken using a long-hole open stoping (LHOS) method, with rib pillars used to support the rock mass within the stoping areas. The mine will be accessed via a single decline developed from the planned surface portal location and extending along the length of the orebody.

The underground mine is designed to be mined from the upper levels downward, allowing earlier access to the ore reserves. Stopes will be drilled using upholes, and no backfill will be placed within the mined voids. Each level will incorporate rib pillars spaced at about 50 m intervals and about 10 m wide to provide structural support to the surrounding stoping area. These pillars will be staggered between levels to avoid vertically continuous pillars and to optimise support of the rock mass.

2.6.4. Box cut description

To provide geotechnical stable conditions for development of the underground portal, a box cut will be excavated. The box cut will cover an area of six hectares and will be excavated to at least 10 m below the oxidised waste rock, a depth of 60-70 m.

A two-metre high safety bund with a base width of 7.3 m surrounds the box cut excavation, five metres from the crest. The bund is a safety measure and will prevent surface water run-off entering the box cut excavation. On the western side of the box cut, a contour drain will capture surface water run-off from the adjacent elevated areas to reduce the risk of water build up behind the safety bund.

A sump and pump system in the base of the box cut will be used for dewatering of rainfall and groundwater inflows.

2.6.5. Underground mine description

A portal installed near the base of the box cut and a 400 m decline will be used to the top of the ore body. A further 1.7 km of decline constructed over the Life of Mine will provide access to each production level, down to an elevation of approximately -360 mAHD.

The underground mine will comprise ten production levels (5 stope horizons). Each level will contain stope access from the decline, sump/drainage, ventilation network and a turning/stockpile bay. The underground mine will be ventilated via a dedicated raise bored Return Air Raise (RAR) to the surface.

A schematic of the BP33 underground design for the Life of Mine is presented in Figure 2-8.

2.7. BP33 mining schedule and underground development

The BP33 underground workings are represented using time varying seepage face boundary conditions. The schedule has been simplified by assuming that development occurs based on the excavation of the box cut and 5 underground stope horizons (refer Figure 2-9). The component

Table 2-4 Underground mine development schedule used in the groundwater model.

Component	Interval	Period (Months)
Box cut	20 to -40	17 to 20
UG stope horizon **1**	-90 to -150	31 to 36
UG stope horizon **2**	-150 to -210	37 to 42
UG stope horizon **3**	-210 to -270	43 to 48
UG stope horizon **4**	-270 to -330	49 to 54
UG stope horizon **5**	-330 to -360	54 to 59

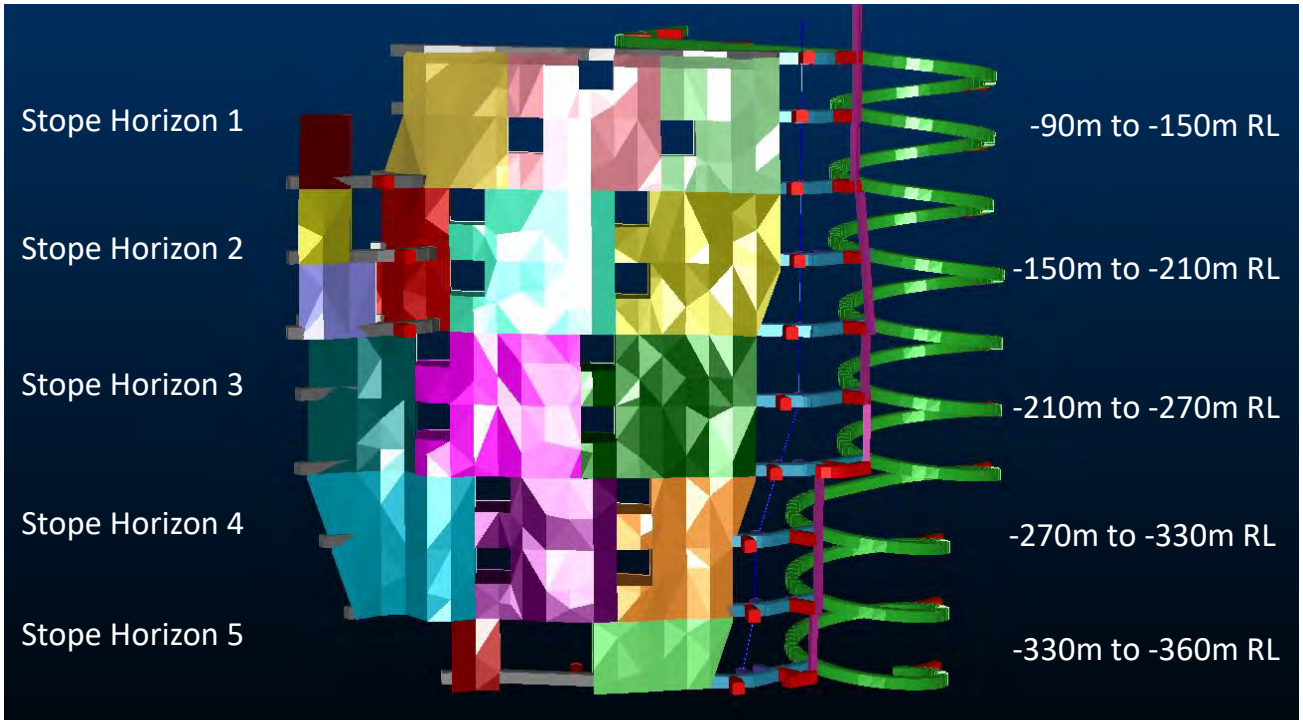


Figure 2-9 BP33 underground stope horizons.

2.8. BP33 box cut and underground mine closure

At completion of underground mining activities at BP33, the underground and box cut will be completely backfilled, no waste material will remain on the surface and the site will be revegetated. Rehabilitation of BP33 will involve the following:

- Progressively backfill the underground mine stopes using fresh rock from the underground waste rock dump and additional backfill material sourced from the Grants waste rock dump.
- Reclaim material from the box cut waste rock dump to completely backfill the box cut.
- Spread the safety bund over the top of the finalised surface of the box cut.
- Re-profiling of the final surface.
- Subsoil and topsoil re-spreading and contour ripping.

The estimated material (kt) that will be backfilled into the box cut (2,000 kt) and the underground (229 kt from BP33 development WRD), the remainder of material will be required to be sourced from the Grants WRD (1,065 kt) to complete the backfill. All the excavated box cut material will be returned to the box cut. This is scheduled to occur at the cessation of mining, following completion of the underground backfill. The development waste rock dump will be progressively returned as backfill underground, proposed to be completed by month 19. Grants waste rock dump will be brought back from Grants to BP33 from month 11 to month 41, utilising the return haul trucks that run from the BP33 ROM to the Grants processing facility.

The proportion of LiO2 extracted is expected to be about 1-2%, based on this it is assumed that the infill material will have a higher storage coefficient to the host rock 2-3% compared with the assumed host rock storage of 1%. However, it is likely that the permeability of the infill material is much greater than the host rock.

2.9. Significant sites and sensitive receptors

2.9.1. Sites of Conservation Significance

The Project does not occur within any Sites of Conservation Significance (SOCS) or nationally important wetlands, nor does surface water from the Project area drain directly to any of these areas. The closest SOCS is Darwin Harbour, located about 12 km northwest of the Lei deposit. As the Project is not expected to affect these areas, they are not considered further in this assessment.

2.9.2. Charlotte River catchment

The Project is situated within the approximately 119 km² Charlotte River catchment. The Lei Mining Lease (ML33874) occupies about 2.9 km², representing around 2.4% of the total catchment area. The Charlotte River traverses the south-western corner of the mining lease and is located about 300 m from the proposed disturbance area at its closest point. The catchment is identified in the Bureau of Meteorology Groundwater Dependent Ecosystem (GDE) Atlas as having moderate potential for aquatic groundwater dependent ecosystems. Downstream of the Project area, the Charlotte River supports riparian vegetation and transitions into mangrove communities closer to Bynoe Harbour.

2.9.3. Bynoe Harbour

Bynoe Harbour is used for both recreational and commercial activities and contains mangrove communities that comprise about 6% of the Northern Territory's total mangrove extent (Lee, 2003). These mangrove communities are supported by numerous small tidal creeks and extend upstream along the Charlotte River to the western boundary of ML33874. Bynoe Harbour is located about 8 km northwest of the Project area. Detailed mapping of mangrove communities was produced by the Northern Territory Government at a scale of 1:10,000 (DEPWS, 2024a).

2.9.4. Groundwater dependent ecosystems

An assessment of groundwater dependent ecosystems (GDEs) within 2 km of the Project area was undertaken using the Bureau of Meteorology Groundwater Dependent Ecosystem Atlas (2025). The Charlotte River is mapped as a moderate-potential aquatic GDE and traverses the south-western corner of the mining lease. The proposed disturbance area is located about 300 m from the river at its closest point.

Moderate-potential terrestrial GDEs, identified as Eucalypt woodland, occur across much of the Project area, including the proposed disturbance footprint. A smaller area of low-potential terrestrial GDE, identified as drainage open woodland, occurs within the south-western corner of the Project area and is also present north of the Project within the 2 km assessment area. Figure X shows the mapped aquatic and terrestrial GDEs within 2 km of the Project area.

Mangroves are mapped along the lower reaches of the Charlotte River to the western boundary of ML33874. Although groundwater discharge may provide nutrients to riparian and aquatic vegetation, it is unlikely that the mangrove communities are directly groundwater dependent. Groundwater levels exhibit a strong seasonal response (see Figure 2-5 and Figure 2-6), while upstream surface water monitoring sites, particularly SW1 and SW4, are frequently dry or cease flowing during the dry season. Surface water permanence mapping also indicates that the upper

reaches of the Charlotte River are generally ephemeral, suggesting that groundwater contributes little baseflow to the river during the dry season.

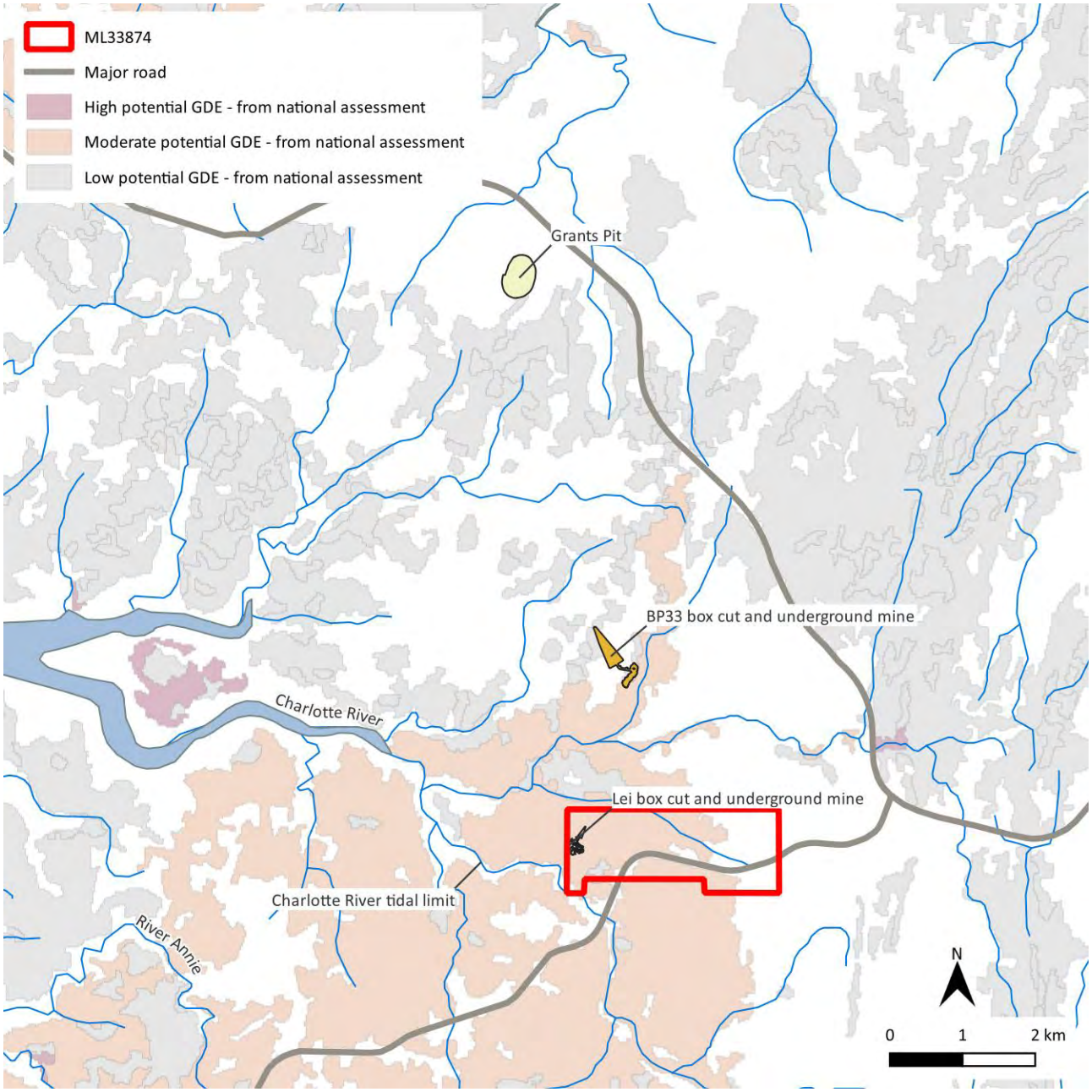


Figure 2-10 Location of Lei Project relative to the mapped terrestrial GDES (source BoM, 2025).

3 Hydrogeological conceptual model

3.1. Introduction

The development of a conceptual model is one of the most important steps in groundwater modelling (Barnett et al, 2012). The conceptual model establishes the basic design principles for a groundwater model and identifies any key knowledge gaps to guide future investigations.

At this stage of the modelling process, a decision is made on what processes to include (or exclude) and what simplifying assumptions should be made to achieve the modelling objective(s). These decisions will strongly influence the mathematical model and ultimately the modelling outcome.

3.2. Groundwater system extents

Similar geological / hydrogeological conditions (BCF) extend well beyond the expected impact of the Lei Project, therefore, to build a functional numerical groundwater model, the modelled groundwater system extents have been taken from hydrological features such as surface water catchment divides and surface water drainage features.

The extents of the groundwater model are presented below in Figure 3-1. The model domain has adequate lateral extents to prevent the interaction between areas showing potential changes to the groundwater system due to mining activities and the model boundaries (about 3 – 4 km separation).

The geometry of the groundwater model are based on the following criteria:

- The western and eastern boundaries roughly correspond with surface water drainage divides, assuming that the groundwater surface is a subdued reflection of the topography.
- The western boundary also corresponds with a geological contact between the BCF to the east and the Welltree Metamorphics to the west.
- The northern boundary coincides with drainage features, which are assumed to be tidal and forms a constant head.
- The southern boundary coincides roughly with surface water drainage divides and is likely to form a local no-flow boundary.

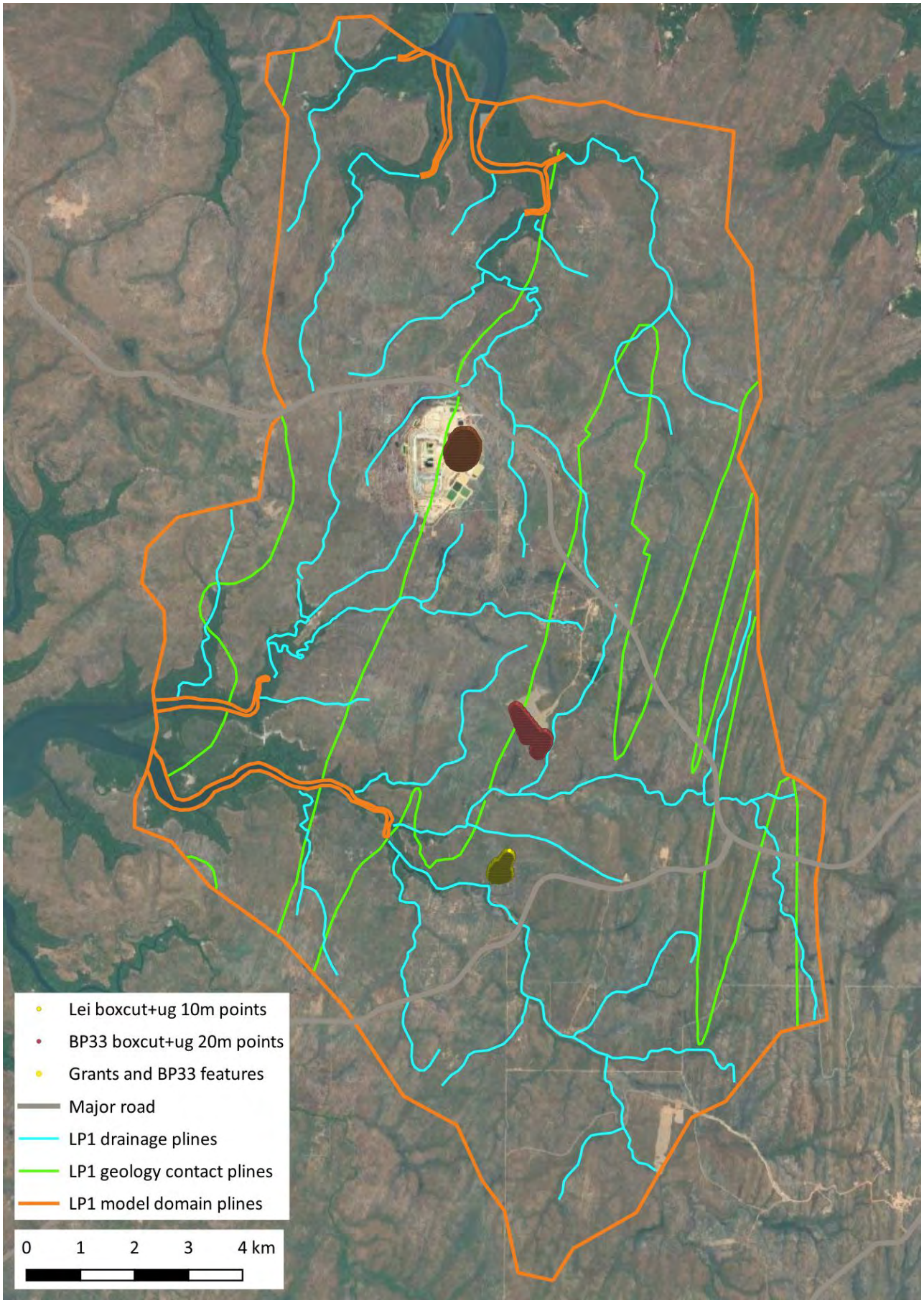


Figure 3-1 Conceptual features incorporated into the Lei Project groundwater model.

3.3. Hydraulic characteristics

The BCF comprises heavily weathered shale, siltstone and strongly foliated phyllite with lenses of quartz pebble conglomerate. Investigation bores at BP33 intersected a thin cover of Quaternary sediments overlying the BCF. These sediments range in thickness from 2 – 4.5 m and comprise of silty sands with minor laterite horizons. Except for one site at BP33 (BPG2s) the Quaternary sediments were unsaturated during the late dry season.

Low yielding localised fractured and weathered aquifers are present in the BCF typically occurring at the base of the weathered zone. Discrete aquifers also occur where drilling intersects fracture zones within the fresh BCF. The most permeable sediments occur in the Cenozoic sands and gravels, and the laterised top of the Burrell Creek Formation. However, the potential of these deposits to store and transmit groundwater is not significant due to their limited saturated thickness. The permeability of the BCF is relatively low with hydraulic testing indicating hydraulic conductivity values of around 0.03 m/d for unfractured BCF and 1 m/day for fractured BCF. The storage characteristics are unknown, however, the specific yield is expected to be low and in the order of 0.01. In the absence of site data the specific yield is based on typical values for weathered and fractured rocks and is consistent with values adopted for other groundwater modelling studies undertaken in similar hydrogeological environments (i.e. the Burrell Creek Formation).

3.4. Groundwater flow dynamics

Groundwater across the Lei site generally flows toward the south-west, moving from the higher terrain in the north-east toward lower-lying areas along the Charlotte River drainage line and its tidal reaches. The overall groundwater flow direction remains broadly consistent between the Wet and Dry seasons, although hydraulic gradients steepen in the north-east during the Wet season, indicating that recharge primarily occurs in these elevated areas.

Groundwater levels in the lower-lying areas rise rapidly in response to wet season recharge before stabilising as they approach ground level. This response suggests that the BCF aquifer effectively reaches near-saturation in these areas during the wet season. Observed vertical hydraulic gradients indicate that groundwater level responses in the lower-lying areas are likely driven by a combination of lateral groundwater flow from elevated recharge areas and direct recharge from rainfall or surface water.

At the regional scale, groundwater level data are limited. However, the water table is inferred to broadly follow surface topography. A subtle local catchment divide occurs north of the site, separating the Lei Project area from the BP33 mine located about 2.5 km to the north. A more prominent sub-catchment divide occurs further north, separating both the Lei and BP33 areas from the GLP. Groundwater divides are inferred to broadly coincide with these surface water catchment boundaries, with groundwater in the Lei and BP33 areas generally flowing west to south-west toward Charlotte River Bynoe Harbour. A groundwater divide is inferred along the catchment divide between GLP and BP33 and Lei, with groundwater around Lei and BP33 moving generally in a westerly to south-westerly direction toward Bynoe Harbour and the groundwater around GLP moving towards Darwin Harbour to the north.

3.5. Recharge

Two mechanisms provide recharge to the aquifers of the study area:

- Direct (or diffuse) recharge – this is defined as the water added to the groundwater in excess of soil moisture deficits and evapotranspiration, by direct vertical percolation of precipitation through the unsaturated zone and is typically distributed over large areas; and
- Indirect (or local) recharge – results from the percolation of water to the water table following runoff as ponding in low-lying areas or through the beds of surface water courses and features (e.g. Observation Hill and the BP33 pit-lake) (Lerner et al., 1990).

Groundwater level monitoring data indicate that direct recharge from rainfall is likely to be the dominant recharge mechanism across the Lei site.

Recharge rates were estimated using the water table fluctuation method (WTFM) (Healy, 2010). Based on groundwater level monitoring data, annual water level fluctuations of about 8 to 10 m were observed in bores located in the elevated areas (LG3 and LG4). In the lower-lying areas (LG1-S and LG2), annual groundwater level fluctuations are smaller, typically ranging from about 3 to 6 m.

A specific yield range of 0.01 to 0.02 was adopted for the recharge calculations. Using the WTFM approach, estimated recharge rates range from about 80 to 200 mm/year in the elevated areas and about 30 to 120 mm/year in the lower-lying areas.

The model domain covers an area of about 194 km^2. Based on the estimated recharge rates, total annual recharge across the model domain is estimated to range from about 6 and 39 GL/year, with median values likely closer to about 15 to 23 GL/year.

3.6. Groundwater Discharge

Natural mechanisms for groundwater leaving the aquifers in the study area are thought to be via:

- Evapotranspiration and diffuse discharge where groundwater is relatively close to the surface.
- Discharge to streams and creeks.

Evapotranspiration can be estimated from studies conducted in similar vegetation types and climatic conditions. Cook et al (1998) provided an annual estimate of runoff of 590 mm/year and evapotranspiration from the unsaturated zone of 1,110 mm for an annual rainfall of 1,720 mm. Overstorey evapotranspiration at the end of the Dry season was less than 1 mm/d and has been assumed to be a proxy for ET discharge from the groundwater. This equates to groundwater discharge due to ET processes of less than 365 mm/year.

The volume and rate of groundwater discharge to surface features (streams and creeks) is expected to be relatively small as the aquifer has a low hydraulic conductivity.

The model domain has an area of about 194 km^2 which means total annual rainfall is about 333 GL/year, and total actual evapotranspiration is about 215 GL/year and evapotranspiration from the groundwater could be as high as 71 GL/year although .

3.7. Summary hydrogeological conceptualisation

Groundwater flow around the BP33 site occurs in a fractured and weathered aquifer within the BCF. The pegmatite, which hosts the lithium resource, has limited spatial extent and negligible primary porosity. It is expected to operate as a fractured rock aquifer with similar or lower permeability than the surrounding host rock (BCF). Alluvial deposits occur around drainage lines and from in-situ weathering of the BCF but are thin (< 4.5 m), discontinuous and typically only saturated during the wet season.

The weathering profile in the BCF is significant to the groundwater dynamics. Based on examination of numerous boring logs, the top 3 m of material is generally completely weathered, very highly fractured, or unconsolidated. The weathering profile generally extends from 30 to 60 m below land surface. Weathering is often associated with increased fracturing, infilling of fractures with clay or mineralisation, or oxidation. The degree of weathering decreases with depth. The alluvium and uppermost weathered portion of bedrock have the potential to transmit reasonable volumes of groundwater, especially during rain events. However, they are generally unsaturated except in the immediate vicinity of the local streams and surface water bodies. Also, the infilling and mineralisation along fractures in the weathered zone above 30 m depth has the potential to cause a decrease in their transmissivity.

Groundwater flow in the BCF aquifer is away from slightly elevated areas in the north-west and toward lower lying areas along the drainage line in the east and south of the site. The regional groundwater gradient is toward the south and the groundwater flow direction generally mimics the topography. A groundwater flow divide is inferred along the topographic divide located in the north of the BP33 site.

Streams in the area are inferred to act as the discharge points. Topographic highs and surface water ponds, to the north and proposed dams/water storages, act as recharge areas. Groundwater recharging in the vicinity of the Lei mine and its infrastructure is expected to migrate offsite, either as discharge to surface water features such as Charlotte River or through evapotranspiration losses.

The conceptualisation of the key components of the groundwater system is presented in Table 3-1.

Table 3-1 Summary of key features of the hydrogeological conceptualisation

Component	Description
Hydrostratigraphy	Groundwater is present in the weathered and fractured Burrell Creek Formation. The thin veneer of alluvial sediments is predominantly unsaturated across the site with groundwater only present during the wet season.
Flow dynamics	Groundwater generally flows from north to south and locally from areas of higher topography to areas of lower topography such as drainage features.
Recharge processes	Recharge primarily occurs during the Wet season as diffuse recharge. This hypothesis implies that preferential or local recharge is not significant.
	Mean total recharge fluxes were estimated at between 15 to 23 GL/year, which (for an assumed total recharge area of 194 km^2), equate to rates of about 80 to 120 mm/year, or 0.2 to 0.3 mm/d.
Discharge processes	Diffuse discharge also occurs via streambed seepage (unquantified) and via evapotranspiration from shallow groundwater.
	Total discharge fluxes were estimated to range from 28 to 49 GL/year, which (for an assumed total discharge area of 194 km^2), equate to rates of about 146 – 256 mm per year, or 0.4 to 0.7 mm/d.

4 Groundwater flow model design

4.1. Introduction

This section describes the design and construction of the numerical groundwater flow model developed for the Lei Lithium Project. It outlines the selected modelling platform, model domain and mesh, representation of hydrostratigraphic units, boundary conditions, hydraulic parameters, recharge and evapotranspiration processes, and simulation periods. The model design is based on the conceptual hydrogeological model described in Section 3 and incorporates the Lei, BP33 and Grants mining areas to support assessment of both Project-specific and cumulative groundwater impacts.

4.2. Model platform

FEFLOW (Finite Element subsurface FLOW and transport system v 10.0.5), developed by DHI-WASY GmbH, was selected as the numerical modelling platform (Diersch, 2015). FEFLOW is an industry standard groundwater modelling tool used by many jurisdictions to groundwater flow and contaminant transport.

FEFLOW represents groundwater flow using equations based on Darcy's law and can simulate a range of saturated and unsaturated subsurface processes. It also provides capabilities for representing groundwater recharge and interactions between groundwater and surface water.

Rejected recharge is an important mechanism in Top End groundwater systems. It occurs where rainfall-derived recharge exceeds the capacity of the aquifer to accept and transmit water, causing excess water to remain at or return to the ground surface. Appropriate representation of this process is important for simulating groundwater levels and assessing the potential effects of mine dewatering. FEFLOW's ability to represent rejected recharge and groundwater–surface water interactions was therefore a key reason for its selection for the Lei Project groundwater flow model, referred to as LP1.

4.3. Model domain and grid

4.3.1. Model domain

The 3D finite element model domain is roughly centred on the Lei and BP33 mining activities and covers an area of 193.6 km^2. The model domain extends well beyond the anticipated extent of mining-induced drawdown to minimise the influence of boundary conditions on simulated groundwater responses. The mesh has been refined within the footprint of Grants Pit, the BP33 box cut and underground mine (equilateral elements with 20 m sides), and the Lei box cut and underground mine (equilateral elements with 10 m sides). The model domain is discretised into a mesh consisting of 31,913 elements per layer.

The final FEFLOW mesh extents are summarised in Table 4-1 and the model domain is presented below in Figure 4-1.

Table 4-1 Lei Project numerical flow model domain specifications.

X min	686948 mE
X max	699775 mE
Y min	8583596 mN
Y max	8606985 mN
Width	12,827 m
Height	23,389 m
Model area	193.6 km^2
Map projection	GDA94 / MGA zone 52

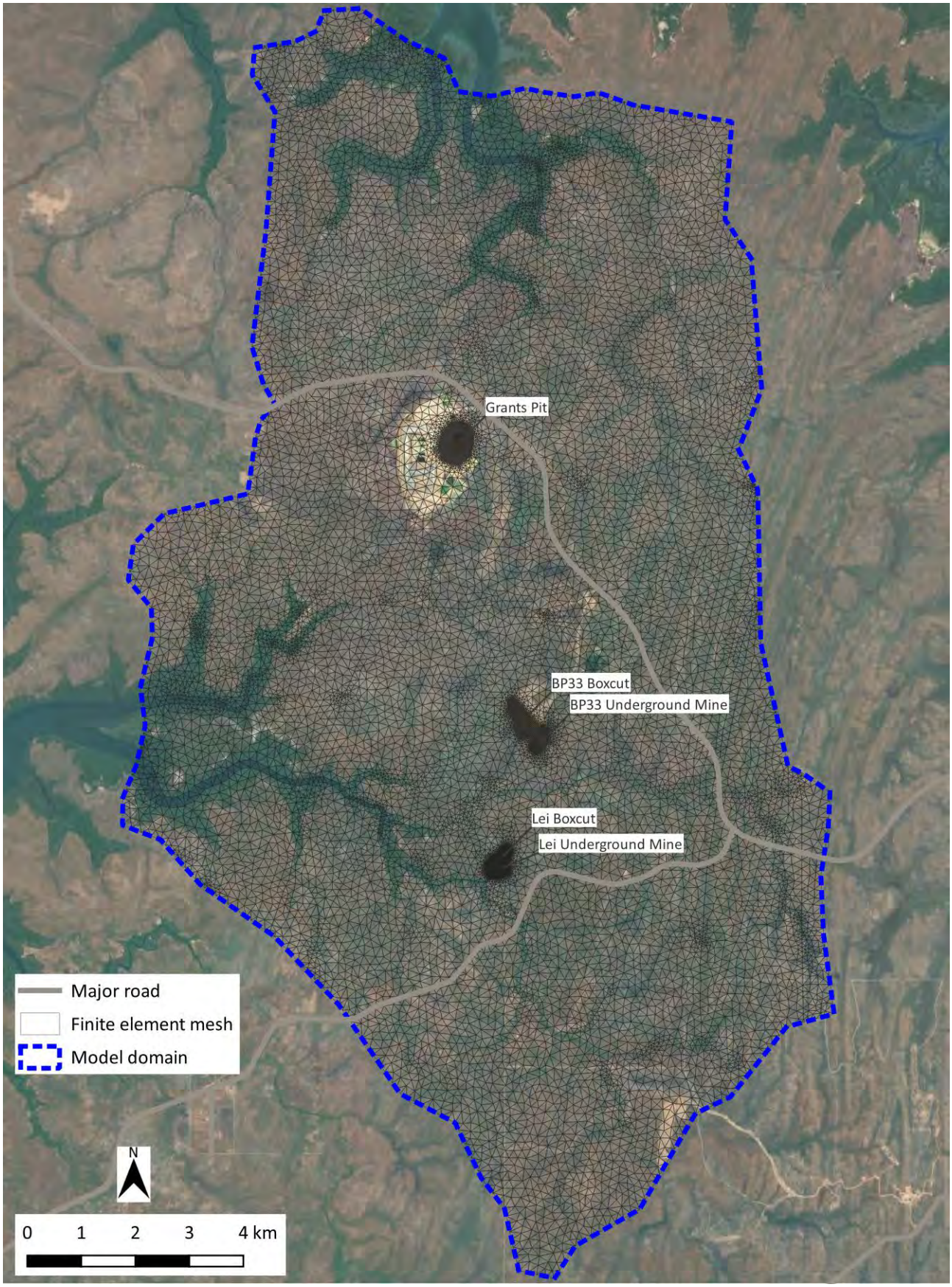


Figure 4-1 Lei Project FEFLOW groundwater model domain and grid indicating the locations of the mine infrastructure associated with the Lithium Plus Lei project and the Core Lithium Grants and BP33 projects.

4.3.2. Vertical discretisation / model layers

The hydrostratigraphic units (HSUs) correspond to the alluvium and the upper completely weathered or lateritised horizon, the moderately to highly weathered zone extending to about 30–40 m below ground level, the slightly weathered zone extending to about 60–70 m depth, and the underlying fresh rock.

A total of 19 model layers were used to represent the three HSUs within the groundwater flow system. The elevation of the model top (Slice 1) was derived from the hydro-enforced SRTM 1 sec DEM, while the base of the model is set at -1,000 m AHD.

HSU1 is represented by Layer 1 and extends from the surface to a depth of 30 m. HSU2 is represented by Layer 2 and extends a further 30 m below Layer 1. HSU3 is represented by Layers 3 to 16, each 50 m thick, and Layers 17 to 19, each 100 m thick.

A south–north cross-section of the numerical model showing the model layers, observation bore locations, and the geometry of the BP33 and Lei underground mines is presented in Figure 4-2.

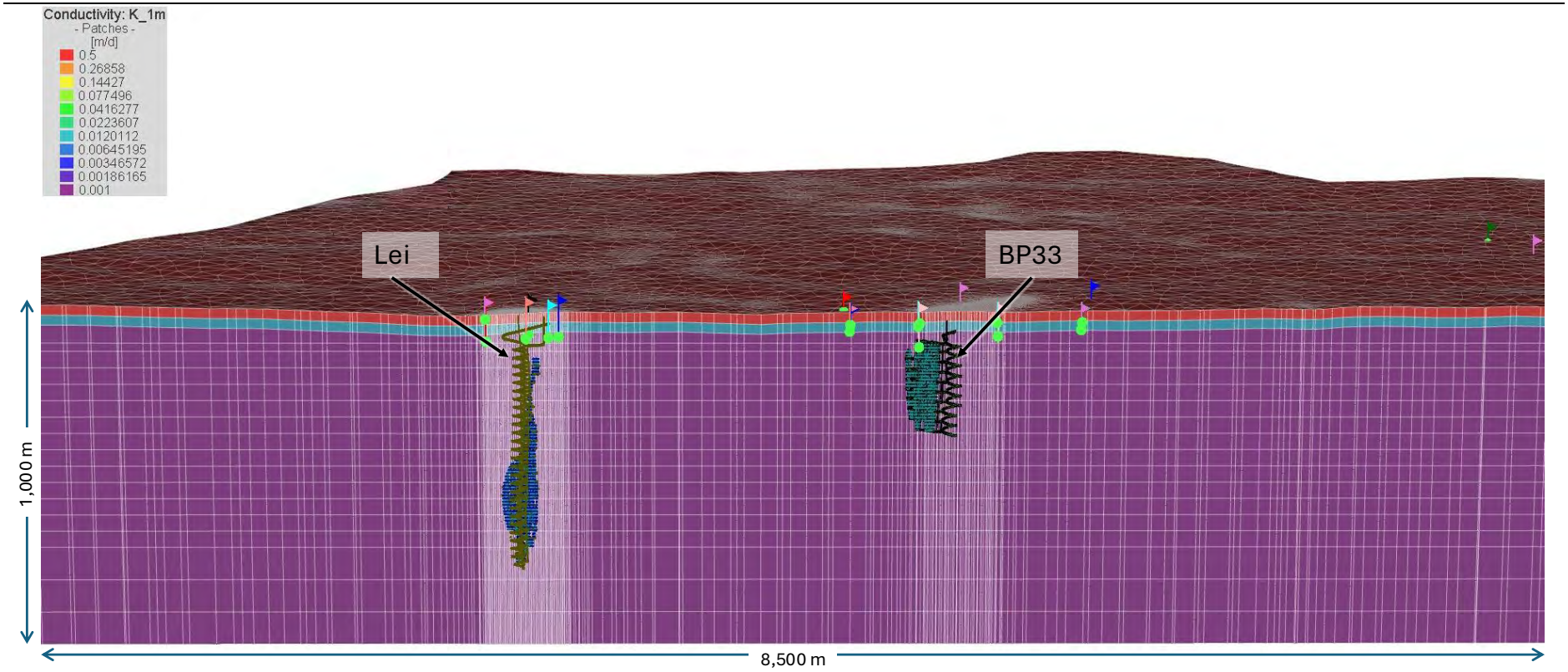


Figure 4-2 North-south section through the FEFLOW model showing relationship between Lei and BP33 underground mines, model mesh and layers. Layer 1 & 2 30 m thick; Layer 4 variable thickness; Layers 5-16 elevations 50m thick; Layers 17-19 100m thick. Slice 1 hydro enforced SRTM 1 sec DEM; Layer 1 & 2: 30 m thick bottom elevation variable; Layers 5 – 16 bottom elevation-100 to –700 mAHD; Layers 17-19 bottom elevation -800, -900 and -1000 mAHD.

4.3.3. Boundary conditions

The boundary conditions (BCs) are defined at nodes along the boundary or within the model domain. The BCs available in FEFLOW that have been employed in the LP1 groundwater model are:

- Zero flux BCs - This is a special flux no-flow boundary, which is the default around the external model boundary.
- Specified head BCs - this boundary condition prescribes a head value at the boundary node, which can be fixed at a prescribed value or assigned to a time series file. The tidal section of the Charlotte River and other tidal portions of rivers in the model domain are assigned specified head BCs at the elevation derived from the hydro-enforced SRTM.
- Seepage face specified head BCs - this boundary condition prescribes a head value at the boundary node, which can be fixed at a prescribed value or assigned to a time series file. A seepage face BC is a specified head BC with a zero flux inflow constraint applied, meaning the boundary condition can discharge groundwater from the model domain but no inflow to the model domain can occur. Seepage face BCs are used at the ground surface and to represent the pit shell and underground mine excavations. A seepage face is a specified hydraulic-head boundary condition with a zero-flux inflow constraint applied.
- Well BCs - this boundary condition is applied to nodes and represents a time-constant or time-varying local injection or abstraction of water at a single node or at a group of nodes. Well BCs have not been employed at this time, however may be required if active dewatering options are considered in future modelling campaigns.

4.3.4. Areal flux (recharge and ET)

The recharge is applied to the model as a Parameter Expression using the In / outflow on top / bottom areal flux distribution.

The Parameter Expression is a user-defined expression linking the time- varying values of recharge to the In / outflow on top / bottom parameter, based on the dependencies of other parameters, in this case the recharge reference distribution, maximum evapotranspiration flux, extinction depth and reference distribution. Scaling factors are applied to the time- varying rainfall values using the recharge zones and the distribution of ET based on the vegetation mapping.

The ET function is determined using an estimate of the potential evaporation rate, an estimate of root depth.

The recharge timeseries was generated using the LUMPREM utility (Doherty, 2021). Lumprem is a simple lumped parameter model used to represent unsaturated zone processes such as runoff, infiltration, evapotranspiration and deep drainage (recharge). The inputs are SILO rainfall and potential evaporation and the outputs include actual evapotranspiration and recharge.

4.3.5. Representation of Grants pit during mining

Dewatering of the Grants Pit during excavation is simulated using seepage face boundary conditions that are activated sequentially in time. The implication of using seepage face boundary conditions to represent the pit is that the inflow to the pit is a predicted output of the modelling.

The seepage face requires a reference elevation, which in this case has been determined from the planned progression of the pit-levels over the Life of Mine (CloudGMS, 2018).

4.3.6. Grants pit-lake post-closure representation

To reduce model complexity, the recovery water level reported by CloudGMS (2017) to provide the specified heads at the Grants pit during the post-closure phase.

4.4. Transient model design & construction

4.4.1. Simulation period and time stepping

The period from 01/01/2016 to 01/01/2026 was selected for parameter estimation. This timeframe provides a warm-up period prior to the availability of groundwater level data at the Lei Project, GLP, and BP33 sites. The FEFLOW simulation time, equation solver and numerical settings are presented in Table 4-2.

Table 4-2 FEFLOW simulation specification settings

Model code	FEFLOW
Software version	10.0.5 (x64)
Mesh	
Element geometry	Triangle prism
Free surface	3D phreatic surface (fixed mesh)
Head limits for unconfined conditions	
Top of model domain	Unconstrained head
Storage change in phreatic top layer	Extend storage of unconfined layer to water table
Bottom of model domain	Unconstrained head
Numerical parameters	
Time stepping	Adams-Bashforth/Trapezoid rule (AB/TR) predictor-corrector
Error tolerance	
Euclidian L2 integral (RMS) norm	5e-03
Maximum number of iterations per timestep	12
Equation System Solver	Preconditioned conjugate-gradient method

4.4.2. Error tolerance

The Error tolerance (units: 10^{-3}) is defined as the averaged absolute error (change in the primary variable) divided by the maximum value occurring in initial or boundary conditions. For the averaging process over all nodes, the default Euclidian L2 integral (RMS) norm was used and set to a value of 5.

5 Parameter estimation

5.1. Parameter estimation approach & criteria

Calibration, or parameter estimation, is the process undertaken after model design and construction to determine a set of parameters, boundary conditions and stresses that produce

simulated heads and fluxes that match field-measured values within a pre-defined error range. This allows the model to be accepted as a good representation of the physical system of interest.

During calibration, important model parameters are adjusted, within realistic limits, to produce the best possible agreement between simulated and observed data. The process typically begins with an initial estimate of parameters (for example, horizontal and vertical hydraulic conductivity, specific yield and recharge) for each active element in the model mesh, or boundary conditions assigned at model nodes. Parameter adjustment can be performed manually through trial and error, or automatically using optimisation algorithms.

Regardless of the technique employed all parameter estimation methods require:

- selection of the parameters to be estimated
- an objective function, defined such that its value is to be minimised, based on the measured values
- constraints that limit the range of possible values of the estimated parameters.

5.1.1. Adjustable parameters

Adjustable parameters were selected for both LUMPREM recharge estimation and hydraulic material properties in the LP1 groundwater flow model. These include hydraulic conductivity, specific yield, and specific storage. An additional parameter was the anisotropy angle defining the orientation of the major horizontal hydraulic conductivity axis. Geological mapping in the project area indicates preferred structural orientations, suggesting that groundwater flow may be directionally biased by stratigraphic and structural features. Although the available monitoring data do not provide strong constraints on anisotropy, including this parameter allows the model to incorporate geologically realistic flow pathways and supports robust prediction and uncertainty analysis, particularly for scenarios where directional connectivity may be influential.

The adjustable parameters, their initial estimate and range are presented in Table 5-1.

Table 5-1 Adjustable parameters, initial values and parameter ranges.

Model	Parameter	Description	Unit	Initial value	Minimum value	Maximum value
LUMPREM	vol	unsaturated storage volume	m^3	2.00E-01	1.00E-01	5.00E-01
	ks1	Unsaturated infiltration rate	m/d	4.00E-03	1.00E-05	1.00E-02
	m1	Drainage rate vs. stored water relationship	-	1.00E+00	1.00E-01	2.00E+00
	l1	Pore-connectivity parameter	-	5.00E-01	1.00E-01	1.00E+00
	mf1	Maximum macropore recharge allowed per day	m/day	1.00E-04	1.00E-05	1.00E-02
	rdelay1	Delay in soil moisture infiltrating as groundwater recharge	days	5.00E+00	1.00E+00	1.00E+01
	mdelay1	Delay in soil macropore moisture as groundwater recharge	days	5.00E+00	1.00E+00	1.00E+01
	cf1	Crop factor	-	5.00E-01	1.00E-01	1.00E+00
	gamma1	Evapotranspiration rate vs. stored water relationship	-	3.00E+00	1.00E+00	1.00E+01
FEFLOW	kx1	Horizontal hydraulic conductivity - HSU1	m/d	5.00E-01	1.00E-05	1.00E+01
	ky1	Horizontal hydraulic conductivity - HSU1	m/d	5.00E-01	1.00E-06	1.00E+01
	kz1	Vertical hydraulic conductivity - HSU1	m/d	5.00E-02	1.00E-06	1.00E-01
	sy1	Specific yield - HSU1	-	1.50E-02	1.00E-03	3.00E-01
	ss1	Specific storage - HSU1	1/m	1.00E-06	1.00E-07	1.00E-05
	aniso1	Angle of hydraulic conductivity anisotropy	degrees	6.00E+01	1.00E+00	3.60E+02
	kx2	Horizontal hydraulic conductivity - HSU2	m/d	2.00E-02	1.00E-05	1.00E-01
	ky2	Horizontal hydraulic conductivity - HSU2	m/d	2.00E-02	1.00E-06	1.00E-01
	kz2	Vertical hydraulic conductivity - HSU2	m/d	3.00E-03	1.00E-06	1.00E-01
	sy2	Specific yield - HSU2		1.50E-02	1.00E-03	3.00E-01
	ss2	Specific storage - HSU2	1/m	1.00E-06	1.00E-07	1.00E-05
	aniso2	Angle of hydraulic conductivity anisotropy - HSU2	degrees	6.00E+01	1.00E+00	3.60E+02
	kx3	Horizontal hydraulic conductivity - HSU3	m/d	1.00E-03	1.00E-05	1.00E-01
	ky3	Horizontal hydraulic conductivity - HSU3	m/d	1.00E-03	1.00E-06	1.00E-01
	kz3	Vertical hydraulic conductivity - HSU3	m/d	2.00E-03	1.00E-06	1.00E-01
	sy3	Specific yield - HSU3		1.00E-02	1.00E-03	3.00E-01
	ss3	Specific storage - HSU3	1/m	1.00E-06	1.00E-07	1.00E-05
	aniso3	Angle of hydraulic conductivity anisotropy - HSU3	degrees	6.00E+01	1.00E+00	3.60E+02

5.1.2. Objective function

The objective function comprises all available groundwater elevation observations presented in Section 2.4.4.

5.1.3. Measure of 'goodness of fit'

The 'goodness of fit' of the modelled to the observed data is often measured using a simple statistic. Statistics used in this study to describe the fit of final model output values to observed values include:

The weighted root mean squared error (RMSE):

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}\left(W_i * \left(y_i - f(x_i)\right)\right)^2}{n}}$$

Where:

W_i is the i'th observation weighting
y_i is the *i*'th observed value
$f(x_i)$ is the i'th predicted value

The scaled root mean squared error (SRMS) is the RMSE divided by the range of measured heads and expressed as a percentage. Weights are sometimes introduced to account for different levels of confidence in different measurements.

$$SRMS = \frac{100}{H}\sqrt{\frac{\sum_{i=1}^{n}\left(W_i * \left(y_i - f(x_i)\right)\right)^2}{n}}$$

Where:

W_i are weights between 0 and 1; and
H is the range of measured heads (hmax – hmin) across the model domain.

5.2. Parameter estimation results

5.2.1. Recharge

The adopted recharge distribution was determined through the model calibration process. Recharge parameters were adjusted simultaneously with aquifer hydraulic properties to reproduce the observed groundwater level behaviour at monitoring bores across the model domain. Consequently, the adopted recharge estimates are constrained by observed groundwater responses over a range of climatic conditions rather than representing independently selected input values. Recharge rates substantially greater or lower than the calibrated values produced poorer agreement with observed groundwater levels and were therefore rejected during calibration.

The final calibrated average recharge rate was 147 mm/year, equivalent to about 28.6 GL/year across the model domain. This value is consistent with recharge estimates reported for similar hydrogeological environments in the Northern Territory and therefore provides confidence that the calibrated value represents a realistic estimate of long-term groundwater recharge.

5.2.2. Hydraulic conductivity and specific yield

The final hydraulic conductivity values for each of the HSUs are presented in Table 5-2:

Table 5-2 Final calibrated model parameters.

Layer	Hydrostratigraphic Unit	Horizontal hydraulic conductivity (m/d)	Vertical hydraulic conductivity (m/d)	Specific yield
1	HSU 1 laterite / completely weathered rocks	0.5	0.05	0.015
2	HSU 2 extremely / highly / moderately weathered rocks	0.05	0.002	0.015
3-19	HSU 3 slightly weathered to fresh rocks	0.001	0.002	0.01

5.3. Model domain water balance

The cumulative water balance for the entire model domain is presented in Table 5-3. The imbalance is 0.2 GL, equivalent to less than 0.4% of the total model inflows and outflows. This is within the adopted target criteria of less than 1%.

Average annual recharge from rainfall contributes 28.6 GL/year to the model domain. Based on a model domain area of 194 km², this is equivalent to an average recharge rate of 147 mm/year and is consistent with the recharge estimates presented in Section 3.7.

Nearly all the groundwater leaving the model domain 21.5 GL/year, or 110 mm/year, is through interception by evapotranspiration. The evapotranspiration component is less than the total evapotranspiration estimate presented in Section 3.7, as the groundwater model only represents evapotranspiration sourced from the saturated zone. Evapotranspiration from the unsaturated zone above the water table is represented separately in the LUMPREM model.

Table 5-3 Model domain water balance components

Component	Total (GL)	Annual (GL/year)
Inflows		
Dirichlet BCs (Rivers)	18.1	0.9
Wells	0	0
Areal Flux (Recharge)	572.5	28.6
Storage Change	380.2	19.0
Outflows		0.0
Dirichlet BCs (ground surface and rivers)	165.6	8.3
Wells	0	0
Areal Flux (Evapotranspiration)	429.1	21.5
Storage Change	372.4	18.6
Imbalance	3.6	0.2 (0.4%)

5.4. Transient model performance

Barnett et al (2012) recommend that the groundwater model acceptance should be based on a number of measures that may not be specifically related to model calibration. These measures are

required to demonstrate that a groundwater model is robust, simulates the water balance as required and is consistent with the conceptual model on which it is based. The four measures recommended by Barnett et al (2012) are presented below in Table 5-4. The performance of the Lei Lithium Project groundwater model is discussed in the following sections.

Table 5-4 Recommended groundwater model performance measures (after Barnett, 2012)

PERFORMANCE MEASURE	CRITERION
Model convergence	
The model must converge in the sense that the maximum change in heads between iterations is acceptably small.	The iteration convergence criterion should be one or two orders of magnitude smaller than the level of accuracy required in head predictions. Typically of the order of centimetres or millimetres.
Water balance	
The model must demonstrate an accurate water balance, at all times and in steady state. The water balance error is the difference between total predicted inflow and total predicted outflow, including changes in storage, divided by either total inflow or outflow and expressed as a percentage.	A value less than 1% should be achieved and reported at all times and cumulatively over the whole simulation. Ideally the error should be much less. An error of >5% would be unacceptable, and usually indicates some kind of error in the way the model has been set up.
Qualitative measures	
The model results must make sense and be consistent with the conceptual model. Contours of heads, hydrographs and flow patterns must be reasonable, and similar to those anticipated, based either on measurements or intuition. Estimated parameters must make sense, and be consistent with the conceptual model and with expectations based on similar hydrogeological systems.	Qualitative measures apply during calibration, when comparisons can be made with historical measurements, but also during predictions, when there is still a need for consistency with expectations. There is no specific measure of success. A subjective assessment is required as to the reasonableness of model results, relative to observations and expectations. The modeller should report on relevant qualitative measures and discuss the reasons for consistency and inconsistency with expectations.
Quantitative measures	
The goodness of fit between the model and historical measurements can be quantified, using statistics such as RMS, SRMS, MSR and SMSR for trial-and-error calibration and the objective function in automated calibration.	Quantitative measures only apply during calibration. Statistics of goodness of fit are useful descriptors but should not necessarily be used to define targets. Targets such as SRMS < 5% or SRMS < 10% may be useful if a model is similar to other existing models and there is good reason to believe that the target is achievable. Even if a formal target is not set, these measures may provide useful guides.

5.4.1. Model convergence

Section 4.4.2 documents that the dimensionless error criterion in FEFLOW is used for the automatic time-stepping process.

On completion of the transient model runs, the model log was queried and it was confirmed that all timesteps converged to a value less than the error criterion of 2×10^{-3}.

5.4.2. Water balance

The water balance for the entire model domain is presented above in Table 5-3. The imbalance is less than 0.4% and consistent with the Class 2 target criteria of <1%.

5.4.3. Qualitative performance

The final estimated parameters are considered to be consistent with the conceptual model and with expectations based on similar hydrogeological systems.

The modelled water budget is also considered to be consistent with the conceptual model.

The contours of heads, hydrographs and flow patterns are reasonable, and similar to those anticipated, based on observed measurements. Generally, the absolute modelled groundwater levels are in reasonably good agreement with the observed values. Long term trends in the groundwater levels are generally reproduced. The modelled vertical gradient between GWB08 / GWB10 and GWB06 / GWB07 are also generally well reproduced.

The modelled and observed heads at all available sites are presented below in Figure 5-1 through Figure 5-14.

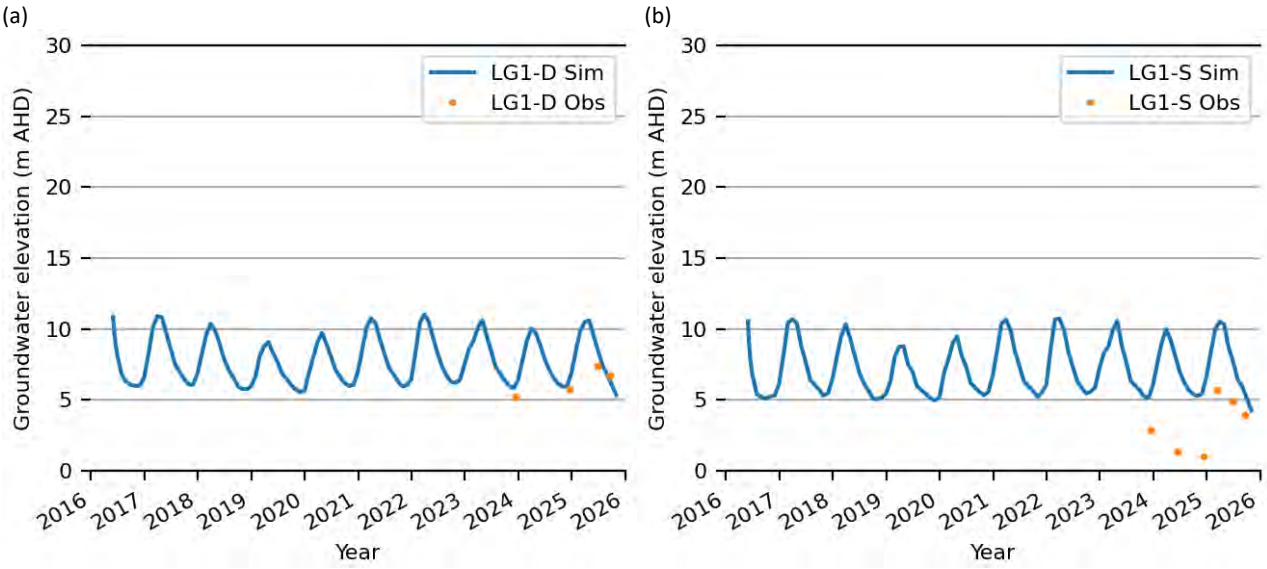


Figure 5-1 Groundwater level response at existing Lei observation bores: (a) LG1-D and (b) LG1-S.

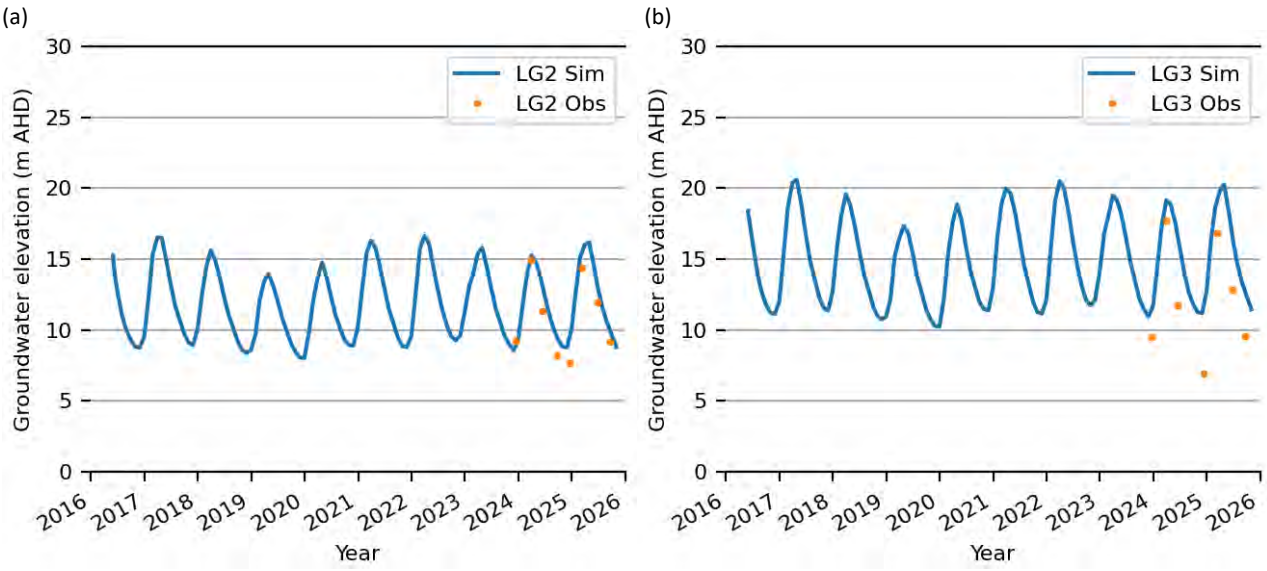


Figure 5-2 Groundwater level response at existing Lei observation bores: (a) LG2 and (b) LG3.

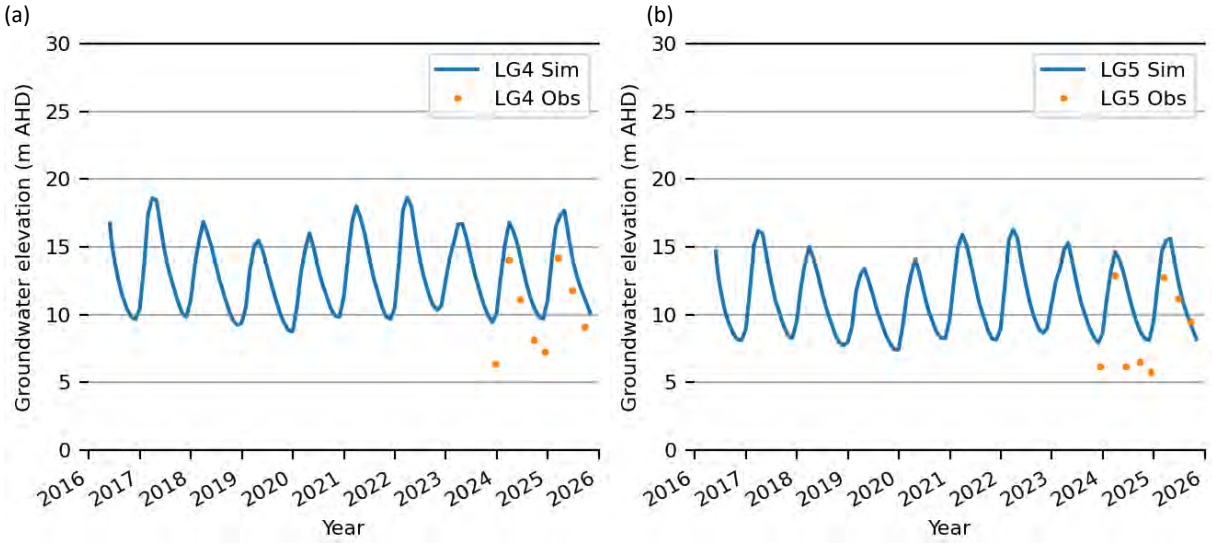


Figure 5-3 Groundwater level response at existing Lei observation bores: (a) LG4 and (b) LG5.

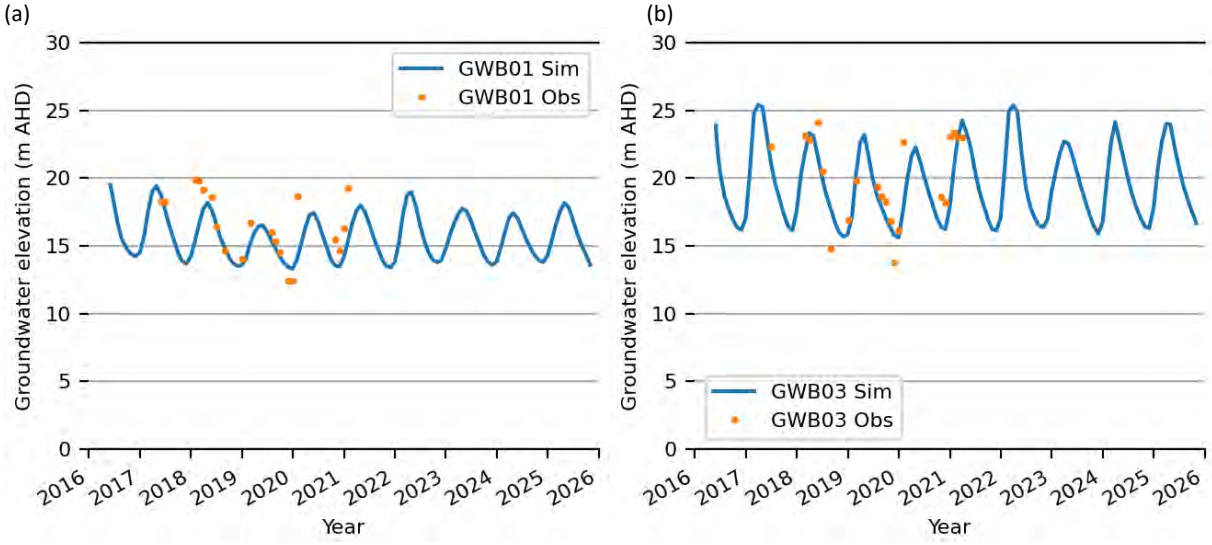


Figure 5-4 Groundwater level response at existing Grants observation bores: (a) GWB01 and (b) GWB03.

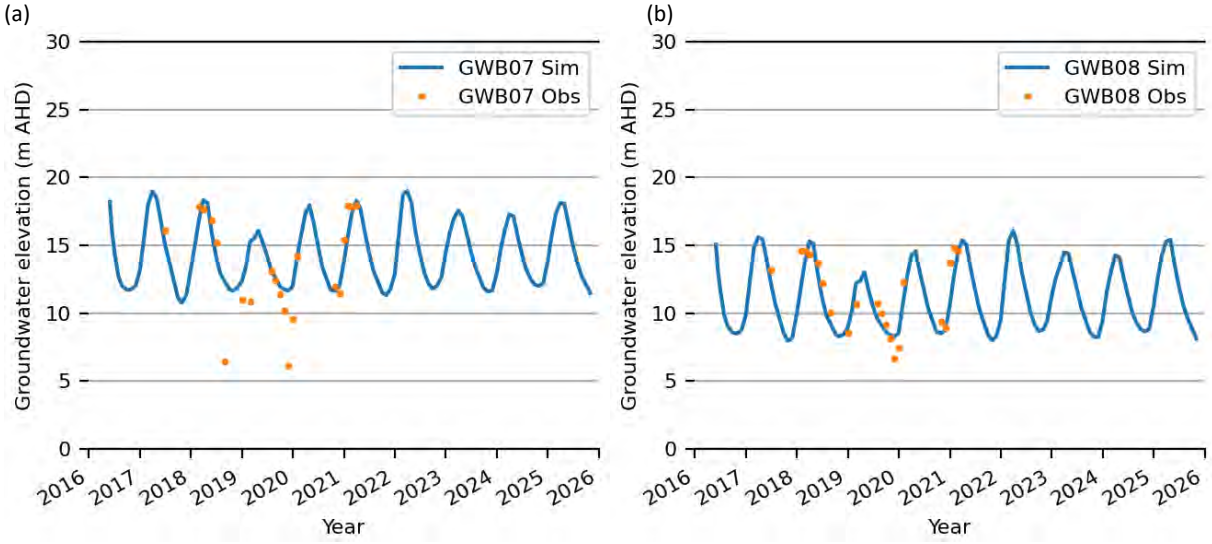


Figure 5-5 Groundwater level response at existing Grants observation bores: (a) GWB07 and (b) GWB08.

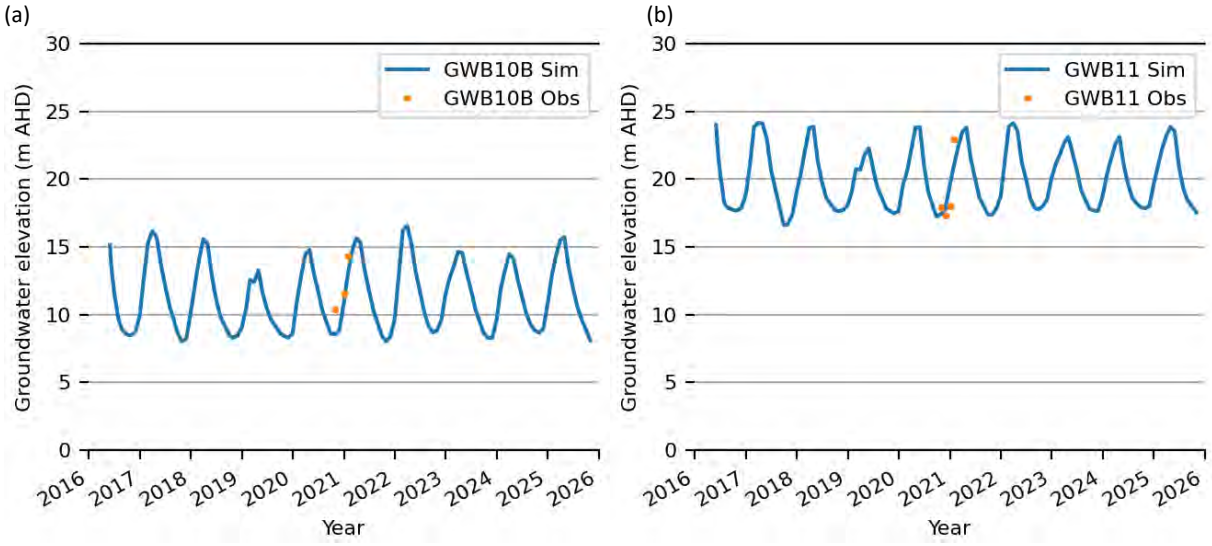


Figure 5-6 Groundwater level response at existing Grants observation bores: (a) GWB10B and (b) GWB11.

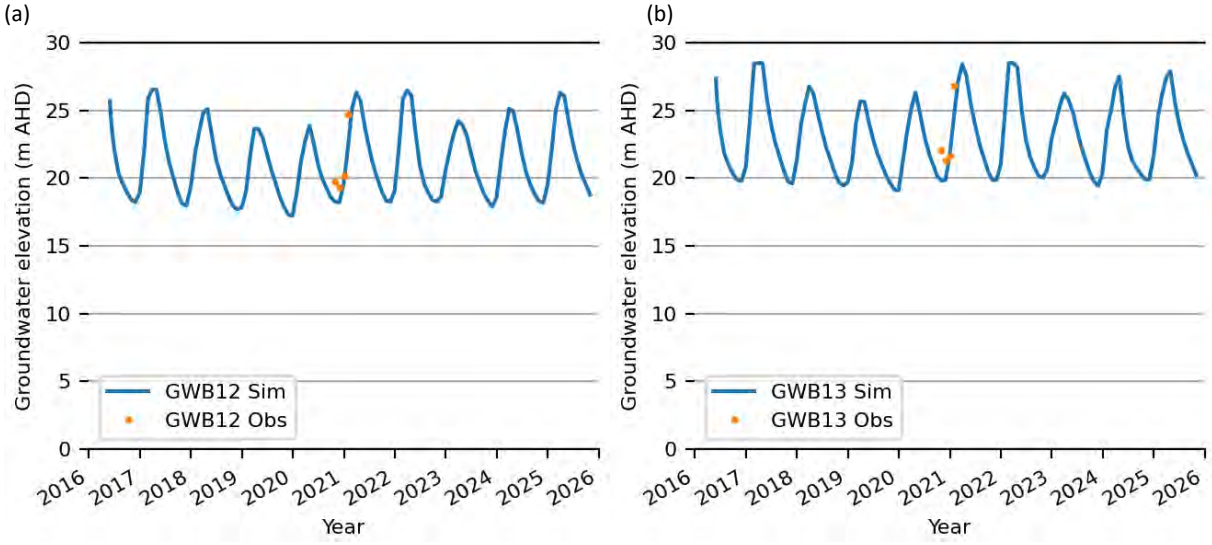


Figure 5-7 Groundwater level response at existing Grants observation bores: (a) GWB12 and (b) GWB13.

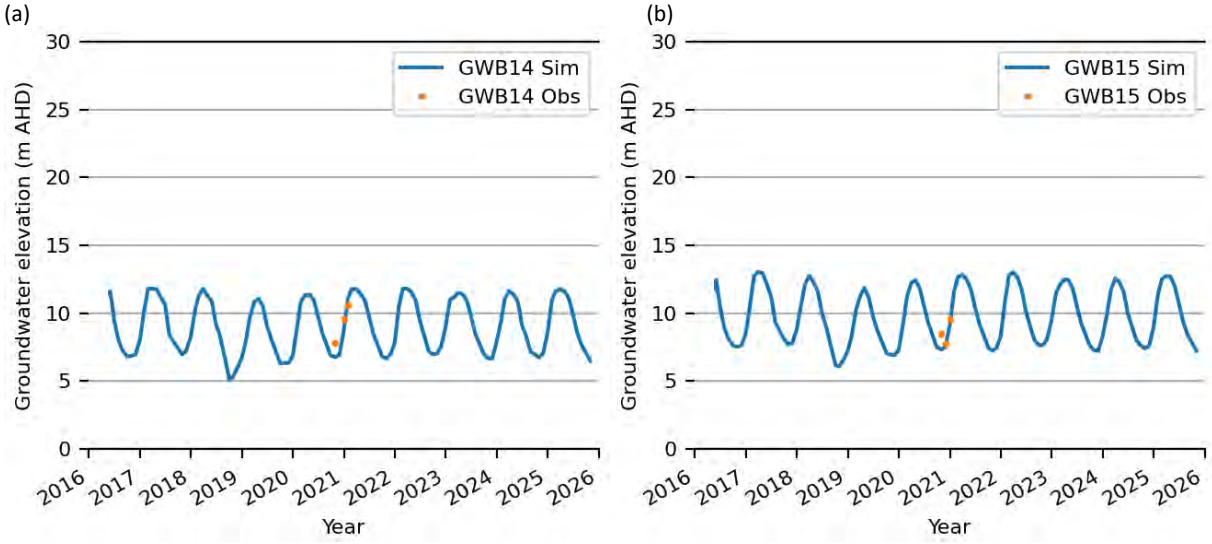


Figure 5-8 Groundwater level response at existing Grants observation bores: (a) GWB14 and (b) GWB15.

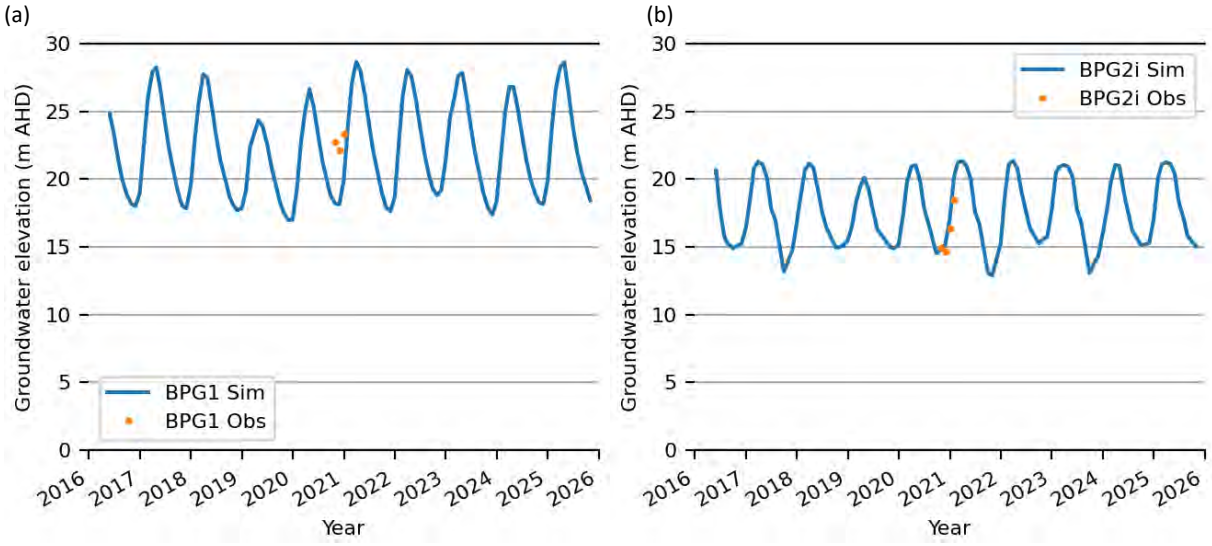


Figure 5-9 Groundwater level response at existing Grants observation bores: (a) BPG1 and (b) BPG2i.

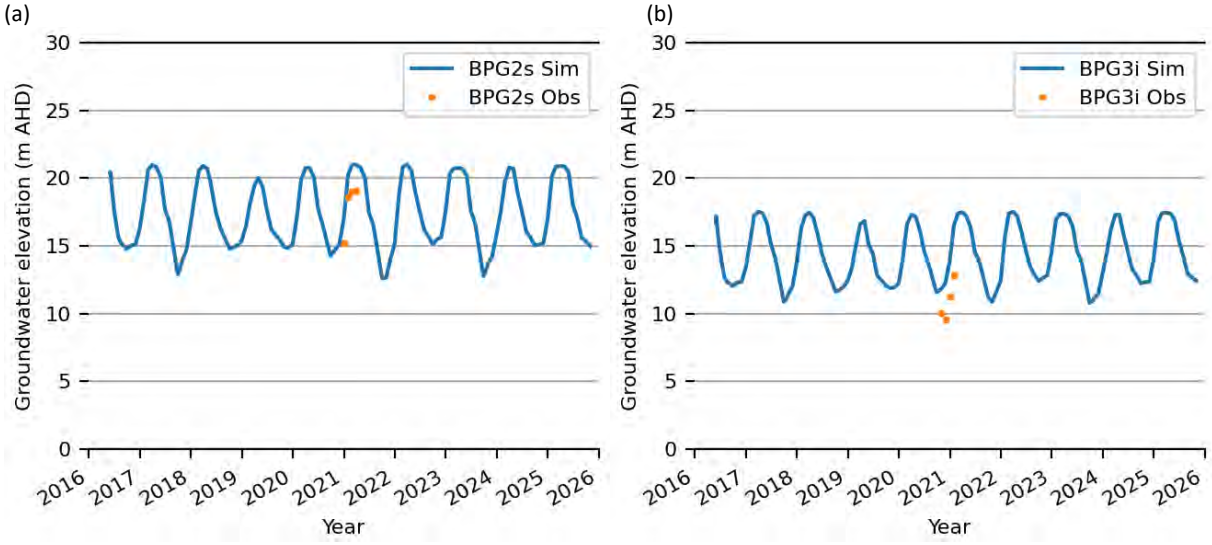


Figure 5-10 Groundwater level response at existing Grants observation bores: (a) BPG2s and (b) BPG3i.

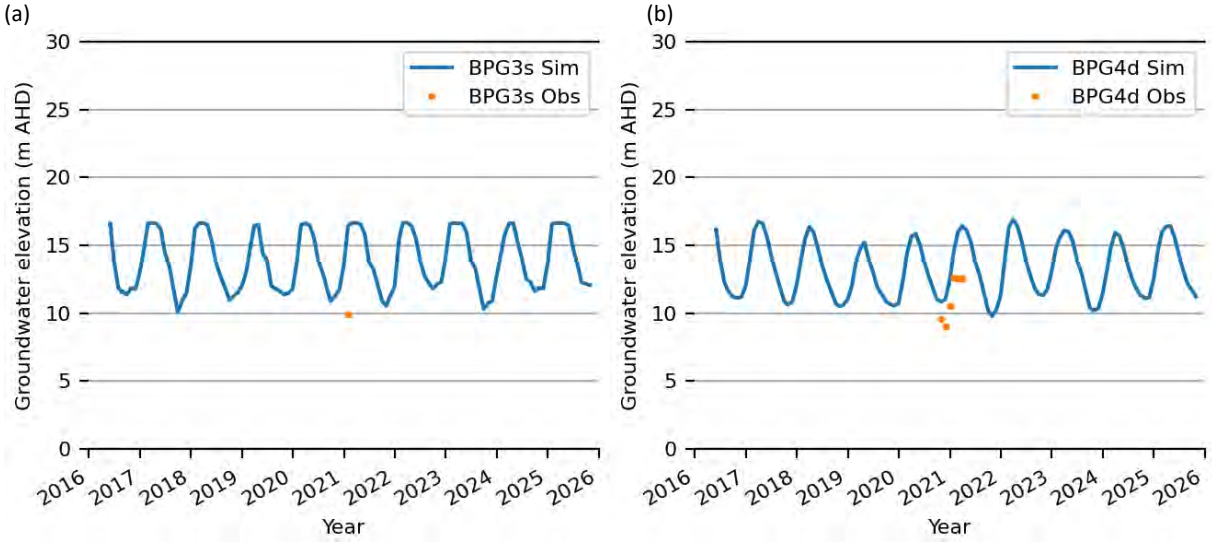


Figure 5-11 Groundwater level response at existing Grants observation bores: (a) BPG3s and (b) BPG4d.

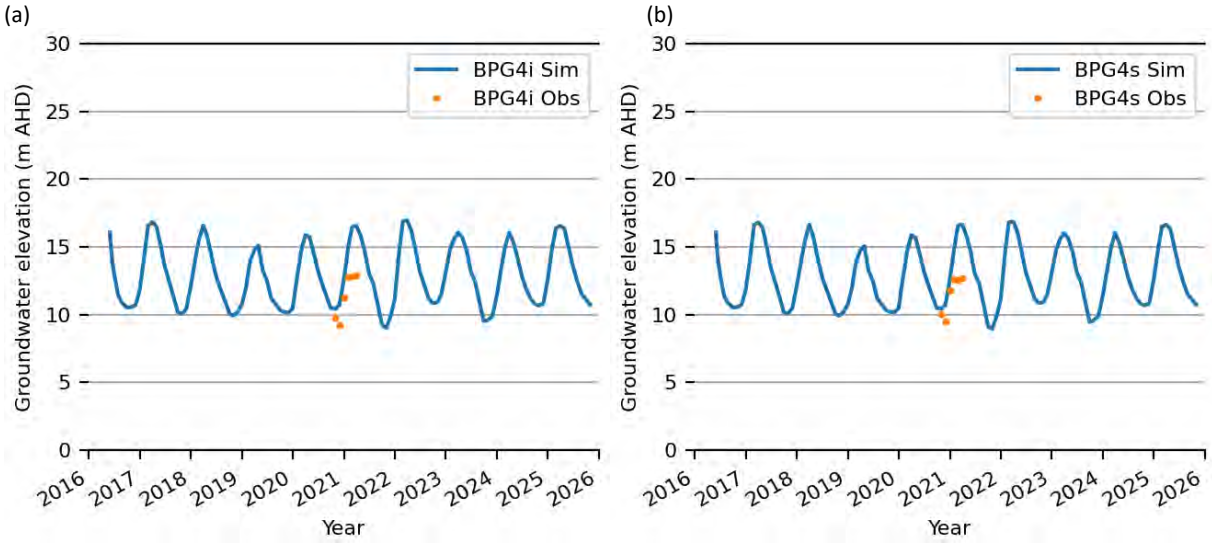


Figure 5-12 Groundwater level response at existing Grants observation bores: (a) BPG4i and (b) BPG4s.

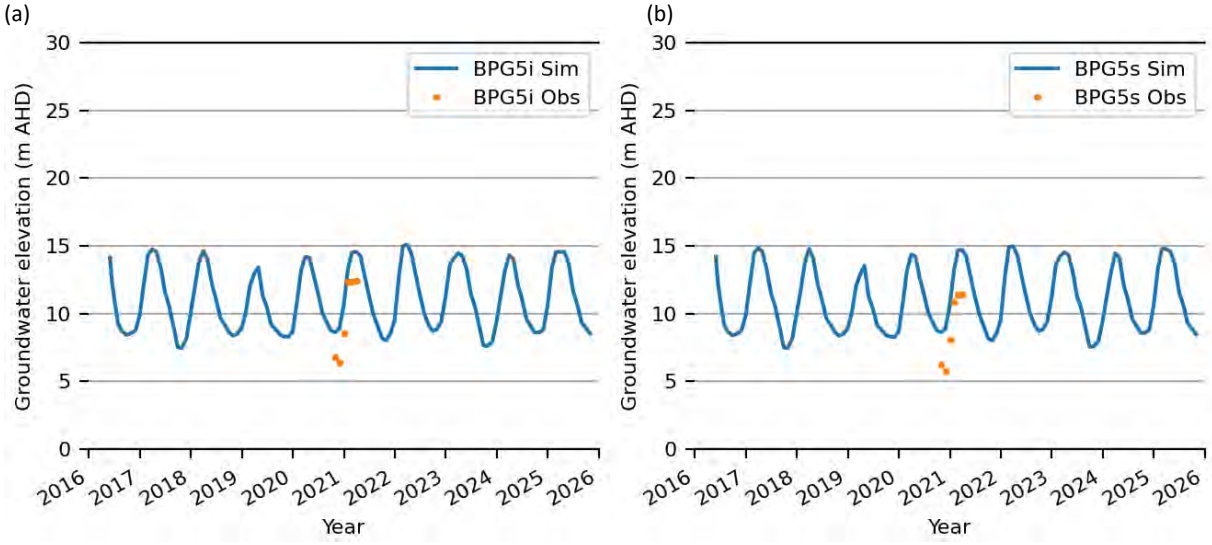


Figure 5-13 Groundwater level response at existing Grants observation bores: (a) BPG5i and (b) BPG4d.

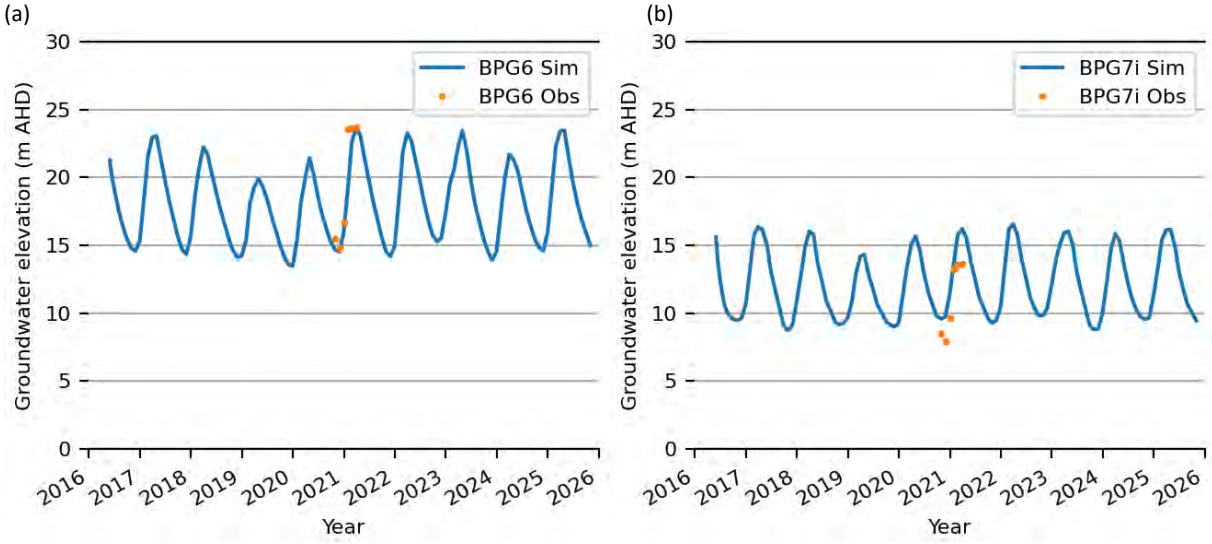


Figure 5-14 Groundwater level response at existing Grants observation bores: (a) BPG6 and (b) BPG7i.

The modelled and measured heads are also presented as a scatter plot in Figure 5-15. Points below the line indicate the model is underestimating the observed value, whereas points above the line indicate the model is overestimating the groundwater levels and RMS values are consistent with those reported in previous studies (Section 5.4.4). The scatter plot is distributed along the 1:1 fit and point are reasonably well distributed either side of the line. The results indicate a slight systemic bias, with groundwater level highs tending to be slightly underestimated and lower groundwater levels being overestimated.

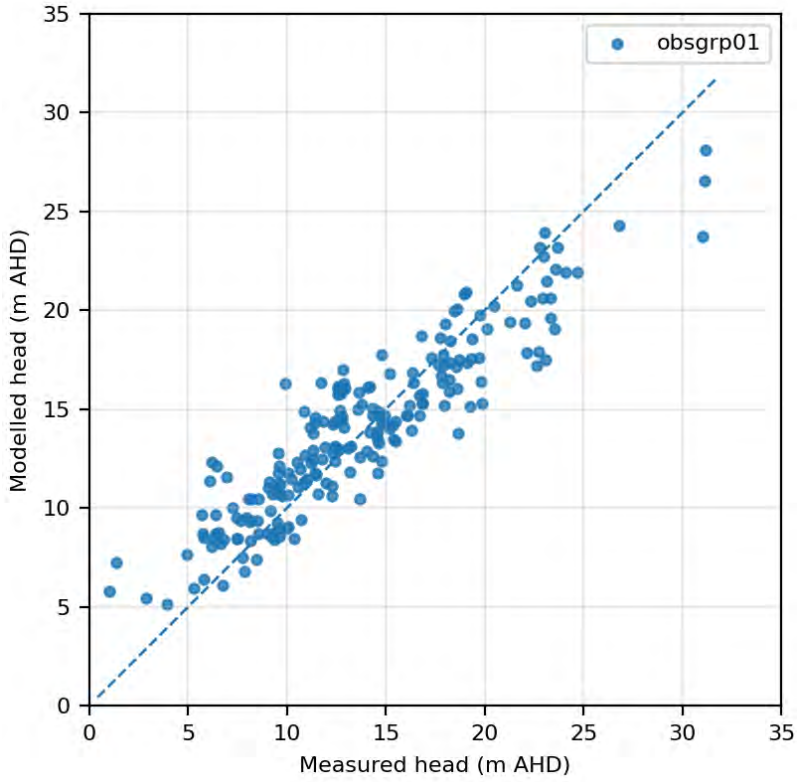


Figure 5-15 Scatter plot of modelled vs measured heads. The point colour indicates the magnitude of the residuals (i.e. the absolute difference between measured and modelled heads).

5.4.4. Quantitative performance

At the conclusion of the parameter estimation process, the final root mean square (RMS) error was 2.5 m. The maximum observed head was 31.2 m and the minimum observed head was 1.0 m.

The observed head range was therefore 30.2 m, resulting in a scaled root mean square (SRMS) error of 8.2%, which is slightly above the nominal target SRMS of 5%. The SRMS value is considered acceptable given that groundwater levels are dependent on SRTM-derived ground elevations (error <15m), which can contain considerable uncertainty, particularly along drainage inverts that influence end-of-dry-season minimum groundwater levels.

Statistical measures describing the goodness of fit between observed and modelled groundwater levels are presented in Table 5-5.

Table 5-5 Analysis of residuals using final estimated parameters.

METRIC	ALL OBS.
Number of residuals with non-zero weight	212
Mean value of non-zero weighted residuals	0.08
Maximum weighted residual	6.2
Minimum weighted residual	3.6
Standard variance of weighted residuals	2.8 m
Standard error of weighted residuals (RMS)	2.49 m
Scaled standard error (SRMS)	8.2 %

6 Lei mine forecast model results

This section investigates the groundwater impacts of the Lei box cut and underground workings (decline and stopes). Impacts are assessed over the Life of Mine (LoM) and during the post-closure period associated with recovery of groundwater levels at the Lei underground mine. The components considered were:

- Lei Life of Mine, 6 years
- Lei post-closure, 14 years

6.1. Lei mine Life of Mine forecast

The Lei LoM forecast scenario was developed to assess the effects of the proposed Lei box cut and underground workings development on groundwater flow dynamics in the surrounding area, particularly groundwater interaction with the Charlotte River. The following assumptions were adopted for the predictive model runs:

- All model parameters were derived from the calibrated model.
- Passive groundwater dewatering via sumps, with no groundwater dewatering from production bores.
- The model was run for a forecast period of 6 years LoM and 14 years post-closure.
- Initial conditions were taken from the final hydraulic heads of the calibrated model.
- During the post-closure period, the storage parameters for elements representing the Lei decline and stopes were increased to reflect the mine void volume, assuming no backfill.
- The time series climatic inputs from the period 1900 – 2000 were repeated to obtain the time series used to calculated recharge for the forecast model.

Groundwater responses predicted for the Lei Project are relatively localised and primarily confined to the vicinity of the proposed underground mine. Drawdown decreases rapidly with distance from the excavations due to the relatively low hydraulic conductivity of the fractured Burrell Creek Formation and the limited duration of mining. Model results indicate that groundwater levels recover progressively following closure, with no long-term regional groundwater depression predicted. The following sections present the detailed groundwater level, drawdown and inflow predictions that support these conclusions.

6.2. Groundwater levels Lei LoM and post-closure

The groundwater level response for bores installed around the Lei project for the 6-year LoM period and an additional 14-year post-closure period ensuring groundwater levels had fully recovered following mine closure and rehabilitation. Groundwater levels are also presented for the monitoring bores at BP33 project and the Grants project for comparison to the cumulative results presented in Section 0.

6.2.1. Lei groundwater levels

The forecast groundwater levels in the observation bores around the Lei box cut, decline and underground workings are presented in Figure 6-2 through Figure 6-4. The locations of the observation bores associated with the Lei underground mine are presented in Figure 6-1.

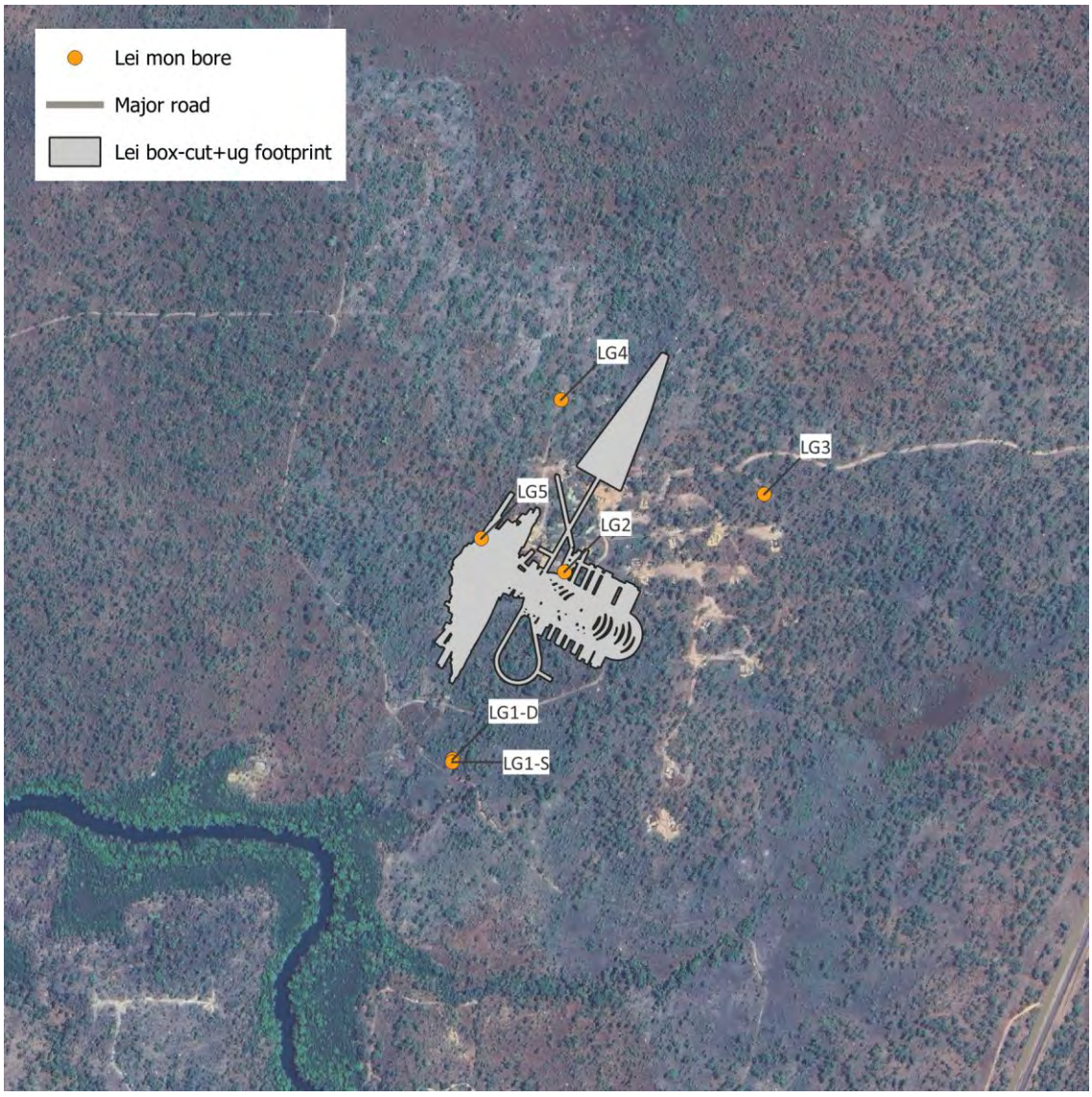


Figure 6-1 Locations of observation bores associated with the proposed Lei underground mine.

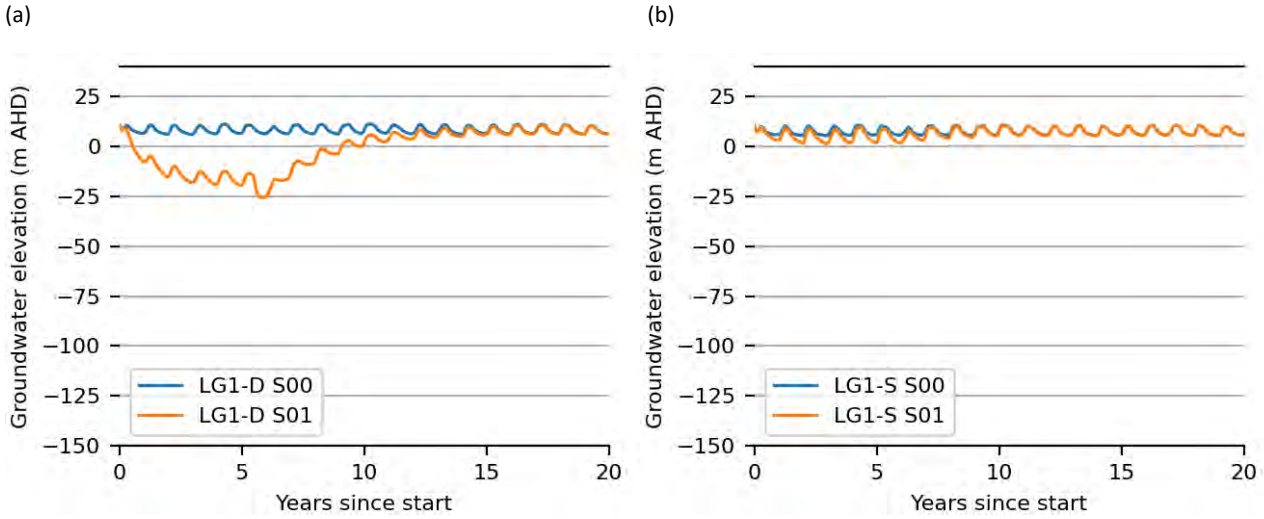


Figure 6-2 Groundwater level response during Lei LoM and 168 months post-closure at existing Lei observation bores a) LG1-D and b) LG1-S.

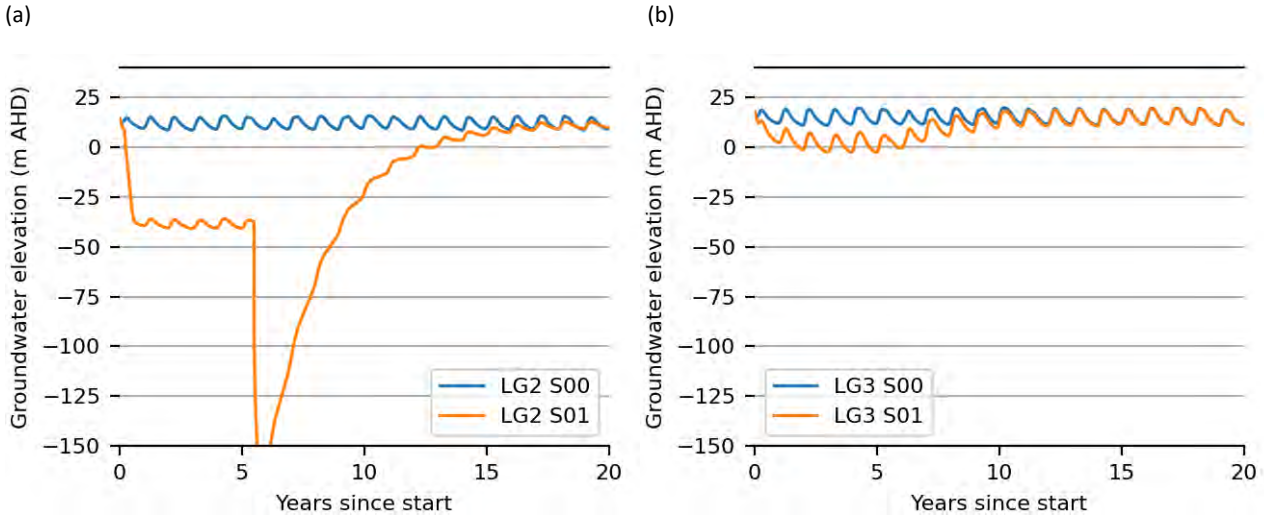


Figure 6-3 Groundwater level response during Lei LoM and 168 months post-closure at existing Lei observation bores a) LG2 and b) LG3.

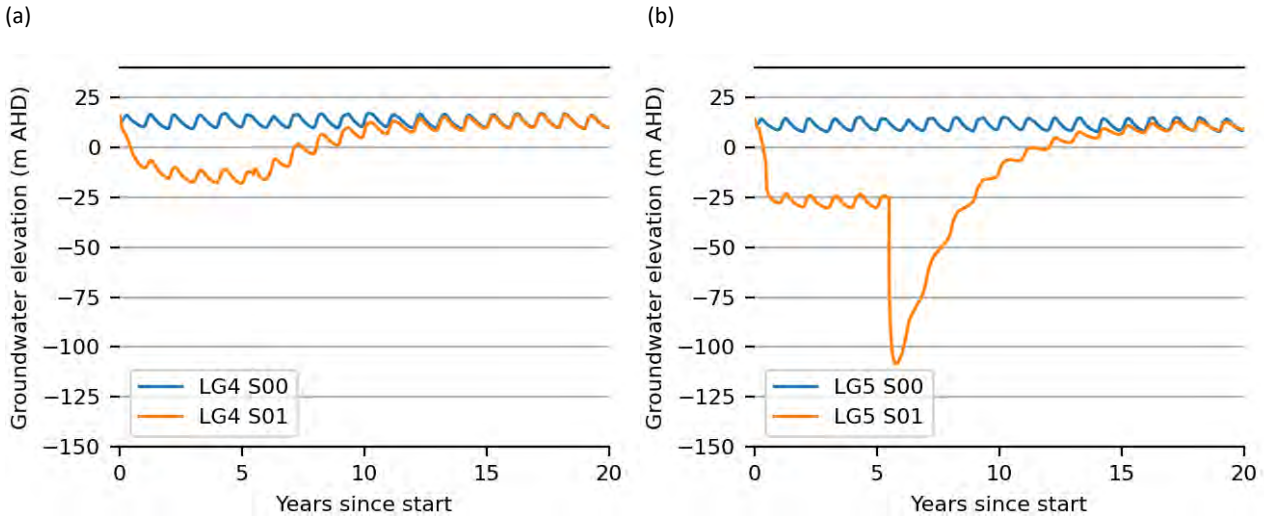


Figure 6-4 Groundwater level response during Lei LoM and 168 months post-closure at existing Lei observation bores a) LG4 and b) LG5.

6.2.2. BP33 groundwater levels

The Lei LoM groundwater levels in the observation bores around the BP33 box cut, decline and underground workings are presented in Figure 6-6 through Figure 6-12. The locations of the observation bores around BP33 are presented in Figure 6-5.



Figure 6-5 Locations of observation bores associated with the BP33 underground mine.

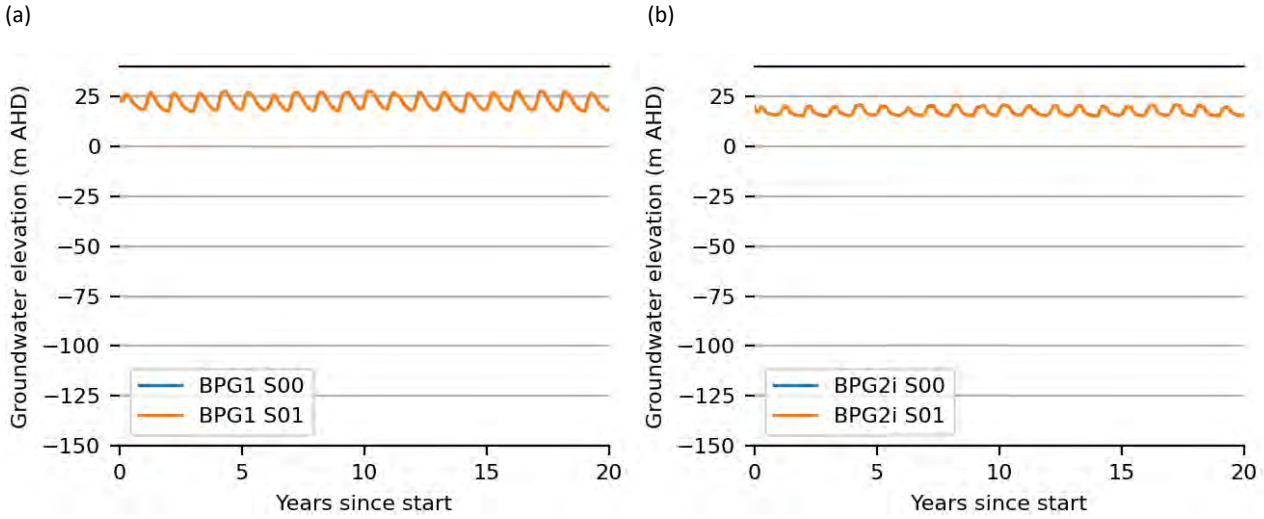


Figure 6-6 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG1 and b) BPG2i.

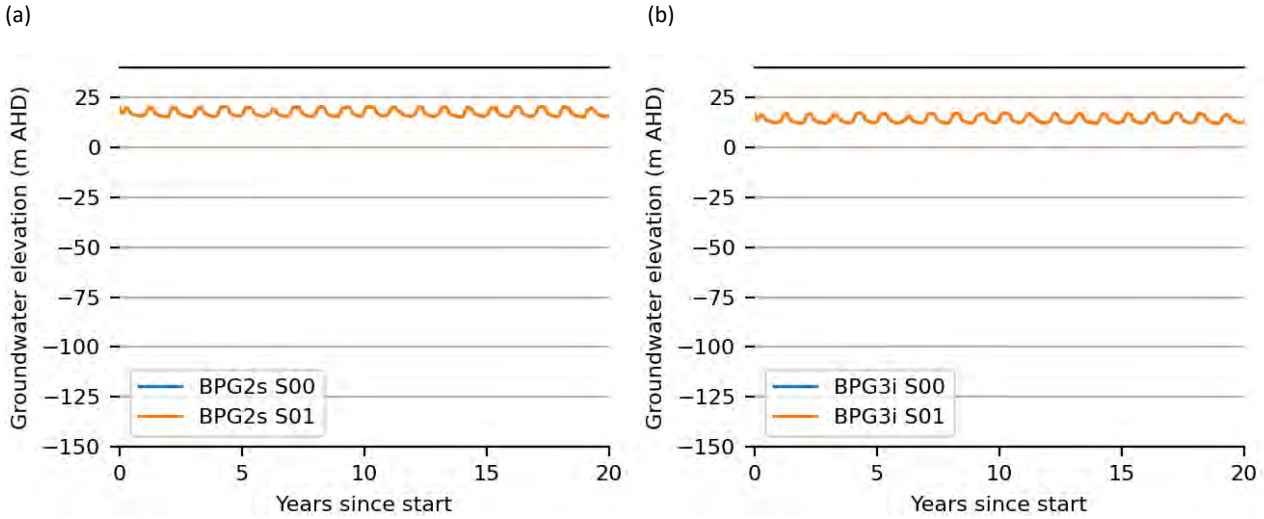


Figure 6-7 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG2s and b) BPG3i.

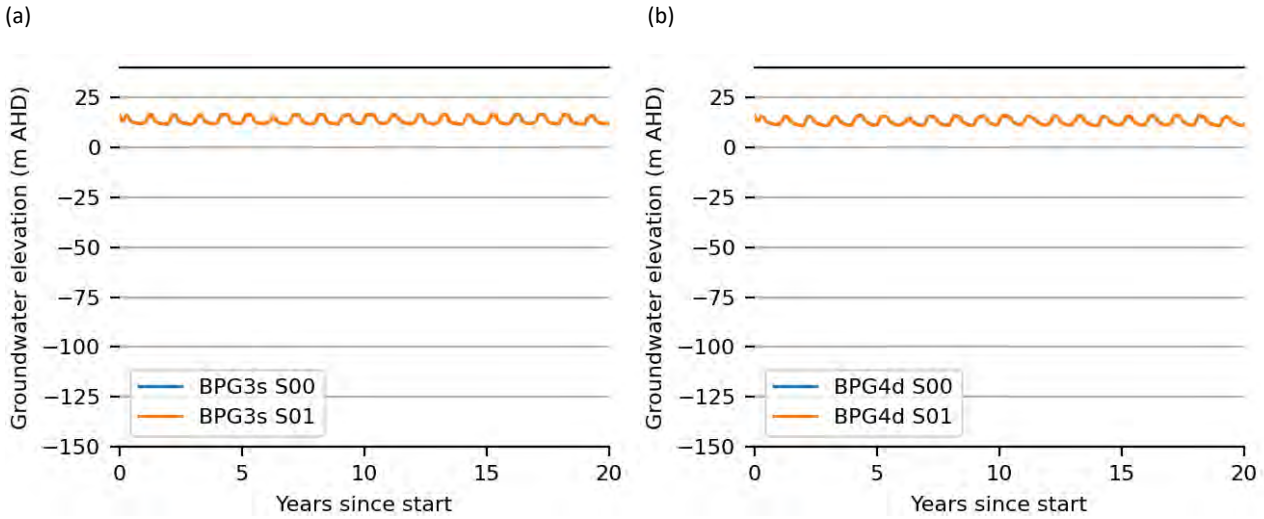


Figure 6-8 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG3s and b) BPG4d.

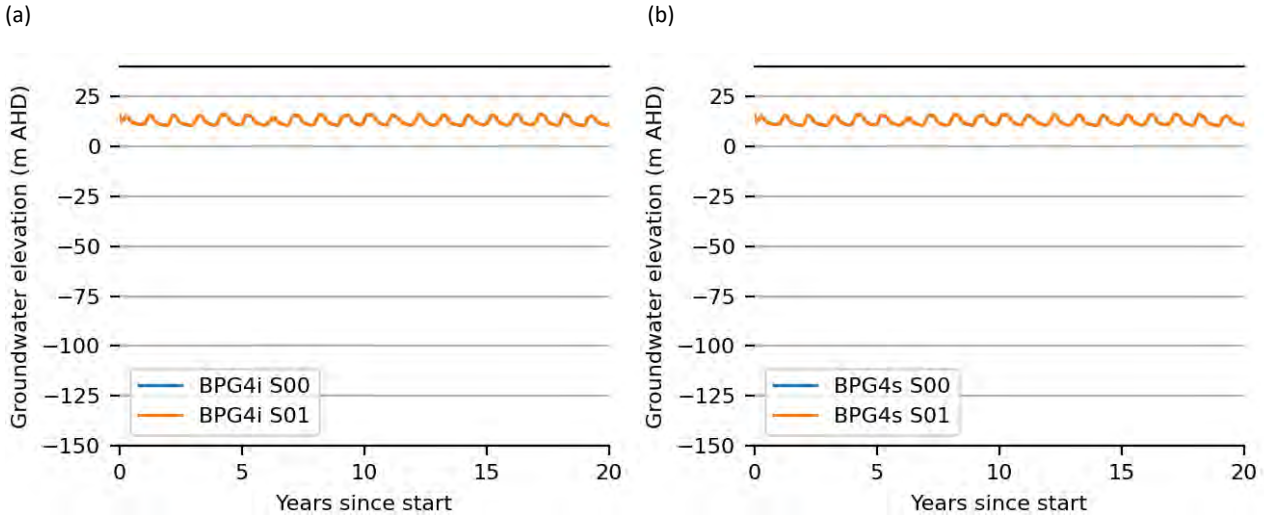


Figure 6-9 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG4i and b) BPG4s.

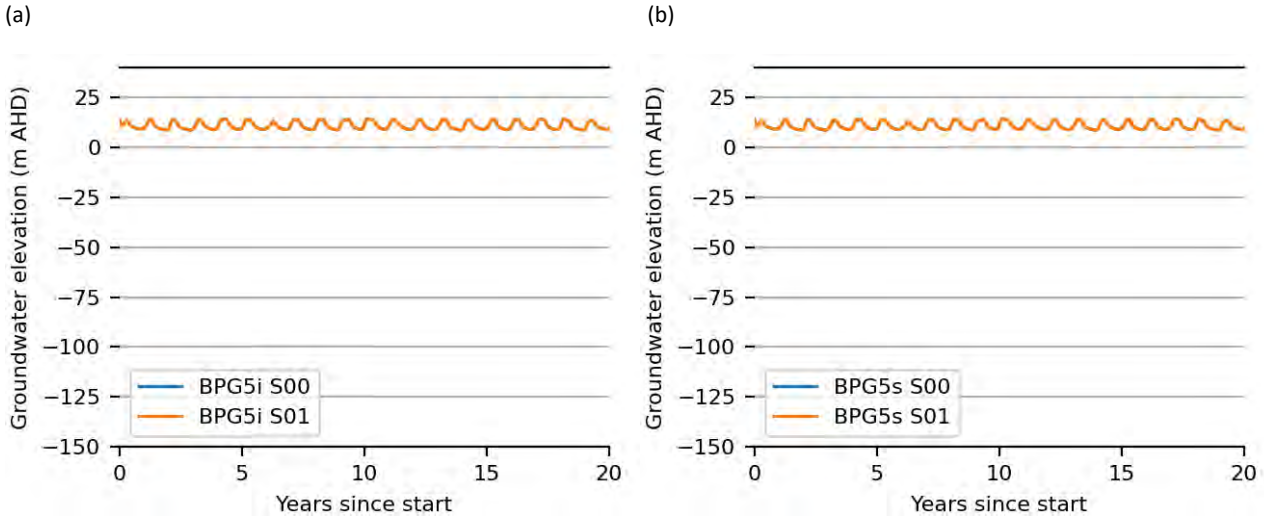


Figure 6-10 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG5i and b) BPG5s.

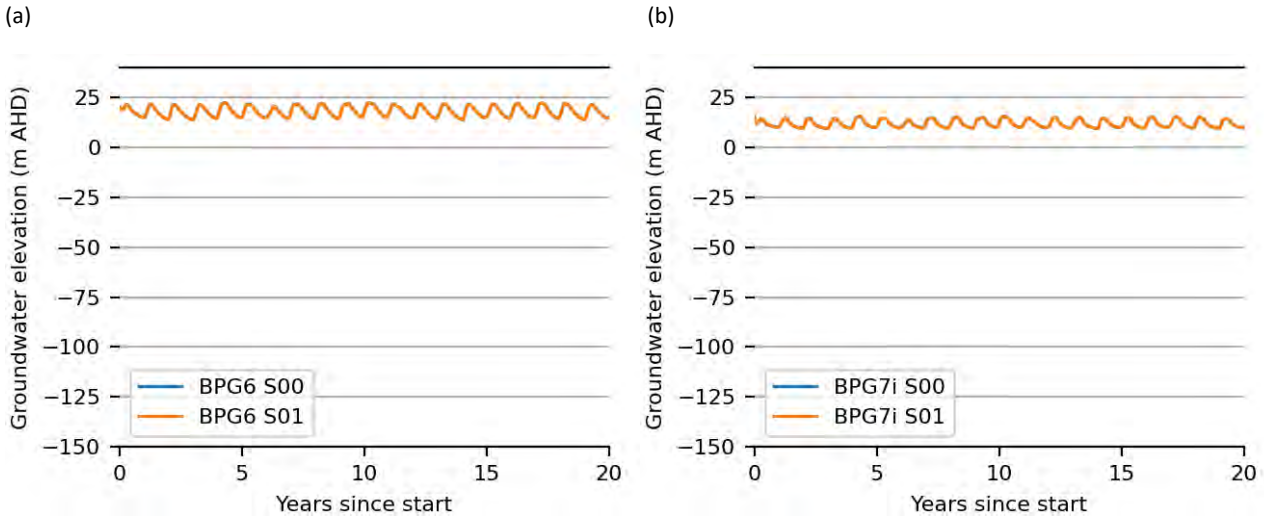


Figure 6-11 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG6 and b) BPG7i.

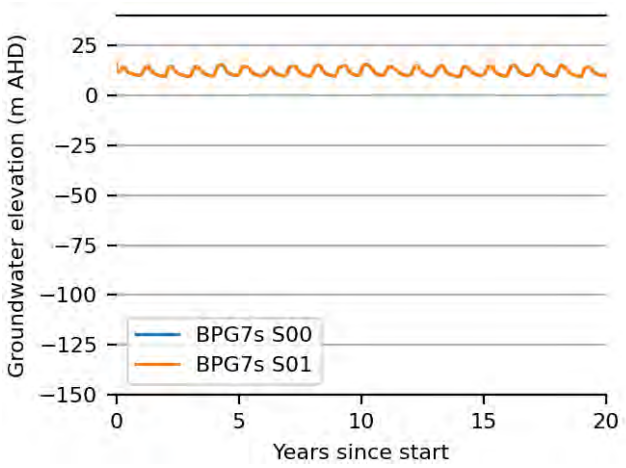


Figure 6-12 Groundwater level response during Lei LoM and 168 months post-closure at existing BP33 observation bores a) BPG7s.

6.2.3. Grants Pit groundwater levels

The Lei LoM groundwater levels in the observation bores around the GLP pit are presented in Figure 6-14 through Figure 6-18. The locations of the observation bores around the GLP pit are presented in Figure 6-13.

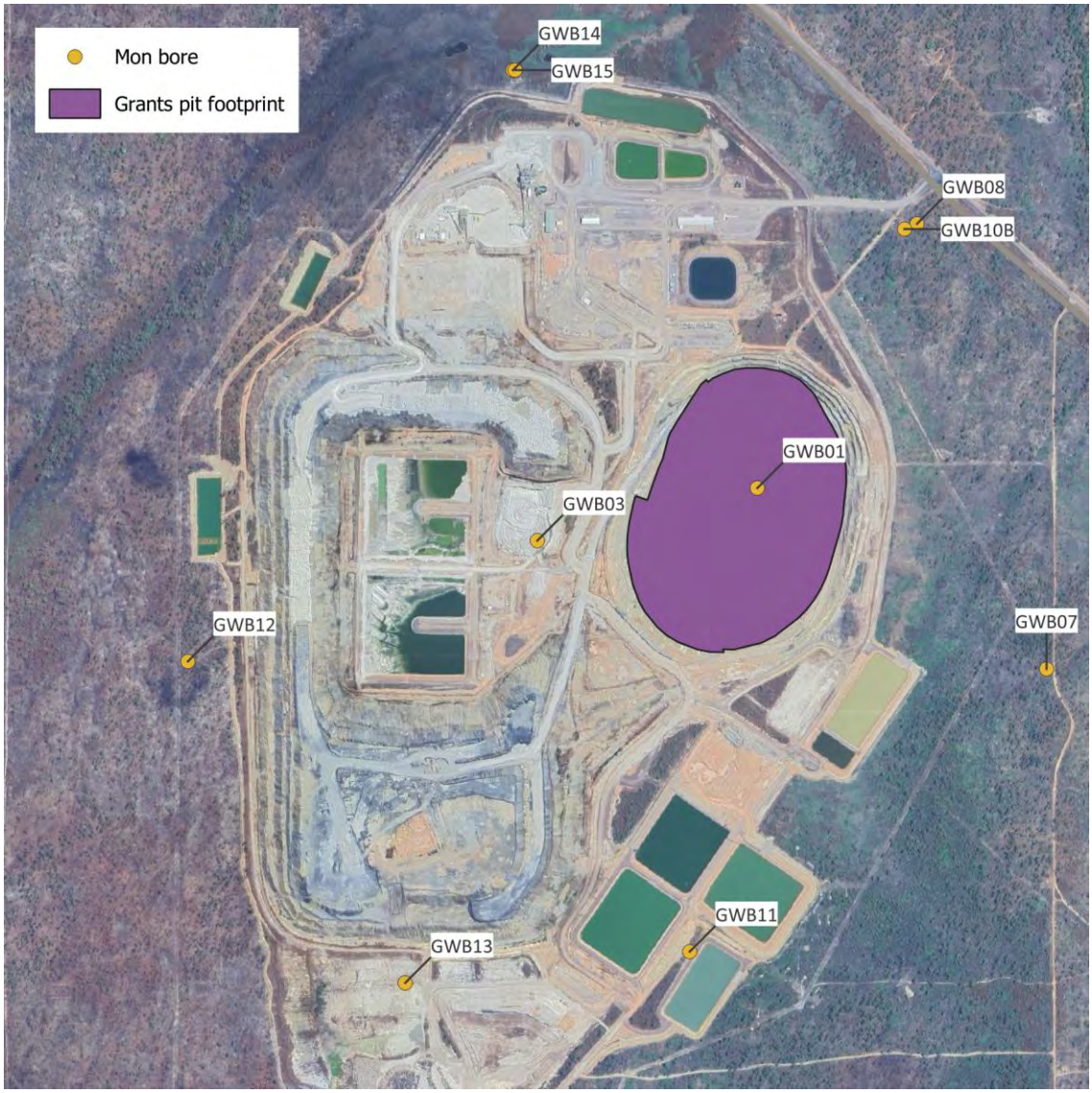


Figure 6-13 Locations of observation bores associated with the Grants Pit.

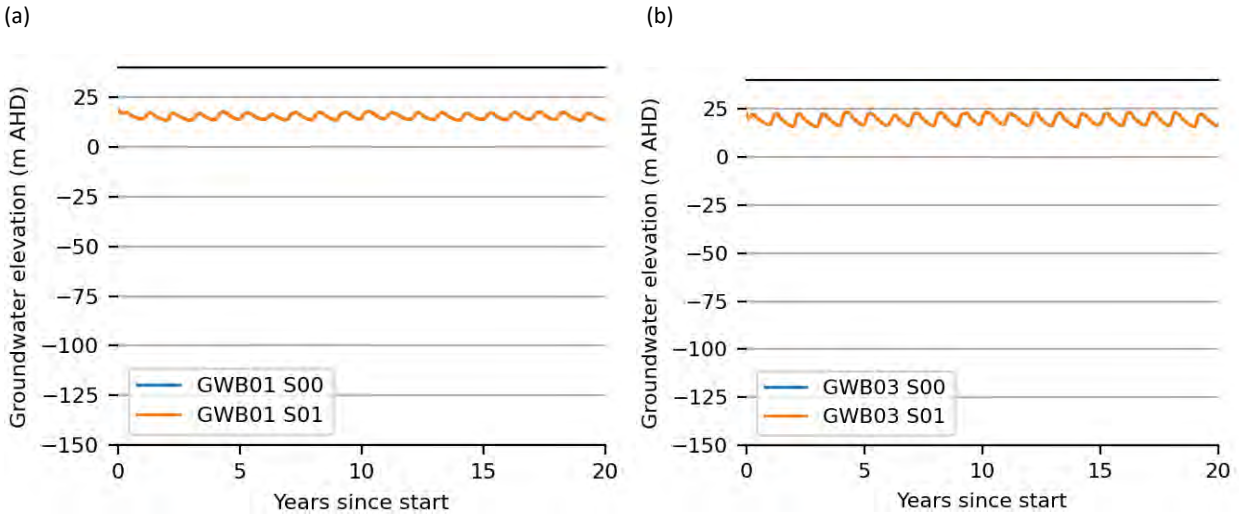


Figure 6-14 Groundwater level response during Lei LoM and 168 months post-closure at existing Grants Pit observation bores a) GWB01 and b) GWB03.

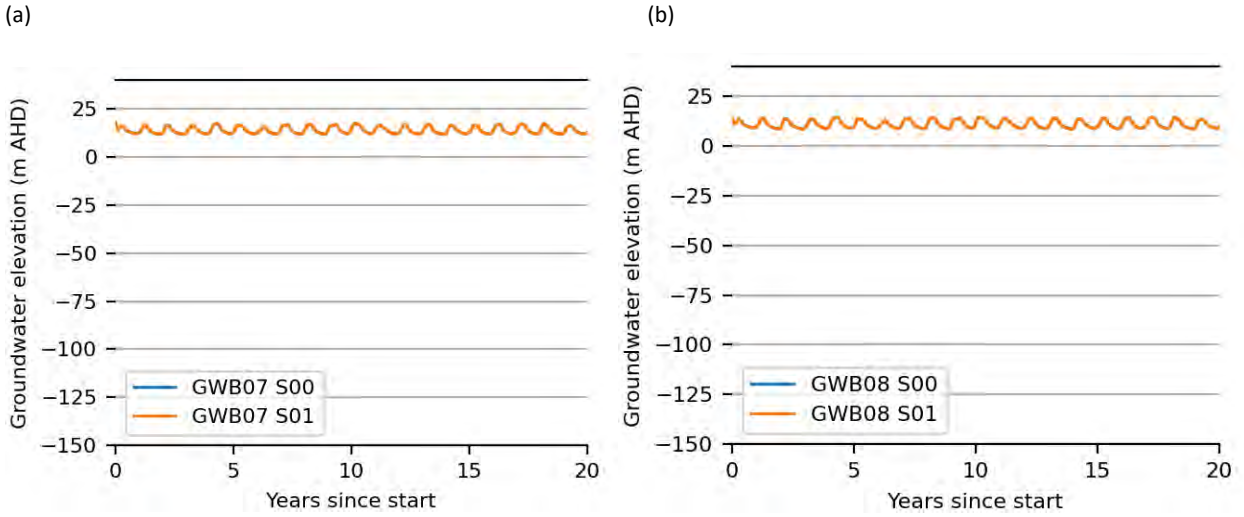


Figure 6-15 Groundwater level response during Lei LoM and 168 months post-closure at existing Grants Pit observation bores a) GWB07 and b) GWB08.

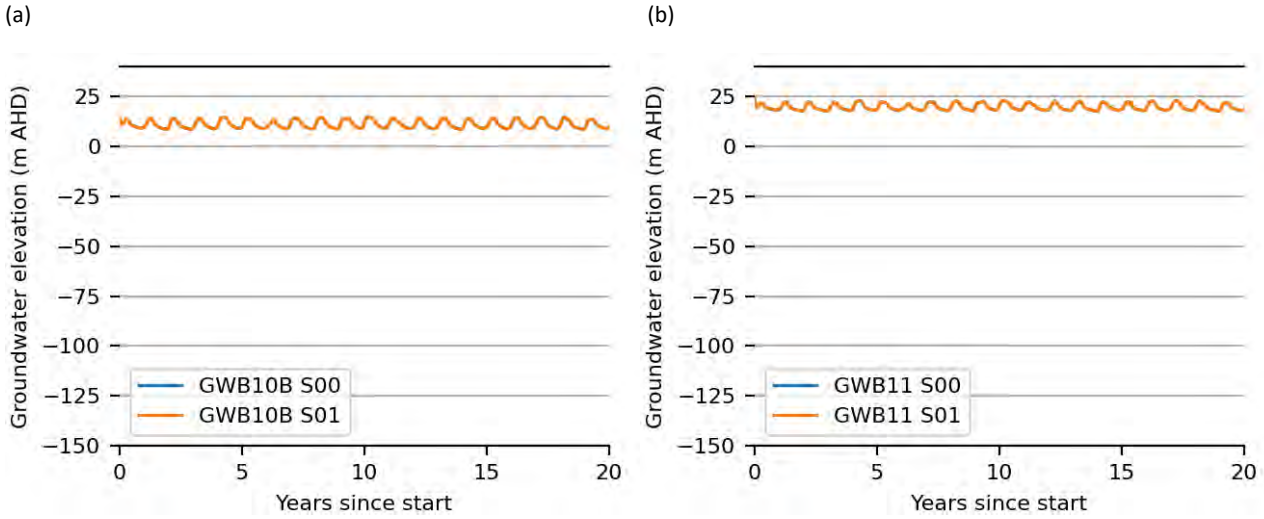


Figure 6-16 Groundwater level response during Lei LoM and 168 months post-closure at existing Grants Pit observation bores a) GWB10b and b) GWB11.

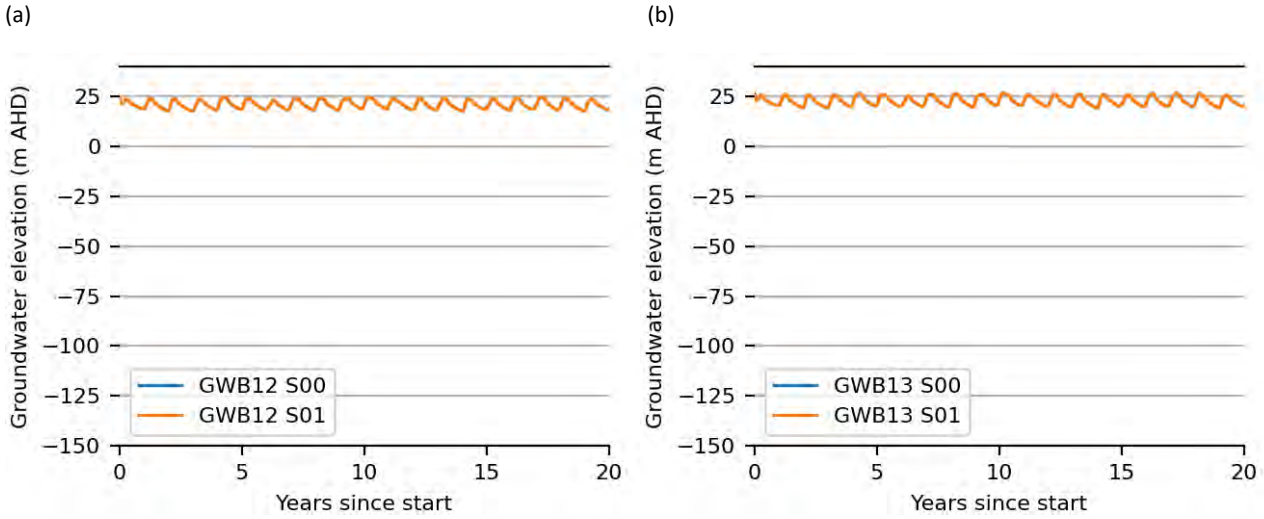


Figure 6-17 Groundwater level response during Lei LoM and 168 months post-closure at existing Grants Pit observation bores a) GWB12 and b) GWB13.

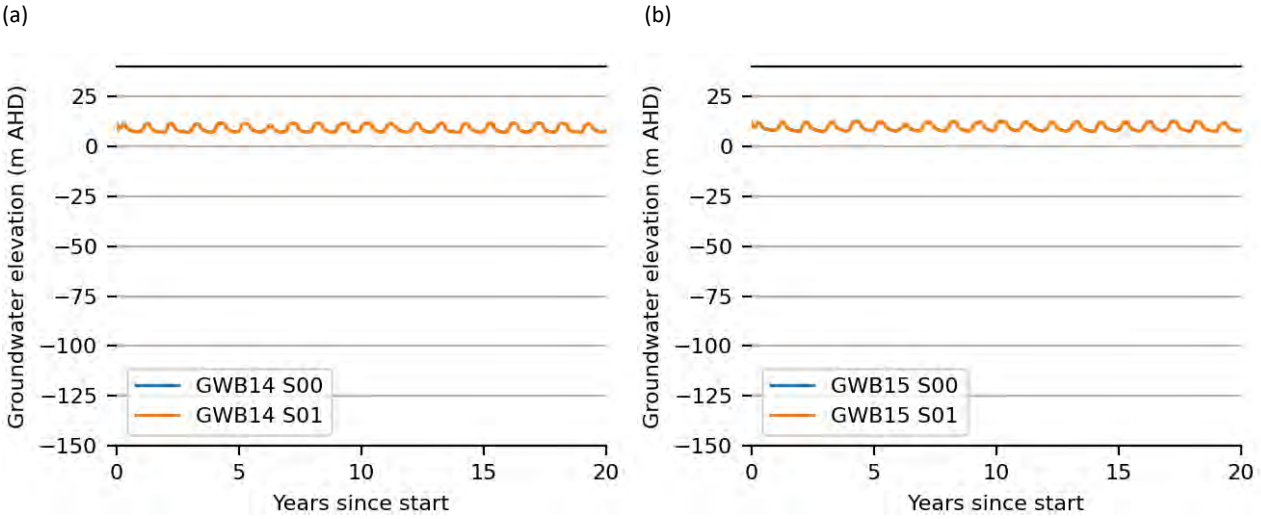


Figure 6-18 Groundwater level response during Lei LoM and 168 months post-closure at existing Grants Pit observation bores a) GWB14 and b) GWB15.

6.2.4. Preliminary groundwater-level trigger ranges at available Lei monitoring sites

Predicted groundwater levels and drawdown at the Lei monitoring bores provide reference values against which future groundwater monitoring can be compared during mine operations. The model results indicate the groundwater responses expected under the calibrated base-case scenario and may be used to support model verification and adaptive groundwater management.

Consistent with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012), the predicted effect of mining is principally assessed using drawdown, calculated as the difference between groundwater levels simulated under the no-mining base-case scenario and the corresponding mining scenario. Relative predictions of this type isolate the groundwater response attributable to mine dewatering and generally have lower predictive uncertainty than absolute groundwater-level forecasts because uncertainties associated with the conceptual model and calibration that are common to both simulations are partially cancelled. Absolute groundwater-level predictions are also presented to support operational monitoring and the development of preliminary thresholds.

Table 6-1 presents the minimum observed groundwater level for each monitoring year and bore. The range between the lowest and highest annual groundwater level minima was adopted as a preliminary representation of interannual variability in dry-season groundwater levels. This approach assumes that the minimum measurements in each year were collected at broadly comparable stages of the seasonal groundwater cycle.

The baseline ranges should be interpreted cautiously because the available monitoring record is short and the sampling frequency may not have captured the actual annual minimum. In particular, only four measurements are available for LG1-D. The 2023 values are generally based on a single December observation, while the 2025 record extends only to September. The baseline ranges are therefore preliminary and should be updated following at least one additional wet–dry seasonal cycle and progressively refined as operational groundwater-level and mine-discharge data become available.

Table 6-2 presents the maximum annual drawdown predicted at each monitoring bore during the operational phase. Preliminary operational groundwater-level ranges were derived by subtracting the predicted maximum annual drawdown from the observed baseline annual minimum range:

Preliminary operational range = baseline annual minimum range − predicted maximum annual drawdown

The resulting values are presented in Table 6-3. They provide preliminary ranges for groundwater levels that could occur if the maximum predicted drawdown coincided with groundwater conditions comparable to the observed annual minima. The calculation does not account for the timing of seasonal groundwater fluctuations relative to the timing of maximum simulated drawdown. Consequently, the derived lower values may be lower than the minimum groundwater levels directly simulated by the transient model.

The lower value of each range represents the preliminary investigation threshold, calculated using the lowest observed annual minimum and the maximum predicted drawdown. The upper value represents the corresponding groundwater level calculated using the highest observed annual minimum. Groundwater levels above the upper value indicate groundwater responses less severe than predicted by the conservative screening assessment and would not, by themselves, warrant further investigation.

A single measurement below the preliminary investigation threshold should initiate verification of the measurement and review of rainfall, seasonal groundwater conditions, nearby monitoring results and mine-discharge rates. It should not, by itself, be interpreted as evidence of an unacceptable impact. Sustained or progressively increasing departures below the threshold, particularly where observed across multiple bores and not explained by climatic variability or operational conditions, should trigger review of model performance and the need for further investigation or adaptive management.

This approach is consistent with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012), which recommend that model predictions be progressively verified and refined as additional monitoring data become available during project implementation.

Table 6-1 Annual minimum observed groundwater levels.

Site	Available monitoring period	Number of observations	2023 minimum (mAHD)	2024 minimum (mAHD)	2025 minimum (mAHD)	Baseline annual minimum range (mAHD)
LG1-D	December 2023 to September 2025	4	5.26	5.78	6.73	5.26 to 6.73
LG1-S	December 2023 to September 2025	6	2.85	1.02	3.94	1.02 to 3.94
LG2	December 2023 to September 2025	8	9.27	7.66	9.18	7.66 to 9.27
LG3	December 2023 to September 2025	7	9.54	6.95	9.57	6.95 to 9.57
LG4	December 2023 to September 2025	8	6.37	7.26	9.10	6.37 to 9.10
LG5	December 2023 to September 2025	8	6.19	5.76	9.49	5.76 to 9.49

Note: The baseline annual minimum range represents the range between the minimum groundwater levels observed in each monitoring year. Due to the frequency and timing of monitoring, the reported values may not coincide with the actual annual groundwater-level minima.

Table 6-2 Maximum annual modelled drawdown at available Lei monitoring sites.

Site	Year 1 (m)	Year 2 (m)	Year 3 (m)	Year 4 (m)	Year 5 (m)
LG1-D	14.4	21.5	24.4	25.5	26.1
LG1-S	2.8	3.8	4.2	4.1	3.9
LG2	49.0	51.3	51.7	51.9	52.1
LG3	9.9	12.4	13.7	14.6	15.0
LG4	20.7	25.1	27.0	28.7	29.4
LG5	36.9	38.3	39.2	39.7	39.9

Table 6-3 Preliminary operational groundwater-level ranges at available Lei monitoring sites.

Site	Baseline range (mAHD)	Year 1 (mAHD)	Year 2 (mAHD)	Year 3 (mAHD)	Year 4 (mAHD)	Year 5 (mAHD)
LG1-D	5.26 to 6.73	−9.14 to −7.67	−16.24 to −14.77	−19.14 to −17.67	−20.24 to −18.77	−20.84 to −19.37
LG1-S	1.02 to 3.94	−1.78 to 1.14	−2.78 to 0.14	−3.18 to −0.26	−3.08 to −0.16	−2.88 to 0.04
LG2	7.66 to 9.27	−41.34 to −39.73	−43.64 to −42.03	−44.04 to −42.43	−44.24 to −42.63	−44.44 to −42.83
LG3	6.95 to 9.57	−2.95 to −0.33	−5.45 to −2.83	−6.75 to −4.13	−7.65 to −5.03	−8.05 to −5.43
LG4	6.37 to 9.10	−14.33 to −11.60	−18.73 to −16.00	−20.63 to −17.90	−22.33 to −19.60	−23.03 to −20.30
LG5	5.76 to 9.49	−31.14 to −27.41	−32.54 to −28.81	−33.44 to −29.71	−33.94 to −30.21	−34.14 to −30.41

Note: The lower value in each range is the preliminary threshold. The ranges are derived by subtracting the maximum predicted annual drawdown from the observed baseline annual minimum range.

6.2.5. Lei groundwater drawdown contours

Consistent with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012), the primary measure used to assess the groundwater effects of mining is modelled groundwater drawdown, defined as the difference between groundwater levels simulated under the no-mining (s00) and mining (s01) scenarios. Assessing the relative change in groundwater levels isolates the effects attributable to mine dewatering and generally provides a more robust measure of mining impacts than comparison of absolute groundwater levels alone, because uncertainties associated with the conceptual hydrogeological model and model calibration that are common to both simulations are partially cancelled. Consequently, drawdown provides the principal basis for assessing the magnitude, spatial extent and duration of groundwater impacts.

The forecast drawdown magnitude and extent at Year 6 (end of underground mining), Year 10, and Year 15 at the Lei Project are presented in Figure 6-19, Figure 6-22a and Figure 6-22b respectively. Drawdown was calculated by subtracting heads under the mining scenario (s01) from heads under the natural scenario (s00).

The model predicts that the groundwater response remains localised around the proposed mine excavations. After six years of mining, the drawdown cone extends about 1 to 2 km beyond the mining lease boundary to the north, west and south, while approaching the lease boundary to the east. This drawdown is primarily associated with excavation of the box cut. The drawdown also extends below the areas identified with moderate potential for GDEs.

To the west, the 0.1, 0.2 and 0.5 m drawdown contours approach the upstream end of the tidal section of the Charlotte River and is likely to intersect the river; however, it is constrained by the specified head boundary conditions representing the river. However, in Slice 2, the drawdown does extend beneath the river (not shown here).

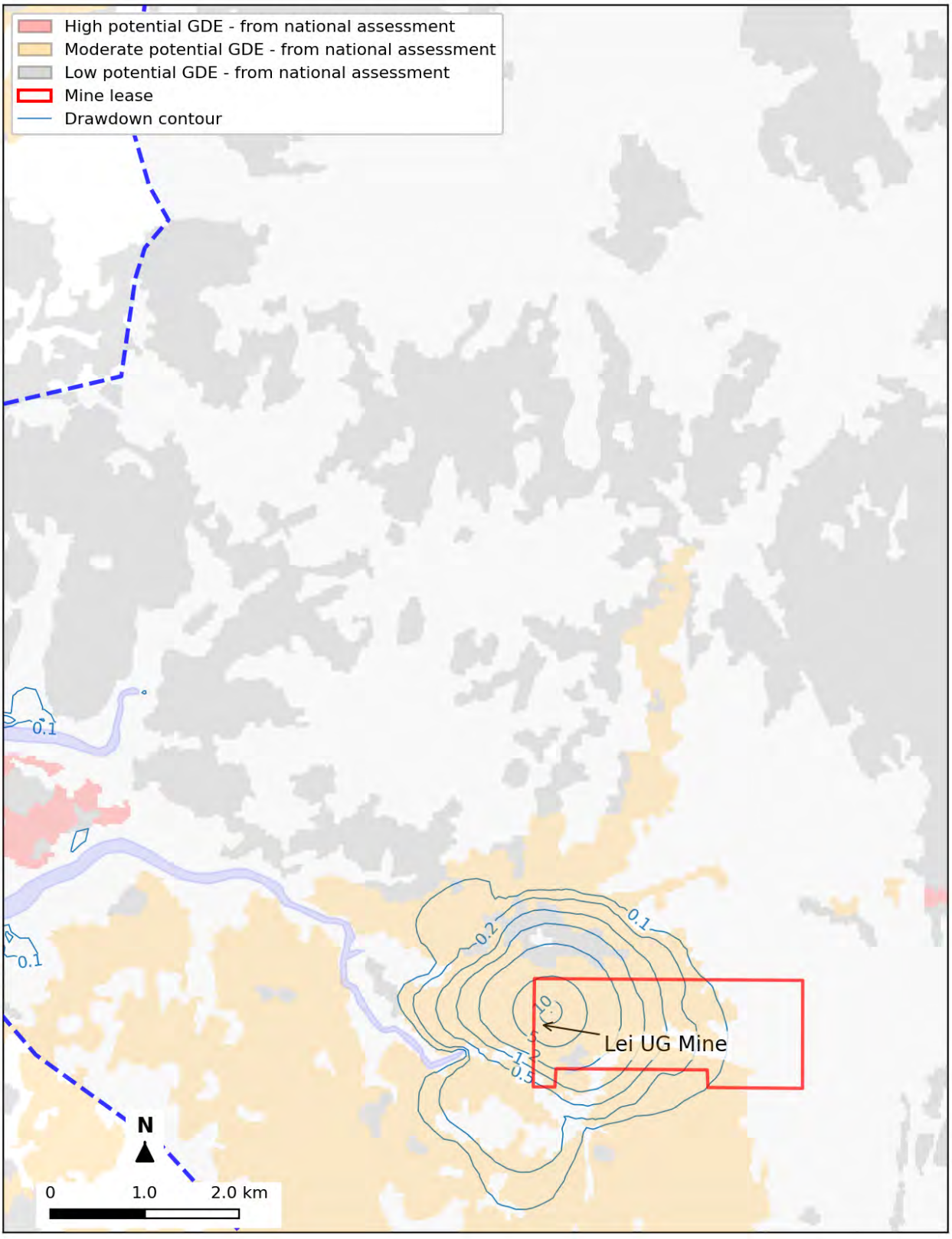


Figure 6-19 Forecast drawdown contours at the watertable (slice 1) after 6 years of mining at the Lei Project.

6.2.6. Life of Mine inflows

The Lei Project mine component groundwater inflows over the Life of Mine (LoM), expressed as ML/year, are presented for the box cut, decline, stopes, and total combined inflows in Figure

6-20a, Figure 6-20b, Figure 6-21a and Figure 6-21b respectively. The inflows are presented as annualised volumes consistent with the schedule for mine components described in Section 2.5.2. Total inflows expressed as ML/year for the different mine components, are presented in Table 6-4.

Inflows to these components of the Lei Project are briefly described below:

- Inflows to the Lei box cut increase from commencement of excavation and remain relatively constant at about 200 ML/year (~6-7 L/s). Lei box cut inflows, expressed as ML/year over the LoM, are presented in Figure 6-20a.
- Inflows to the Lei decline increase from commencement of excavation reaching a peak in Year 4 at about 270 ML/year (~8-9 L/s). Inflow decreases towards the end of mining. Lei decline inflows, expressed as ML/year over the LoM, are presented in Figure 6-20b.
- Inflows to the Lei stopes increase from commencement of mining and reach a peak in Year 5 at about 130 ML/year (~4 L/s). Lei stope inflows, expressed as ML/year over the LoM, are presented in Figure 6-21a.
- Combined inflows to the underground mine (decline and stopes) and the box cut increase from commencement of mining and reach a peak in Year 5 at about 610 ML/year (~19-20 L/s). Combined inflows to the underground mine components, expressed as ML/year over the LoM, are presented in Figure 6-21b.

Table 6-4 Lei Project annual Life of Mine inflows

Year	Lei box cut ML/year	Lei decline ML/year	Lei stopes ML/year	Lei UG mine (decline and stopes) ML/year	Combined box cut and UG mine ML/year
1	209	84	17	101	310
2	194	219	38	257	450
3	186	260	76	336	523
4	186	273	106	379	565
5	212	263	132	395	608
6	128	136	82	218	346

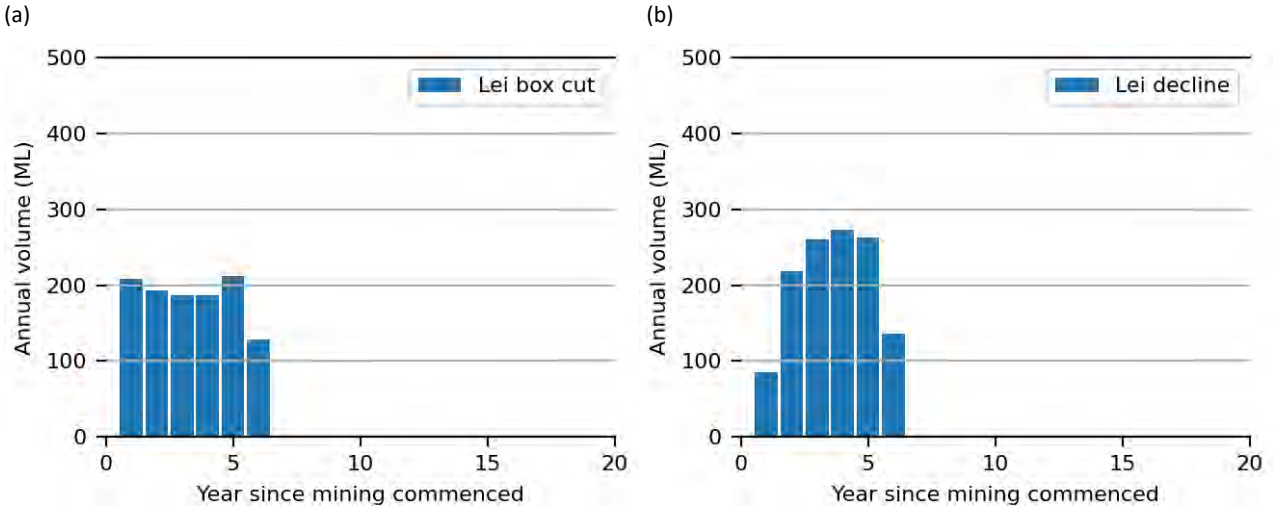


Figure 6-20 Life of Mine predicted inflows (ML/year) for: (a) Lei box cut and (b) Lei decline.

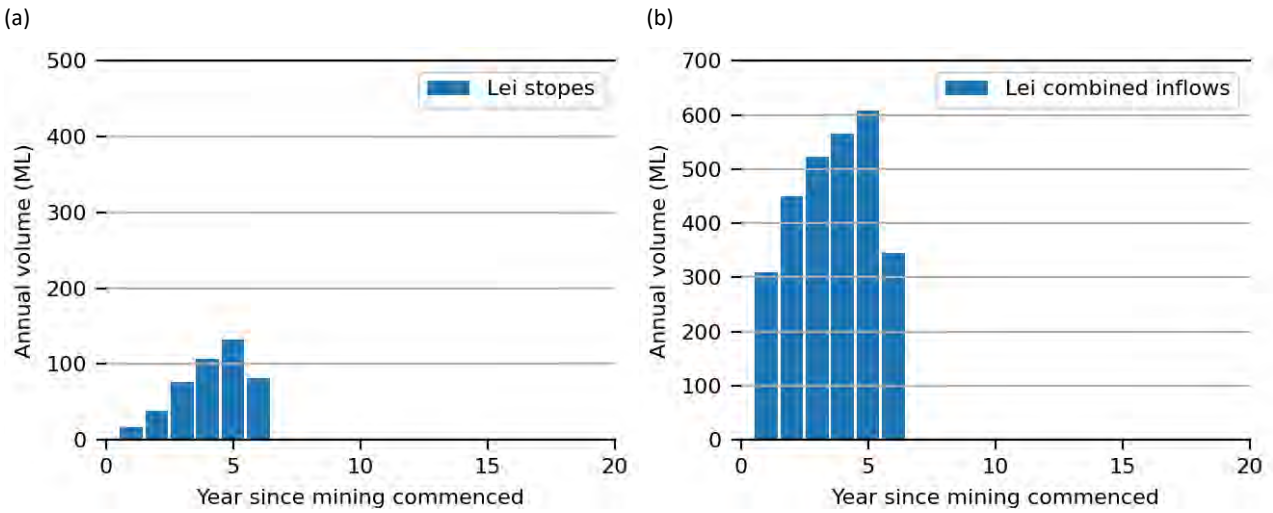


Figure 6-21 Life of Mine predicted inflows (ML/year) for: (a) Lei stopes and (b) Lei box cut, decline and stopes.

6.3. Lei Project post-closure forecast

The post-closure impacts scenario represents an extension of the LoM scenario with the following additional assumptions and settings:

- The model was extended for an additional 14 years immediately following the end of mining at the Lei Project, resulting in a total simulation period of 20 years from the commencement of mining.
- The seepage face boundary conditions associated with the underground mine were removed.
- The material properties of the underground mine are consistent with the mine void volume.

Due to the seasonal nature of recharge, a steady state representation of the system was not considered appropriate for assessing post-closure impacts. Instead, the transient model until an approximate dynamic equilibrium was achieved, characterised by stabilisation of groundwater levels (refer to Section 6.2.1). The post-closure period of 14 years was determined from preliminary modelling.

6.3.1. Groundwater level recovery

Post-closure groundwater level recovery at bores around the Lei Project is shown in Figure 6-2 through Figure 6-4. Groundwater levels recover to pre-mining conditions at all sites within about 15 years, except at LPG2. This bore, located above the decline, takes about 20 years to recover due to the time required to fill the underground mine void.

6.3.2. Groundwater drawdown contours

Post-closure drawdown contours after 4 years (Year 10) and 9 years (Year 15) of recovery are shown in Figure 6-22a and Figure 6-22b, respectively. These figures show the drawdown surface following 4 and 9 years of recovery after mine closure at the Lei Project. After 4 years of recovery, drawdown is largely confined to the mine lease, although it extends about 1 km to the north and west beyond the lease boundary. After 9 years, drawdown is fully contained within the mine lease, with residual drawdown greater than 0.1 m centred on the box cut. By Year 20 (14 years after closure), the watertable has fully recovered.

(a) (b)

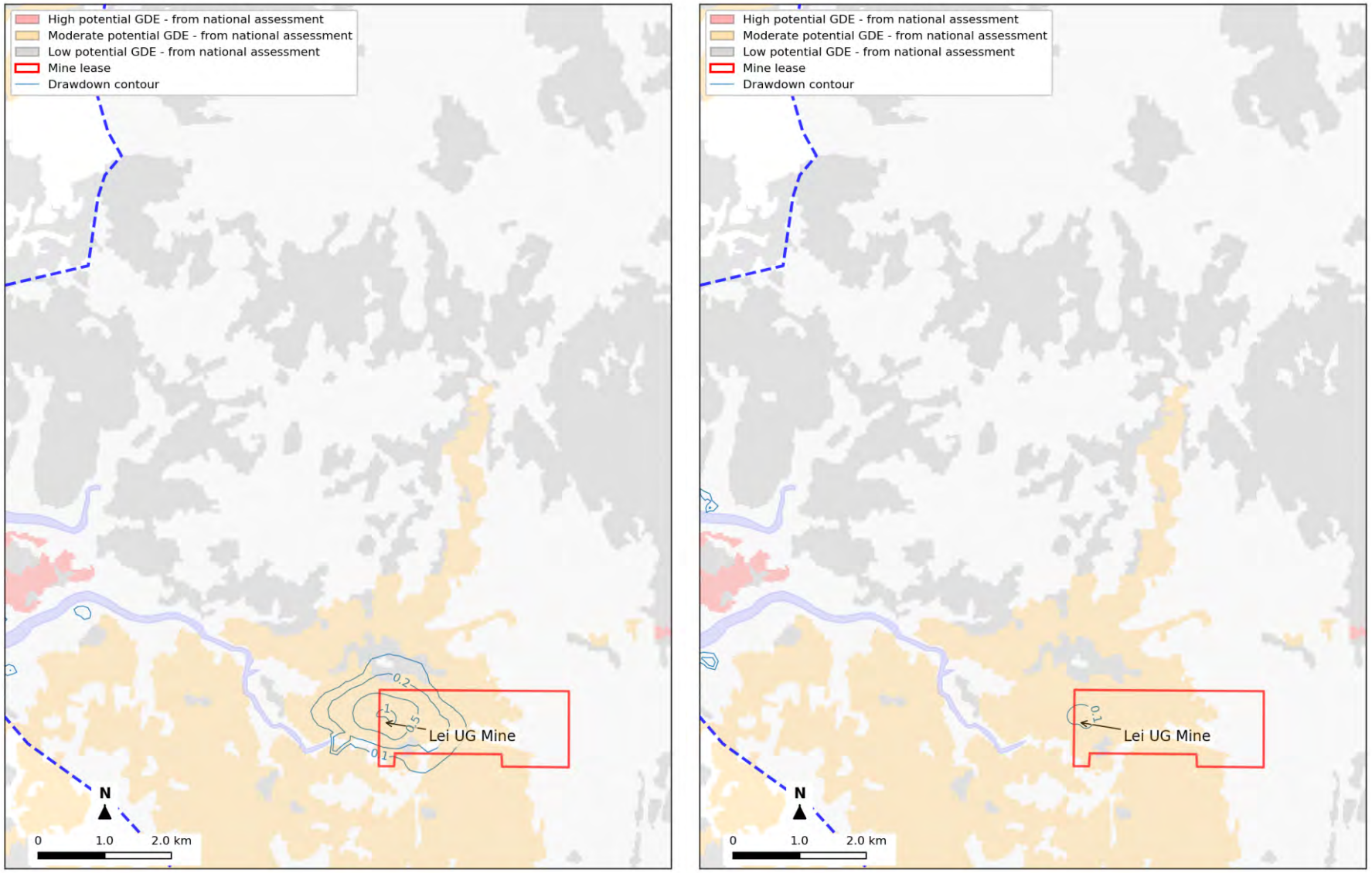


Figure 6-22 Lei Project forecast drawdown contours at the watertable following (a) 4 years of recovery, Year 10 from the start of mining and (b) 9 years of recovery, Year 15 from the start of mining.

6.4. Impacts to existing users and environmental receptors

Based on the forecast scenarios, groundwater flow modelling indicates that over the 20-year simulation period, impacts are limited to areas within about 2 km of the Lei underground mine footprint. Watertable drawdown is predicted to extend beyond the mining lease boundary toward the tidal section of the Charlotte River to the southwest of the Lei site. No impacts are predicted to existing groundwater users, the nearest of which is more than 13 km from the site.

The depth to groundwater supporting terrestrial GDEs within 2 km of the Lei Project are likely to be influenced by the underground dewatering activities. Due to the proximity of the saline surface water within the tidal portion / reach of the Charlotte River the drawdown of the watertable could result in saline water being induced inland where it may adversely affect GDEs, to assess this possibility, particle tracking was used to estimate the extent that water may be drawn into areas supporting GDEs.

Particle tracking was used in lieu of solute transport modelling to assess the potential for saline water from the tidal reach of the Charlotte River to migrate toward areas supporting GDEs. Solute transport modelling requires parameters such as effective porosity, dispersivity, and background salinity distributions, which are not currently available for the study area. In the absence of site-specific data, transport modelling would rely on assumed values and introduce significant uncertainty to the results. In addition, simulation of saline intrusion would require density-dependent flow and transport modelling, which adds considerable model complexity. Particle tracking provides a robust and computationally efficient method for identifying potential groundwater flow paths and hydraulic connectivity between the tidal reach and adjacent groundwater systems.

6.4.1. Particle tracking

Forward particle tracks (transient flow field) and streamlines (steady-state flow field) simulate the advective transport of solutes. They are generated by releasing multiple particles from defined seeding points, in this case the nodes beneath the tidal section of the Charolette River, into the groundwater flow field. The particles move along the hydraulic gradient until exiting the model at an outflowing boundary or enter a zone with negligible flow velocity.

In this way, forward particle tracks help visualise groundwater flow patterns and can be used to assess the fate of solutes leaching into the groundwater system.

Random-Walk Particle-Tracking (RWPT) solutions incorporate dispersive processes into the standard advective particle tracking. RWPT solutions are theoretically consistent with advection - dispersion equation solutions and have been used here to assess the likelihood of saline water from the tidal section of the Charolette River being induced into the box cut or underground mine excavations. The effective porosity parameters used in the RWPT analysis are presented in Table 6-5.

Table 6-5 Random walk particle tracking parameters.

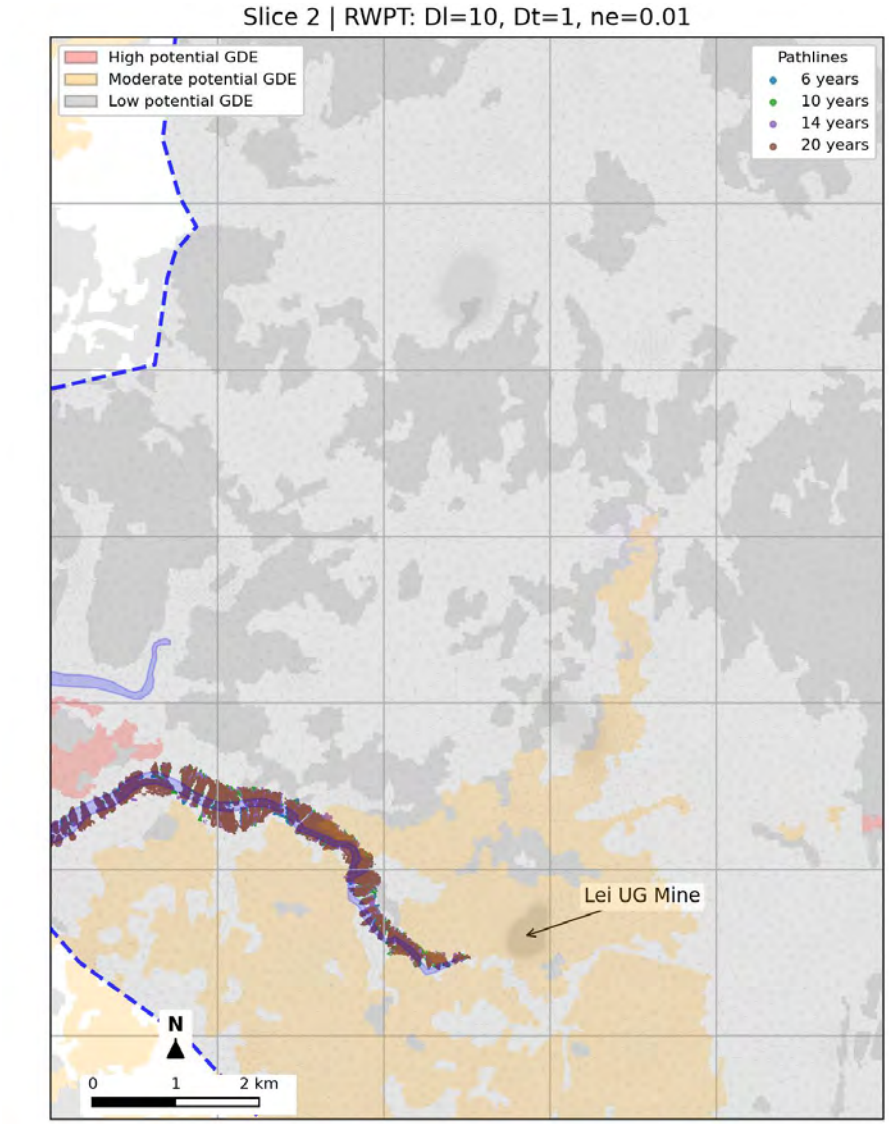
PARAMETER	VALUE	UNIT
Effective porosity (ne)	0.01 and 0.001	[-]
Longitudinal dispersivity (D_L)	10 and 100	[1/m]
Transverse dispersivity (D_T)	1 and 10	[1/m]

6.4.2. Particle tracking results

The fate of particles seeded beneath the tidal section of the Charlotte River on Slice 2 at the start of mining was evaluated using two parameter sets. A best-case scenario (D_L = 10, D_T = 1 and ne = 0.01), where particle migration from the source is expected to be limited, and a conservative scenario (D_L = 100, D_T = 10 and ne = 0.001), where particles are expected to travel further, The results are presented in Figure 6-23a and Figure 6-23b, respectively. The figures also show the particle migration after 6, 10, 14 and 20 years from the start of mining. Under both parameter sets, the particle tracks indicates that water originating from the Charlotte River migrates less than about 500 m inland from the river.

A similar analysis was conducted with particles seeded on Slice 4 (top of the fresh BCF) to determine if groundwater can reach the mine workings where the hydraulic gradient is much greater. A best-case scenario (D_L = 10, D_T = 1 and ne = 0.01), where particle migration from the source is expected to be limited, and a conservative scenario (D_L = 100, D_T = 10 and ne = 0.001), where particles are expected to travel further, The results are presented in Figure 6-24a and Figure 6-24b, respectively. The figures also show the particle migration after 6, 10, 14 and 20 years from the start of mining. The best-case scenario shows similar results to the results where particles were seeded on Slice 2, however, the conservative scenario indicates particles are captured by the mine workings. This suggests that if saline groundwater is present at depth beneath the Charlotte River it is possible that saline water can be expected at the mine.

(a)



(b)

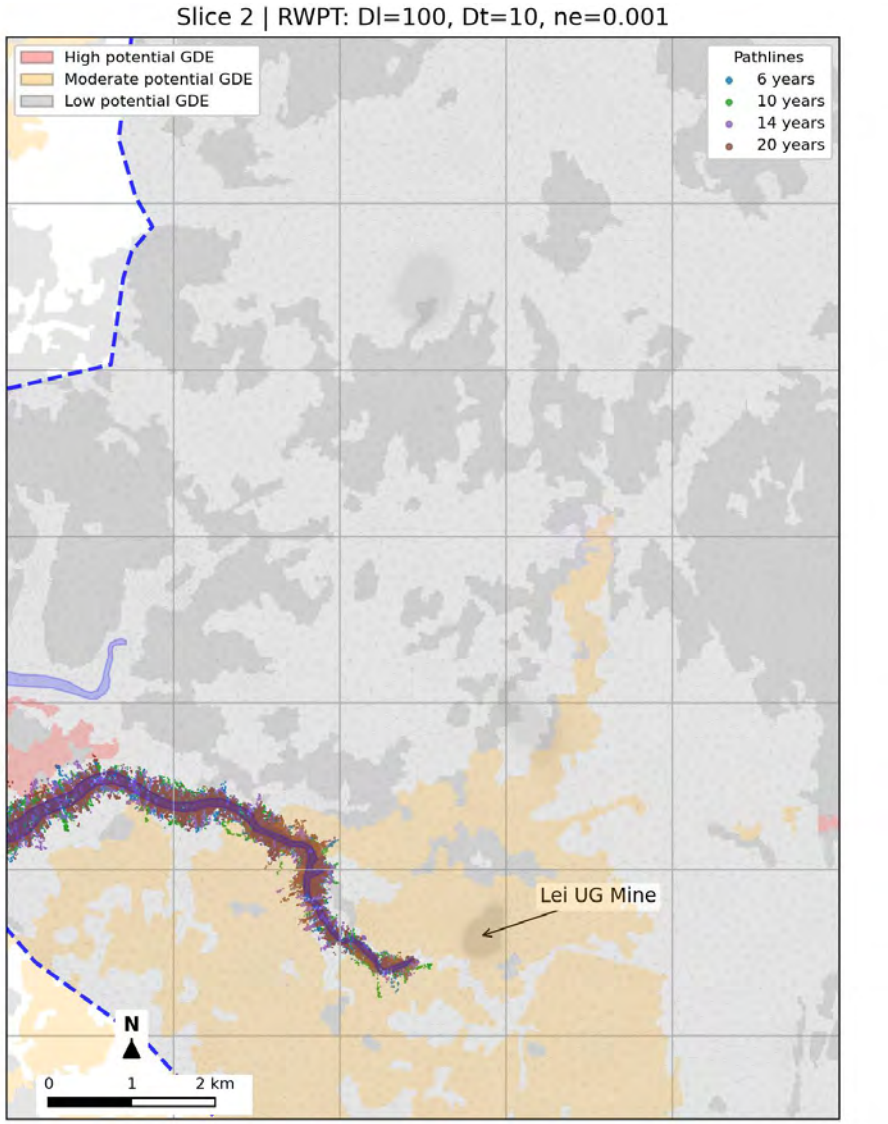
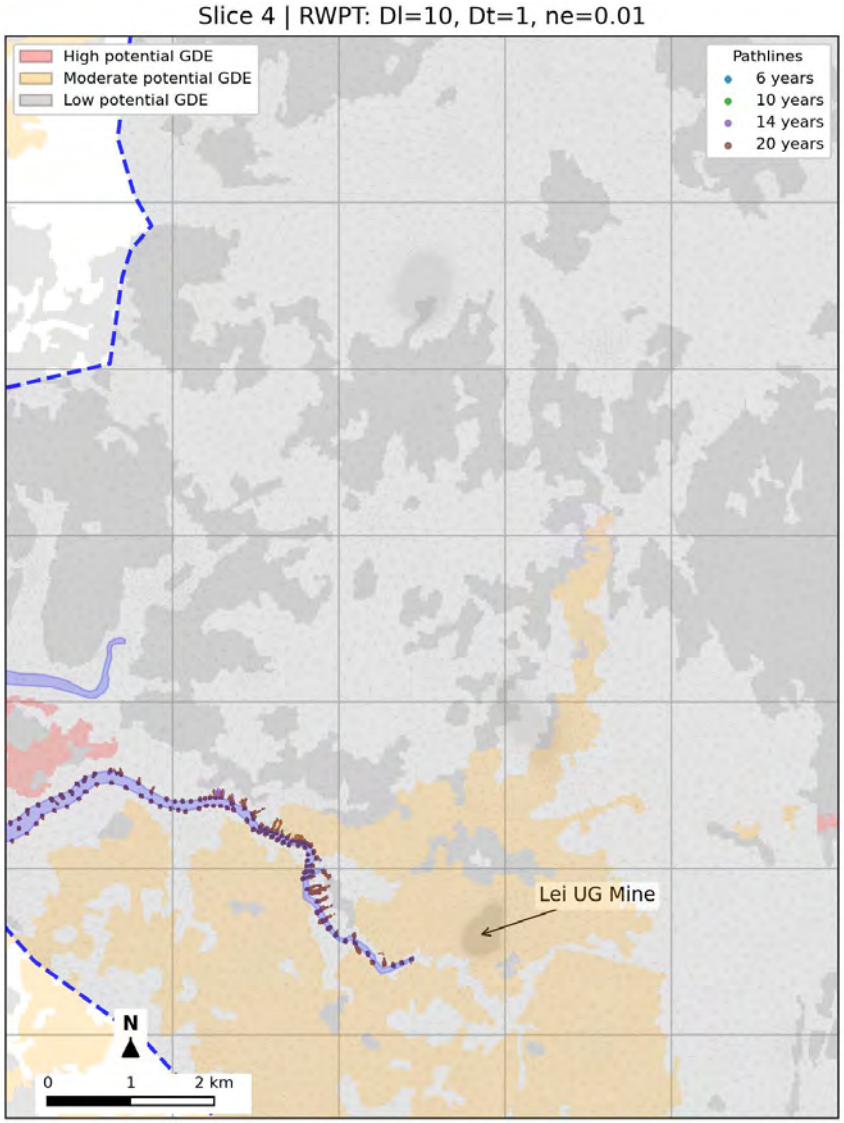


Figure 6-23 Random walk particle tracking at slice 2 for years 6, 10, 14 and 20 under parameters (a) Longitudinal dispersivity (D_L)=10, transverse dispersivity (D_T)=1 and effective porosity (ne)=0.01 and (b) Longitudinal dispersivity (D_L)=100, transverse dispersivity (D_T)=10 and effective porosity (ne)=0.001.

(a)



(b)

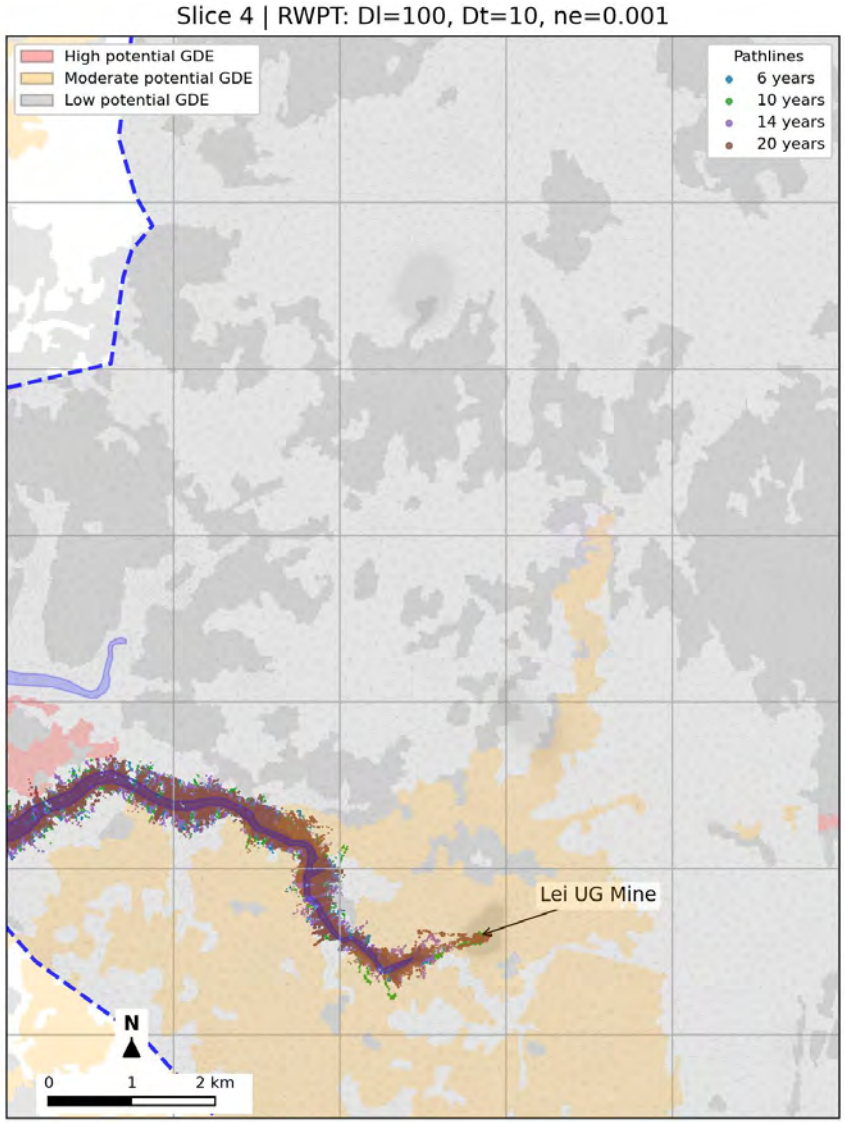


Figure 6-24 Random walk particle tracking at slice 4 for years 6, 10, 14 and 20 under parameters (a) Longitudinal dispersivity (D_L)=10, transverse dispersivity (D_T)=1 and effective porosity (ne)=0.01 and (b) Longitudinal dispersivity (Dl)=100, transverse dispersivity (Dt)=10 and effective porosity (ne)=0.001.

6.4.3. Post-closure particle tracking results

Random walk particle tracking has also been used to investigate the fate of particles beneath the proposed box cut waste rock dump following closure of the mine (Figure 6-25). The parameters used to calculate the particle tracks are consistent with those used to determine particle tracking for LoM in Section 6.4.2.

The particle tracks are different to those determined for the EoM with the particles distributed roughly evenly to the east and west of the box cut WRD. The recovery of groundwater within the box cut and underground workings has resulted in the return of the natural gradient towards the drainage lines to the east and west.

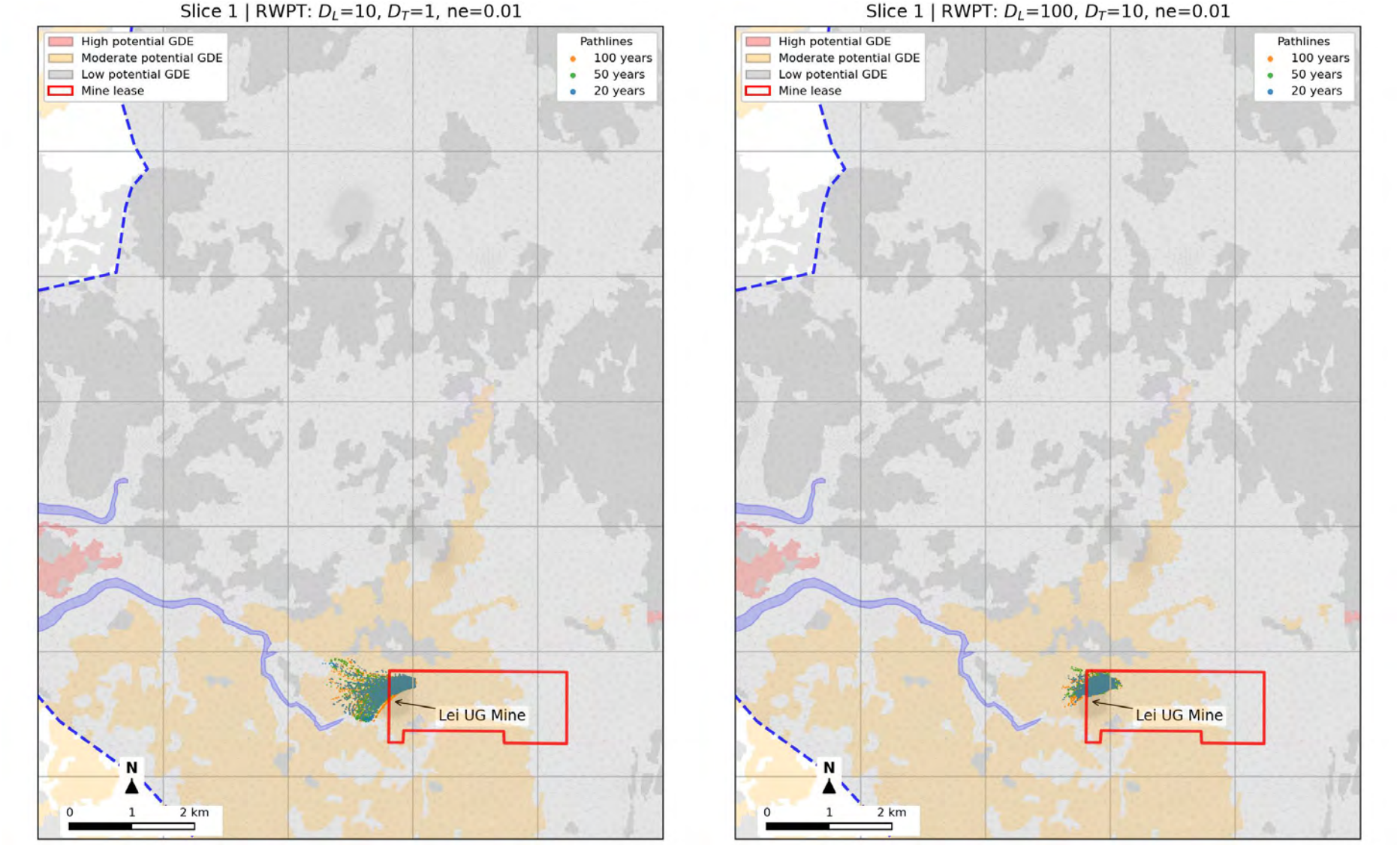


Figure 6-25 Random walk particle tracking at slice 1 for years 20, 50 and 100 under parameters (a) Longitudinal dispersivity (D_L)=10, transverse dispersivity (D_T)=1 and effective porosity (ne)=0.01 and (b) longitudinal dispersivity (Dl)=100, transverse dispersivity (Dt)=10 and effective porosity (ne)=0.01.

6.5. Project only impact discussion

The project-only forecast indicates that groundwater drawdown will be greatest near the Lei box cut, decline and underground workings, with lower-magnitude drawdown extending beyond the mining lease during operations. At the end of mining, the 0.1 m drawdown contour is predicted to extend about 1 to 2 km beyond the lease boundary to the north, west and south. Drawdown approaches or intersects the upstream tidal reach of the Charlotte River and extends beneath areas mapped as having moderate potential for groundwater-dependent ecosystems.

The significance of these groundwater-level changes depends on the magnitude and duration of drawdown at each receptor, the seasonal range in groundwater levels, the depth and reliability of groundwater dependence, and the hydraulic connection between the shallow weathered aquifer and surface-water features. Predicted drawdown outside the lease is generally low compared with the observed seasonal groundwater-level range. The upper Charlotte River is ephemeral and the available information indicates limited dry-season baseflow. These factors reduce the likelihood of a material effect on shallow aquatic or terrestrial ecosystems, although the predicted intersection with the tidal reach warrants monitoring because saline groundwater may be drawn towards the underground workings.

Groundwater inflow to the combined Lei box cut and underground mine is predicted to peak at about 608 ML/year in Year 5. This volume is about 2.1% of the modelled annual recharge of 28.6 GL/year across the 194 km² model domain. This comparison is a broad water-balance indicator rather than a local allocation limit, because recharge and extraction are not uniformly distributed and the environmental significance of abstraction also depends on local drawdown and receptor sensitivity.

Following closure, groundwater levels are predicted to recover progressively. Drawdown is largely confined to the lease after about four years of recovery, is fully contained within the lease after about nine years, and the watertable is predicted to recover to pre-mining conditions by about Year 20. The predicted impacts are therefore temporary and reversible at the modelled time scale, subject to the assumptions discussed in Section 8.

7 Cumulative impact assessment

This section investigates the groundwater impacts of the cumulative impacts of the Lei Project, the BP33 Project (BP33) including the box cut and underground workings, and the Grants Lithium Project (GLP) pit development. Impacts are assessed over the LOM and during the post-closure period associated with recovery of groundwater levels associated with the Lei mine. The scenario considers the following components:

7.1. Cumulative scenario forecast

The cumulative forecast scenario was developed to assess the combined effects of the Lei, BP33 and Grants mining operations on groundwater flow under the assumed concurrent mining schedule. The predictive simulations were based on the following assumptions:

- The model was simulated for a total forecast period of 20 years, comprising 6 years of concurrent mining followed by 14 years of post-closure recovery.
- Lei Life of Mine (LoM): 6 years, commencing at model day 0.
- BP33 Life of Mine (LoM): 5 years, commencing at model day 0.
- Grants Lithium Project (GLP) pit excavation: 4 years, commencing at model day 0.
- The post-closure simulation extends for 14 years following closure of the Lei underground mine, with the BP33 and Grants excavations represented as flooded mine voids following completion of mining.
- Hydraulic properties, recharge parameters and boundary conditions were adopted from the calibrated groundwater model.
- Mine dewatering was represented by passive drainage to excavations and sumps. Groundwater abstraction from dedicated production bores was not simulated.
- Initial hydraulic heads were taken from the final stress period of the calibrated transient model.
- Recharge during the predictive simulations was derived using the calibrated recharge model. The historical climate record (1900-2000) was repeated to provide a continuous climatic sequence for the forecast period, thereby preserving the observed variability in rainfall and recharge.

The cumulative assessment considers the concurrent operation of the Lei, BP33 and Grants mining projects. Although the individual drawdown cones overlap locally, the combined effects remain confined to the regional fractured rock aquifer surrounding the mining operations. The cumulative simulations indicate that groundwater responses remain localised, recover following closure, and represent a relatively small proportion of the annual groundwater recharge to the model domain. The following sections present the detailed groundwater level, drawdown and inflow predictions that support these conclusions.

7.2. Groundwater levels LoM results

The groundwater level response for bores installed around the Lei project, BP33 project and the Grants project are presented for the 6-year LoM period and an additional 14-year post-closure period.

7.2.1. Lei groundwater levels

The groundwater levels at the six monitoring sites around the Lei box cut, decline and underground workings under the natural (s00) and cumulative (s02) scenarios are presented in Figure 6-2 through Figure 6-4.

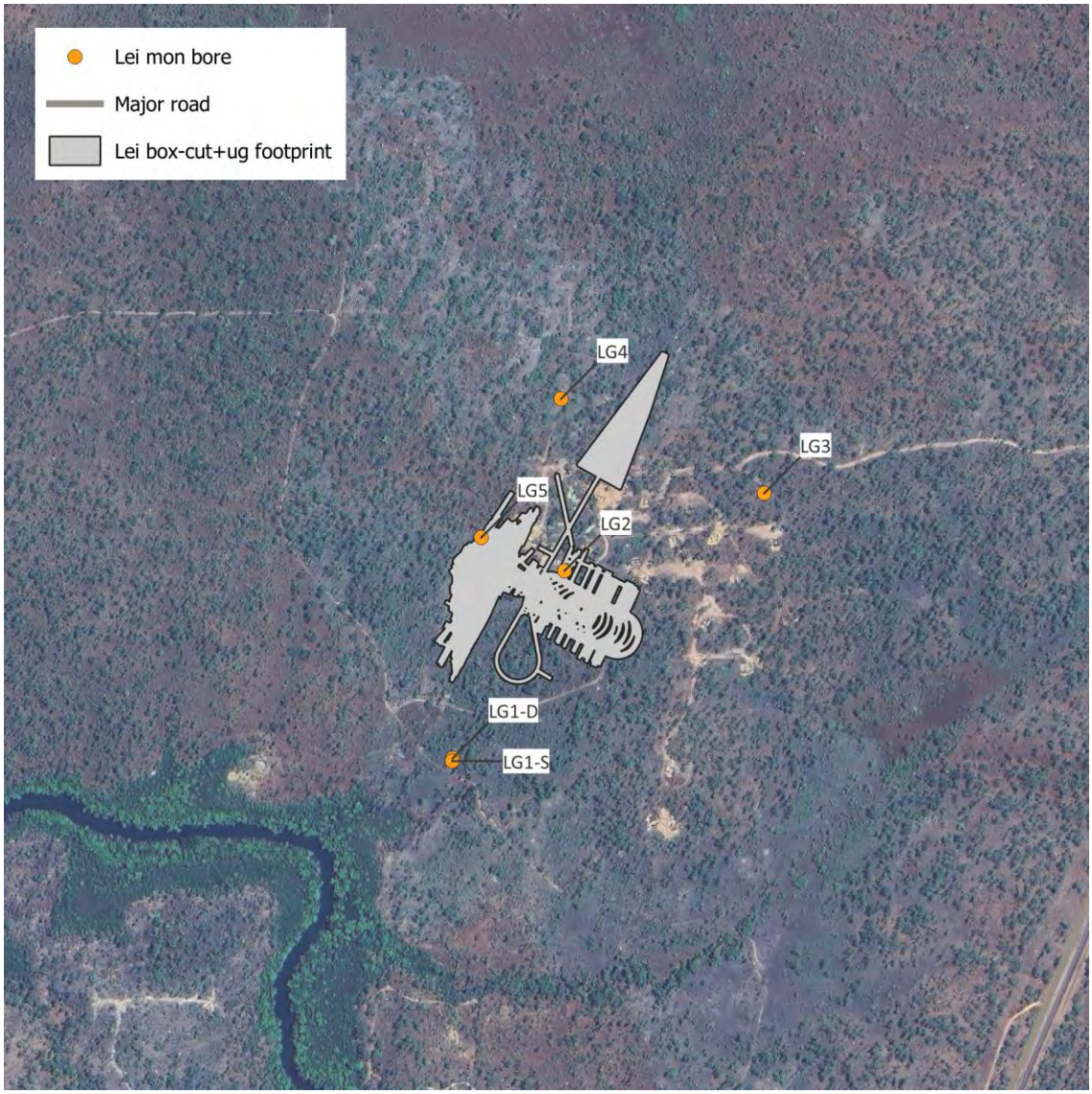


Figure 7-1 Locations of observation bores associated with the proposed Lei underground mine.

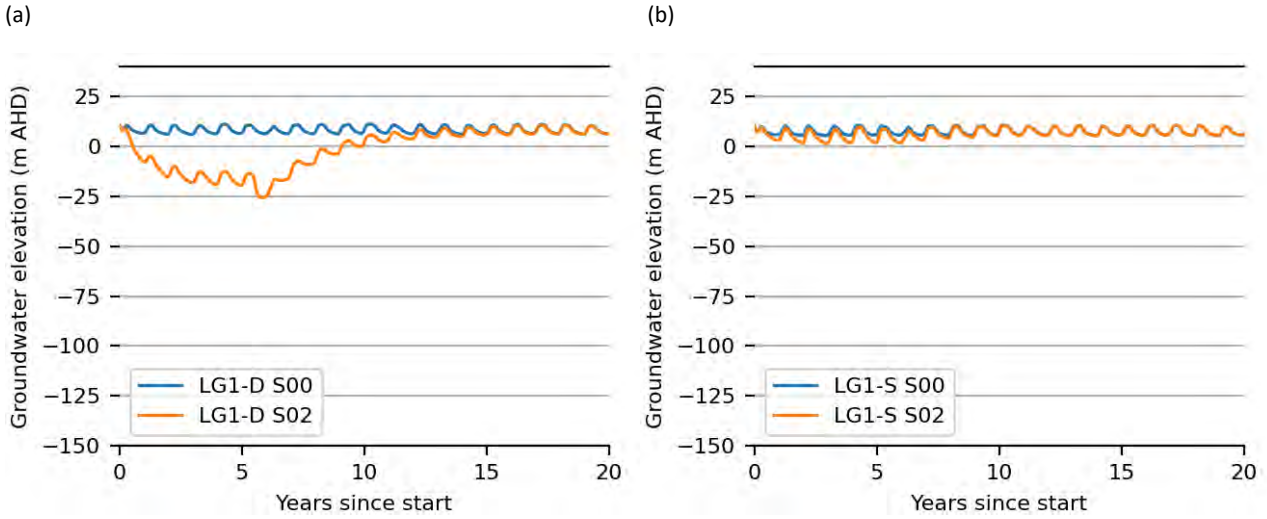


Figure 7-2 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants Pit excavations at existing Lei observation bores: (a) LG1-D and (b) LG1-S.

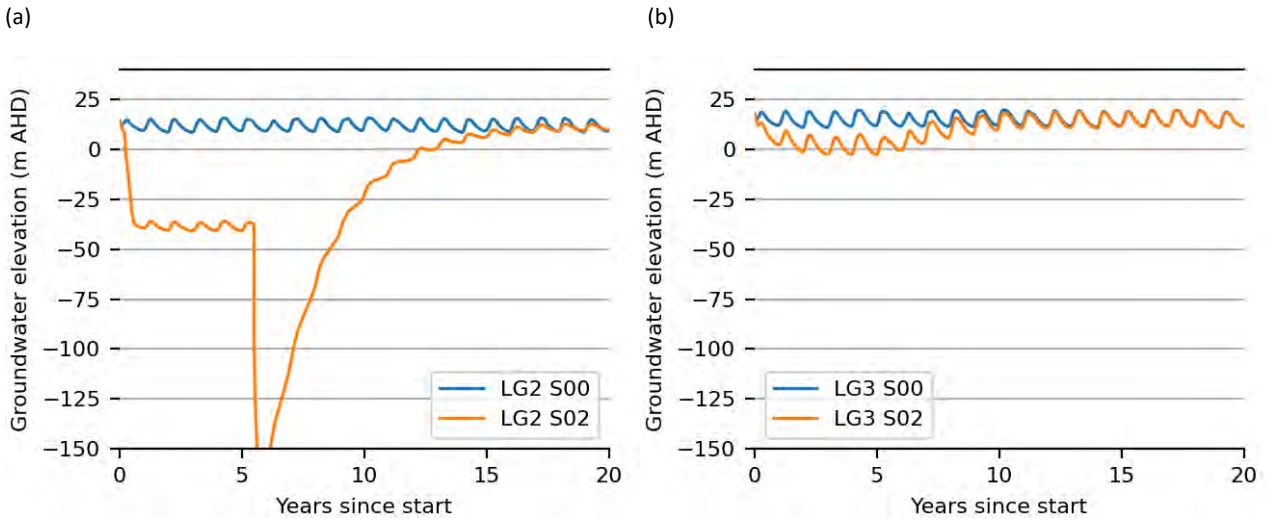


Figure 7-3 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants Pit excavations at existing Lei observation bores: (a) LG2 and (b) LG3.

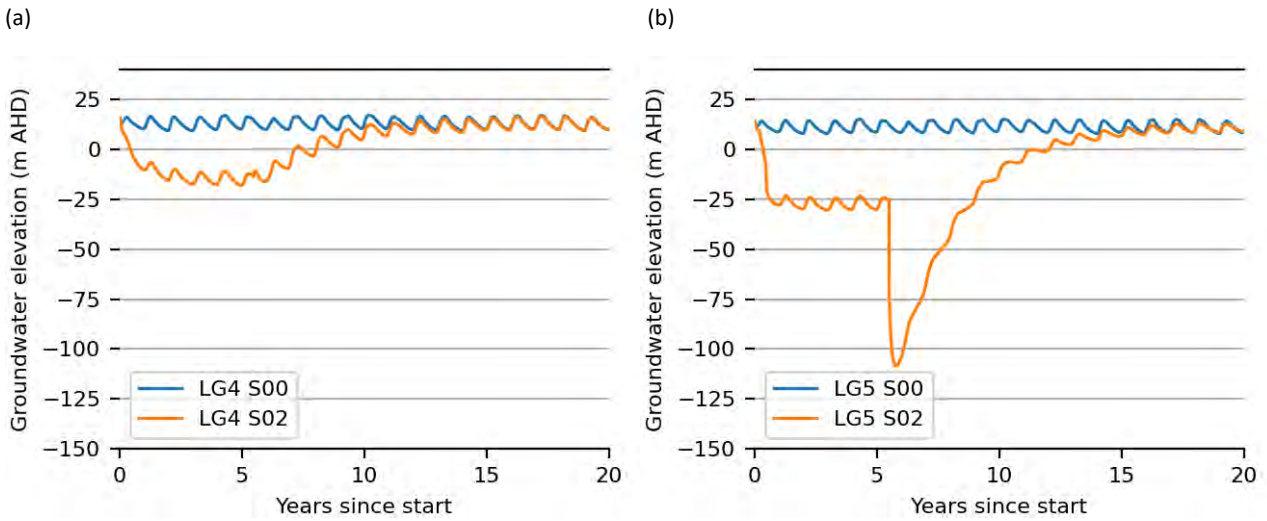


Figure 7-4 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants Pit excavations at existing Lei observation bores: (a) LG4 and (b) LG5.

7.2.2. BP33 groundwater levels

The groundwater levels in the observation bores around the BP33 box cut, decline and underground workings under the natural (s00) and cumulative (s02) scenarios are presented in Figure 7-6 through Figure 7-11.



Figure 7-5 Locations of observation bores associated with the BP33 underground mine.

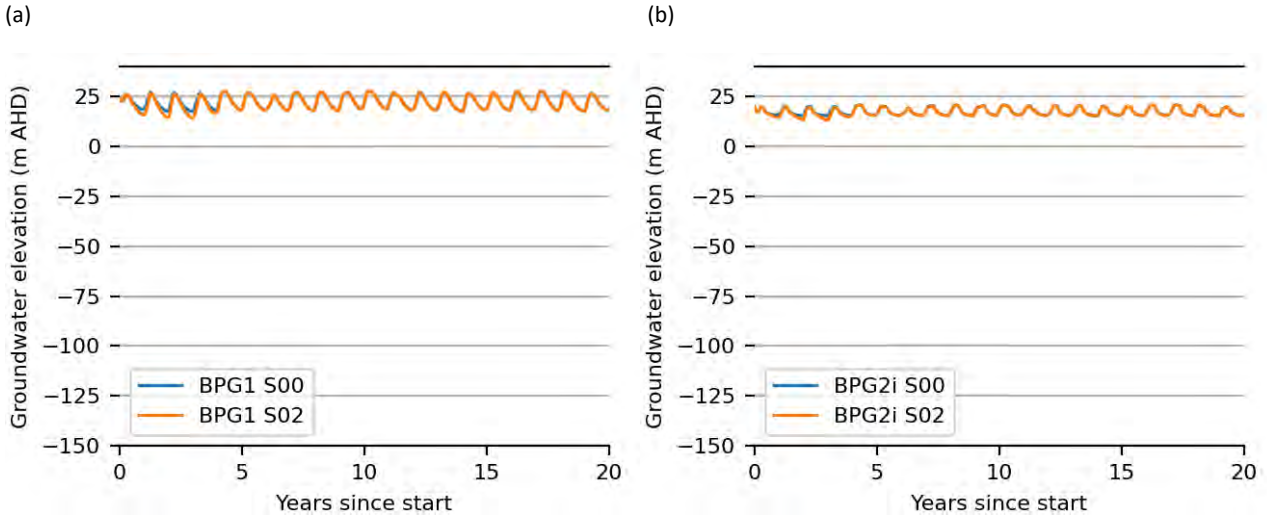


Figure 7-6 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG1 and (b) BPG2i.

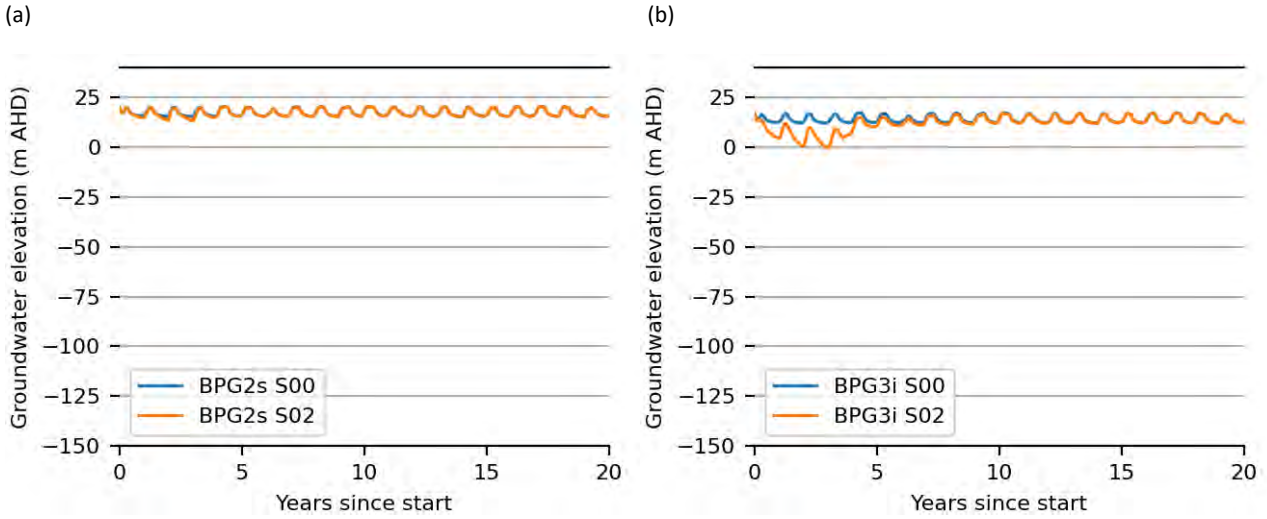


Figure 7-7 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG2s and (b) BPG3i.

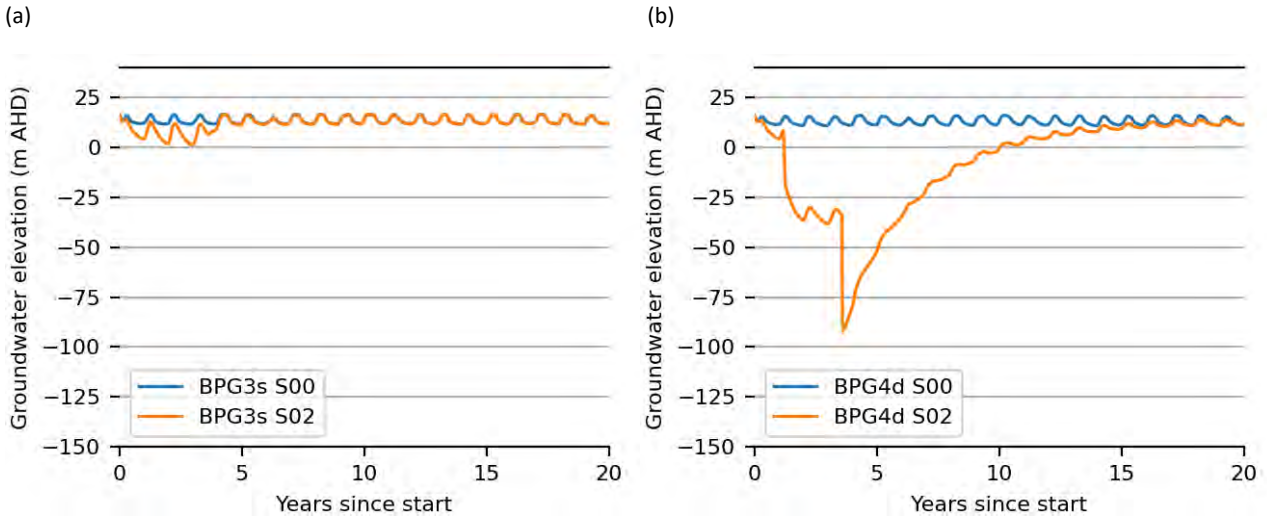


Figure 7-8 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG3s and (b) BPG4d.

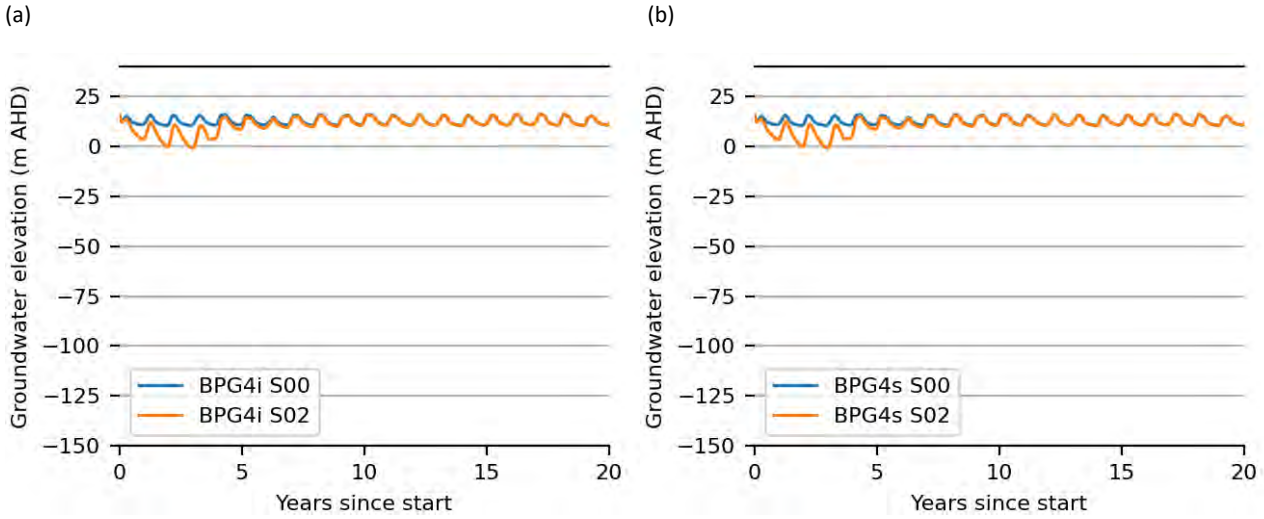


Figure 7-9 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG4i and (b) BPG4s.

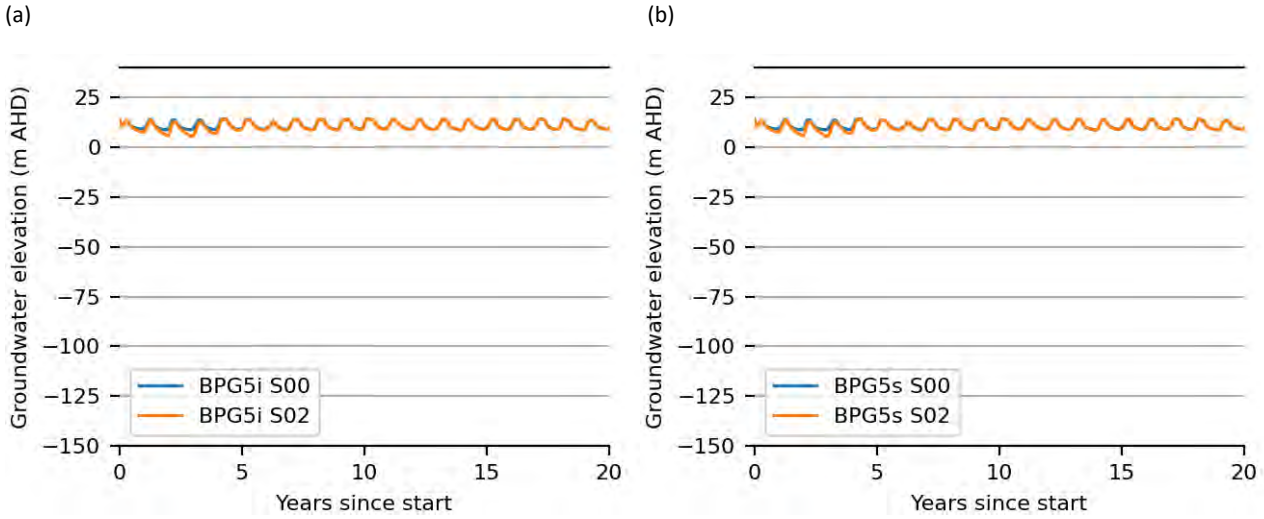


Figure 7- Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG5i and (b) BPG5s.

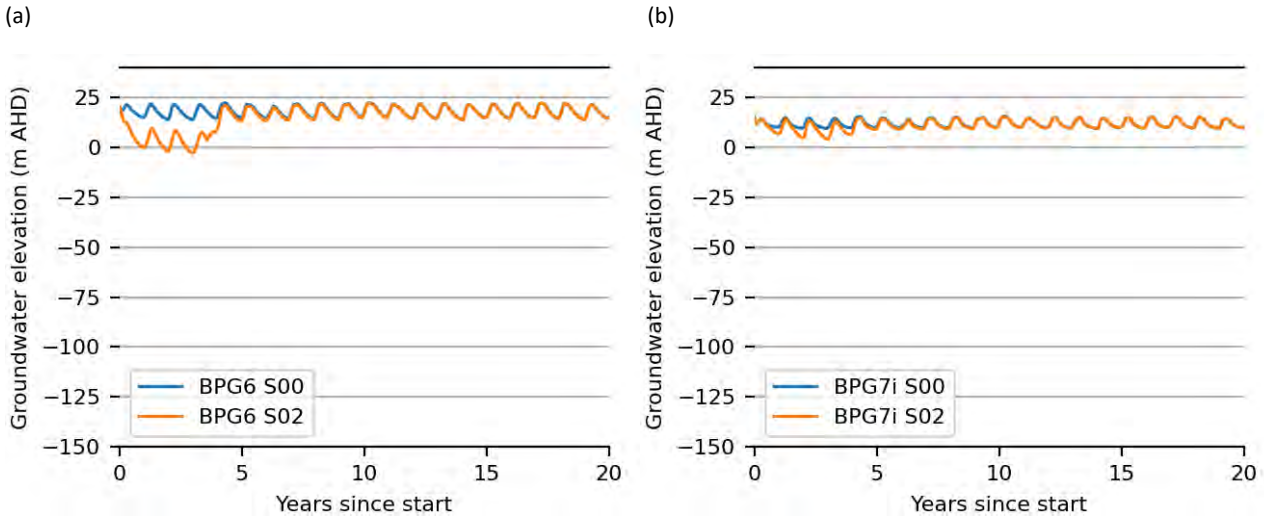


Figure 7-10 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG6 and (b) BPG7i.

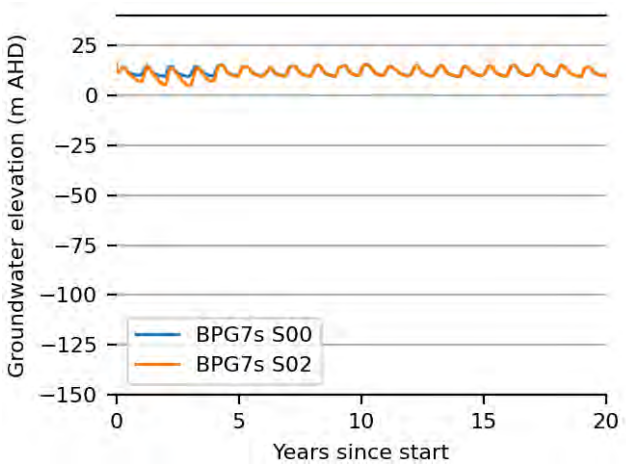


Figure 7-11 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG7s.

7.2.3. Grants Pit groundwater levels

The groundwater levels in the observation bores around the BP33 box cut, decline and underground workings under the natural (s00) and cumulative (s02) scenarios are presented in Figure 7-13 through Figure 7-17.

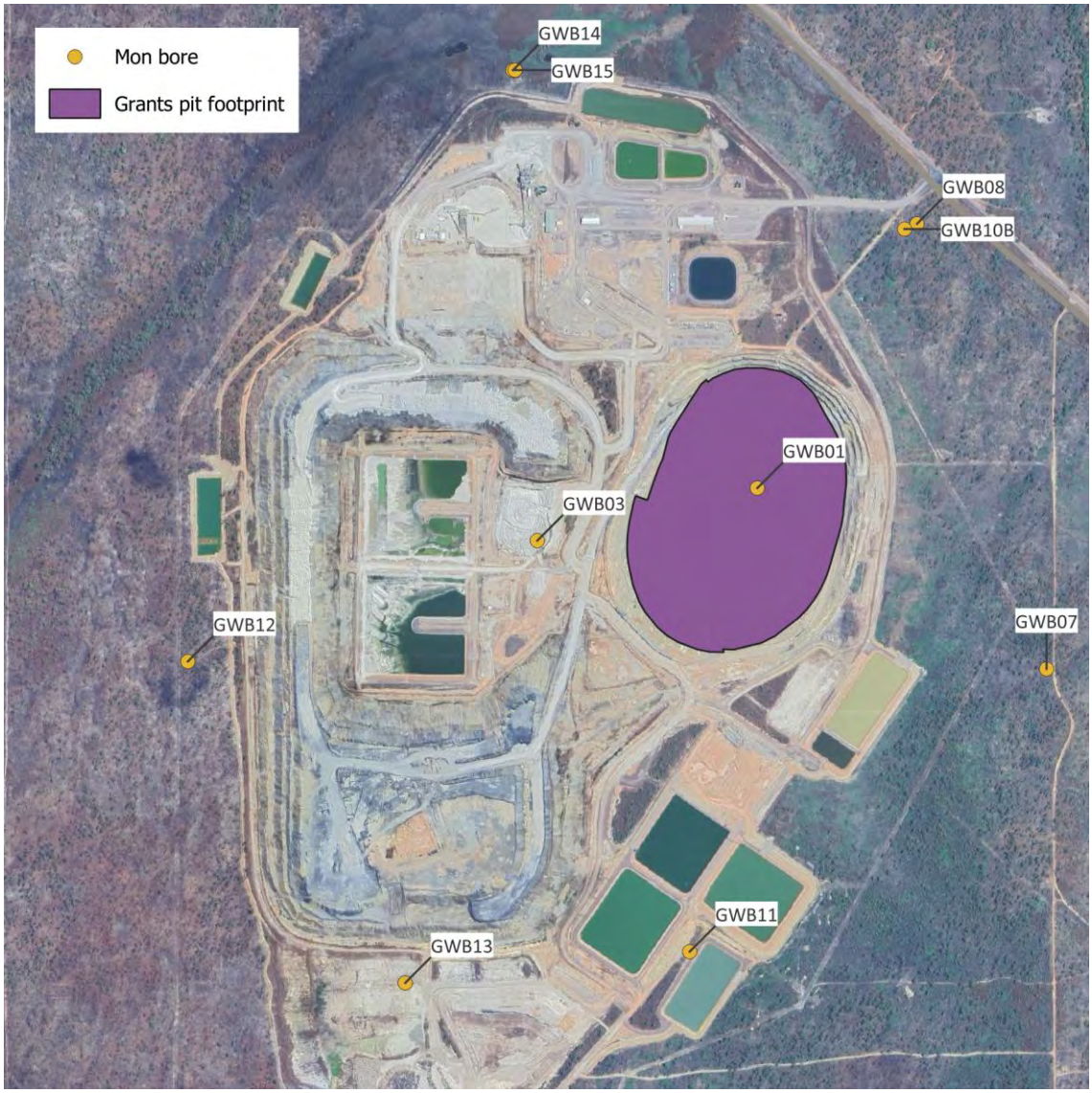


Figure 7-12 Locations of observation bores associated with the Grants Pit.

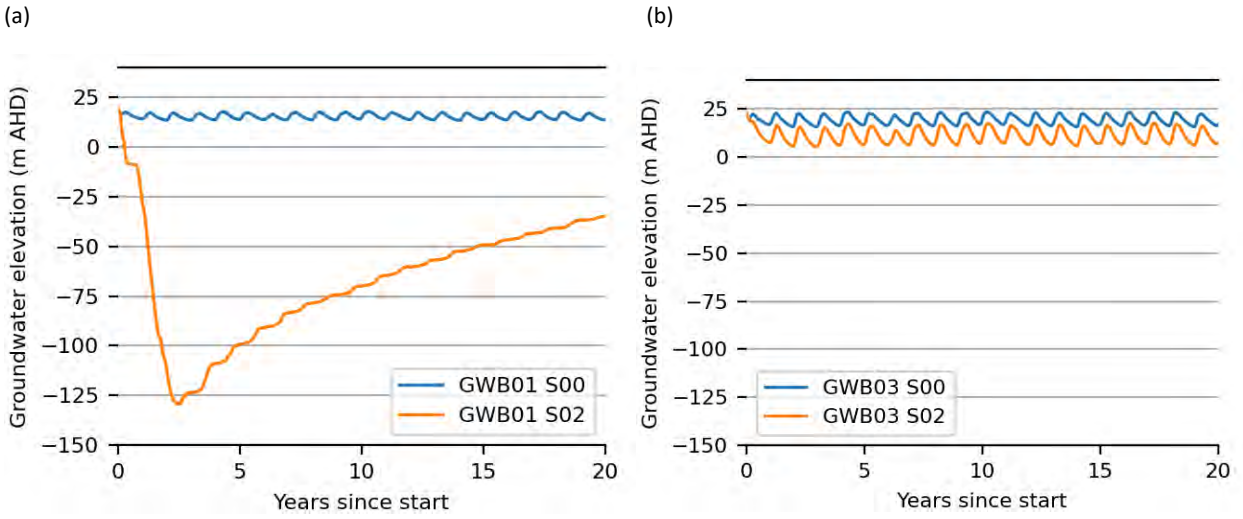


Figure 7-13 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB01 and (b) GWB03.

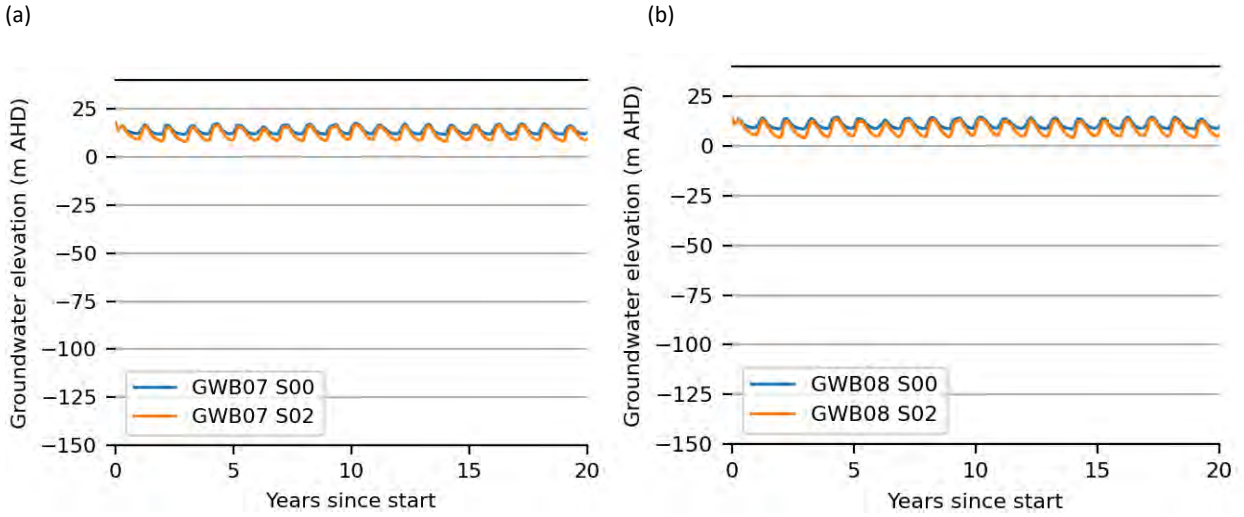


Figure 7-14 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB07 and (b) GWB08.

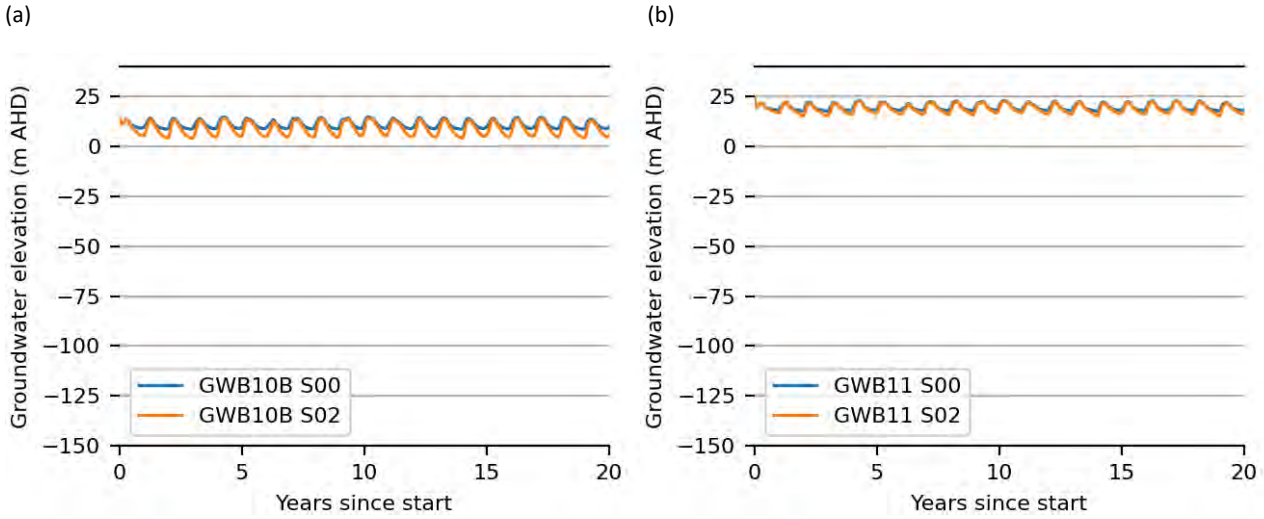


Figure 7-15 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB10b and (b) GWB11.

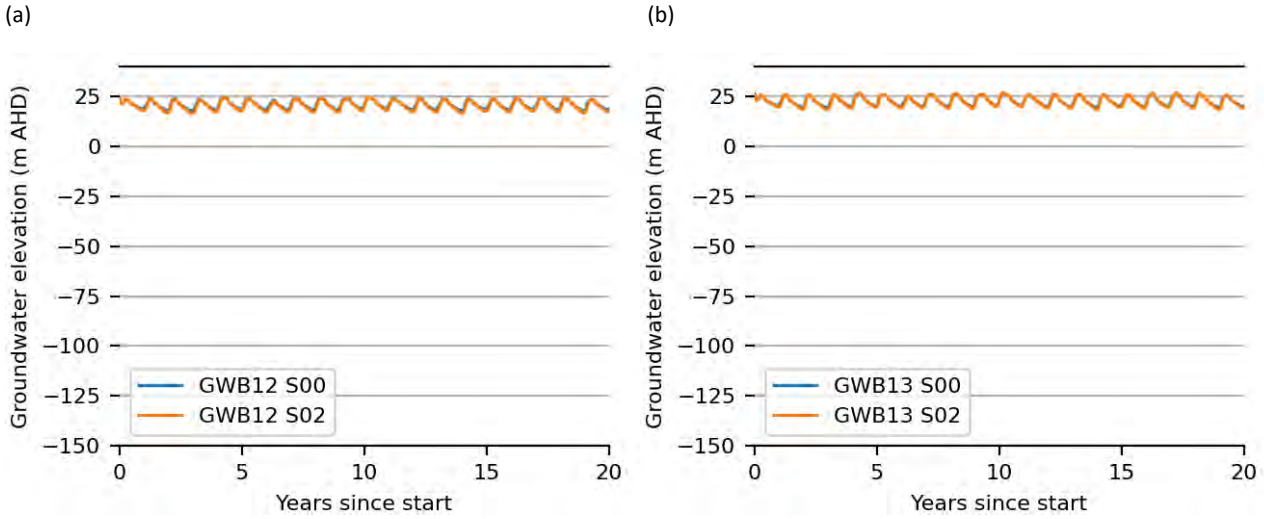


Figure 7-16 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB12 and (b) GWB13.

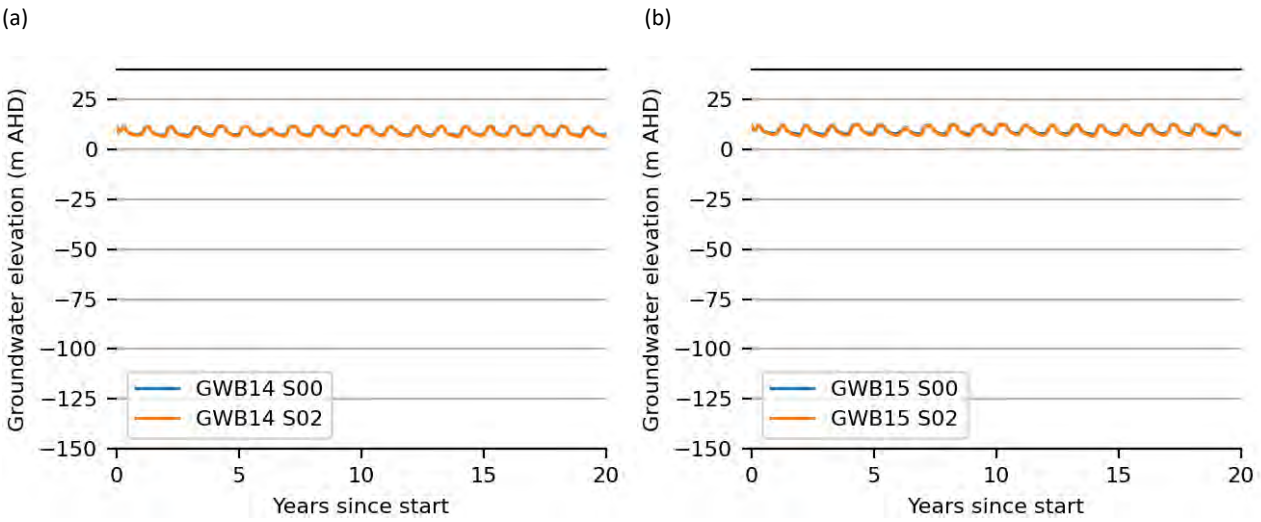


Figure 7-17 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB14 and (b) GWB15.

7.2.4. Cumulative LoM groundwater drawdown contours

The forecast drawdown impacts after 4 years, at the end of the mining period at BP33, and after 6 years, at the end of the mining period at Lei, are presented in Figure 7-18a and Figure 7-18b, respectively.

The predicted drawdown cone resulting from pit dewatering at the Grants Lithium Project extends about 2 km to the south. There is no apparent hydraulic interaction between the drawdown at Grants and the BP33 and Lei mines to the south.

However, drawdown from BP33 and Lei does interact, with a maximum drawdown of about 0.5m occurring about three years after the start of mining. This occurs just prior to the closure of the BP33 mine.

If the commencement of the BP33 mine were delayed by two years so that both mines stopped operating at the same time, the drawdown may be slightly greater in the area where they intersect.

As with the s01 (Lei only) scenario, drawdown reaches the tidal portion of the Charlotte River indicating that there is a potential for salt water to be induced towards the mine.

Drawdown associated with the Lei project extends beyond the eastern and southern edges of the mining lease. This drawdown is associated with excavation of the box cut. The drawdown also extends below the areas identified with moderate potential for GDEs.

(a) (b)

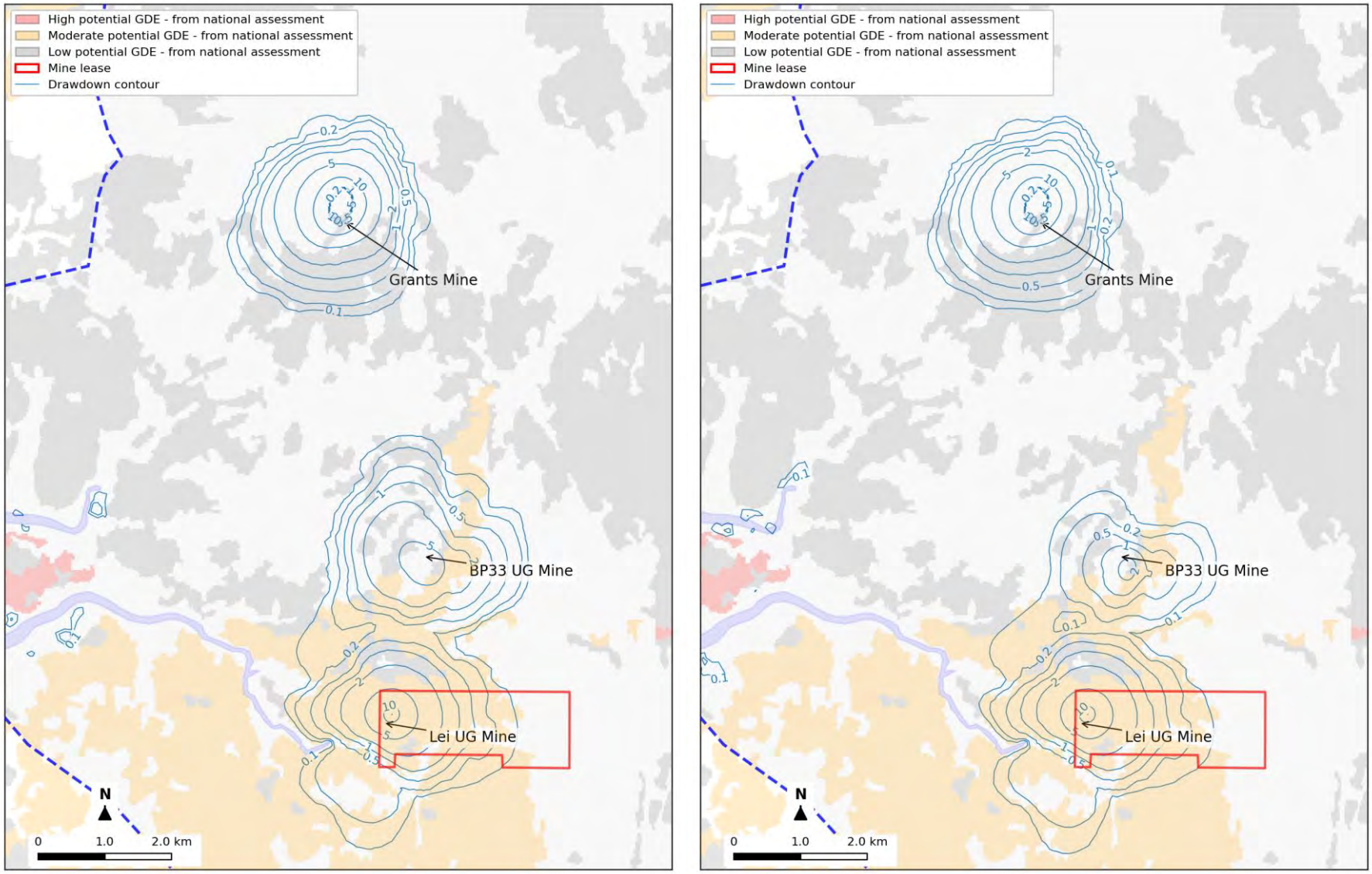


Figure 7-18 Forecast drawdown contours after (a) 4 years and (b) 6 years of mining.

7.2.5. Cumulative post-closure groundwater drawdown contours

The post-closure impacts scenario was based on the Life of Mine scenario with the following additional assumptions / settings:

- The post-closure model runs for an additional 14 years from the final time step of the LoM scenario.
- Removing the seepage face boundary conditions associated with the underground mine.
- Material properties of the underground mine are consistent with the volume of underground mine void.
- Pit lake water levels taken from the GLP (CloudGMS 2018 s4.3.5) to simulate the filling of the pit void.

The seasonal nature of recharge meant that a steady state model of the system was not deemed appropriate to assess the post-closure impacts. The model was run to an approximate dynamic equilibrium is represented as a stabilisation of groundwater levels around the Lei underground mine.

The post-closure drawdown contours at 4 years and 9 years are presented in Figure 7-19a and Figure 7-19b.

(a) (b)

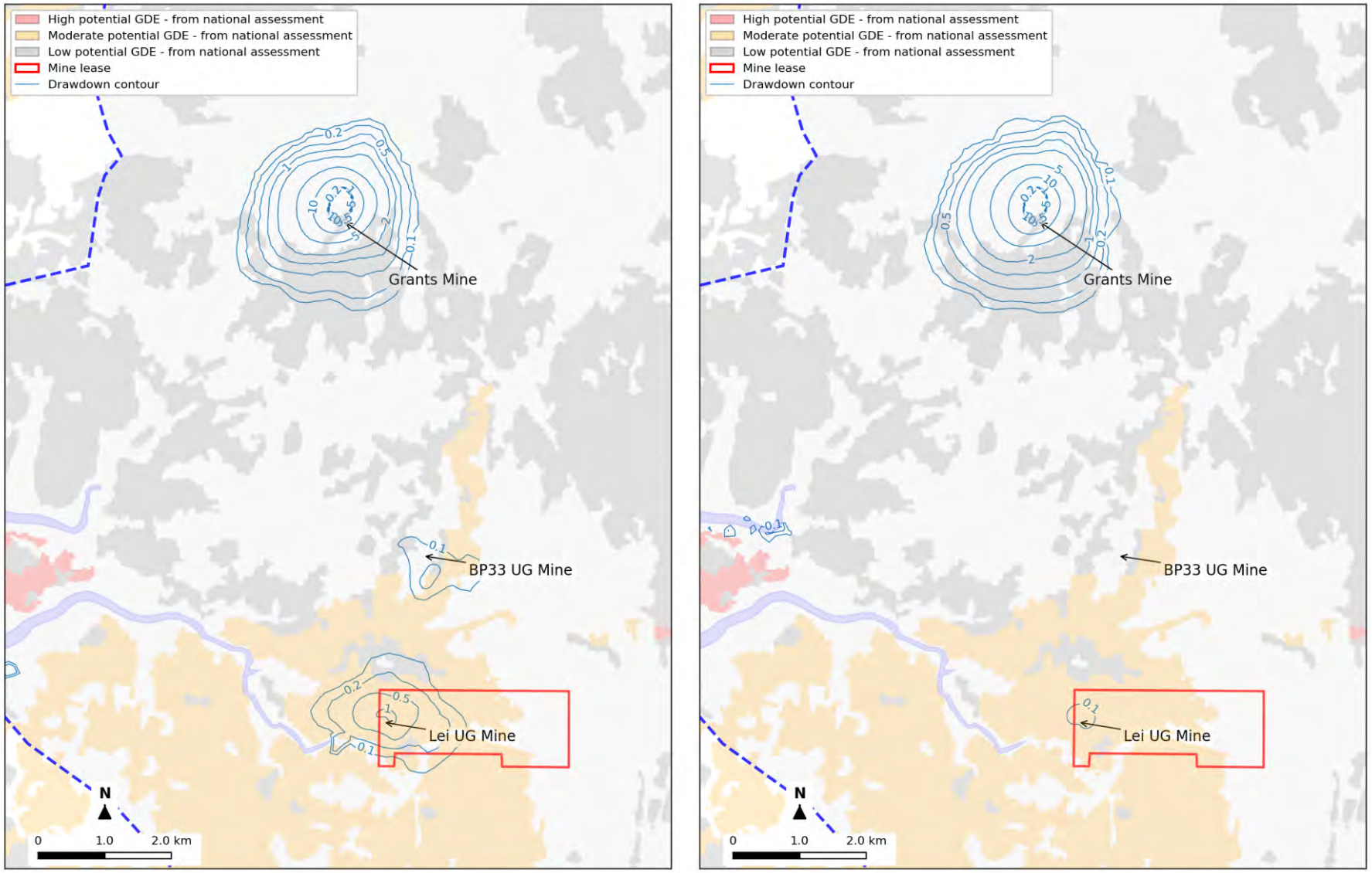


Figure 7-19 Lei Project forecast drawdown contours at the watertable following (a) 4 years of recovery, Year 10 from the start of mining and (b) 9 years of recovery, Year 15 from the start of mining.

7.3. Cumulative impact discussion

The cumulative scenario represents the concurrent and sequential influence of the Lei Project, BP33 underground mine and Grants Pit. The model predicts little hydraulic interaction between Grants and the two underground mines. In contrast, the Lei and BP33 drawdown cones overlap, with an additional drawdown of about 0.5 m in the area between the mines around three years after mining commences. The timing of concurrent operations is important, and a delay in BP33 development that causes both mines to cease dewatering at a similar time may slightly increase drawdown where the cones intersect.

The cumulative zone of influence is therefore not adequately represented by a fixed 2 km buffer around the Lei Project. It is defined by the modelled drawdown contours and varies with time, mine schedule, depth of excavation and the selected drawdown threshold. The cumulative model indicates that low-magnitude drawdown extends beyond the Lei lease, overlaps the BP33 response and reaches the tidal part of the Charlotte River. The Grants drawdown cone remains largely separate under the modelled schedule.

While groundwater drawdown provides the spatial measure of impact, comparison of cumulative groundwater abstraction with regional groundwater recharge provides additional context regarding the scale of the proposed dewatering activities. Table 7-1 compares the maximum annual groundwater extraction associated with the Lei, BP33 and Grants operations with the calibrated average annual recharge to the model domain.

The maximum concurrent groundwater extraction represents about 14% of the long-term average recharge to the model domain. While recharge is spatially variable and cannot be directly compared with localised dewatering at individual mine sites, this comparison demonstrates that cumulative groundwater abstraction remains a relatively small proportion of the recharge represented within the calibrated model domain.

Table 7-1 Maximum annual groundwater extraction associated with the Lei, BP33 and Grants operations with the calibrated average annual recharge to the model domain

Project	Maximum annual extraction (ML/year)	Year of maximum	Basis	Status
Lei	608	Year 5	Combined box cut, decline and stopes	Available
BP33	2,210	Year 5	Box cut, decline and underground mine	Extracted from model output
Grants	1,323	Year 2	Pit dewatering	Extracted from model output
Combined	4,141	-	Concurrent Lei, BP33 and Grants annual extraction	Calculated
Model-domain recharge	28,600	Annual average	Calibrated water balance	Available

8 Uncertainty analysis

Although uncertainty exists in several model parameters, the available hydrogeological evidence suggests that the calibrated model is likely to represent the more transmissive end of the plausible range for the deeper fresh rock. Hydraulic conductivity and storage are expected to decrease with depth as fracture frequency and connectivity reduce. Consequently, many plausible alternative parameter combinations would be expected to reduce groundwater inflows and constrain the regional extent of drawdown relative to the base model. The uncertainty analysis was undertaken to quantify this effect and assess the robustness of the predicted impacts.

PESTPP-IES (Parameter ESTimation using iterative ensemble smoother) is a state-of-the-art tool used to implement calibration-constrained Monte Carlo analysis efficiently. It employs iterative ensemble smoothing (IES) to condition ensembles of model runs to observed data, minimising mismatch while preserving ensemble variability. This method is well-suited to large, high-dimensional models, as it significantly reduces the number of model evaluations required compared to traditional inverse or gradient-based approaches. Once conditioned, the ensemble can be used to:

- Quantify predictive uncertainty, ensuring forecasts reflect both natural system variability and calibration data constraints.
- Assess parameter sensitivity to guide data collection and model refinement.
- Evaluate the likelihood of groundwater outcomes under alternative management scenarios, such as active or passive dewatering.

In the current assessment, uncertainty analysis focused on key saturated zone parameters, such as hydraulic conductivity and storage, due to their expected influence on model response to dewatering. To examine climate variability, a recharge scaling factor was employed to adjust the recharge by up to ±20% (i.e. 0.8 to 1.2), which is greater than the expected uncertainty in the climate variability within the 20 years that the mining activities associated with Lei will persist.

8.1. Recharge and recovery assumptions

Recharge uncertainty arises from both natural climatic variability and potential changes to surface conditions associated with mining. Climate variability was represented in the uncertainty analysis using a recharge scaling factor. Mining activities may also result in localised changes to recharge within the Project area. Clearing of native vegetation may increase the proportion of rainfall available for infiltration through reduced interception and evapotranspiration, while seepage from water storages and other mine water management infrastructure may provide additional localised sources of recharge where not fully contained. Conversely, roads, hardstand areas and other compacted or engineered surfaces may reduce infiltration and increase runoff. The net effect on recharge within the mining lease will therefore depend on the final mine layout, surface water management measures and the performance of engineered containment systems.

The predictive simulations cover a relatively short 20-year period and are based on a repeated historical climate sequence that preserves the observed variability in rainfall and recharge. Given the relatively short duration of the operational and post-closure assessment, the influence of long-term climate change on groundwater recharge is considered to be secondary to natural climatic

variability and is not expected to materially alter the conclusions of the groundwater impact assessment.

Despite these localised changes, the Lei Mining Lease occupies only about 2.9 km², representing approximately 1.7% of the 170 km² Charlotte River catchment. Consequently, any changes to recharge associated with mining activities are expected to have a negligible influence on recharge at the catchment scale. Groundwater recovery is therefore controlled primarily by regional recharge rather than localised mine-site recharge changes. The ±20% scaling range encompasses variability well beyond that required to achieve calibration, providing a conservative assessment of the sensitivity of predicted groundwater responses to recharge uncertainty.

The uncertainty analysis did not explicitly represent the spatial redistribution of recharge associated with individual mine infrastructure components. Given the relatively small proportion of the catchment affected by mining activities, together with the uncertainty surrounding the magnitude and distribution of localised recharge changes during operations, representing recharge uncertainty using a uniform catchment-wide scaling factor was considered appropriate for this assessment. This approach provides a conservative assessment of the potential influence of recharge uncertainty on predicted groundwater responses while avoiding the introduction of additional assumptions that are not currently supported by site-specific data.

The uncertainty analysis examined two scenarios: (1) the calibrated model under natural conditions referred to as Scenario s00, and (2) predicted impacts from mining activities at the Lei Project referred to as Scenario s01. While not exhaustive, the results highlight key areas where further data or analysis could reduce uncertainty and improve understanding of potential impacts on the groundwater resource.

8.2. Prior and post parameter ranges

The prior parameter combinations (prior) were generated using the PESTPP-IES. Each parameter distribution was centred on its calibrated value and the allowable range assigned using a value for the standard deviation of the log transformed parameter value, the range for each parameter is presented in Table 5-1.

A total of 100 prior realisations were generated for the 3 hydrostratigraphic unit zones based upon field observations and typical values found in the literature. These pre-calibration parameter sets are referred to as ‘prior’ and corresponds to the initial IES iteration ‘Iter 0’. The objective function in this case, quantifies the differences between observed and simulated groundwater levels.

Post calibration parameter ranges were taken from the second iteration of PESTPP-IES analysis, which resulted in a reasonable range in the objective function and maximised the range for parameters that are in the null space. These post-calibration parameter sets are referred to as ‘post’ and corresponds to the second IES iteration ‘Iter 2’.

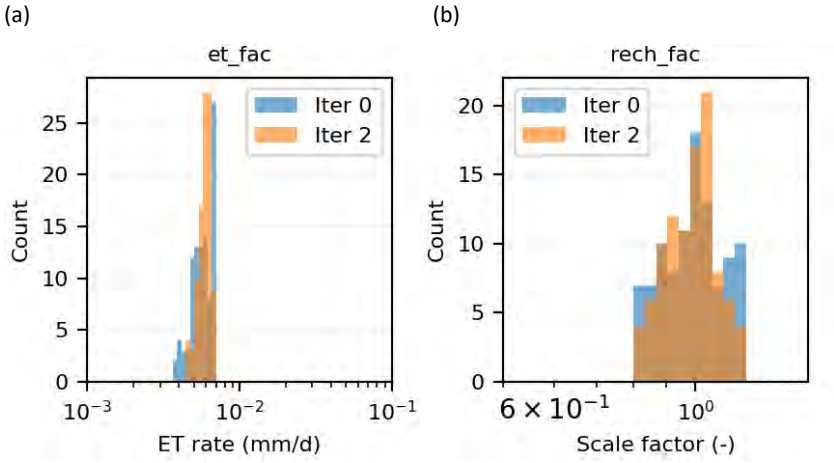


Figure 8-1 Prior (Iter 0) and post (Iter2) parameter distributions for (a) evapotranspiration rate (et_fac) and (b) recharge scaling factor (rech_fac).

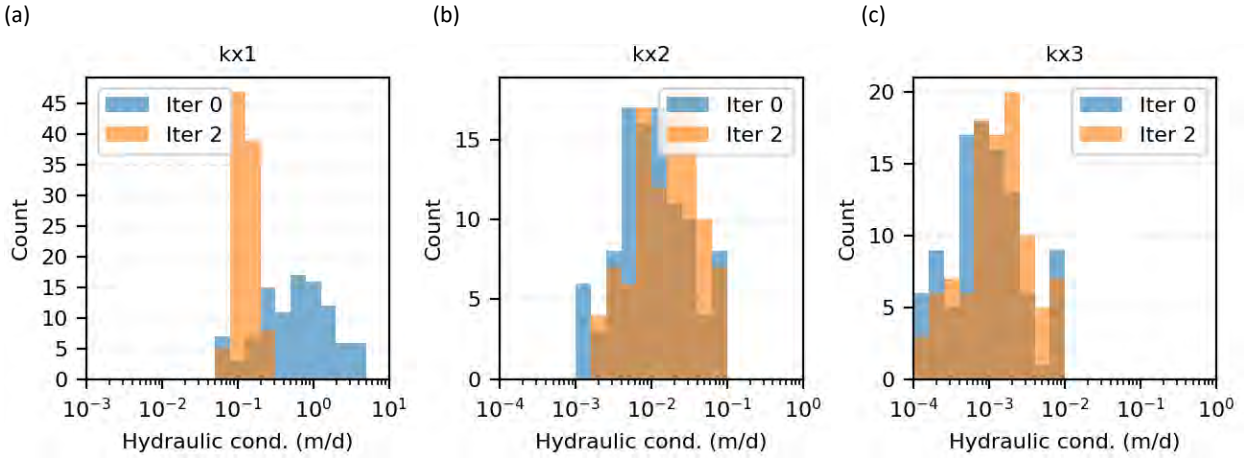


Figure 8-2 Prior (Iter 0) and post (Iter2) parameter distributions for (a) hydraulic conductivity HSU1 (kx1), (b) hydraulic conductivity HSU2 (kx2) and hydraulic conductivity HSU3 (kx3).

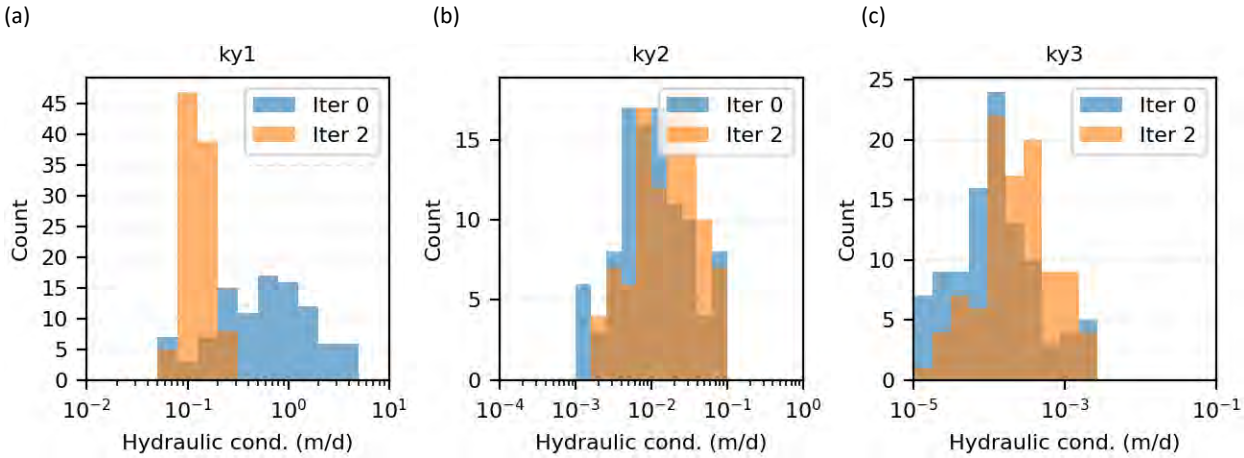


Figure 8-3 Prior (Iter 0) and post (Iter2) parameter distributions for (a) hydraulic conductivity HSU1 (ky1), (b) hydraulic conductivity HSU2 (ky2) and hydraulic conductivity HSU3 (ky3).

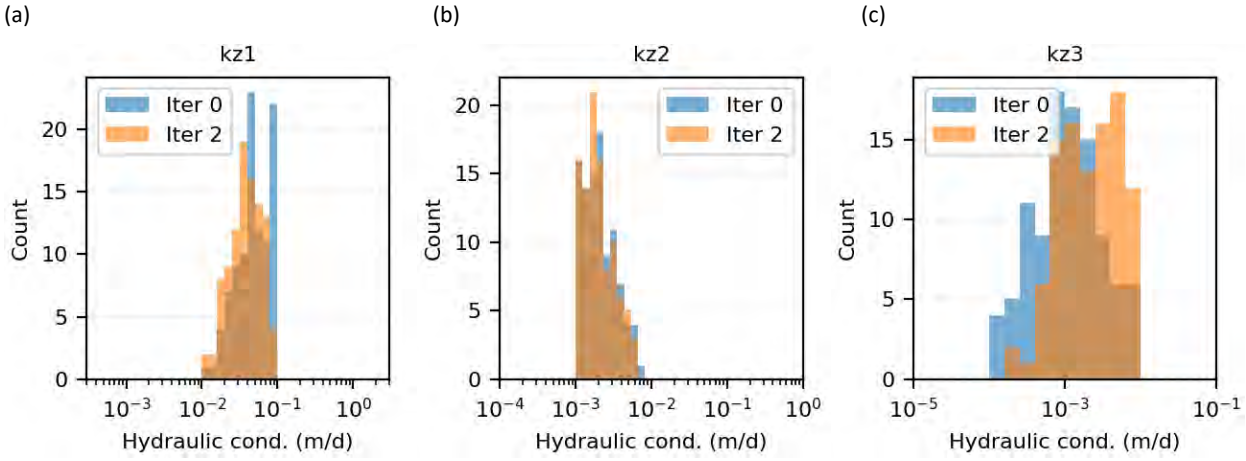


Figure 8-4 Prior (Iter 0) and post (Iter2) parameter distributions for (a) vertical hydraulic conductivity HSU1 (kz1), (b) hydraulic conductivity HSU2 (kz2) and hydraulic conductivity HSU3 (kz3).

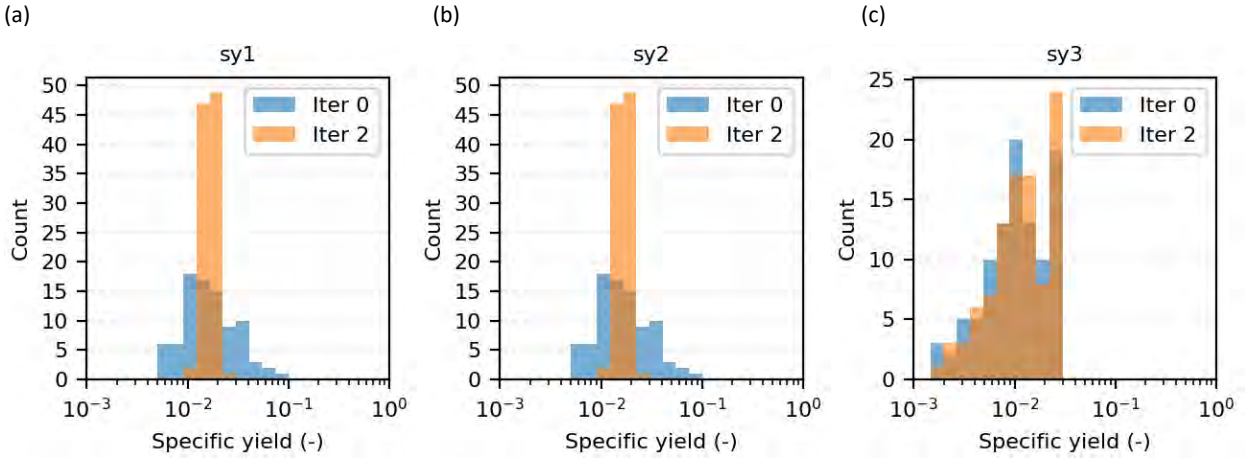


Figure 8-5 Prior (Iter 0) and post (Iter2) parameter distributions for (a) specific yield HSU1 (sy1), (b) specific yield HSU2 (sy2) and specific yield HSU3 (sy3).

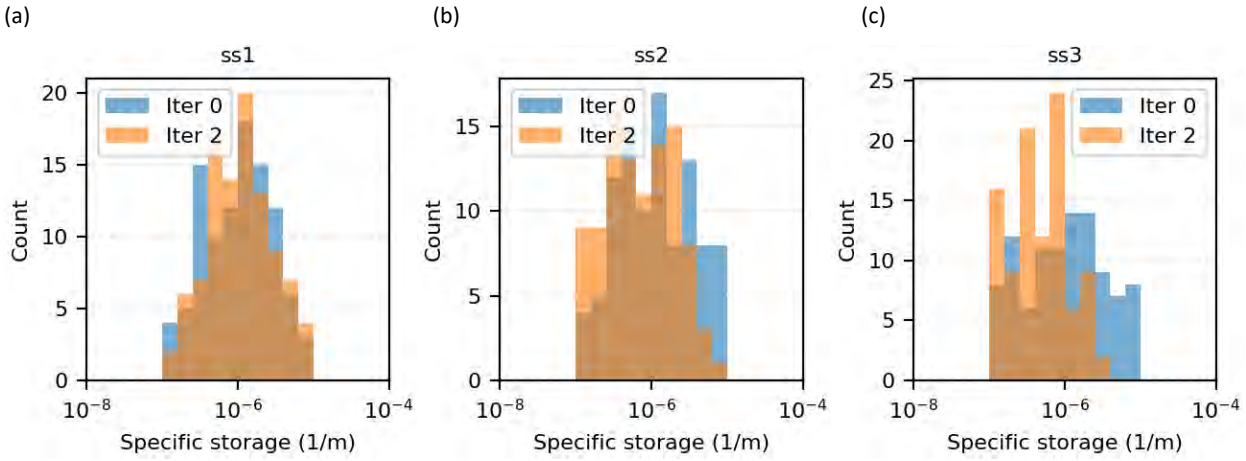


Figure 8-6 Prior (Iter 0) and post (Iter2) parameter distributions for (a) specific storage HSU1 (ss1), (b) specific storage HSU2 (ss2) and specific storage HSU3 (ss3).

8.3. Influence of key model assumptions on predictions

The uncertainty analysis varies hydraulic conductivity, storage properties, recharge and evapotranspiration within plausible ranges and conditions the resulting realisations to observed groundwater levels. The following interpretation explains how predictions would be expected to change if key assumptions differ from actual site conditions.

Parameter or assumption	If lower than modelled	If higher than modelled
Transmissivity / horizontal hydraulic conductivity	Drawdown gradients would generally be steeper, local drawdown near excavations and required dewatering head losses may be greater, and the lateral extent of low-magnitude drawdown may be smaller.	Drawdown would generally be transmitted over a wider area, maximum local drawdown gradients may be lower, and mine inflows may increase.
Vertical hydraulic conductivity	Hydraulic connection between shallow and deeper units would be weaker, reducing vertical propagation of drawdown and potentially slowing mine inflow response.	Vertical leakage and propagation of drawdown between units would increase, potentially increasing mine inflows and the response of shallow groundwater.
Specific yield and specific storage	Less water would be released for a given decline in head, drawdown may develop more rapidly, and recovery may occur more quickly once dewatering stops.	More water would be released from storage, which may reduce the rate of drawdown development but increase the volume requiring removal and extend recovery.
Effective porosity	Groundwater and particle velocities would be faster and modelled travel times shorter. Groundwater-level drawdown predictions would be largely unchanged.	Groundwater and particle velocities would be slower and travel times longer. Groundwater-level drawdown predictions would be largely unchanged.
Recharge	Lower recharge would generally increase drawdown persistence and lengthen recovery.	Higher recharge would generally reduce drawdown persistence and accelerate recovery, although it may increase mine inflows during wet periods.
Mine schedule and dewatering representation	Shorter or less concurrent dewatering would reduce cumulative interaction.	Longer or more concurrent dewatering, particularly if Lei and BP33 cease dewatering at similar times, could increase the magnitude and duration of overlapping drawdown.

In fresh rock, groundwater flow is expected to occur predominantly through fractures rather than through the rock matrix. Fracture frequency, aperture and connectivity commonly decrease with depth as weathering diminishes and confining stress increases. The effective hydraulic conductivity of the deeper fresh rock is therefore likely to be lower than values derived from shallower, more weathered or locally fractured test intervals (Section 2.4.3). Storage properties are also expected to decrease with depth because fresh rock generally has lower drainable porosity and compressibility than the overlying weathered profile. The adopted base-model values may therefore represent relatively transmissive and responsive conditions for the deeper fresh rock.

The uncertainty analysis accounts for this limitation by applying broad ranges to the hydraulic conductivity and storage parameters assigned to HSU2 and HSU3. For HSU3, horizontal hydraulic conductivity was varied from $1x10^{-5}$ to $1x10^{-1}$ m/d, compared with an initial value of $1x10^{-3}$ m/d. Specific yield and specific storage were also varied over several orders of magnitude (Table 5-1). These ranges encompass conditions in which the deeper fresh rock is substantially less permeable and has lower storage than represented in the base model, while also allowing for the possible influence of more transmissive fracture zones.

Lower fresh-rock hydraulic conductivity would generally restrict the lateral propagation of dewatering effects and reduce the volume of groundwater able to move towards the mine

workings. This would be expected to produce a smaller regional extent of drawdown and lower mine inflow volumes than predicted by the base model. Drawdown close to the excavation may remain locally pronounced because the mine workings impose a strong hydraulic sink, but the drawdown response would be more spatially confined.

Lower storage values would reduce the volume of groundwater released from storage as water levels decline. Although lower storage can result in a more rapid local water-level response to dewatering, it does not necessarily produce a larger regional impact. When combined with lower hydraulic conductivity, the likely response is lower inflow and a more localised drawdown cone because less groundwater is available from storage and hydraulic connection through the fresh rock is reduced.

On this basis, the uncertainty ranges are considered sufficiently broad to examine the plausible effects of lower permeability and storage at depth. As the base model adopts fresh-rock properties that may be toward the more transmissive end of the likely range, its predictions of inflow and drawdown extent provide a conservative basis for assessing potential environmental impacts. The uncertainty analysis provides a means of testing this conservatism and quantifying the extent to which predicted impacts reduce under less permeable, lower-storage conditions.

8.4. Results

8.4.1. Groundwater levels

The median and interquartile range in groundwater level response at the six Lei Project observation bores from the 100 realisations are presented in Figure 8-7, Figure 8-8 and Figure 8-9.

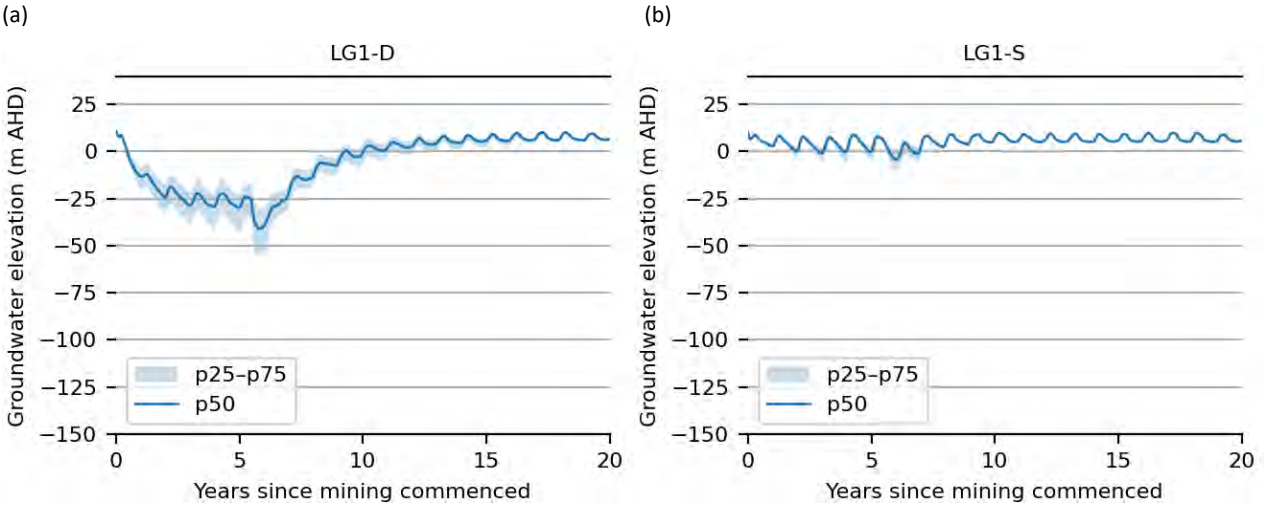


Figure 8-7 Median (p50) and interquartile (p25-p75) groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, excavations at existing Lei observation bores: (a) LG1-D and (b) LG1-S.

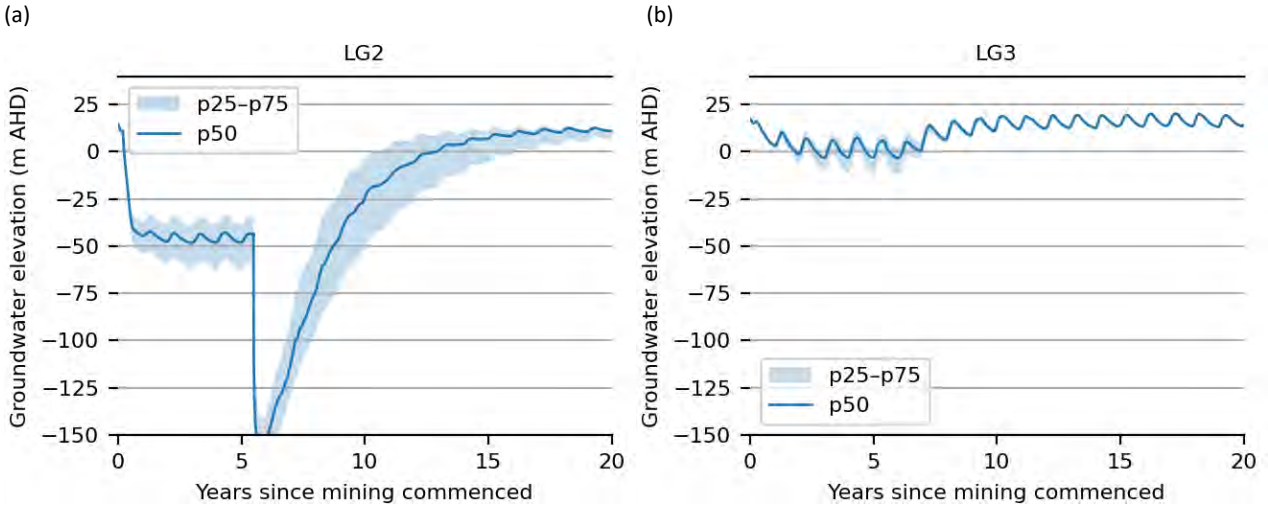


Figure 8-8 Median (p50) and interquartile (p25-p75) groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, excavations at existing Lei observation bores: (a) LG2 and (b) LG3.

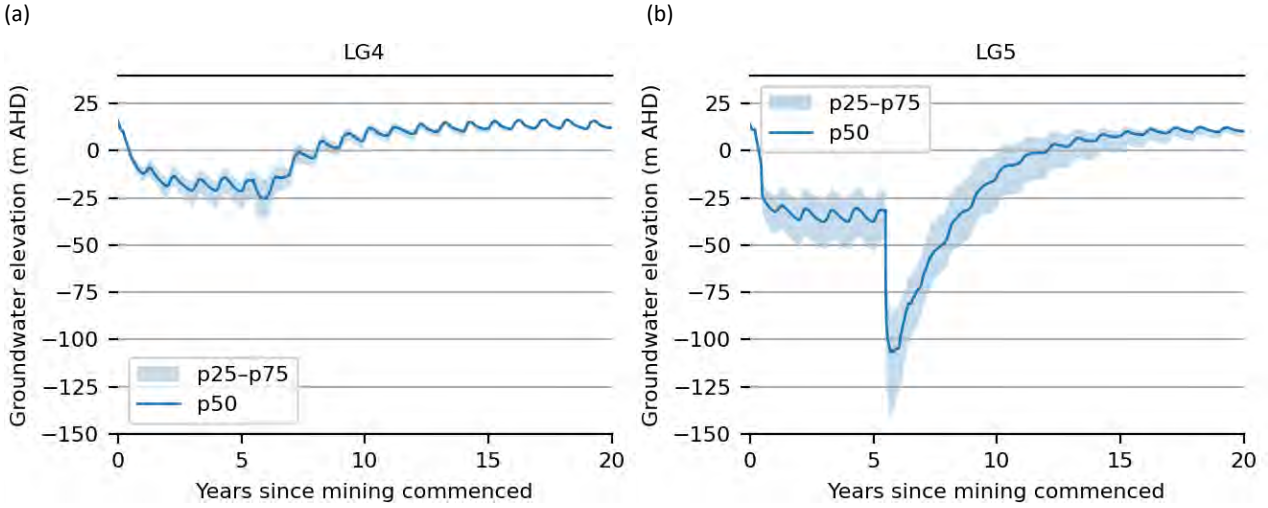


Figure 8-9 Median (p50) and interquartile (p25-p75) groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, excavations at existing Lei observation bores: (a) LG4 and (b) LG5.

8.4.2. Drawdown contours

Drawdown contours for Year 6 (EOM), Year 10, Year 15 and Year 20 after mining commences are presented in Figure 8-10, Figure 8-11, Figure 8-12 and Figure 8-13, respectively. Each figure shows the 25th, 50th and 75th percentile drawdown contours derived from the posterior parameter ensemble across all realisations.

Across all years, the 25th, 50th and 75th percentile drawdown contours are similar in shape, with the impacted area increasing from the 25th to the 50th and 75th percentile.

After 4 years of recovery, the majority of the drawdown is contained within the mine lease with residual drawdown greater than 0.5 m, 1.0 m and 2.0 m centred on the box cut 25th, 50th and 75th percentile plots Figure 8-11a, Figure 8-11b and Figure 8-11c respectively.

After 14 years of recovery, Year 20, the watertable has completely recovered in the 25th and 50th percentile contours, shown in Figure 8-13a and Figure 8-13b, respectively. In the 75th percentile contour, shown in Figure 8-13c, residual drawdown greater than 0.1 m remains centred on the box cut.

(a) (b) (c)

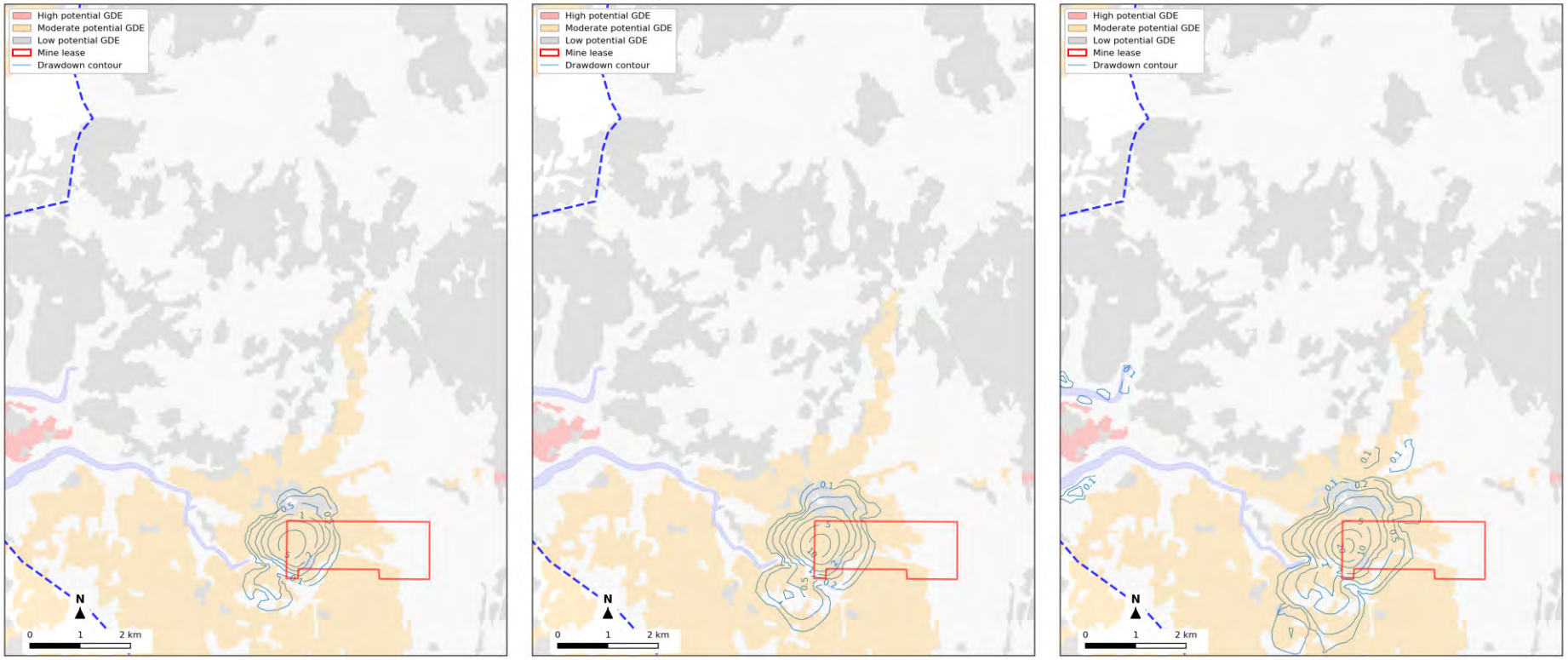


Figure 8-10 Drawdown contours at the end of mining, 6 years after the commencement of mining: (a) the 25th percentile of realisations, (b) 50th percentile of realisations and (c) 75th percentile of realisations.

(a) (b) (c)

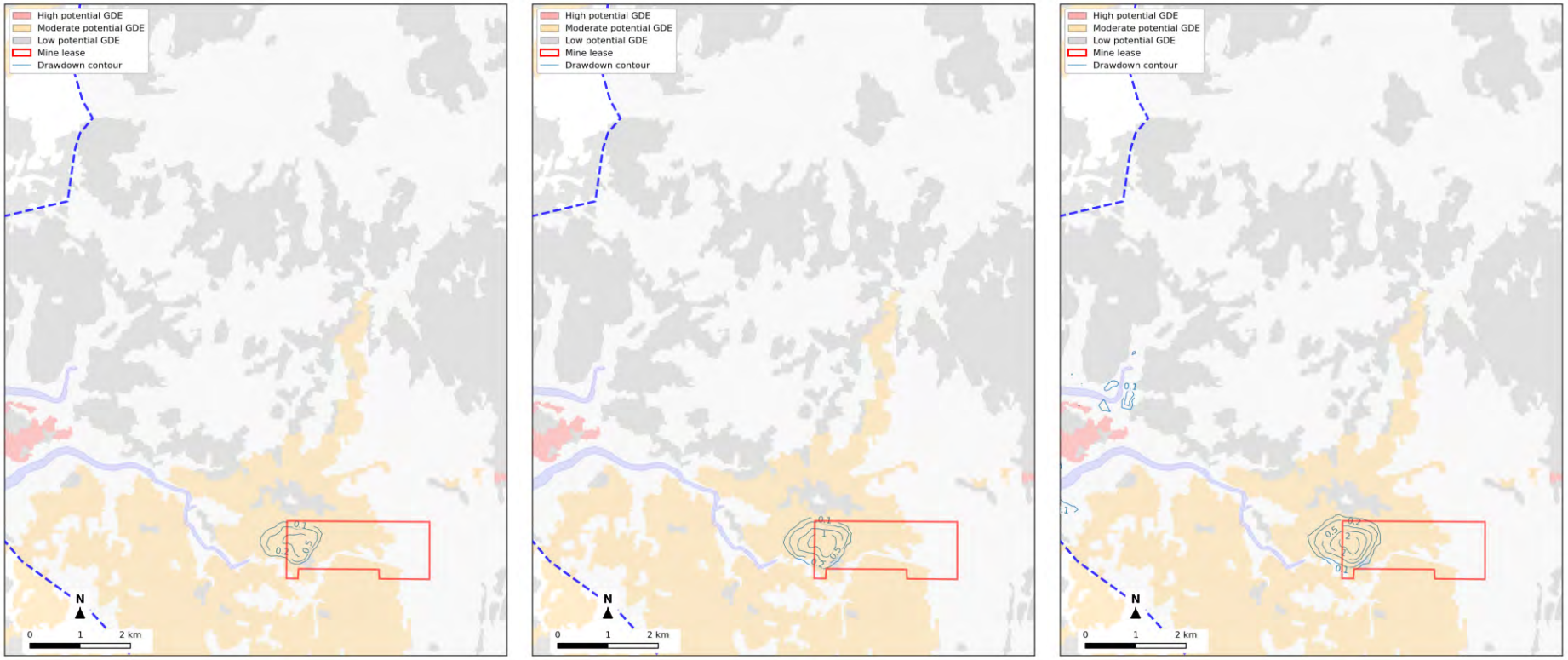


Figure 8-11 Drawdown contours 10 years after the commencement of mining: (a) the 25th percentile of realisations, (b) 50th percentile of realisations and (c) 75th percentile of realisations.

(a) (b) (c)

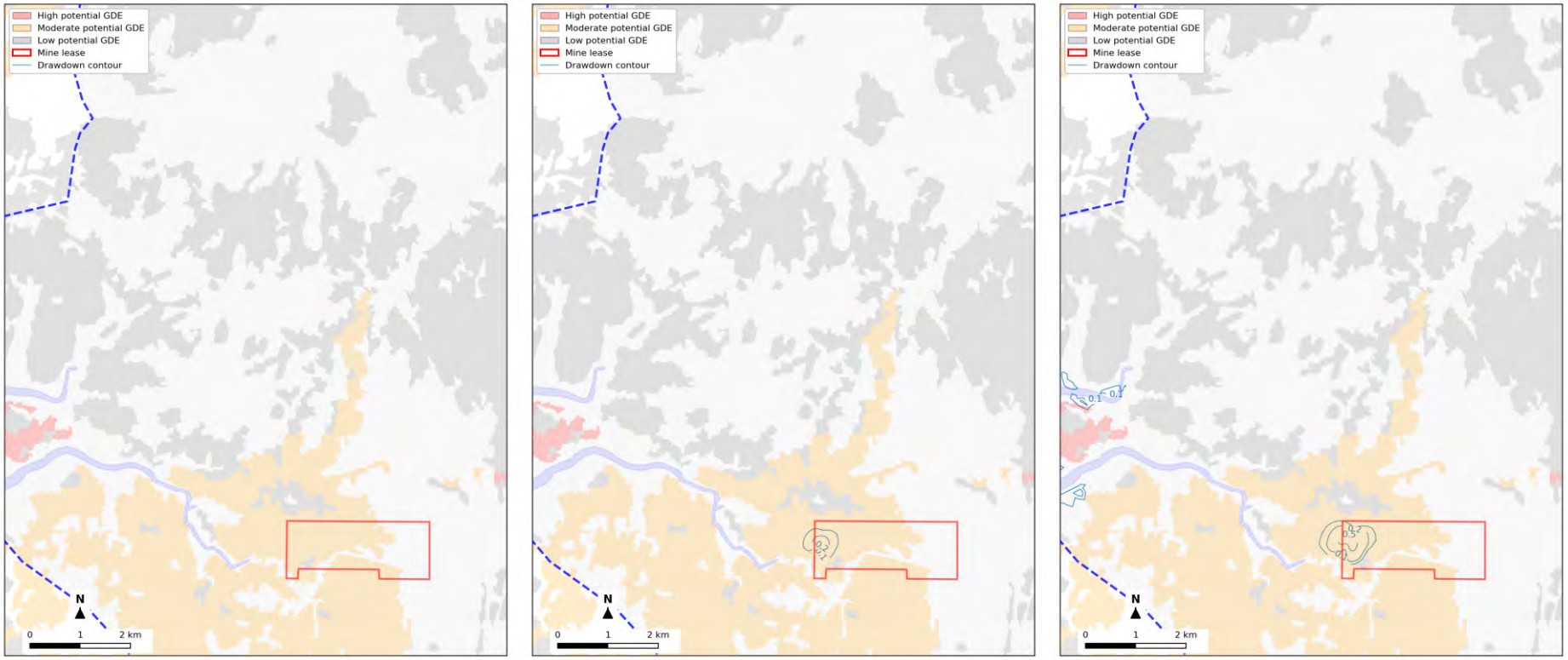


Figure 8-12 Drawdown contours 15 years after the commencement of mining: (a) the 25th percentile of realisations, (b) 50th percentile of realisations and (c) 75th percentile of realisations.

(a) (b) (c)

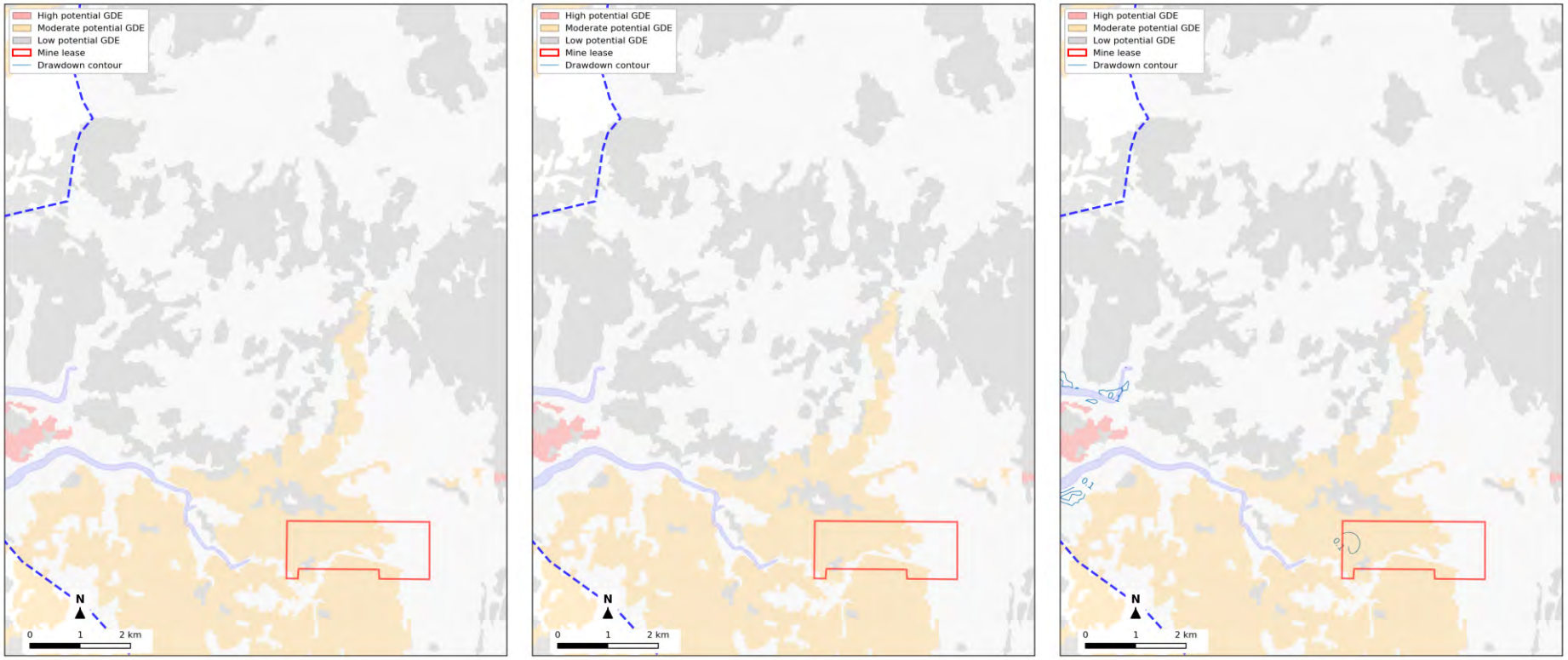


Figure 8-13 Drawdown contours 20 years after the commencement of mining: (a) the 25th percentile of realisations, (b) 50th percentile of realisations and (c) 75th percentile of realisations.

8.5. Residual uncertainty and further work

Overall, the uncertainty analysis indicates that the predicted groundwater impacts are robust to plausible variations in recharge and hydraulic properties. While uncertainty influences the magnitude of predicted groundwater responses, many plausible parameter combinations produce lower inflows and a more spatially confined drawdown response than the calibrated base model. Consequently, the base model provides a suitably conservative basis for environmental impact assessment.

- Extract and report annual groundwater abstraction for BP33 and Grants so that combined annual extraction can be compared with model-domain recharge.
- Install nested monitoring bores near the tidal reach of the Charlotte River to define groundwater salinity stratification and vertical hydraulic gradients.
- Continue groundwater-level monitoring through construction and operations, with trigger levels linked to model predictions and uncertainty bounds.
- Update the model when additional hydraulic testing, mine inflow, groundwater level or salinity data become available.
- Review the assumed recharge distribution when the final infrastructure layout and water-management design are available.
- Reassess cumulative predictions if the BP33 or Grants mine schedules, closure assumptions or dewatering rates materially change.

9 Conclusions

A three-dimensional numerical groundwater model was developed using FEFLOW to assess the potential groundwater effects of the proposed Lei underground lithium mine on ML33874 under the Project-only scenario. The model was also used to assess the cumulative groundwater impacts associated with the Lei Project together with the Grants Lithium Project open pit mine and the BP33 underground mine, located on ML31726 and ML32346 respectively.

The Lei mine is proposed to operate for about 6 years, with the underground void remaining unfilled and the access box cut backfilled with waste rock. The BP33 mine is proposed to operate for about 5 years, with both the underground workings and the access box cut backfilled with waste rock. The GLP pit void is expected to remain open and form a pit lake following mine closure.

The model is based on the conceptual hydrogeological model and was calibrated using the available groundwater-level, hydraulic-property and mine-water data. Parameter estimation and model evaluation were undertaken in accordance with best-practice guidelines (Barnett et al., 2012). The model is considered to meet the requirements of a Class 2 confidence-level classification and is suitable for estimating mine inflows and assessing the magnitude, spatial extent and duration of groundwater drawdown. However, the available calibration record does not include groundwater response under active dewatering. Confidence is therefore greatest for near-term predictions, while longer-term forecasts should be progressively verified and refined as additional groundwater-level and measured mine-discharge data become available.

The modelling indicates that dewatering will produce measurable groundwater drawdown near the proposed mine workings. However, drawdown is predicted to remain largely localised around the Lei and BP33 underground mines and the Grants open pit, without producing a regional groundwater depression. Groundwater levels are predicted to recover progressively following the cessation of dewatering.

These conclusions reflect the available hydrogeological information, the magnitude and duration of stresses represented in the calibration dataset, and the assumptions incorporated into the model. The groundwater model should therefore be reviewed periodically as operational monitoring data become available. The predicted environmental significance of groundwater changes, including effects on groundwater-dependent ecosystems and surface water features, is assessed separately in the overarching groundwater impact assessment report.

9.1. Project-only forecasts

The Project-only scenario represents dewatering of the Lei underground mine and associated access box cut over an operational period of about six years. Following closure, the access box cut is assumed to be backfilled with waste rock, while the underground workings are assumed to remain unfilled.

Predictive simulations were undertaken to estimate mine inflows and groundwater impacts for an overall period of about 20 years, comprising about six years of mine operation followed by about 14 years of post-closure recovery.

- Mine dewatering is predicted to produce a localised cone of groundwater drawdown around the Lei underground workings.

- The 0.1 m drawdown contour is predicted to extend beyond parts of the mining lease and intersect the tidal reach of the Charlotte River. The environmental significance of this predicted drawdown is considered separately in the groundwater impact assessment.
- Groundwater inflow into the underground mine is expected to peak at about 600 ML/year (~19 L/s).
- Groundwater levels are predicted to recover to near pre-mining levels around 15 to 20 years after the start of the simulation. As mining and dewatering occur for about six years, this corresponds to a post-closure recovery period of around 9 to 14 years. No permanent regional groundwater depression is predicted.
- Particle tracking indicates that saline groundwater from the tidal reach of the Charlotte River could be drawn toward the Lei underground workings. However, results suggest this is unlikely to affect shallow groundwater-dependent ecosystems (GDEs). Saline inflows may occur locally within the underground mine, and discharge water may therefore require blending with fresher groundwater prior to release.

The vertical and lateral extent of saline groundwater near the Charlotte River is not well constrained by the available monitoring data. A nested monitoring bore should therefore be installed adjacent to the riparian zone of the tidal reach to characterise salinity stratification and identify any changes associated with mine dewatering. Water-quality monitoring should also inform whether dewatering discharge will require treatment or blending before release.

9.2. Cumulative forecasts

The cumulative scenario represents concurrent dewatering associated with the Lei Project, BP33 underground mine and Grants Lithium Project. At the end of the operational period, separate drawdown cones are predicted around the Grants open pit and the Lei and BP33 underground workings.

The main conclusions from the cumulative simulations are:

- The predicted drawdown cone extends about 1 km from the Grants open pit and about 2 km from the Lei and BP33 underground mines.
- The drawdown cones associated with the Lei and BP33 underground mines are predicted to overlap roughly halfway between the two mines.
- At Lei, the 0.1 m drawdown contour extends beyond the southern, northern and western boundaries of the mining lease and intersects the tidal portion of the Charlotte River. The predicted extent of drawdown is otherwise similar to that under the Project-only scenario.
- Groundwater drawdown associated with the Lei underground mine are predicted to affect groundwater levels beneath ephemeral drainage lines and impact water levels outside the mining lease. The significance of these changes depends on their magnitude, duration and relationship with environmental receptors.
- Post-closure groundwater recovery under the cumulative scenario is generally consistent with the Project-only scenario.

Maximum concurrent groundwater extraction from the three operations is predicted to be about 4.14 GL/year, representing about 14% of the calibrated average annual recharge of 28.6 GL/year across the 193.6 km² model domain.

This comparison provides useful regional context for the scale of groundwater abstraction but does not, by itself, demonstrate that local environmental effects will be absent. Local impacts depend on the spatial and temporal distribution of recharge and groundwater abstraction, aquifer hydraulic properties, fracture connectivity, and the proximity and groundwater dependence of environmental receptors. Accordingly, potential environmental impacts have been assessed using the predicted drawdown, groundwater recovery and particle-tracking results rather than the regional recharge comparison alone.

The Lei Project is located within the DRARWCD; however, the BCF is not currently managed under a declared Water Allocation Plan. The predicted maximum cumulative groundwater extraction is substantially below the 20% recharge-based consumptive allocation adopted as the regional planning basis for the DRARWCD. While this comparison should be regarded as providing regional management context rather than a project-specific impact criterion, it indicates that the cumulative groundwater abstraction represents a relatively small proportion of the renewable groundwater resource.

The BCF is characterised by generally low hydraulic conductivity, low bore yields and limited existing groundwater development. Groundwater flow occurs predominantly through localised fractures and quartz veins rather than a laterally extensive, high-yield aquifer. These characteristics limit the propagation of drawdown and contribute to the relatively localised groundwater responses predicted by the model.

The predicted groundwater responses indicate that impacts to the beneficial uses of groundwater within the DRARWCD are expected to be limited. Existing groundwater use within the BCF is sparse, groundwater levels recover progressively following mine closure, and particle-tracking results under the cumulative scenario are consistent with the Project-only assessment, indicating no increased risk to identified shallow groundwater-dependent ecosystems or connected surface water receptors.

9.3. Post-closure forecasts

Following closure, the Lei underground workings are assumed to remain unfilled and the access box cut is assumed to be backfilled with waste rock. At BP33, both the underground workings and access box cut are assumed to be backfilled. The Grants open pit is assumed to remain open and develop into a pit lake.

Under both the Project-only and cumulative scenarios, groundwater levels are predicted to recover progressively after dewatering ceases. Recovery is initially most rapid near the mine workings and becomes slower as groundwater levels approach the pre-mining condition.

Groundwater levels are predicted to approach or stabilise near pre-mining levels around 15 to 20 years after the start of the simulation. As mining and dewatering occur for about six years, this corresponds to a post-closure recovery period of around 9 to 14 years. No permanent regional groundwater depression is predicted.

The uncertainty analysis indicates that the model predictions are likely to be conservative with respect to the assumed hydraulic properties of the deeper BCF. Hydraulic conductivity and storage

are expected to decrease with depth, whereas the model retains comparatively higher values in parts of the deeper fresh rock. Lower hydraulic conductivity and storage values would generally reduce predicted mine inflows and limit the extent of drawdown.

This conservatism does not remove the need for monitoring. Groundwater levels, mine inflows and groundwater salinity should be monitored during operation and recovery to compare observed responses with model predictions. The groundwater model should be reviewed and, where necessary, updated if observed conditions differ materially from the predictions.

9.4. Model review and adaptive refinement

Recent operational information reported by Artesium Consulting Services (2026) provides additional groundwater-level and mine-water data for the Grants Pit and BP33 Box Cut that were not available during development of the current Lei groundwater model. Although groundwater levels have been monitored at Grants from June 2017 to March 2025 and at BP33 over varying periods between 2020 and 2025, the portions of these records representing sustained active dewatering are comparatively short. At Grants, only about two to three months of complete dewatering records were available, while development of the BP33 Box Cut extended for about five months and the reported groundwater inflows were primarily estimated from subsequent pit-lake recovery and water-balance calculations.

These datasets provide valuable operational evidence but do not yet represent the range of groundwater responses expected over the full LoM. The Lei groundwater model should therefore be reviewed periodically as measured groundwater levels and mine discharge volumes become available during operations. In the interim, the model is considered most suitable for supporting near-term operational forecasts over periods of around one to two years, while the longer-term forecasts provide an appropriate basis for environmental assessment and should be progressively verified and refined.

Recalibration against the expanding operational dataset would improve parameter constraint, reduce predictive uncertainty and strengthen confidence in forecasts of groundwater inflow, drawdown and post-closure recovery. Where practicable, sharing of relevant groundwater monitoring and dewatering information between the Lei, Grants and BP33 proponents would provide mutual benefit by improving understanding of the shared groundwater system and strengthening future cumulative impact assessments.

10 References

Artesium Consulting Services, 2026. *Core Lithium BP33 Mine Groundwater Dewatering Model Update. Technical Report 2026-002, prepared for Core Lithium, 13 April 2026.,* s.l.: Unpub..

Barnett, B. et al., 2012. *Australian groundwater modelling guidelines.,* Waterlines report 82: National Water Commision, Canberra.

CDM Smith, 2024. Drilling Report Lei Lithium Groundwater Bore Drilling.

CloudGMS, 2018. *Development of a Groundwater Model for the Grants Lithium Project. Final Version 1.0 Unpublished,* Adelaide: Unpub..

CloudGMS, 2021. *Fininiss Lithium Project: BP33 Groundwater Modelling Report,* Adelaide: Unpub..

Cook, P. et al., 1998. Water balance of a tropical woodland ecosystem, Northern Australia: a combination of micro-meteorological, soil physical and groundwater chemical approaches. *Journal of Hydrology,* Volume 210, pp. 161-177.

Diersch, H. J., 2015. *FEFLOW Finite Element Modeling of Flow, Mass and Heat Transport in Porous and Fractured Media.,* Heidelberg: Springer.

DLPE, 2026. *Natural Resource Maps – NR Maps, https://nrmaps.nt.gov.au/nrmaps.html.* [Online].

Frater, K. M., 2005. Tin-tantalum pegmatite mineralisation of the Northern Territory. Northern Territory Geological Survey, Report 16..

GHD, 2017. Finniss Lithium Project Groundwater Investigation Report. Unpublished report prepared for Core Exploration, August 2017..

Groundwater Enterprises, 2020a. BP33 Groundwater Investigation Report. Unpublished report prepared for Core Lithium, November 2020..

Groundwater Enterprises, 2020b. Grants Prospect Drilling Completion Report. Unpublished report prepared for Core Lithium, December 2020..

Groundwater Enterprises, 2023. Lei Lithium Prospoect Preliminary Groundwater Assessment. September.

Karp, D., 2009. *Groundwater Investigation in the Johnston and Zuccoli,* Darwin: DENR.

Karp, D., 2010. *Groundwater Investigation in the City of Weddell,* Darwin: DENR.

Northern Territory Government, 2024. *Adelaide River Water Allocation Plan - Plan in Progress.* [Online].

NRETA, 2008. *Groundwater Supply Prospects and Hydrogeology of the Cox Peninsula Region. Land and Water Division, Northern Territory Department of Natural Resources, the Environment and the Arts.,* Darwin: Northern Territory Government.

NT EPA, 2025. *Notice of decision and statement of reasons - EP2024/038,* Darwin: NT EPA.

NT EPA, 2025. *NT EPA Environmental factors and objectives,* Darwin: NT EPA.

Pietsch, B. A., 1983. *Geology Map of Darwin 5073 1:100000 Geological Map Series,* Darwin: Northern Territory Geological Survey.

Pietsch, B. & Stuart-Smith, P., 1987. *Darwin SD52-4, 1:250 000 Geological Map Series Explanatory Notes,* Darwin: Department of Mines and Energy, Northern Territory Geological Survey.

Verma, M., 1982. *Cox Peninsula Hydrogeology, Report 8/1982, Water Division, Department of Transport and Works, Darwin, 1982.,* Darwin: Northern Territory Government.

Verma, M., 1994. *Report on Hydrogeology of the Berry Springs – Noonamah Area WRD62/1994,* Darwin: Northern Territory Government.

Verma, M., 2002. *Hydrogeological Map of Darwin Explanatory Notes 1:250 000 Scale Map WRD34/2002,* Darwin: Northern Territory Government.

Verma, M., 2004. *Water Resources Map of Bynoe 1:100 000 Map Sheet 5072. Department of Infrastructure, Planning and Environment, Northern Territory Government.,* Darwin: Northern Territory Government.

A2: Cloud GMS Modelling Report addendum

Lei Lithium Project Groundwater Model Addendum Report

Final Version 1.0

PREPARED FOR LITHIUM PLUS MINERALS LTD
BY CLOUDGMS

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Abbreviations and acronyms

AHD	Australian Height Datum
BCF	Burrell Creek Formation
BOM	Bureau of Meteorology
BC	Boundary Condition
DEM	Digital Elevation Model
DEPWS	Department of Environment, Parks and Water Security
DIPE	Department of Infrastructure, Planning and Environment
DLRM	Department of Land Resource Management
DSO	Direct Shipping Ore
EC	Electrical Conductivity
EIS	Environmental Impact Statement
ET	Evapotranspiration
FEFLOW	Finite Element subsurface FLOW and transport system
GDA94	Geocentric Datum of Australia 1994
GDE	Groundwater-Dependent Ecosystem
GLP	Grants Lithium Project
HSU	Hydrostratigraphic Unit
LHOS	Long-Hole Open Stoping
Li_2O	Lithium Oxide
LoM	Life of Mine
ML	Mineral Lease
MWD1	Mine Water Dam 1
ne	Effective porosity
NRETA	Natural Resources, Environment, The Arts and Sport
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
pH	Potential of Hydrogen
Qa	Quaternary Alluvium
Qe	Quaternary Estuarine Deposits
RAR	Return Air Raise
ROM	Run of Mine
RMS	Root Mean Square
RWPT	Random-Walk Particle Tracking
SER	Supplementary Environmental Report
SILO	Scientific Information for Land Owners climate database
SOCS	Sites of Conservation Significance
SRTM	Shuttle Radar Topography Mission
SWL	Standing Water Level
WRD	Waste Rock Dump
WTFM	Water Table Fluctuation Method
ZOI	Zone of Influence

Units

GL	gigalitre (10^9 litres)
kL	kilolitre (10^3 litres)
km	kilometre
km^2	square kilometre
kt	Kilotonnes
ktpa	Kilotonnes per annum
L/s	litres per second
m^2/d	metres squared per day
m^2/d	metres squared per day
m^3	cubic metre
m^3/d	cubic metres per day
m^3/s	cubic metres per second
ML	megalitre (10^6 litres)
m AHD	metres above Australian Height Datum
mBGL	metres Below Ground Level
mm	millimetre
mm/d	millimetre per day
Mt	Million tonnes

1 Introduction

1.1. Background

Lithium Plus Minerals Ltd (Lithium Plus) proposes to develop the Lei Lithium Project, an underground lithium mine located on the Cox Peninsula in the Northern Territory, about 30 km south of Darwin within mineral lease application ML 33874. In 2025/26, CloudGMS completed a numerical groundwater modelling assessment of the Project to support environmental approvals and evaluate potential groundwater impacts associated with the proposed underground mine development.

The Project is located within the Bynoe Pegmatite Field, with mineralisation hosted in the Burrell Creek Formation, a fractured and weathered metasedimentary unit that forms a marginal regional aquifer. About 3.10 Mt of high-grade spodumene ore is proposed to be extracted using underground mining methods. The original mine design incorporated a surface box cut and portal providing access to a spiralling underground decline. Updated mine planning has since replaced the box cut configuration with a cut-and-cover tunnel arrangement for underground access.

This addendum report documents revisions to the numerical groundwater model to incorporate the updated cut-and-cover tunnel design and revised mine schedule. The revised modelling focuses on reassessment of groundwater inflows and evaluation of any changes to predicted drawdown impacts relevant to the ongoing environmental assessment process.

1.2. Purpose and scope

This addendum groundwater modelling report has been prepared to support the ongoing groundwater impact assessment for the Lei Project being undertaken by as part of the Supplementary Environmental Report (SER) under the Environment Protection Act 2019. The report updates the previous numerical groundwater modelling assessment completed by CloudGMS to incorporate revised mine planning assumptions associated with replacement of the proposed box cut access with a cut-and-cover tunnel configuration.

The original groundwater model provided the technical basis for assessment of groundwater impacts associated with the Project through development, calibration and application of a numerical groundwater flow model. This addendum documents revisions to the conceptualisation and numerical representation of the underground mine access and presents updated predictive simulations of groundwater inflows and groundwater drawdown associated with the revised mine design. The revised modelling has been undertaken to reassess potential impacts on identified environmental receptors, including groundwater-dependent ecosystems (GDEs), the Charlotte River and associated riparian and estuarine environments, together with cumulative groundwater impacts associated with nearby mining developments.

Accordingly, the numerical groundwater model continues to function as a supporting technical tool informing the broader groundwater impact assessment rather than constituting the impact assessment itself.

The specific objectives of the updated groundwater modelling are to:

- document revisions to the conceptualisation and numerical representation of the revised underground mine access design;
- predict groundwater inflows to the proposed cut-and-cover tunnel;
- reassess the magnitude, extent, duration and recovery of groundwater drawdown associated with Lei Project dewatering activities;
- reassess cumulative groundwater impacts associated with Lei Project dewatering activities in combination with the Grants Lithium Project and BP33 underground mine, including consideration of overlapping drawdown cones and recovery interaction;
- interpret revised numerical groundwater model outputs in the context of site-specific hydrogeology, surface water features and environmental receptors; and
- identify any changes to key uncertainties, assumptions and residual risks relevant to regulatory decision-making.

1.3. Limitations

The groundwater modelling study presented herein is based on the information available at the time of report preparation (April 2026), including existing groundwater investigations, monitoring data, hydrogeological studies, and previous numerical groundwater modelling.

The numerical groundwater model provides the predictive framework used to estimate groundwater drawdown and recovery associated with the Lei Project. Model outputs are inherently dependent on conceptual assumptions, parameterisation and the availability of hydrogeological data. Predicted drawdown magnitudes are therefore interpreted in the context of observed seasonal groundwater fluctuations to assist in evaluating the potential ecological significance of groundwater level changes.

Accordingly, this assessment considers not only the predicted outcomes from the numerical groundwater modelling, but also:

- the confidence associated with those predictions
- the sensitivity of outcomes to key model assumptions
- the implications of uncertainty for environmental risk and regulatory decision-making.

The groundwater modelling report provides the quantitative basis for the impact assessment by defining the predicted magnitude, spatial extent, duration and recovery of groundwater drawdown associated with the Lei Project. The report presents and interprets these modelling outputs in the context of site hydrogeology, surface water features and environmental receptors to evaluate the potential significance of groundwater impacts relevant to the SER.

2 Groundwater model updates

2.1. Overview of model updates

The numerical groundwater model developed by CloudGMS (2026) incorporated the Lei underground mine, the Grants Pit and the BP33 underground mine to assess cumulative groundwater impacts within the Bynoe Pegmatite Field. As part of the current update, revisions have only been made to the representation of the Lei underground mine access arrangement and associated excavation schedule. The Grants Pit and BP33 mine components remain unchanged from the original assessment and continue to be represented in the groundwater model as previously documented in CloudGMS (2026).

The principal change incorporated into the updated groundwater model is replacement of the previously proposed Lei box cut and portal arrangement with a cut-and-cover tunnel providing access to the underground decline and associated mine infrastructure. Updates to the groundwater model therefore focus on reassessment of groundwater inflows and drawdown responses associated with the revised Lei mine access design.

2.2. Lithium Plus Lei Project mining activities

Lithium Plus proposes to develop the Lei Project, an underground lithium mine located within ML 33874 on the Cox Peninsula, about 30 km south of Darwin in the Northern Territory. The Project forms part of the Bynoe Pegmatite Field and is located about 2 km south of the BP33 underground mine.

The Lei deposit comprises a steeply dipping spodumene-bearing pegmatite hosted within the Burrell Creek Formation. About 3.10 Mt of spodumene ore is proposed to be extracted using underground mining methods. The underground workings are planned to extend to a depth of about 700 m below ground level, with a project life of about seven years including construction, operations and closure (refer to CloudGMS 2026 for details of the underground mine design).

Key Project components relevant to the updated groundwater model include:

- development of a cut-and-cover tunnel and underground decline to access the Lei orebody;
- progressive development of underground workings to depths of about 700 m below ground level;
- groundwater and rainfall inflows to the cut-and-cover tunnel and underground mine requiring collection and pumping during operations; and
- temporary storage and reuse of collected mine water within site water storages.

The original mine design incorporated a surface box cut and portal to access a spiralling underground decline located east of the pegmatite body. Updated mine planning has replaced the box cut configuration with a cut-and-cover tunnel providing access to the underground decline and associated mine infrastructure.

The cut-and-cover tunnel and underground workings include sump and pumping infrastructure to manage groundwater and rainfall inflows during operations. Water collected from underground sumps will be transferred to site water storages for reuse. Ventilation raises, return air raises and

associated underground services will support underground mining activities throughout the operational life of the mine. The design of the cut-and-cover tunnel is presented in Figure 2-1.

The mine schedule was offset from the previous model version, in which the box cut commenced in January, so that construction of the cut-and-cover tunnel begins in the early Dry season in May. The timing of all other mine components associated with the Lei underground, including mine closure, was offset by the same amount.

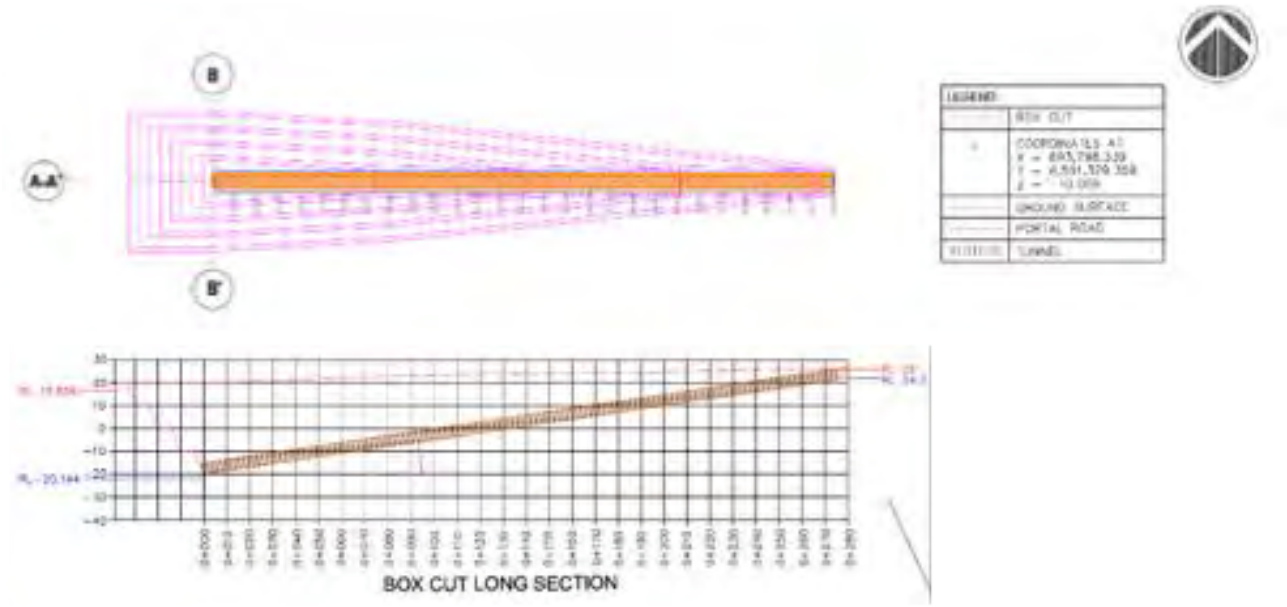


Figure 2-1 Lei conceptual cut-and-cover tunnel design.

2.3. Existing Grants Pit representation (unchanged)

The representation of the Grants Pit within the numerical groundwater model remains unchanged from the original assessment documented in CloudGMS (2026). The conceptualisation, excavation schedule and closure assumptions adopted for the Grants Pit are therefore retained without modification.

2.4. Existing BP33 representation (unchanged)

The conceptualisation and numerical representation of the BP33 underground mine within the groundwater model remain unchanged from the original assessment documented in CloudGMS (2026), including representation of the box cut, underground development sequence, seepage face boundary conditions and closure assumptions.

2.5. BP33 closure assumptions (unchanged)

The BP33 closure conceptualisation and associated groundwater model assumptions remain unchanged from CloudGMS (2026). Closure is assumed to involve progressive backfilling of the

underground workings and box cut using development waste rock and material sourced from the Grants waste rock dump, followed by rehabilitation and revegetation of disturbed areas. Hydraulic property assumptions for the backfilled materials also remain unchanged from the original assessment.

2.6. Significant sites and sensitive receptors

The Project does not occur within any Sites of Conservation Significance (SOCS) or nationally important wetlands, nor does water from the Project area flow into any of these areas. The Darwin Harbour SOCS is the closest, located about 12 km from the Lei deposit to the SOCS boundary to the Northwest. The Project will not impact on these areas and therefore they are not further considered in this report.

The Charlotte River, located 300 m south-east of the Lei deposit, is mapped by the BOM GDE Atlas, as having a moderate potential for aquatic GDEs. The Charlotte River supports significant riparian vegetation and mangrove woodlands directly downstream of the Project area.

Bynoe Harbour is utilised for both recreational and commercial purposes, with the mangrove communities within the harbour constituting 6% of the total mangrove area in the Northern Territory (Lee, 2003). The harbour's mangrove communities are supported by small tidal creeks. The Bynoe Harbour is located approximately 8 km Northwest of the Project area. Aerial imagery shows that mangrove woodlands and riparian vegetation occur directly downstream of the Project area.

2.6.1. Groundwater Dependant Ecosystems

Using the Bureau of Meteorology, Groundwater Dependent Ecosystem (GDE) Atlas (2025) an assessment of the surrounding GDEs was undertaken. Within the 2 km from the Project area there is a moderate potential aquatic GDE identified as the Charlotte River, at its closest point the Project area sits transects the river along the southwest corner. With the proposed disturbance area approximately within 300 m of the river.

Terrestrial GDEs of moderate potential is seen across majority of the Project area and the area of disturbance; the ecosystem type is identified as Eucalypt Woodland. There is additionally a low potential terrestrial GDE identified in the south-western corner of the disturbance area and Project area. The ecosystem type is identified as drainage open woodland; this species is also seen within the northern section of the 2 km site radius. shows the GDEs within a 2 km radius of the Project area.

Mangroves are mapped along the river up to the western boundary of ML33874. While groundwater flows from the aquifer to the river may supply nutrients to aquatic vegetation it is unlikely that the mangroves would be considered groundwater dependent. Mapping of surface water permanence shows that the higher reaches of the drainages are generally not permanent water sources indicating little base flow to the rivers from the groundwater during dry periods.

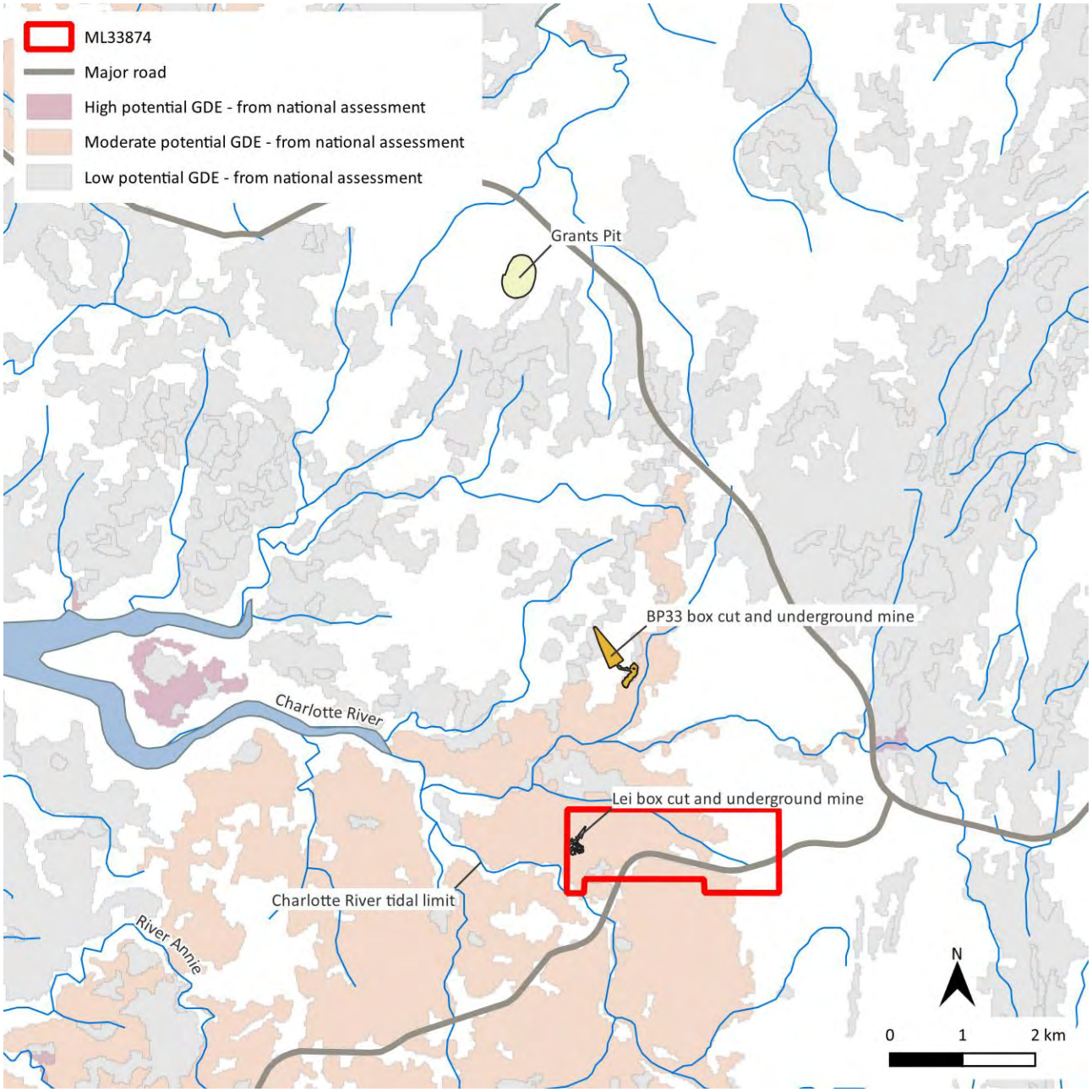


Figure 2-2 Location of Lei Project relative to the mapped terrestrial GDES (source BoM, 2025).

3 Lei mine forecast model results

This section investigates the groundwater impacts of the Lei box cut and underground workings (decline and stopes). Impacts are assessed over the life of mine (LoM) and during the post-closure period associated with recovery of groundwater levels at the Lei underground mine. The components considered were:

- Lei life of mine, 6 years
- Lei post-closure, 14 years

3.1. Lei mine life of mine forecast

The Lei LoM forecast scenario was developed to assess the effects of the proposed Lei box cut and underground workings development on groundwater flow dynamics in the surrounding area, particularly groundwater interaction with the Charlotte River. The following assumptions were adopted for the predictive model runs:

- All model parameters were derived from the calibrated model.
- Passive groundwater dewatering via sumps, with no groundwater dewatering from production bores.
- The model was run for a forecast period of 6 years LoM and 14 years post-closure.
- Initial conditions were taken from the final hydraulic heads of the calibrated model.
- During the post-closure period, the storage parameters for elements representing the Lei decline and stopes were increased to reflect the mine void volume, assuming no backfill.
- The time series climatic inputs from the period 1900 – 2000 were repeated to obtain the time series used to calculated recharge for the forecast model.

3.2. Groundwater levels Lei LoM and post-closure

The groundwater level response for bores installed around the Lei project for the 6-year LoM period and an additional 14-year post-closure period ensuring groundwater levels had fully recovered following mine closure and rehabilitation.

3.2.1. Lei groundwater levels

The forecast groundwater levels in the observation bores around the Lei box cut, decline and underground workings are presented in Figure 3-2 through Figure 3-4. The locations of the observation bores associated with the Lei underground mine are presented in Figure 3-1.

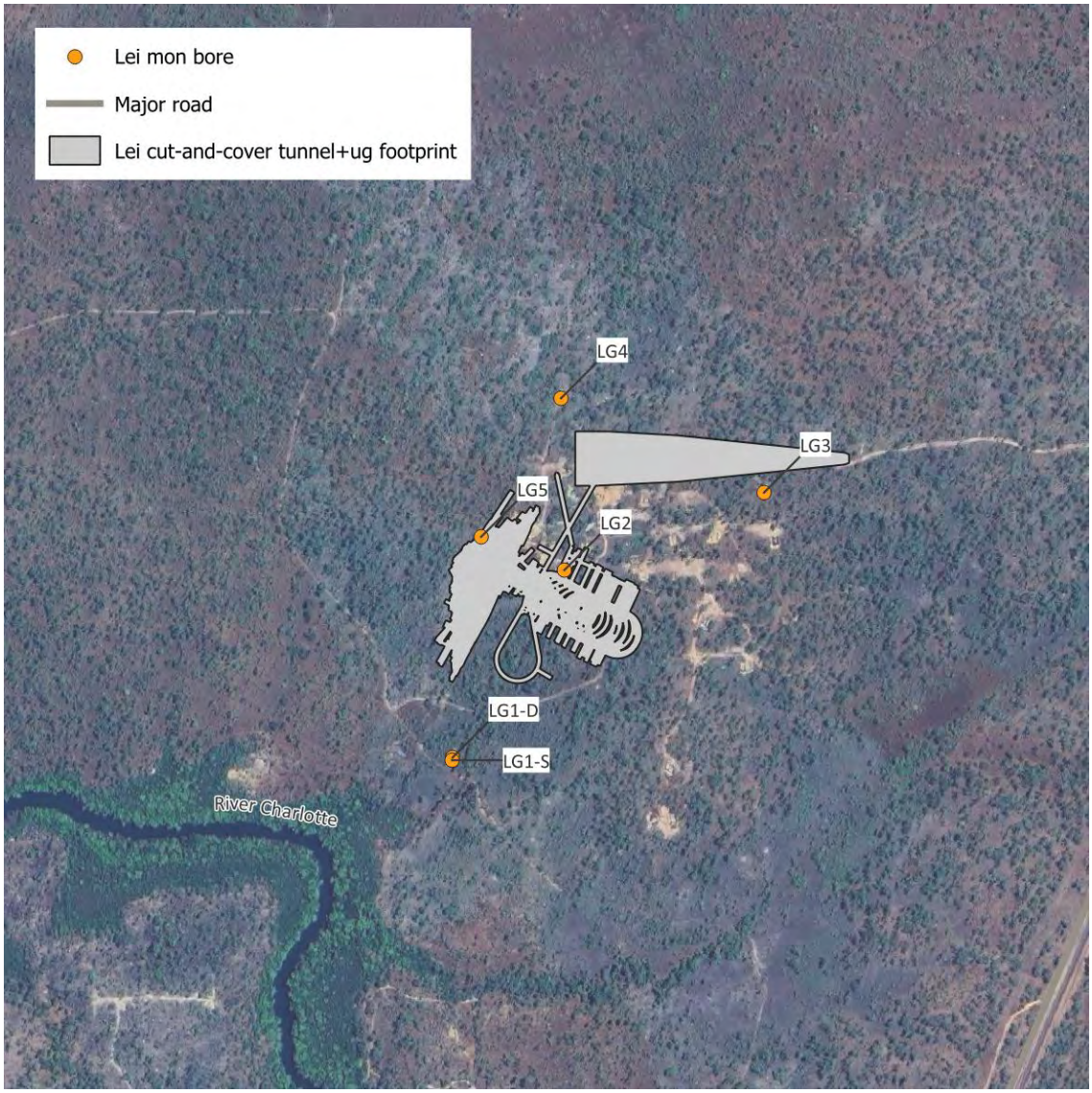


Figure 3-1 Locations of observation bores associated with the proposed Lei underground mine.

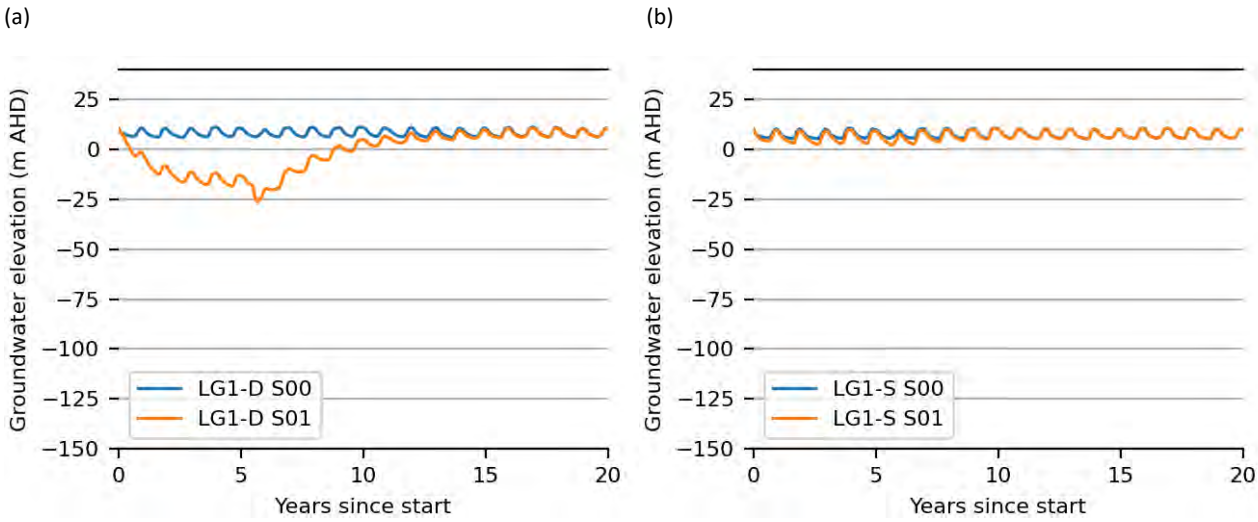


Figure 3-2 Groundwater level response during Lei LoM and 168 months post-closure at existing Lei observation bores a) LG1-D and b) LG1-S.

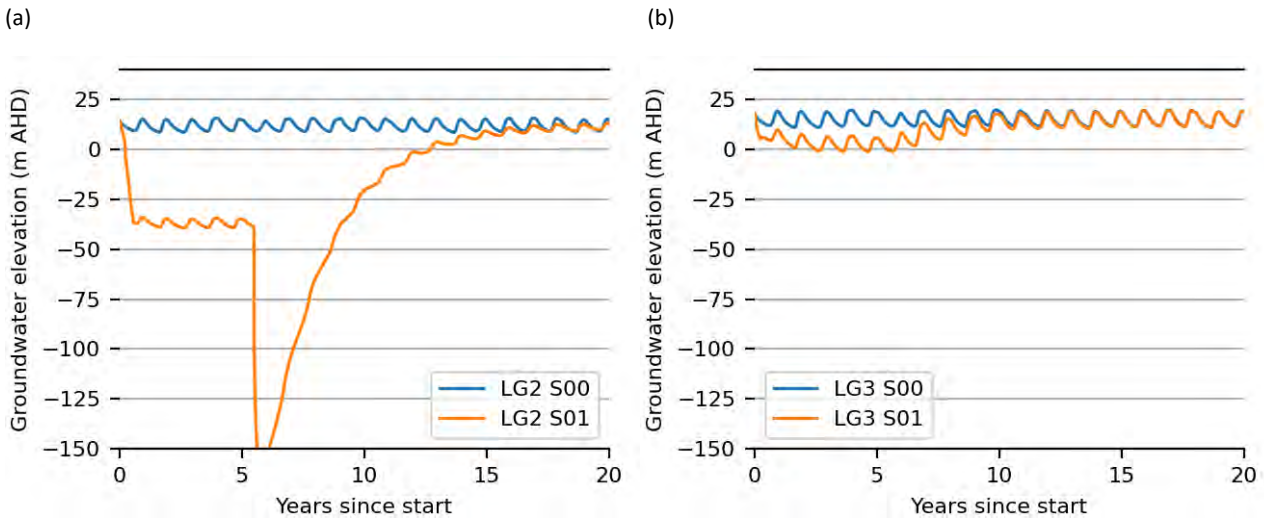


Figure 3-3 Groundwater level response during Lei LoM and 14 years post-closure at existing Lei observation bores a) LG2 and b) LG3.

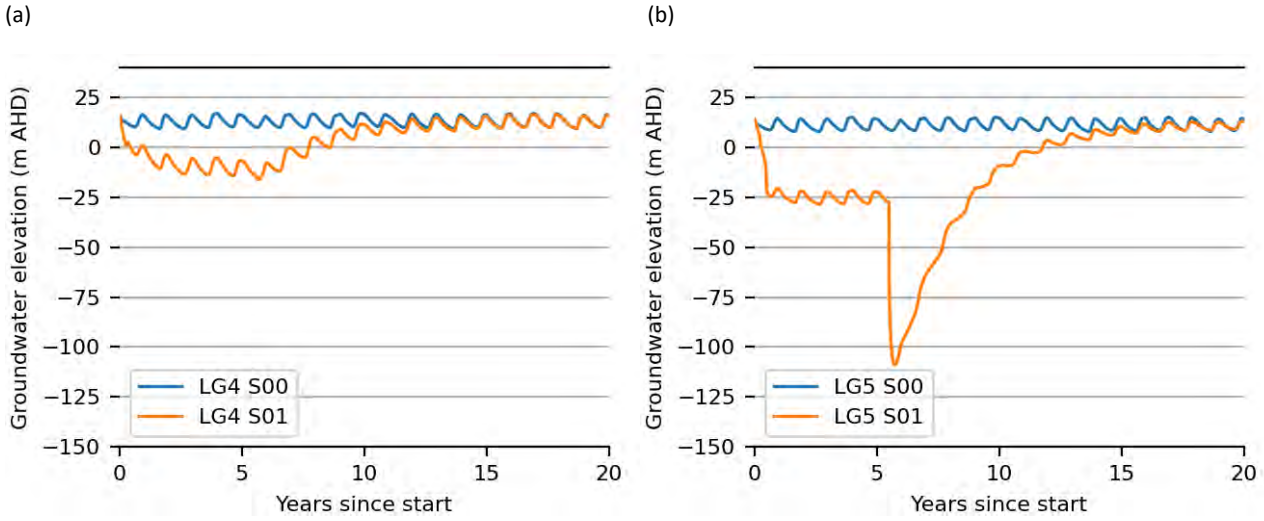


Figure 3-4 Groundwater level response during Lei LoM and 14 years post-closure at existing Lei observation bores a) LG4 and b) LG5.

3.2.2. Lei groundwater drawdown contours

The forecast drawdown magnitude and extent at Year 6 (end of underground mining), Year 10, and Year 15 at the Lei Project are presented in Figure 3-5, Figure 3-11a and Figure 3-11b respectively. Drawdown was calculated by subtracting heads under the mining scenario (s01) from heads under the natural scenario (s00).

The model forecasts indicate that, after 6 years of mining, the drawdown cone resulting from dewatering at the Lei Project extends about 1 to 2 km beyond the mining lease boundary to the north, west and south, while approaching the lease boundary to the east. Comparison of the box cut and cut-and-cover tunnel scenarios indicates that drawdown is primarily driven by dewatering associated with the construction and excavation of the underground mine. Consequently, there is little to no difference in predicted drawdown between the two development scenarios. The predicted drawdown also extends beneath areas identified as having moderate potential for GDEs.

To the west, the 0.1, 0.2 and 0.5 m drawdown contours approach the upstream end of the tidal section of the Charlotte River and is likely to intersect the river; however, it is constrained by the

specified head boundary conditions representing the river. However, in Slice 2, the drawdown does extend beneath the river (not shown here).

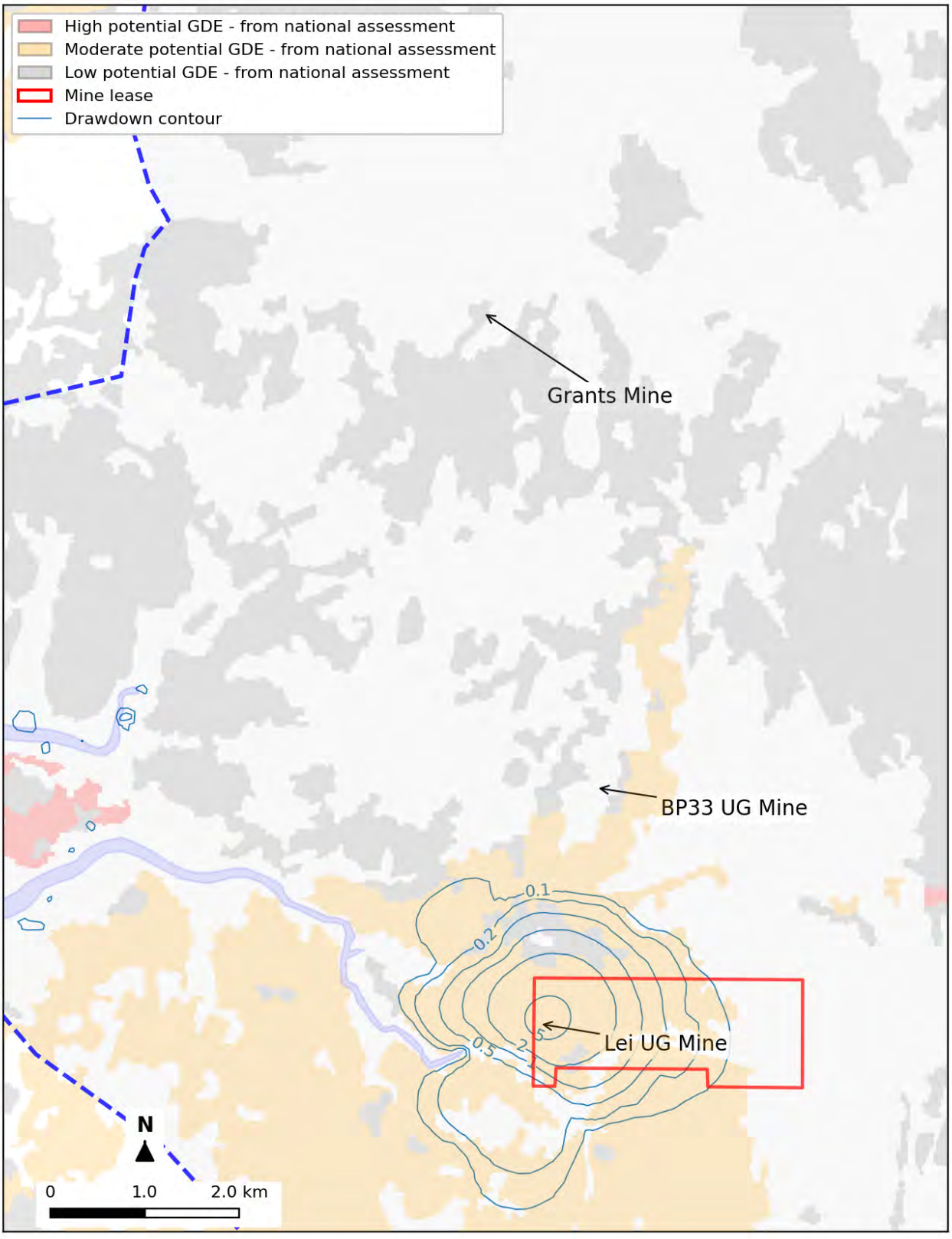


Figure 3-5 Forecast drawdown contours at the watertable (slice 1) after 6 years of mining at the Lei Project.

3.2.3. Quarterly Life of Mine inflows

Quarterly groundwater inflows to the Lei Project mine components over the LoM, expressed as ML to illustrate seasonal variability, are presented in Table 3-1 for the cut-and-cover tunnel, decline, stopes, and total combined inflows. Corresponding inflow hydrographs are presented in Figure 3-8a, Figure 3-8b, Figure 3-9a and Figure 3-9b respectively.

Table 3-1 Lei Project quarterly life of mine inflows

Year	Lei cut-and-cover tunnel (ML/quarter)	Lei decline (ML/quarter)	Lei stopes (ML/quarter)	Combined cut-and-cover tunnel and underground mine (ML/quarter)
0.25	9.6	0	0	9.6
0.5	66.6	5.4	0	72
0.75	16.2	17.4	4.5	38.2
1	29.5	33.1	9.2	71.7
1.25	37.3	44.3	4.8	86.4
1.5	23.1	50.4	6.5	80
1.75	16.6	54.1	8.9	79.6
2	28.4	58.4	11.9	98.7
2.25	34.5	62	15	111.6
2.5	21.3	63.9	17	102.3
2.75	15.7	65.1	18.9	99.7
3	22.4	65.5	20.5	108.4
3.25	36.6	68.1	22.9	127.7
3.5	23.5	69.1	24.6	117.3
3.75	16.6	68.8	26.2	111.7
4	30.2	68.4	28.3	126.9
4.25	41.7	68.6	30.5	140.9
4.5	23.4	61.2	29	113.6
4.75	18.9	74.5	37.1	130.5
5	27.8	67.2	35.1	130.2
5.25	38.1	67.2	36.7	142
5.5	22.3	58.4	34.9	115.5
5.75	13.3	61.9	37.3	112.5
6	0	0	0	0

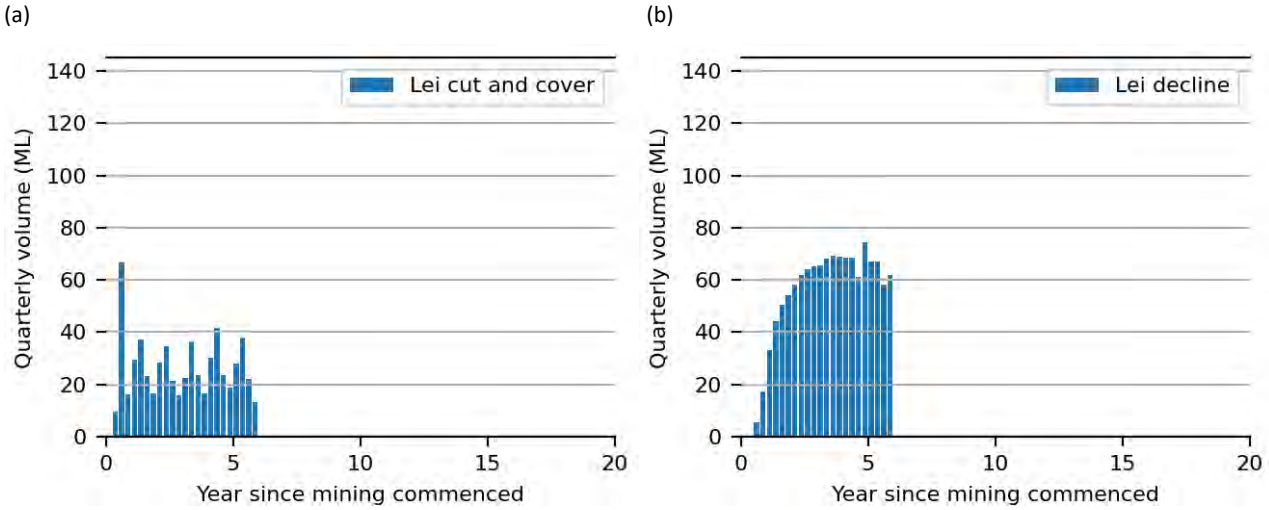


Figure 3-6 Life of mine predicted inflows (ML/quarter) for: (a) Lei cut-and-cover tunnel and (b) Lei decline.

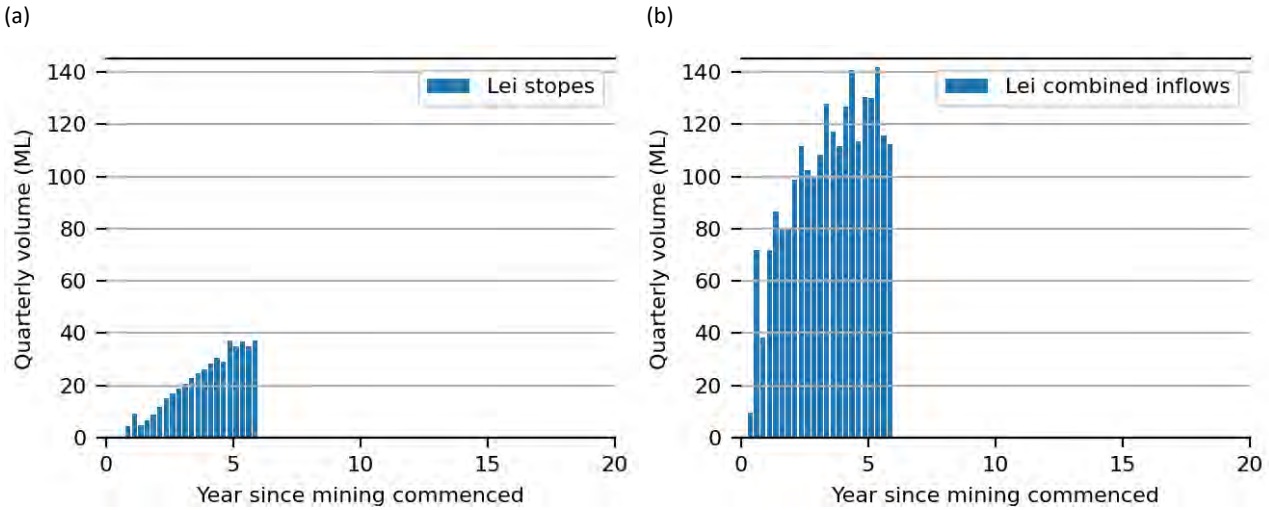


Figure 3-7 Life of mine predicted inflows (ML/year) for: (a) Lei stopes and (b) Lei box cut, decline and stopes.

3.2.4. Annual Life of Mine inflows

Annual groundwater inflows to the Lei Project mine components over the LoM, expressed as ML to illustrate seasonal variability, are presented in Table 3-2 for the cut-and-cover tunnel, decline, stopes, and total combined inflows. Corresponding inflow hydrographs are presented in Figure 3-8a, Figure 3-8b, Figure 3-9a and Figure 3-9b respectively.

Inflows to these components of the Lei Project are briefly described below:

- Inflows to the Lei cut-and-cover tunnel increase from commencement of excavation and remain relatively constant at about 100 ML/year (~3 L/s), this is about half of the inflows predicted for the Lei box cut. Lei cut-and-cover tunnel inflows, expressed as ML/year over the LoM, are presented in Figure 3-8a.
- Inflows to the Lei decline increase from commencement of excavation reaching a peak in Years 4 and 5 at about 270 ML/year (~8-9 L/s). Inflow decreases towards the end of mining. Lei decline inflows, expressed as ML/year over the LoM, are presented in Figure 3-8b.

- Inflows to the Lei stopes increase from commencement of mining and reach a peak in Year 6 at about 140 ML/year (~4 L/s). Lei stope inflows, expressed as ML/year over the LoM, are presented in Figure 3-9a.
- Combined inflows to the underground mine (decline and stopes) and the cut-and-cover tunnel increase from commencement of mining and reach a peak in Year 5 at about 510 ML/year (~16 L/s). Combined inflows to the underground mine components, expressed as ML/year over the LoM, are presented in Figure 3-9b.

Table 3-2 Lei Project life of mine annual inflows

Year	Lei cut-and-cover tunnel ML/year	Lei decline ML/year	Lei stopes ML/year	Combined cut-and-cover tunnel and UG mine ML/year
1	92	23	5	119
2	107	182	29	318
3	100	249	63	412
4	99	272	94	465
5	114	273	125	512
6	102	255	144	501

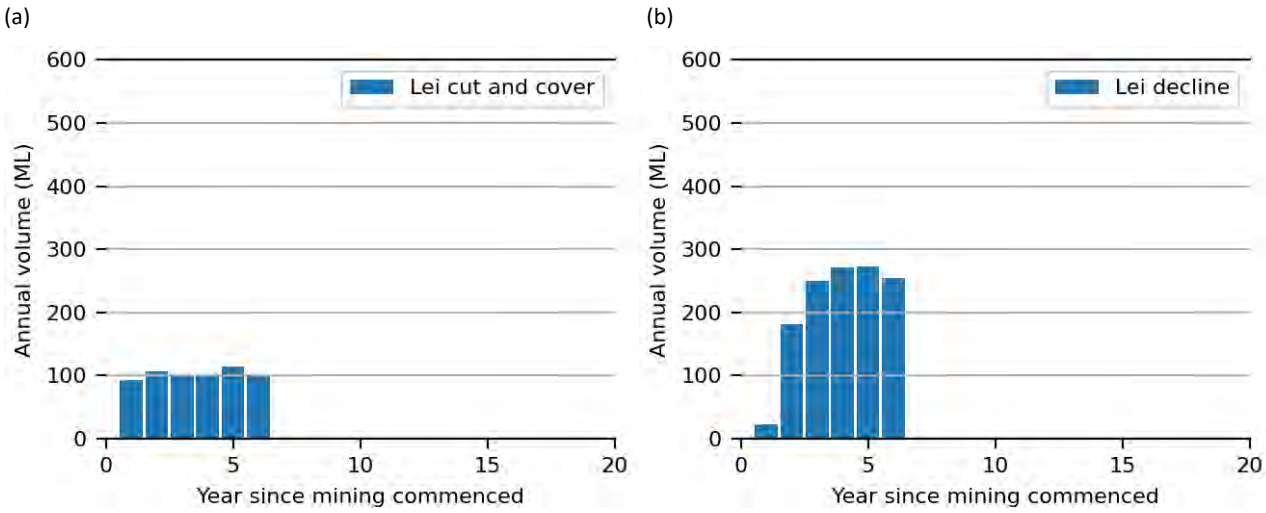


Figure 3-8 Life of mine predicted inflows (ML/year) for: (a) Lei cut-and-cover tunnel and (b) Lei decline.

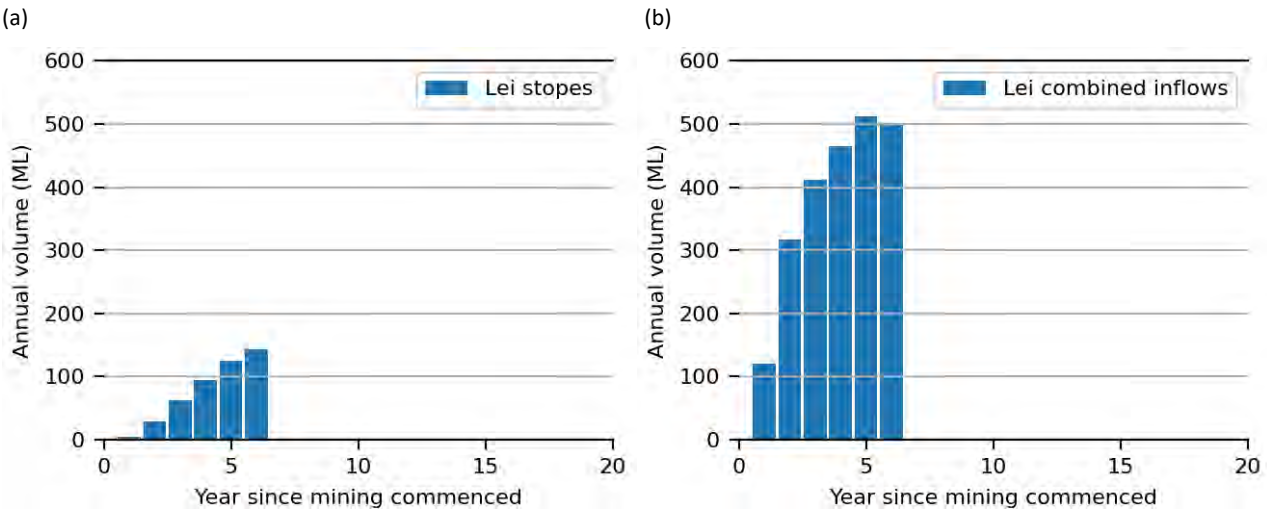


Figure 3-9 Life of mine predicted inflows (ML/year) for: (a) Lei stopes and (b) combined Lei cut-and-cover tunnel, decline and stopes.

3.2.5. Cut-and-cover tunnel inflows with reduced hydraulic connection

The final cut-and-cover tunnel is expected to incorporate a reinforced concrete structure, either cast in situ or assembled from precast concrete elements, that would substantially reduce the hydraulic connection between the surrounding groundwater system and the tunnel drains. To investigate the potential effect of this reduced hydraulic connection, the horizontal hydraulic conductivity of the very weathered layer was reduced by a factor of 10 in the immediate vicinity of the tunnel. Quarterly and annual inflows to the cut-and-cover tunnel are presented in Figure 3-10.

The results indicate that inflows are reduced by about half, suggesting that the tunnel liner is likely to have a significant effect on inflows to the tunnel.

This scenario is indicative only, as the current model does not have sufficient resolution to explicitly represent the tunnel liner, and inclusion of this level of detail would require a substantial redesign and rebuild of the model.

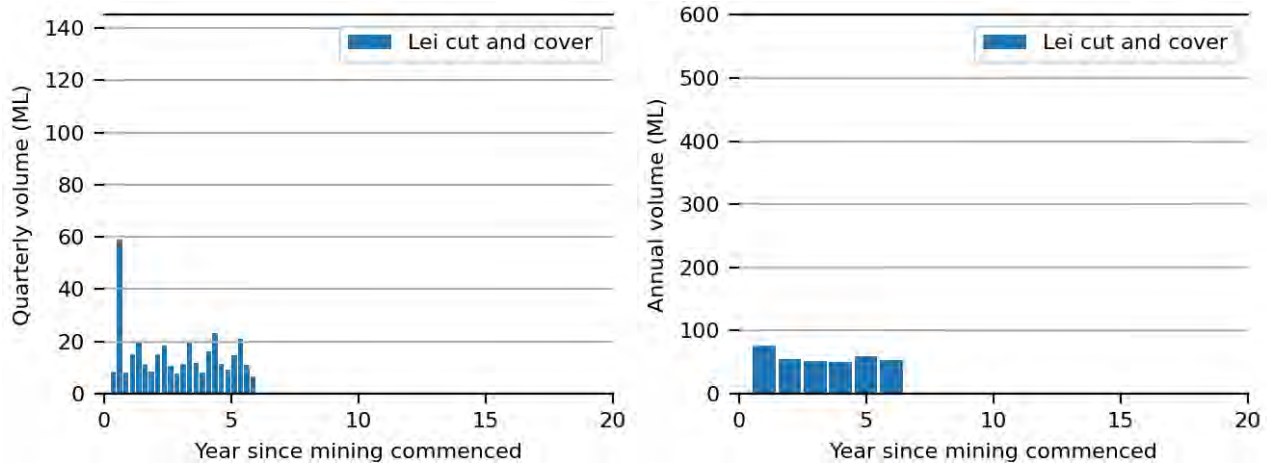


Figure 3-10 Life of mine predicted inflows for the cut-and-cover tunnel: (a) quarterly inflows (ML/month) and (b) annual inflows (ML/year).

3.3. Lei Project post-closure forecast

The post-closure impacts scenario represents an extension of the LoM scenario with the following additional assumptions and settings:

- The model was extended for an additional 14 years immediately following the end of mining at the Lei Project, resulting in a total simulation period of 20 years from the commencement of mining.
- The seepage face boundary conditions associated with the underground mine were removed.
- The material properties of the underground mine are consistent with the mine void volume.

Due to the seasonal nature of recharge, a steady state representation of the system was not considered appropriate for assessing post-closure impacts. Instead, the transient model until an approximate dynamic equilibrium was achieved, characterised by stabilisation of groundwater levels (refer to Section 3.2.1). The post-closure period of 14 years was determined from preliminary modelling.

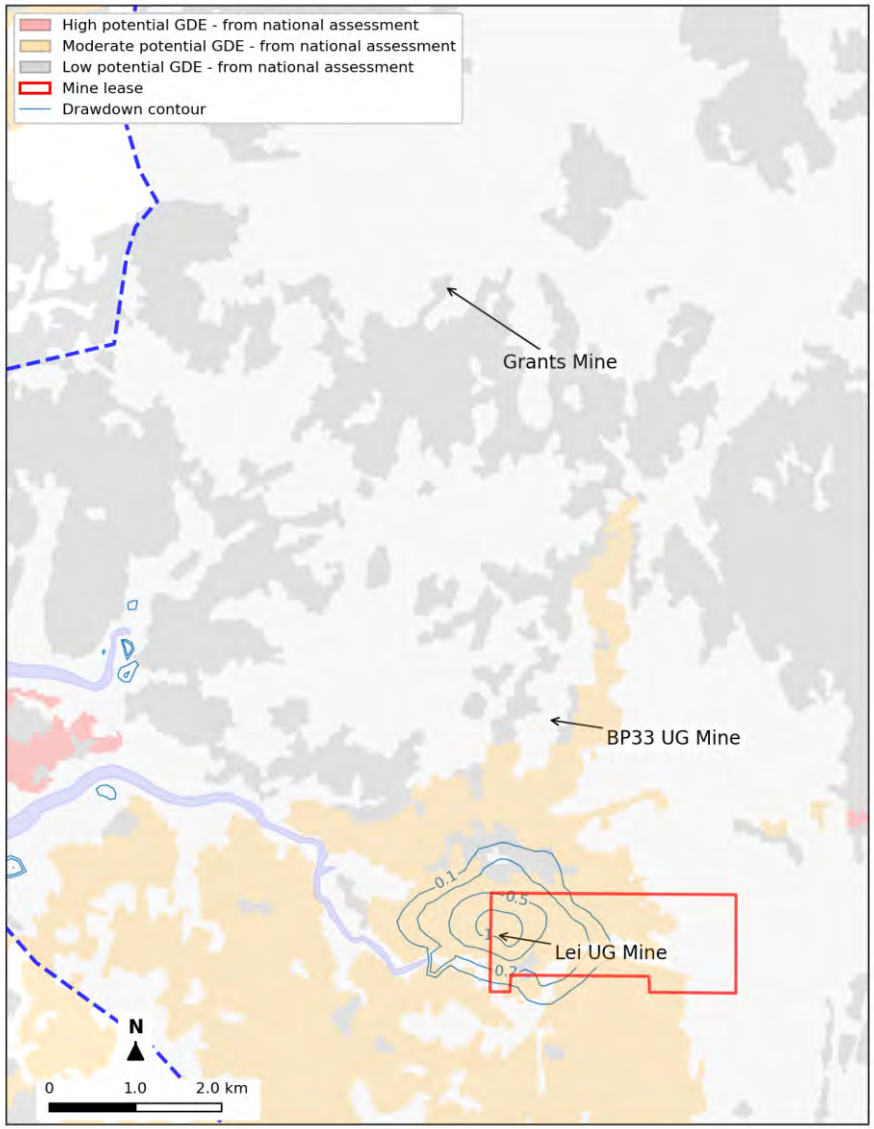
3.3.1. Groundwater level recovery

Post-closure groundwater level recovery at bores around the Lei Project is shown in Figure 3-2 through Figure 3-4. Groundwater levels recover to pre-mining conditions at all sites within about 15 years, except at LPG2. This bore, located above the decline, takes about 20 years to recover due to the time required to fill the underground mine void.

3.3.2. Groundwater drawdown contours

Post-closure drawdown contours after 4 years (Year 10) and 9 years (Year 15) of recovery are shown in Figure 3-11a and Figure 3-11b, respectively. These figures show the drawdown surface following 4 and 9 years of recovery after mine closure at the Lei Project. After 4 years of recovery, drawdown is largely confined to the mine lease, although it extends about 1 km to the north and west beyond the lease boundary. After 9 years, drawdown is fully contained within the mine lease, with residual drawdown greater than 0.1 m centred on the cut-and-cover tunnel. By Year 20 (14 years after closure), the watertable has fully recovered.

(a)



(b)

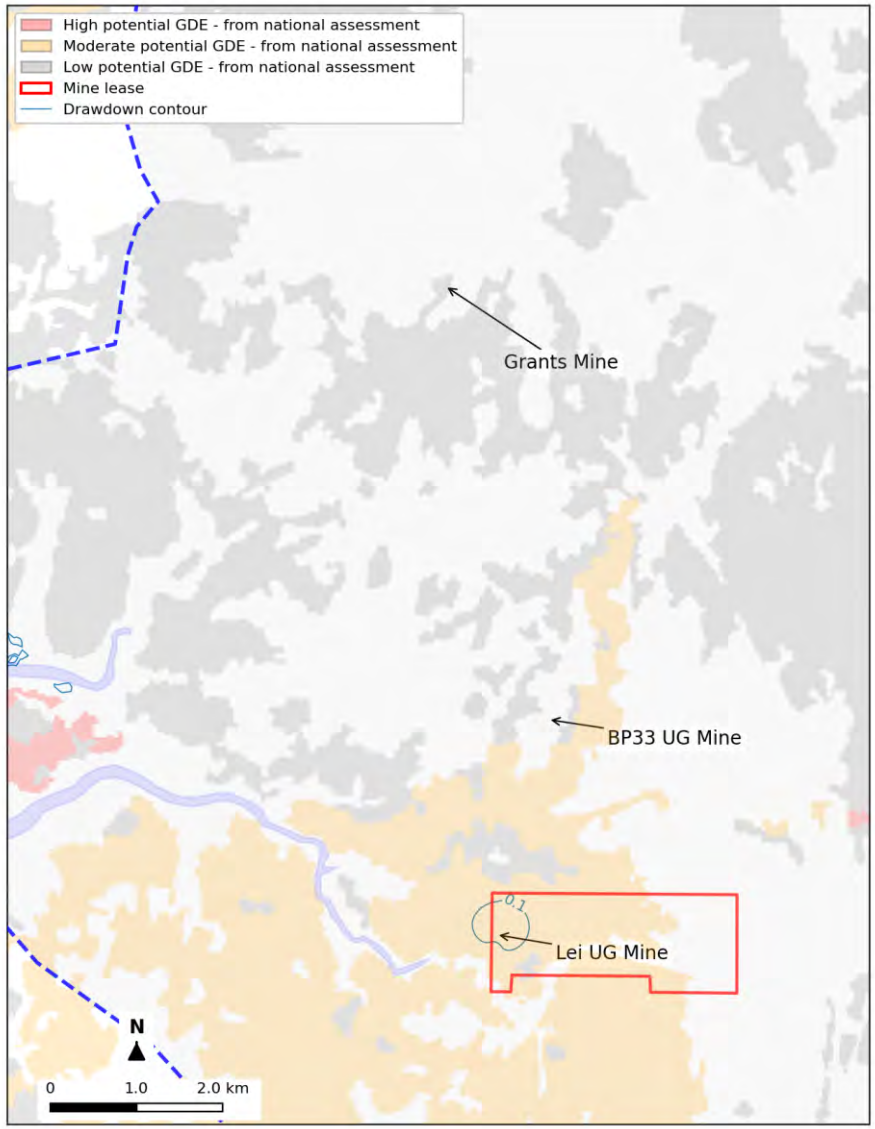


Figure 3-11 Lei Project forecast drawdown contours at the watertable following (a) 4 years of recovery, Year 10 from the start of mining and (b) 9 years of recovery, Year 15 from the start of mining.

3.4. Impacts to existing users and environmental receptors

The impacts to environmental receptors associated with the cut-and-cover tunnel scenario are predicted to be very similar to those of the box cut scenario. Groundwater flow modelling indicates that, over the 20-year simulation period, impacts are largely limited to areas within about 2 km of the Lei underground mine footprint. Watertable drawdown is predicted to extend beyond the mining lease boundary towards the tidal reach of the Charlotte River to the southwest of the Lei site. No impacts are predicted to rural stock and domestic groundwater users or existing licensed groundwater users, the nearest of which is located more than 13 km from the site.

The inclusion of the tunnel liner has little influence on the predicted extent of drawdown or associated impacts to environmental receptors. Predicted drawdown extent, potential impacts to terrestrial GDEs, and the absence of impacts to existing groundwater users remain effectively unchanged from the box cut scenario. The principal difference is a reduction in inflows to the cut-and-cover tunnel resulting from the reduced hydraulic connection provided by the completed concrete tunnel structure.

As discussed for the box cut scenario, watertable drawdown has the potential to induce saline groundwater migration inland from the tidal reach of the Charlotte River. Particle tracking was therefore used to assess potential groundwater flow paths and hydraulic connectivity between the tidal reach and groundwater systems supporting GDEs and mine workings. The particle tracking methodology and assumptions are consistent with those previously presented for the box cut scenario and are not repeated here.

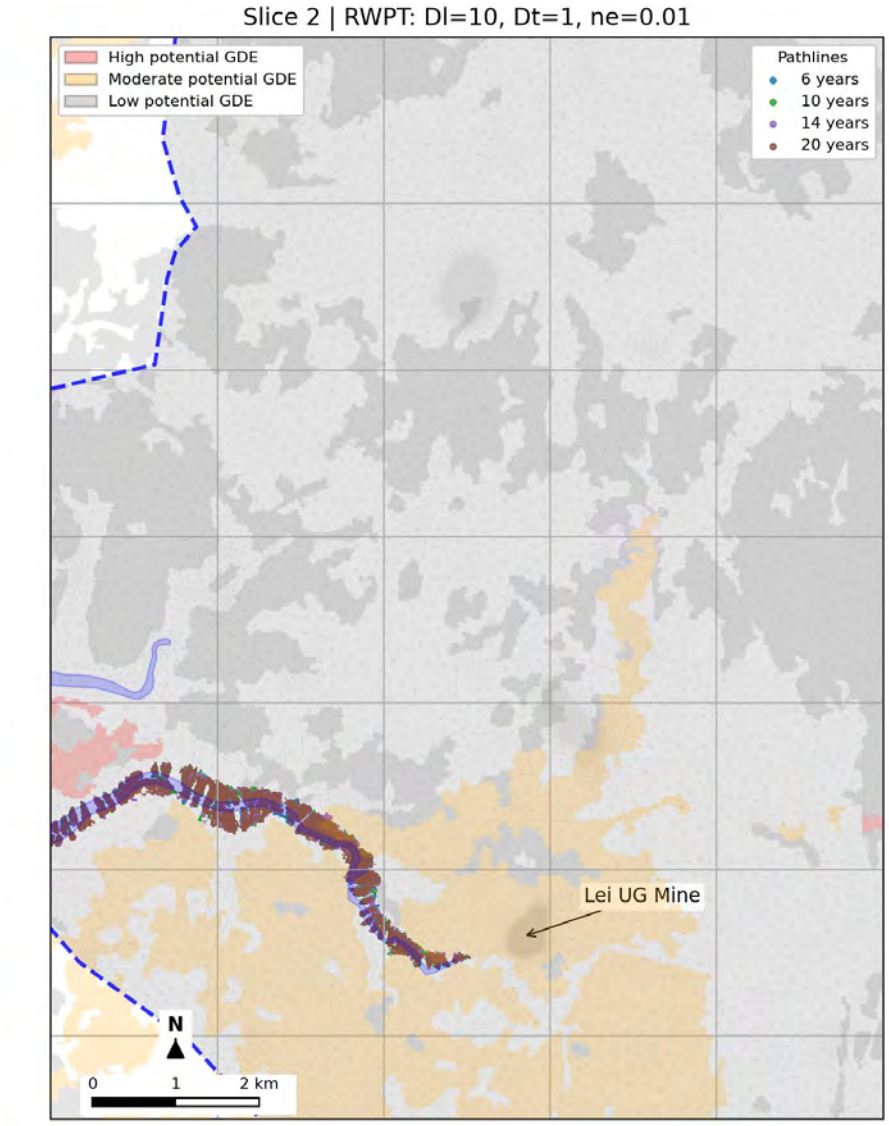
Particle tracking results for the cut-and-cover tunnel scenario were consistent with those of the box cut scenario, indicating limited inland migration from the tidal reach under most parameter combinations. For comparison, the results are presented in the following sections.

3.4.1. Particle tracking results

The fate of particles seeded beneath the tidal section of the Charlotte River was assessed using two parameter sets, consistent with the box cut scenario: a best-case scenario (DL = 10, DT = 1 and ne = 0.01), where particle migration was expected to be limited, and a conservative scenario (DL = 100, DT = 10 and ne = 0.001), where particles were expected to travel further. Results for particles seeded on Slice 2 are presented in Figure 3-12a and Figure 3-12b, respectively. The figures also show the particle migration after 6, 10, 14 and 20 years from the start of mining. Under both parameter sets, the particle tracks indicates that water originating from the Charlotte River migrates less than about 500 m inland from the river.

The fate of particles seeded on Slice 4 (top of the fresh BCF) was also assessed using the same two parameter sets. Results are presented in Figure 3-13a and Figure 3-13b, respectively. The figures also show the particle migration after 6, 10, 14 and 20 years from the start of mining. The results are consistent with the results under the box cut scenario with low possibility of saline groundwater ingress to the underground mine.

(a)



(b)

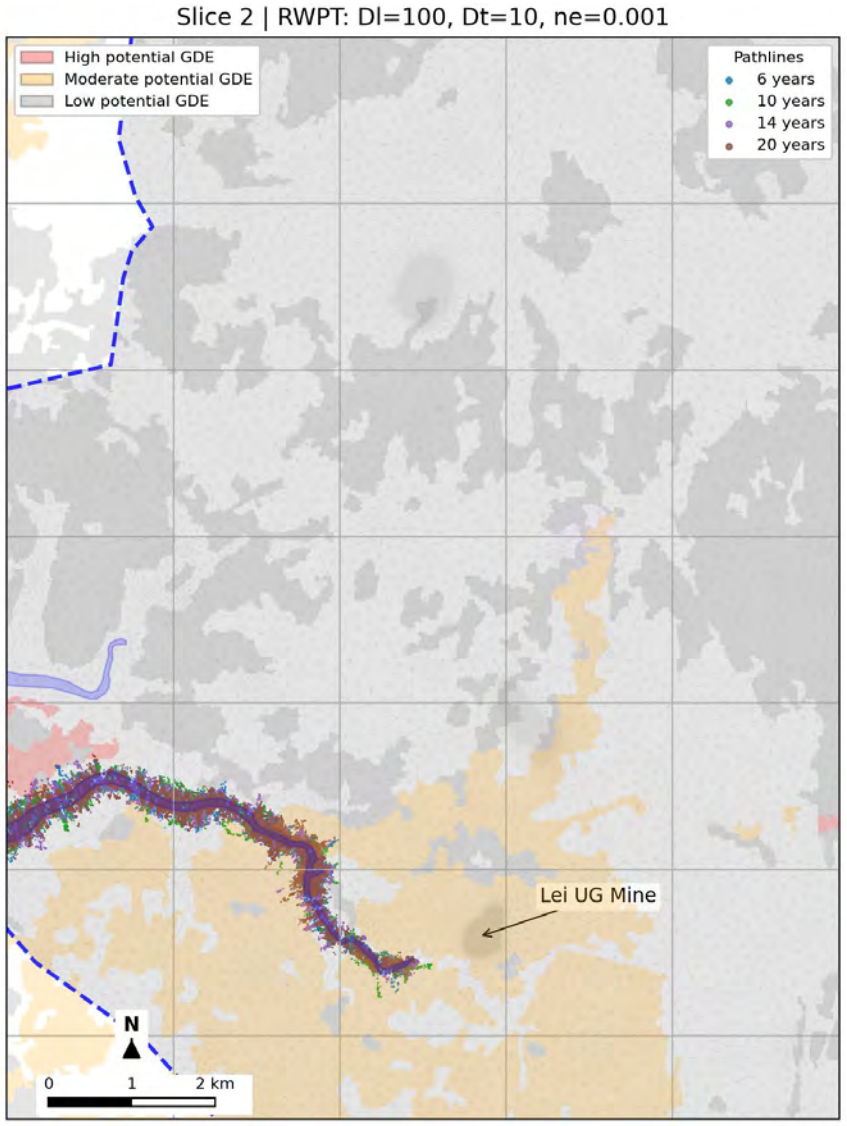
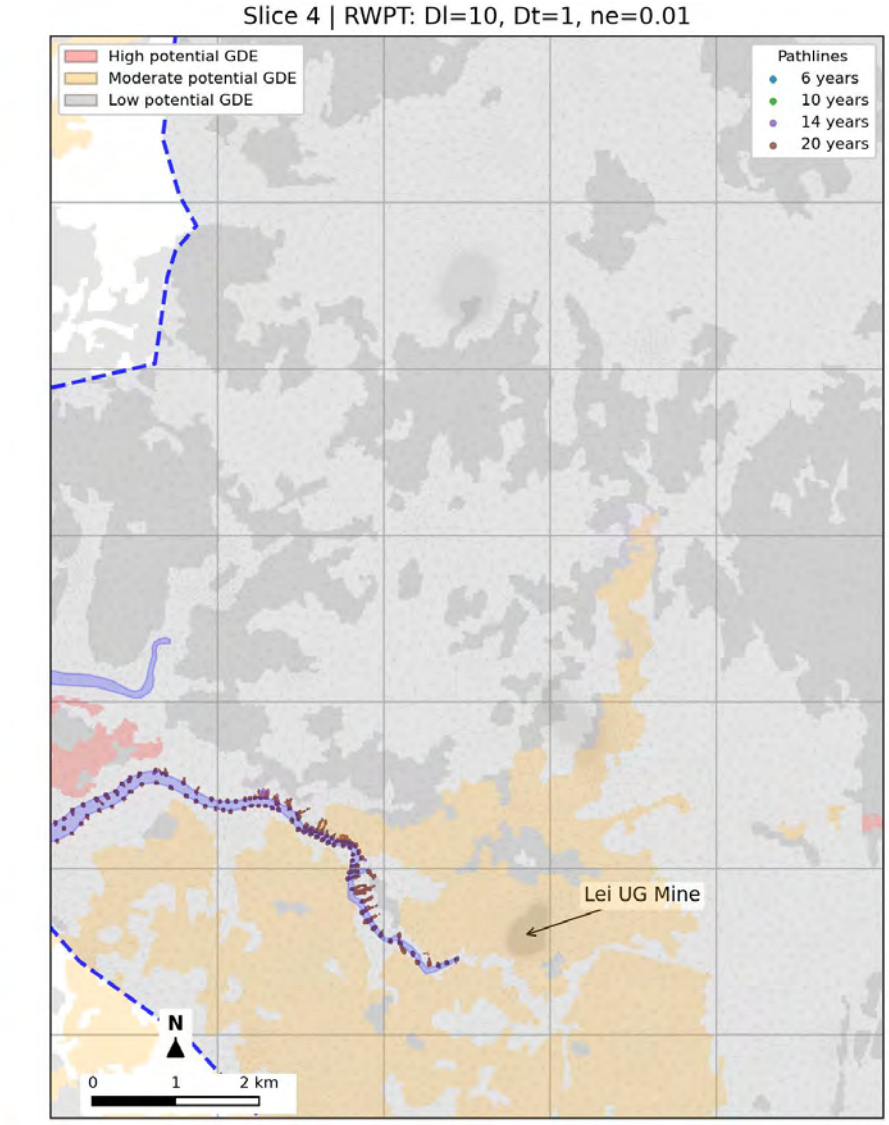


Figure 3-12 Random walk particle tracking at slice 2 for years 6, 10 14 and 20 under parameters (a) Longitudinal dispersivity (D_L)=10, transverse dispersivity (D_T)=1 and effective porosity (ne)=0.01 and (b) Longitudinal dispersivity (D_L)=100, transverse dispersivity (D_T)=10 and effective porosity (ne)=0.001.

(a)



(b)

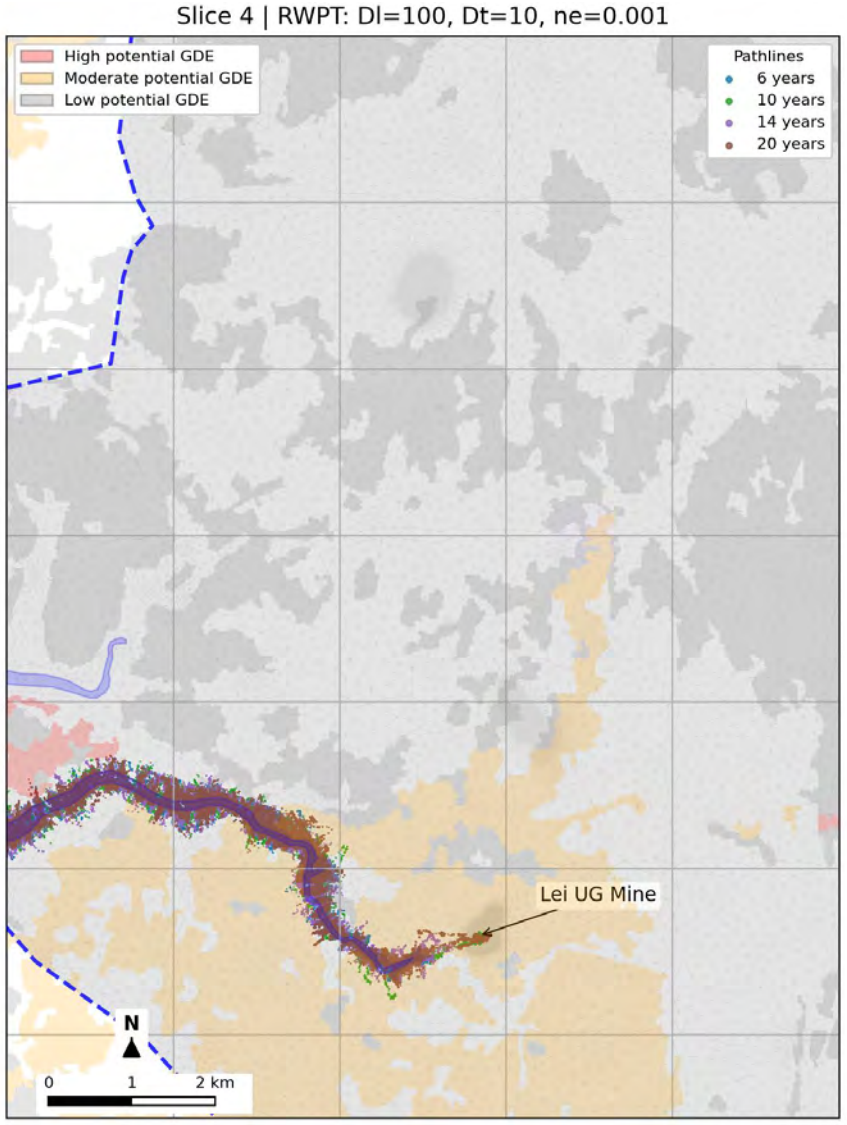


Figure 3-13 Random walk particle tracking at slice 4 for years 6, 10 14 and 20 under parameters (a) Longitudinal dispersivity (D_L)=10, transverse dispersivity (D_T)=1 and effective porosity (ne)=0.01 and (b) Longitudinal dispersivity (Dl)=100, transverse dispersivity (Dt)=10 and effective porosity (ne)=0.001.

3.4.2. Post-closure particle tracking results

Random walk particle tracking has also been used to investigate the fate of particles beneath the proposed waste rock dumps following closure of the mine (Figure 3-14). The parameters used to calculate the particle tracks are consistent with those used to determine particle tracking for LoM in Section 3.4.1.

The particle tracks are consistent with the results presented for the box cut, with particles migrating to the west of the mine site. Recovery of groundwater levels within the box cut and underground workings results in the re-establishment of the natural hydraulic gradient towards the Charlotte River to the west.

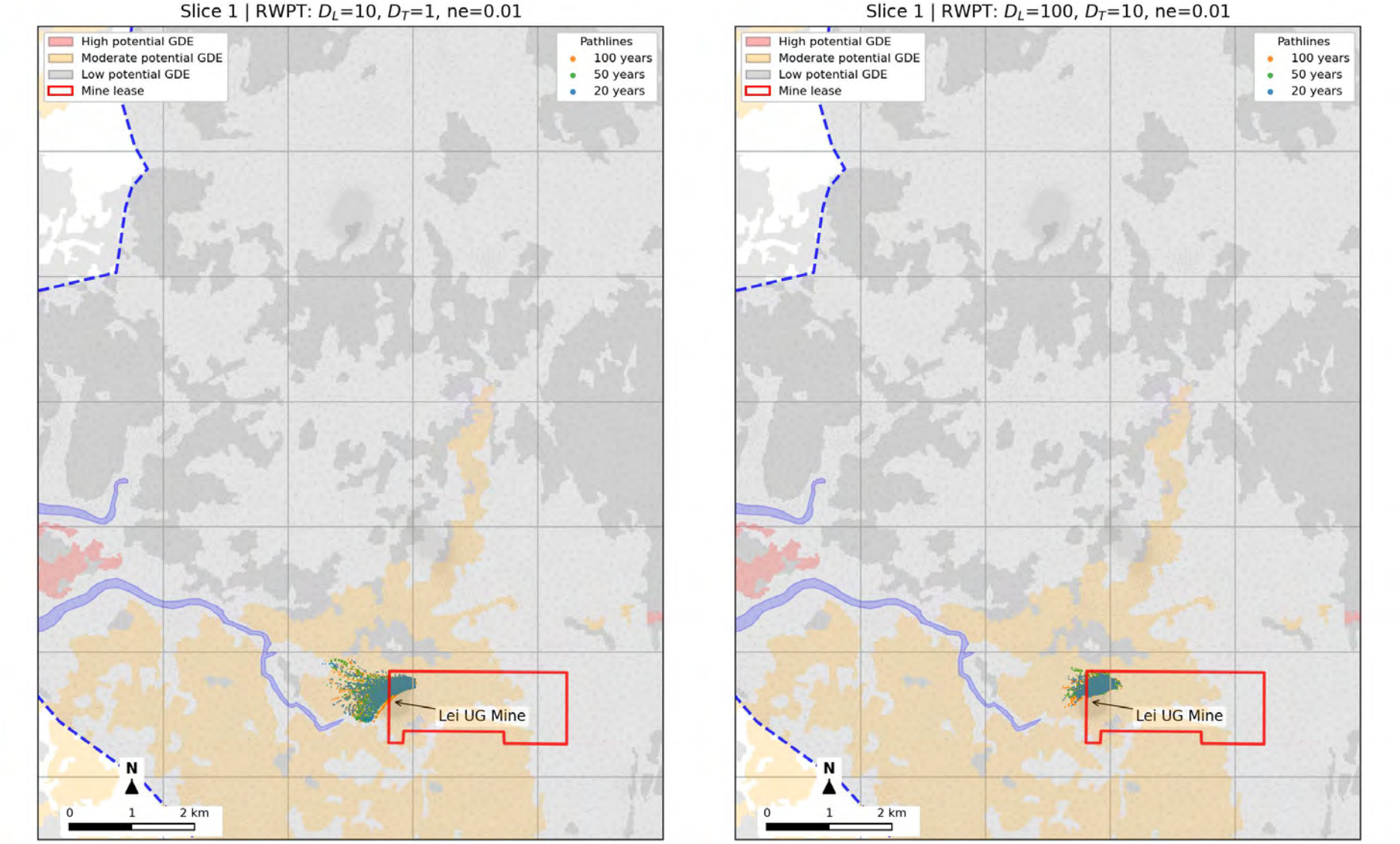


Figure 3-14 Random walk particle tracking at slice 1 for years 20, 50 and 100 under parameters (a) Longitudinal dispersivity (D_L)=10, transverse dispersivity (D_T)=1 and effective porosity (ne)=0.01 and (b) longitudinal dispersivity (Dl)=100, transverse dispersivity (Dt)=10 and effective porosity (ne)=0.01.

4 Cumulative impact assessment

This section investigates the groundwater impacts of the cumulative impacts of the Lei Project, the BP33 Project (BP33) including the box cut and underground workings, and the Grants Lithium Project (GLP) pit development. Impacts are assessed over the LOM and during the post-closure period associated with recovery of groundwater levels associated with the Lei mine. The scenario considers the following components:

4.1. Cumulative scenario forecast

The cumulative forecast scenario was designed to investigate the effect of the three mining projects on the groundwater flow dynamics in the area. The following assumptions were made for the predictive model runs:

- Lei LoM, 6 years
- BP33 LoM, 5 years
- GLP pit excavation, 4 years
- Post-closure, 14 years
- All model parameters were taken from the calibrated model.
- Passive groundwater dewatering via sumps, with no groundwater dewatering from production bores.
- The model was run for a forecast period of 20 years.
- Initial conditions were taken from the final heads of the calibrated model.
- The time series climatic inputs from the period 1900 – 2000 were repeated to obtain the 100-year time series used to calculated recharge for the forecast post-closure model.

4.2. Groundwater levels LoM results

The groundwater level response for bores installed around the Lei project, BP33 project and the Grants project are presented for the 6-year LoM period and an additional 14-year post-closure period.

4.2.1. Lei groundwater levels

The groundwater levels at the six monitoring sites around the Lei box cut, decline and underground workings under the natural (s00) and cumulative (s02) scenarios are presented in Figure 3-2 through Figure 3-4.

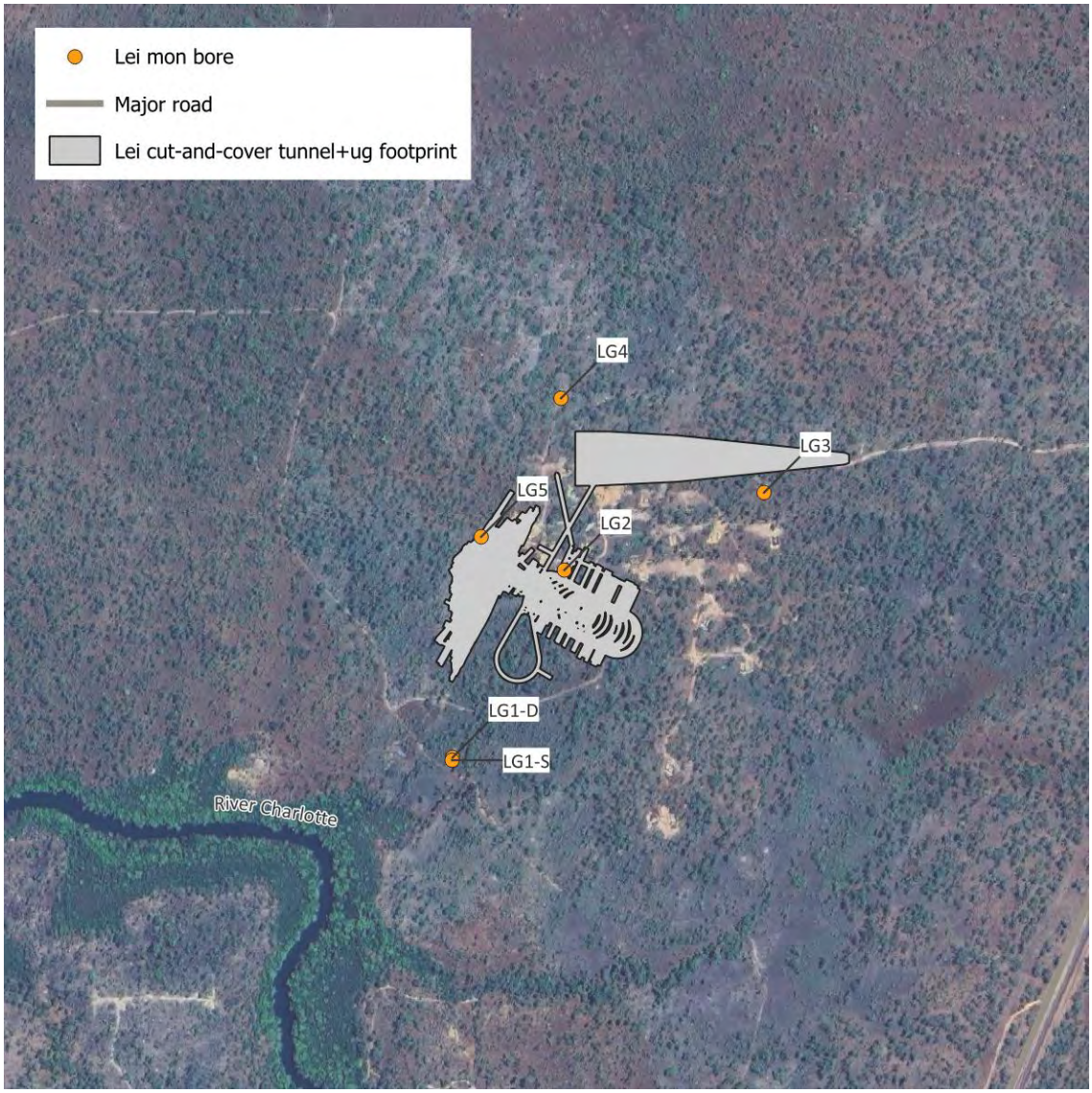


Figure 4-1 Locations of observation bores associated with the proposed Lei underground mine.

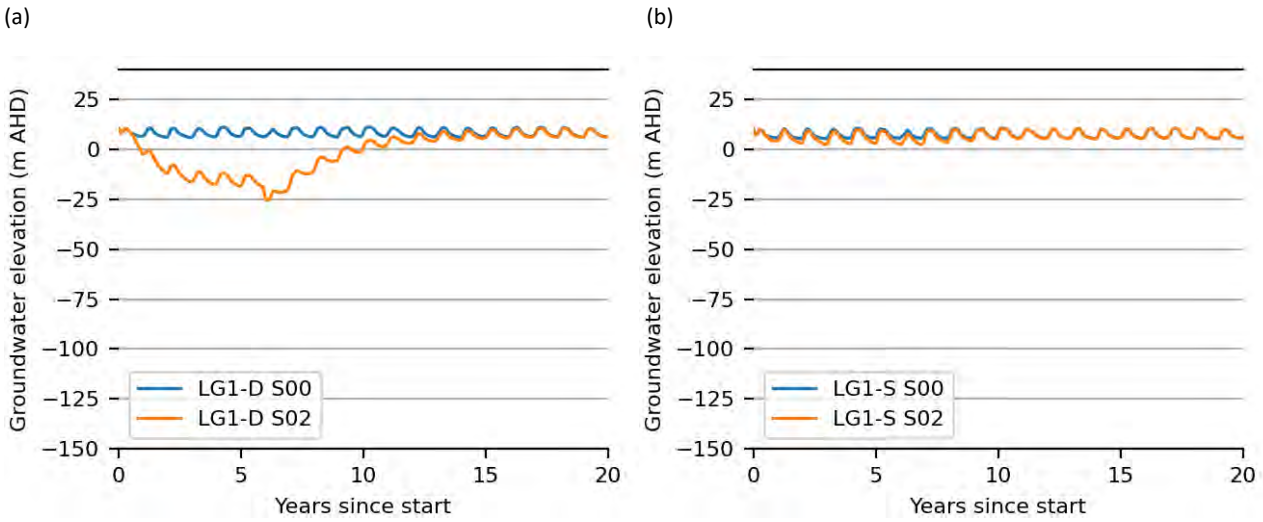


Figure 4-2 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants Pit excavations at existing Lei observation bores: (a) LG1-D and (b) LG1-S.

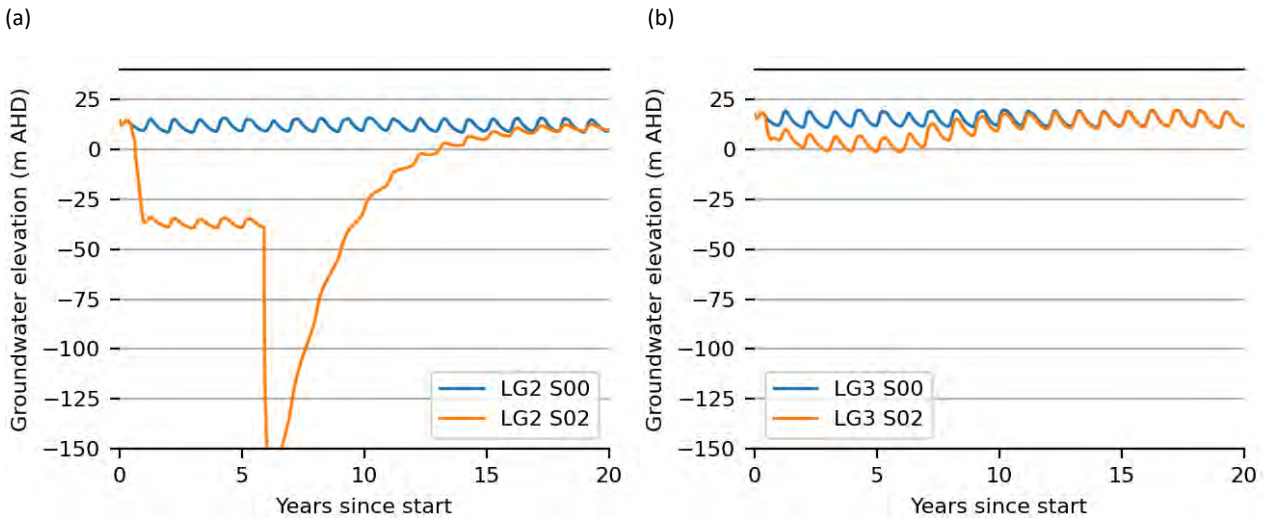


Figure 4-3 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants Pit excavations at existing Lei observation bores: (a) LG2 and (b) LG3.

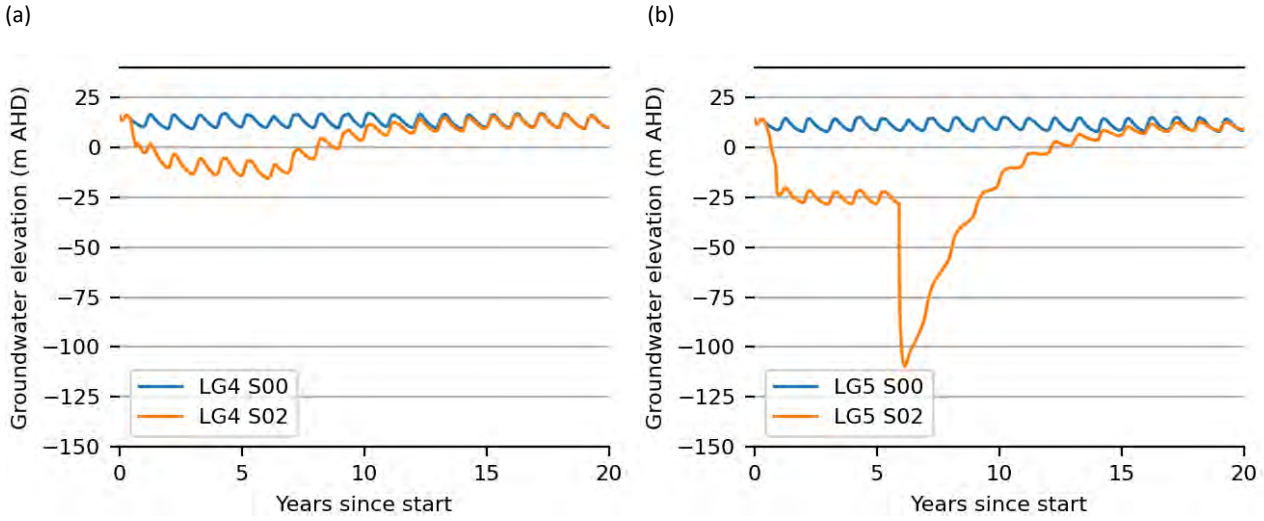


Figure 4-4 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants Pit excavations at existing Lei observation bores: (a) LG4 and (b) LG5.

4.2.2. BP33 groundwater levels

The groundwater levels in the observation bores around the BP33 box cut, decline and underground workings under the natural (s00) and cumulative (s02) scenarios are presented in Figure 4-6 through Figure 4-11.



Figure 4-5 Locations of observation bores associated with the BP33 underground mine.

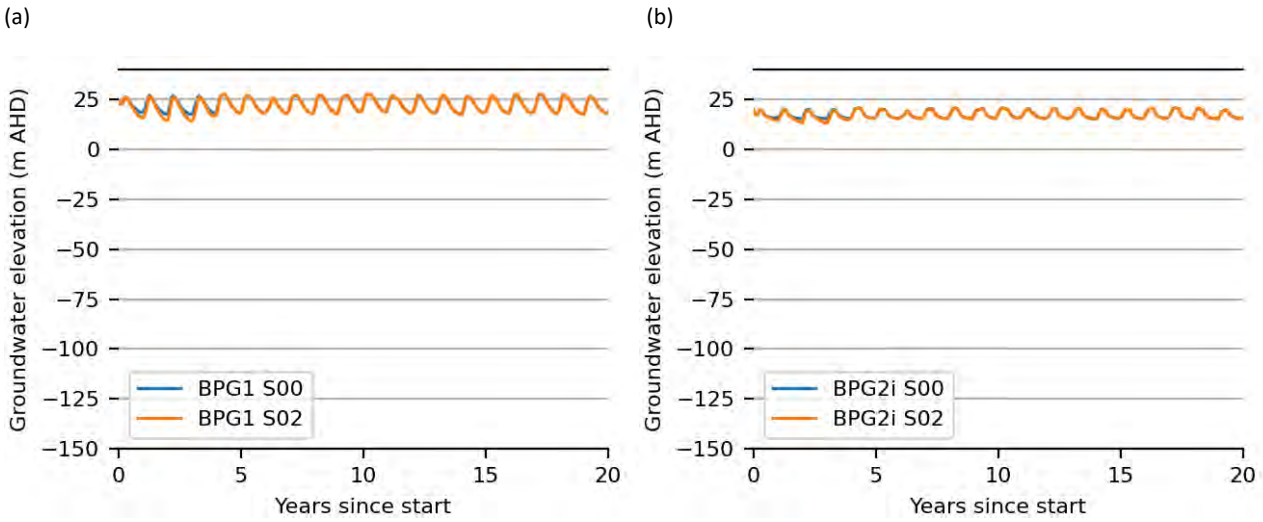


Figure 4-6 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG1 and (b) BPG2i.

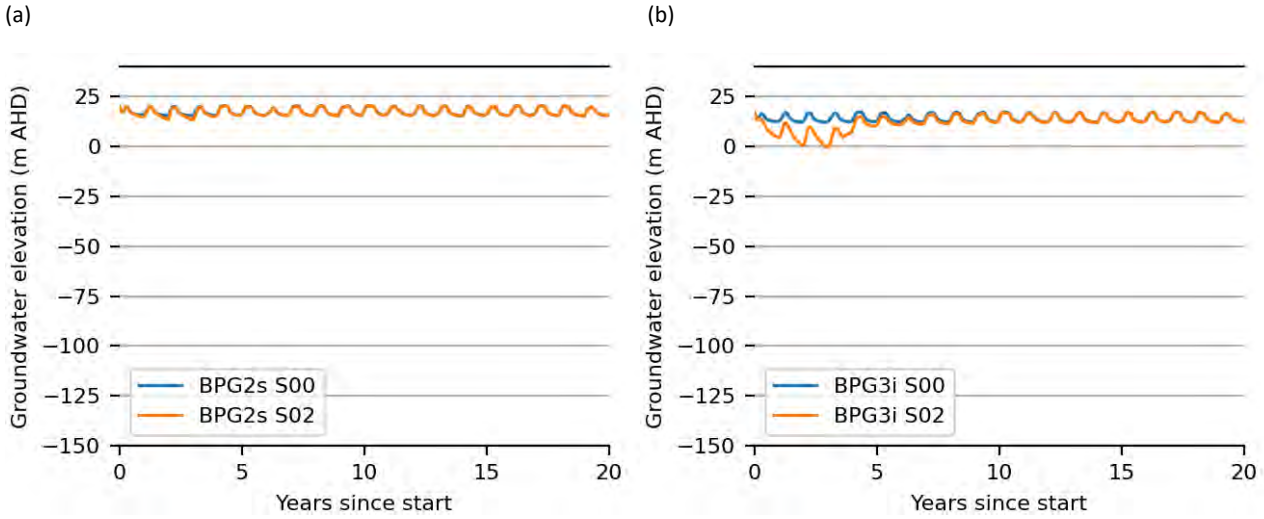


Figure 4-7 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG2s and (b) BPG3i.

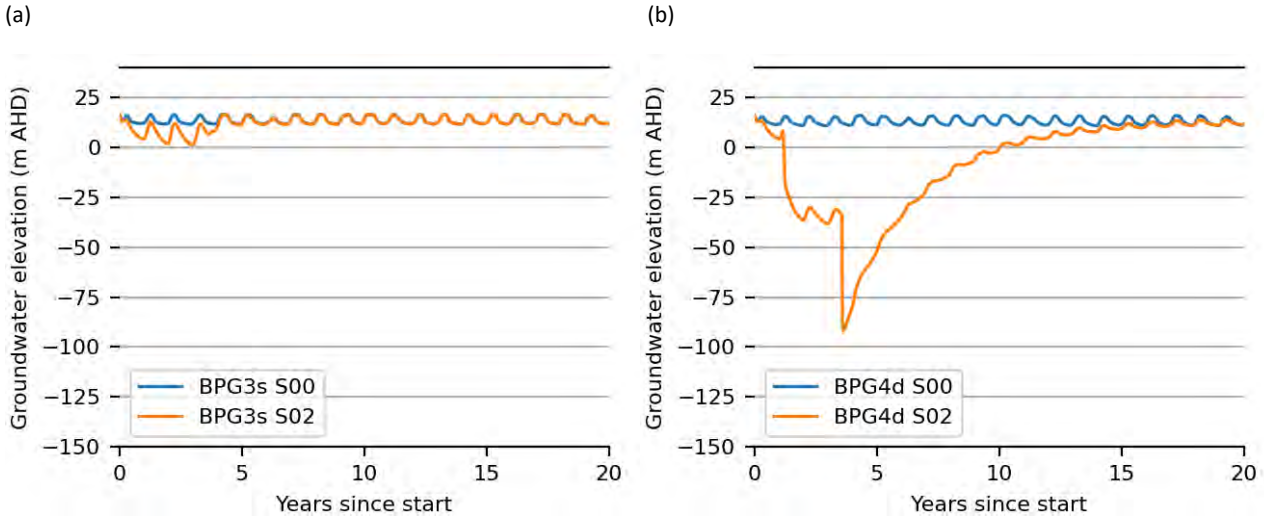


Figure 4-8 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG3s and (b) BPG4d.

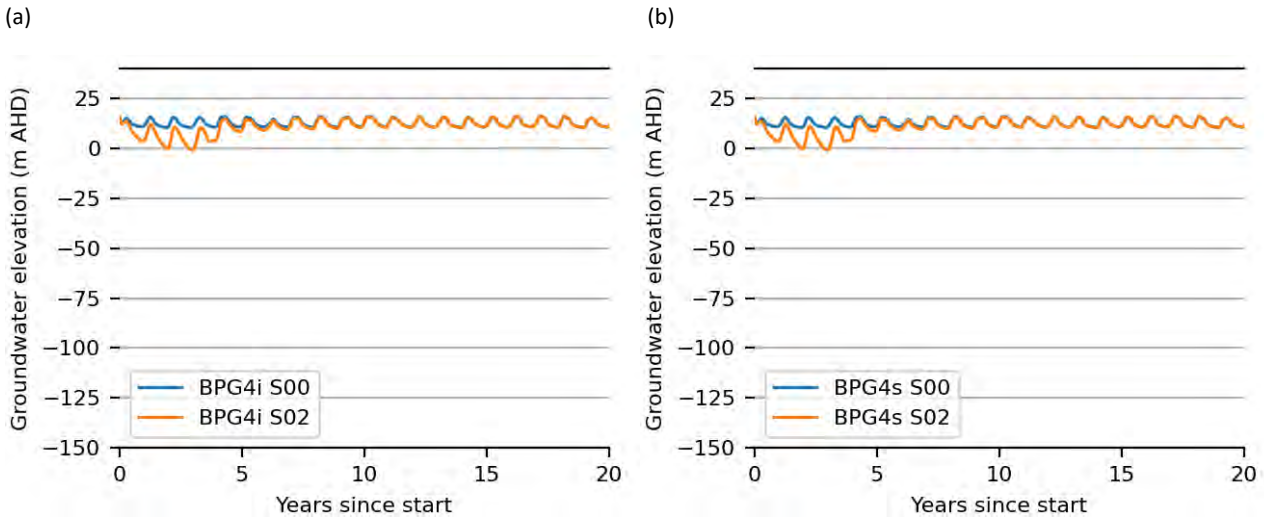


Figure 4-9 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG4i and (b) BPG4s.

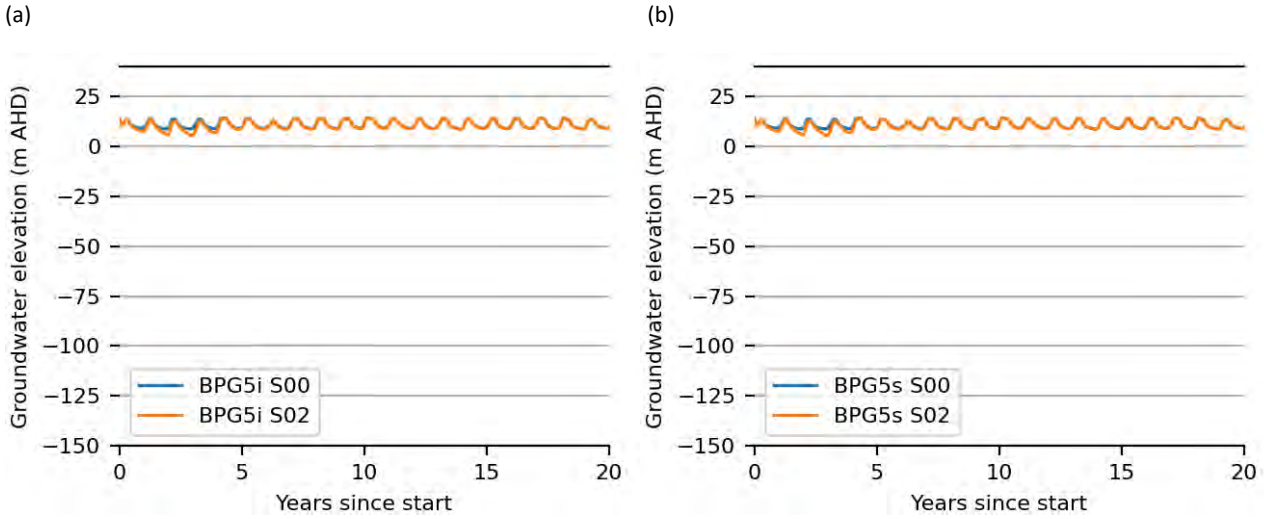


Figure 4- Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG5i and (b) BPG5s.

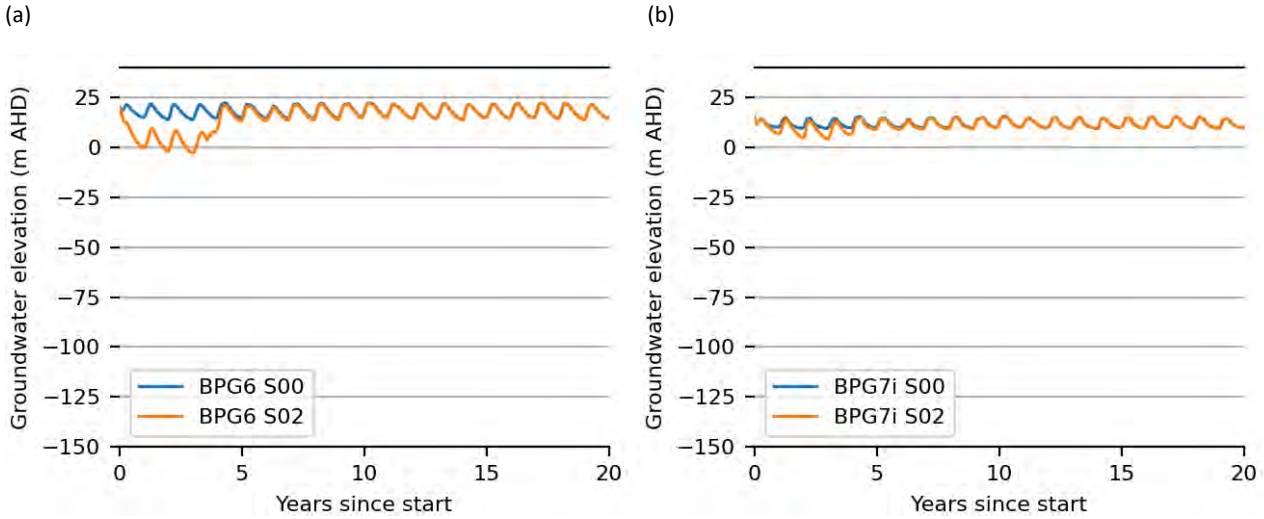


Figure 4-10 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG6 and (b) BPG7i.

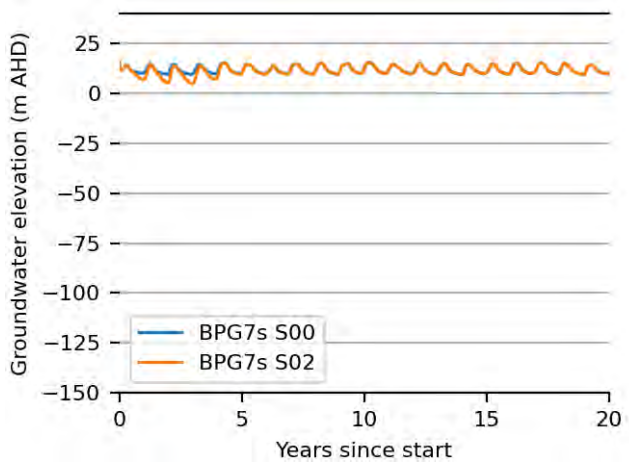


Figure 4-11 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing BP33 observation bores: (a) BPG7s.

4.2.3. Grants Pit groundwater levels

The groundwater levels in the observation bores around the BP33 box cut, decline and underground workings under the natural (s00) and cumulative (s02) scenarios are presented in Figure 4-13 through Figure 4-17.

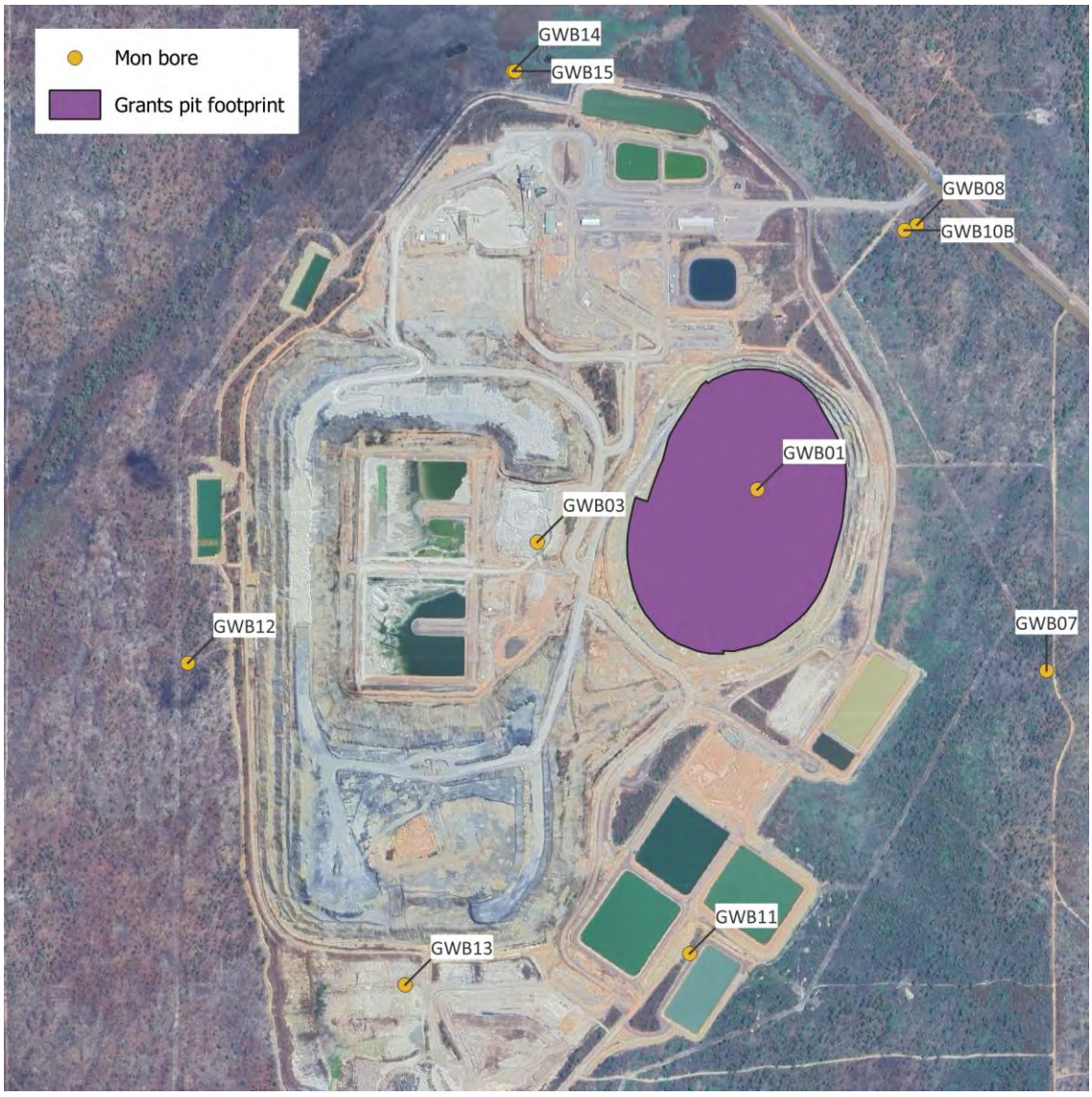


Figure 4-12 Locations of observation bores associated with the Grants Pit.

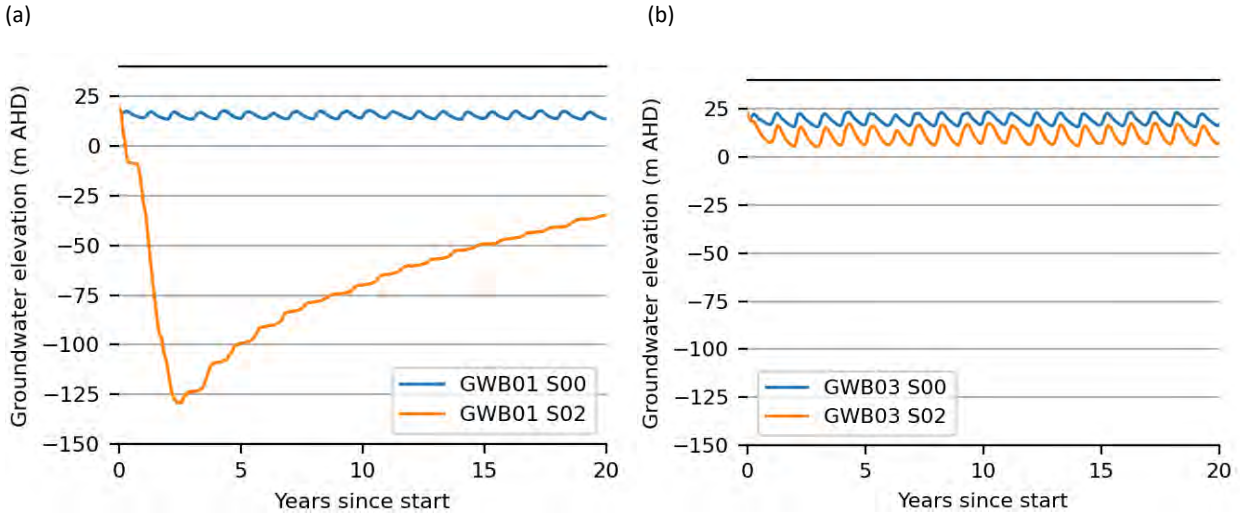


Figure 4-13 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB01 and (b) GWB03.

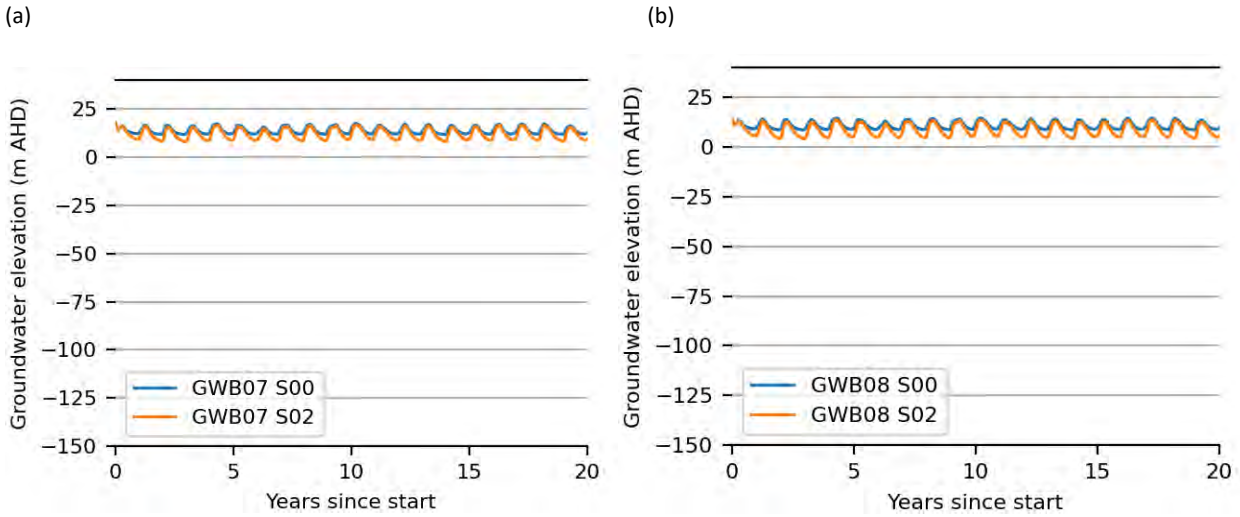


Figure 4-14 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB07 and (b) GWB08.

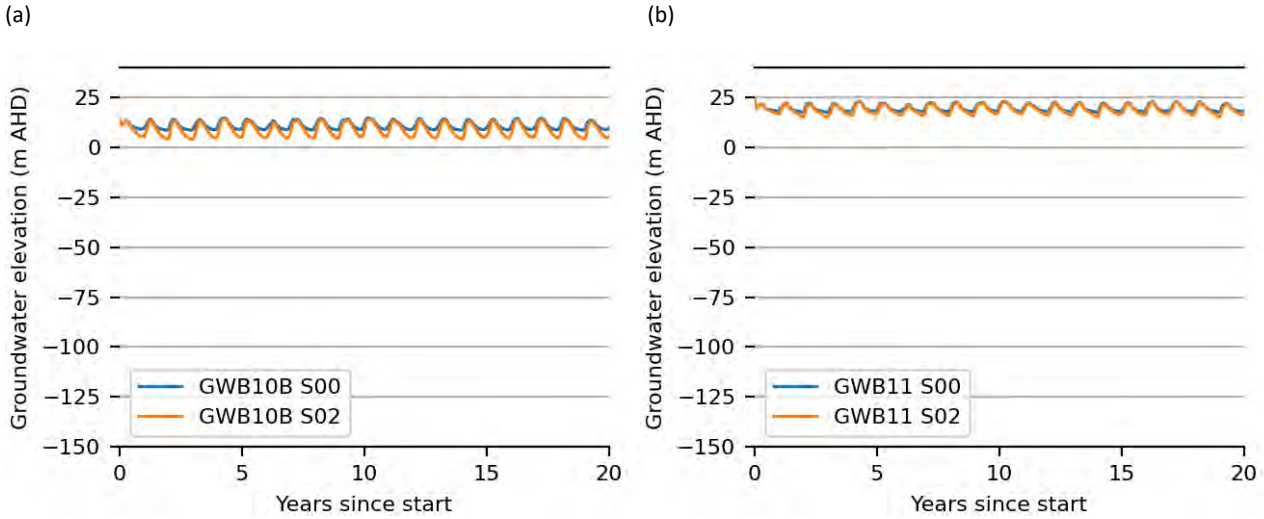


Figure 4-15 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB10b and (b) GWB11.

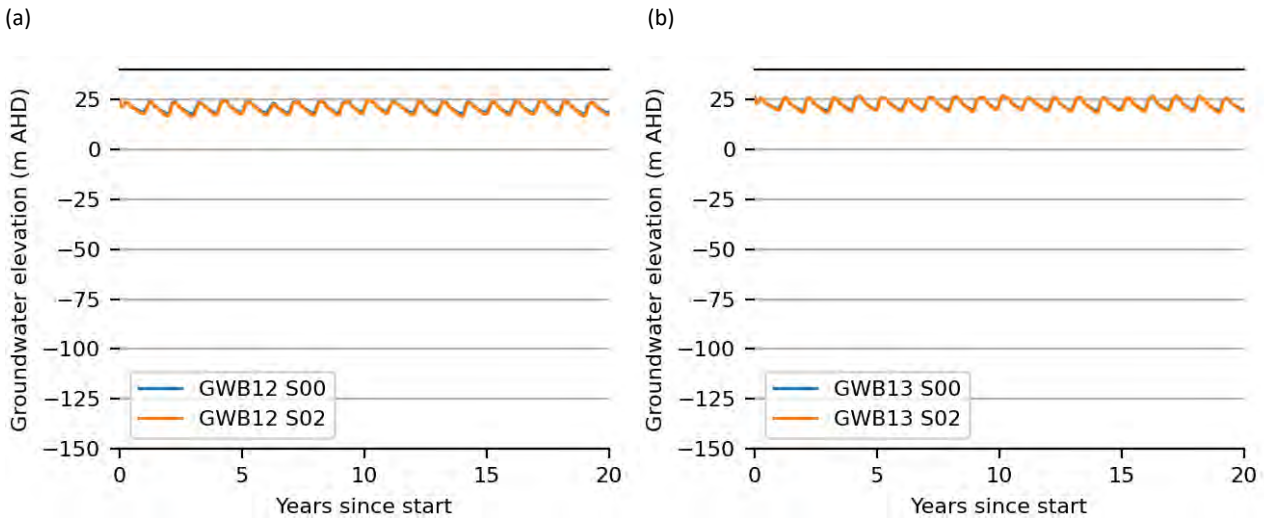


Figure 4-16 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB12 and (b) GWB13.

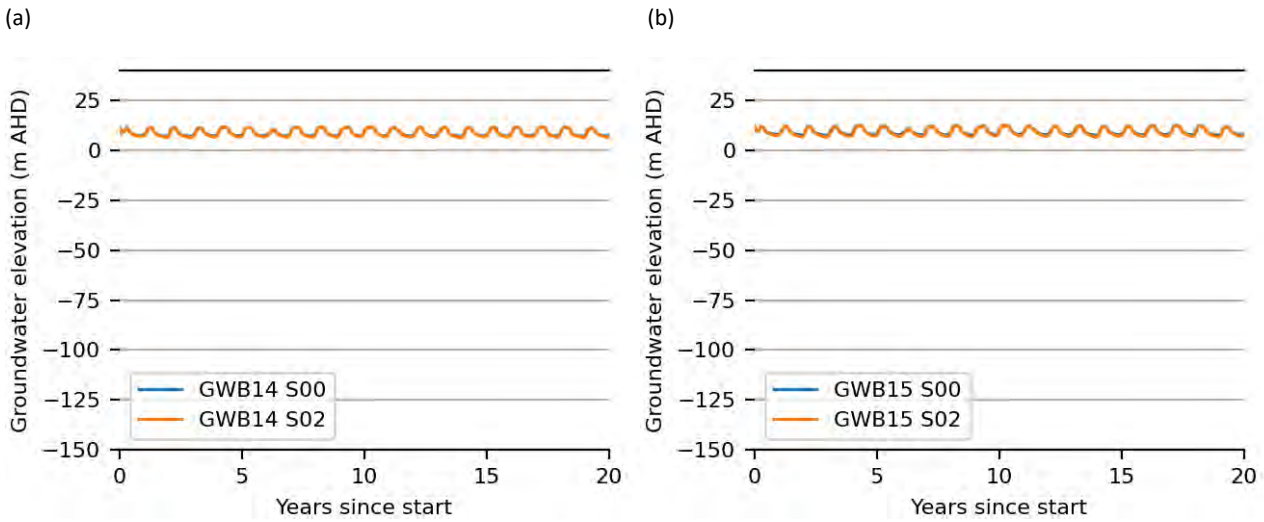


Figure 4-17 Cumulative groundwater level response during the 6-year LoM and 14-year post-closure periods for the Lei, BP33 and Grants excavations at existing Grants Pit observation bores: (a) GWB14 and (b) GWB15.

4.2.4. Cumulative LoM groundwater drawdown contours

The forecast drawdown impacts after 4 years, at the end of the mining period at BP33, and after 6 years, at the end of the mining period at Lei, are presented in Figure 4-18a and Figure 4-18b, respectively.

The predicted drawdown cone resulting from pit dewatering at the Grants Lithium Project extends about 2 km to the south. There is no apparent hydraulic interaction between the drawdown at Grants and the BP33 and Lei mines to the south.

However, drawdown from BP33 and Lei does interact, with a maximum drawdown of about 0.5m occurring about three years after the start of mining. This occurs just prior to the closure of the BP33 mine.

If the commencement of the BP33 mine were delayed by two years so that both mines stopped operating at the same time, the drawdown may be slightly greater in the area where they intersect.

As with the s01 (Lei only) scenario, drawdown reaches the tidal portion of the Charlotte River indicating that there is a potential for salt water to be induced towards the mine.

Drawdown associated with the Lei project extends beyond the eastern and southern edges of the mining lease. This drawdown is associated with dewatering associated with the construction and excavation of the underground mine. Consequently, there is little to no difference in predicted drawdown between the box cut and cut-and-cover development scenarios. The drawdown also extends below the areas identified with moderate potential for GDEs.

(a) (b)

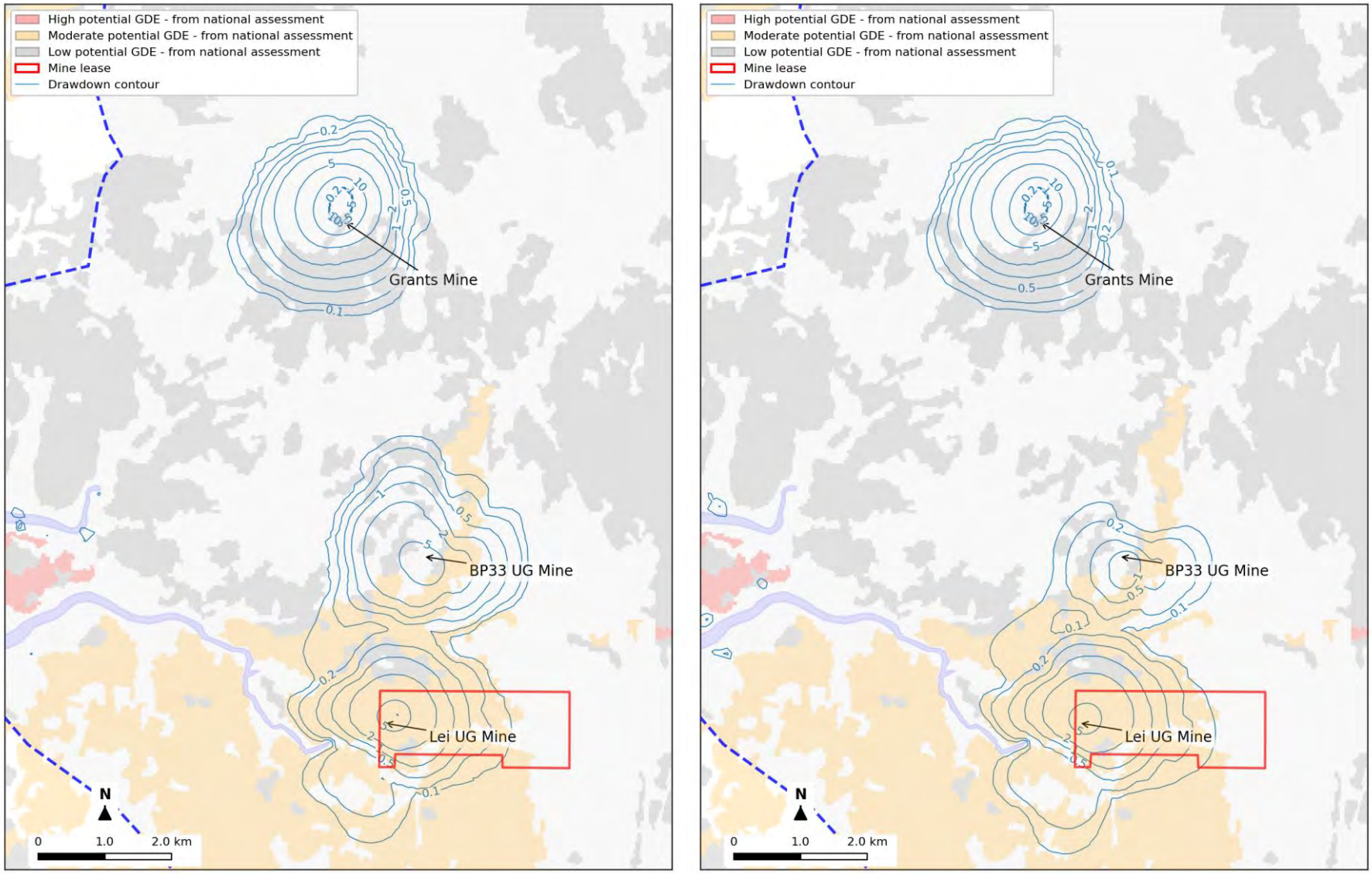


Figure 4-18 Forecast drawdown contours after (a) 4 years and (b) 6 years of mining.

4.2.5. Cumulative post-closure groundwater drawdown contours

The post-closure impacts scenario was based on the life of mine scenario with the following additional assumptions / settings:

- The post-closure model runs for an additional 14 years from the final time step of the LoM scenario.
- Removing the seepage face boundary conditions associated with the underground mine.
- Material properties of the underground mine are consistent with the volume of underground mine void.
- Pit lake water levels taken from the GLP (CloudGMS 2018 s4.3.5) to simulate the filling of the pit void.

The seasonal nature of recharge meant that a steady state model of the system was not deemed appropriate to assess the post-closure impacts. The model was run to an approximate dynamic equilibrium, represented by the stabilisation of groundwater levels around the Lei underground mine.

The drawdown contours at 4 years and 9 years after mine closure are presented in Figure 4-19a and Figure 4-19b.

(a) (b)

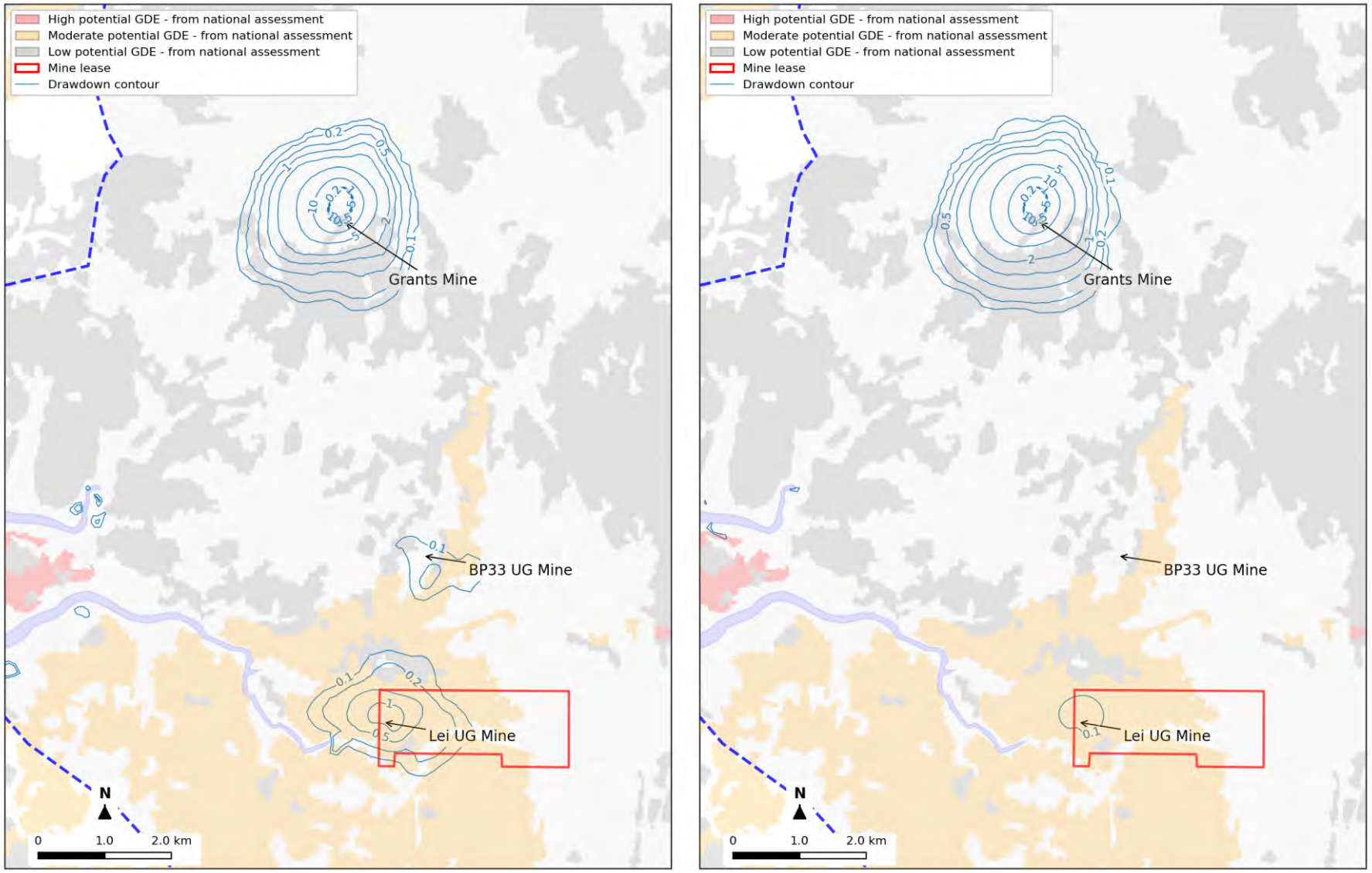


Figure 4-19 Lei Project forecast drawdown contours at the watertable following (a) 4 years of recovery, Year 10 from the start of mining and (b) 9 years of recovery, Year 15 from the start of mining.

5 Conclusions

The groundwater model developed to assess groundwater inflows and impacts associated with the proposed Lei underground lithium mine (ML33874) was updated to replace the original box cut with a cut-and-cover tunnel at Lei. The assessment included both project-only and cumulative scenarios with the Grants Lithium Project open pit mine and the BP33 underground mine.

The modelling approach, conceptual hydrogeological model, and parameter estimation methodology were consistent with those adopted for the original box cut scenario.

Results indicate that predicted groundwater impacts associated with the cut-and-cover tunnel scenario are broadly consistent with those of the original box cut scenario. The primary difference is that inflows to the tunnel are expected to be substantially lower due to the presence of the tunnel liner, which reduces groundwater ingress into the excavation.

5.1. Project-only forecasts

Predictive simulations undertaken for the cut-and-cover tunnel scenario indicate groundwater impacts and post-closure recovery consistent with those predicted for the box cut scenario. The primary difference between the scenarios is that inflows to the cut-and-cover tunnel are expected to be substantially lower due to the presence of the tunnel liner, which restricts groundwater ingress into the tunnel. Peak inflows to the underground mine are predicted to be about half those estimated for the box cut scenario.

Particle tracking results are also consistent with the box cut scenario, indicating that saline groundwater from the tidal reach of the Charlotte River may potentially migrate toward the underground workings, although impacts to shallow GDEs are considered unlikely. Saline inflows may occur locally within the underground mine, and discharge water may therefore require blending with fresher groundwater prior to release. Installation of monitoring bores adjacent to the Charlotte River is recommended to assess the vertical extent of saline groundwater associated with the tidal reach.

5.2. Cumulative forecasts

Cumulative groundwater impact predictions for the cut-and-cover tunnel scenario are consistent with those of the box cut scenario. During mining, dewatering associated with the GLP pit, underground mine workings, and associated excavations results in the development of overlapping drawdown cones within the surrounding BCF groundwater system. Predicted drawdown extents, impacts beneath ephemeral drainage lines, and groundwater level recovery following closure are effectively unchanged from the box cut scenario.

As with the project-only forecasts, inflows to the underground mine are expected to be substantially lower than those predicted for the box cut scenario due to the reduced hydraulic connection provided by the tunnel liner. Particle tracking results similarly indicate a low likelihood of saline intrusion affecting GDEs, although there remains potential for saline groundwater to migrate toward the underground mine. To better characterise salinity stratification near the Charlotte River, installation of a nested monitoring bore adjacent to the riparian zone of the tidal section of the Charlotte River is recommended.

5.3. Post-closure forecasts

Post-closure groundwater recovery predicted for the cut-and-cover tunnel scenario is consistent with that of the box cut scenario. Numerical modelling indicates that groundwater levels recover over a period of about 10 years following mine closure before stabilising near pre-mining conditions.

6 References

CloudGMS, 2018. *Development of a groundwater model for the Grants Lithium Project. v1.0,* Adelaide: Unpub..

CloudGMS, 2021. *BP33 Groundwater Modelling Report,* Adelaide, prepared for Core Lithium, May 2021: Unpub.

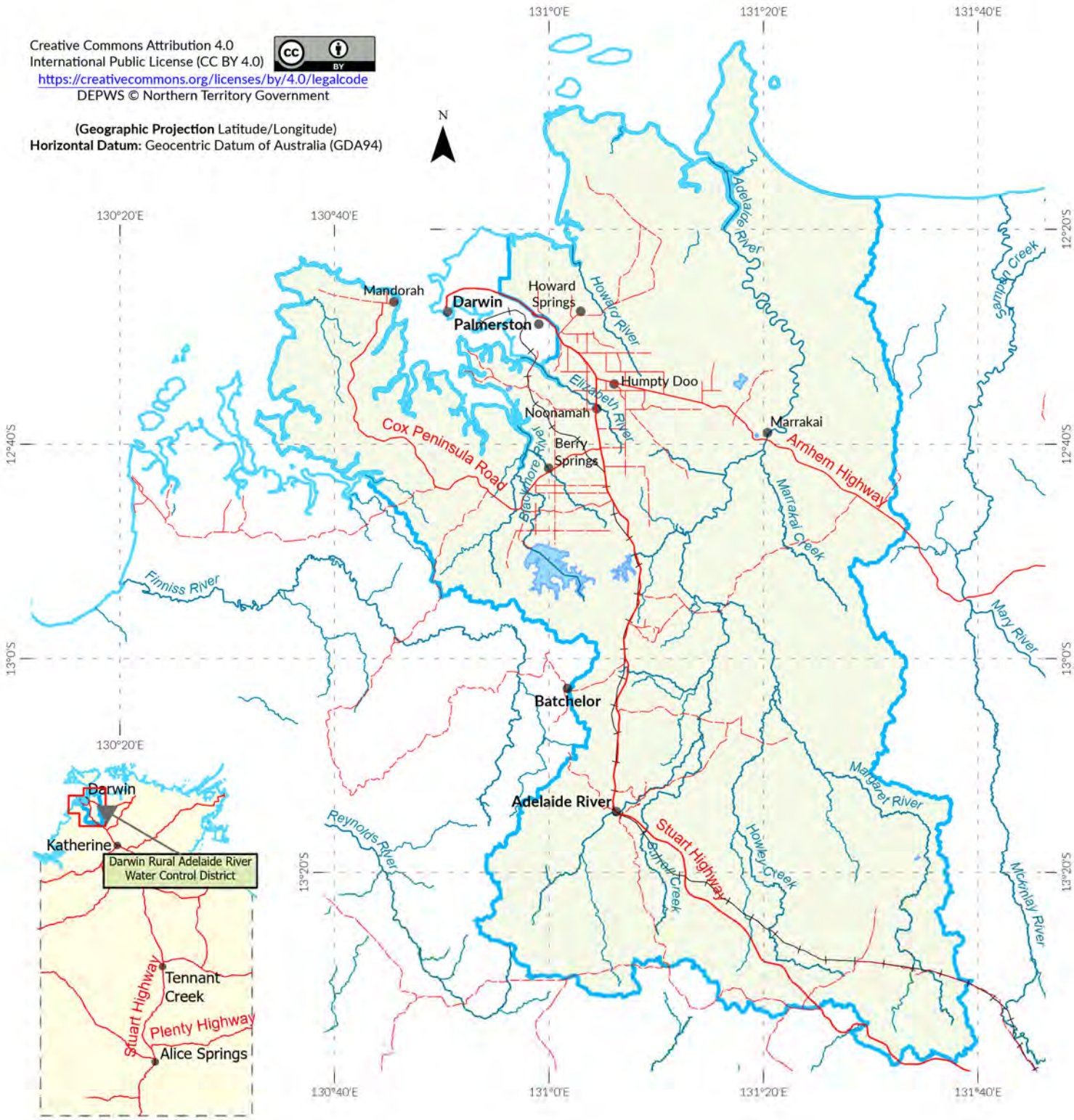
CloudGMS, 2026. *Lei Lithium Project Groundwater Model Report v0.3,* Adelaide: Unpub..

Lee, G., 2003. *Mangroves in the Northern Territory,* Darwin: DIPE.

Appendix B Beneficial Users Maps

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https://creativecommons.org/licenses/by/4.0/legalcode
DEPWS © Northern Territory Government

(Geographic Projection Latitude/Longitude)
Horizontal Datum: Geocentric Datum of Australia (GDA94)



LOCATION MAP
Not to scale

Data Source:

Major NT Roads/Railway Line:
Department Infrastructure, Planning and Logistics
Major Drainage/Coast Line:
Geofabric 3.1 © Commonwealth of Australia (Bureau of Meteorology) 2020
Water Control District:
Water Resources Division/DEPWS

Major Roads
- National Highway
- State Arterial
- Secondary
- Railway Line

- Major Drainage
- Minor Drainage
- Coast Line
- Reservoir
- Water Control District

Notes:

1. **Revocation:**
Darwin Rural water control district (Northern Territory Government Gazette No G31 dated 2 June 1999) revoked on 30 April 2024, published in Northern Territory Government Gazette No S61, 28 June 2024.

2. **Declaration:**
Darwin Rural Adelaide River water control district declared on 30 April 2024, published in Northern Territory Government Gazette No S61, 28 June 2024.

3. **Purpose:**
Darwin Rural Adelaide River water control district declared for surface water and groundwater management purposes.

0 5 10 20
Kilometers

Drawing No: DEPWS2024034
Map compiled: 18/07/2024

Department of Environment, Parks, and Water Security (DEPWS)
Contact: Water Resources Division
Phone: 08 8999 4455
Email: water.licensing@nt.gov.au
Web: https://nt.gov.au/water

NTG Security Classification for the map and data:
PUBLIC

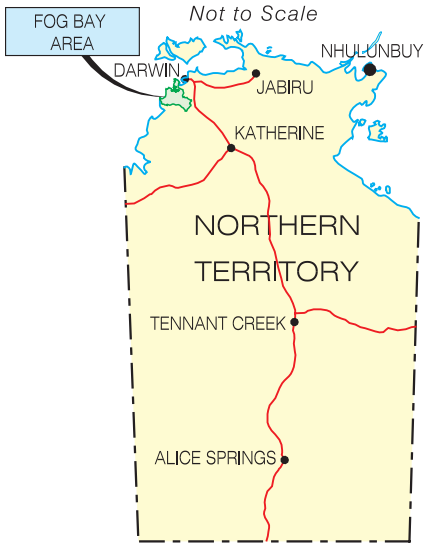
NORTHERN TERRITORY GOVERNMENT

DARWIN RURAL ADELAIDE RIVER WATER CONTROL DISTRICT



MAP LOCALITY

Not to Scale



km 0 10 20 30 km

Design File: Fogbay_bu.dgn

- ..... Limit of Declaration area
- ..... Catchment area/boundary
- ..... Mangrove/coastal flats
- ..... Highway / Road - sealed
- ..... Road - unsealed

Notes:

1; Beneficial Uses are aquatic ecosystem protection and recreation water quality and aesthetics.

2; For declaration and description see Northern Territory Government Gazette No. G9, 11 March 1998 and Government Gazette No. G20, 27 May 1998.

3; Prepared by Natural Resources Division, November 1999.

NATURAL RESOURCES

LANDS PLANNING ENVIRONMENT

Northern Territory Government

DECLARATION OF BENEFICIAL USES

FOG BAY AREA

