BHP

Carrapateena Operation

Program for Environment Protection and Rehabilitation

Volume 1 of 2 Main document

ML 6471	Carrapateena Mineral Lease
MPL 149	Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure
MPL 152	Western Infrastructure Corridor
MPL 153	Eastern Radial Wellfield
MPL 154	Southern Access Road and Radial Wellfield
MPL 156	Northern Wellfield

June 2025

Executive Summary

Under the *Mining Act 1971* (SA) (Mining Act) Part 10A, a compliant program must be in force before carrying out operations as defined in a Program for Environment Protection and Rehabilitation (PEPR). To satisfy section 70B of the Mining Act, BHP submits this PEPR for the following granted tenements:

- Carrapateena Mineral Lease (ML 6471), granted 3 January 2018
- Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure (MPL 149), granted 5 July 2017
- Western Infrastructure Corridor (MPL 152), granted 3 January 2018
- Eastern Radial Wellfield (MPL 153), granted 3 January 2018
- Southern Access Road and Radial Wellfield (MPL 154), granted 3 January 2018
- Northern Wellfield (MPL 156), granted 11 December 2018.

The activities associated with this PEPR include the development of the infrastructure elements detailed in ES Table 1 to ES Table 6.

This PEPR has been developed in accordance with the requirements of Government of South Australia's Department for Energy and Mining (DEM) Determination Terms of Reference (TOR) 005, *Metallic and industrial mineral PEPRs, Notice under Part 10A of the Mining Act 1971*. As such, this PEPR includes the following:

- description of the operations that BHP is approved to carry out in pursuance of the Mineral Lease ML 6471 and Miscellaneous Purposes Licences MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156
- a summary of environmental baseline conditions and the effect (pathway) or impact (receptor) of the approved activities
- the significant impact and risk events identified for the project using the BHP impact assessment framework and source-pathway-receptor (SPR) Model and associated design and management controls
- description of any significant degree of uncertainty pertaining to the likely effectiveness of control and management strategies and future works to remove the uncertainty
- the Outcomes as defined by the Sixth Schedule of the Mineral Lease ML 6471 and Miscellaneous Purposes Licences MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156
- demonstrated compliance with other Non-Outcome based lease and licence conditions
- the monitoring program, including Outcome Measurement Criteria and Leading Indicators to demonstrate compliance with the Outcomes.

Environmental and social performance is key to success for BHP and activities are designed to minimise environmental and social impacts and risks so far as is reasonably practicable.

ES Table 1 | ML 6471 key project elements

Project element	Summary
Mining	
Mining method	Sub-level cave (SLC) and sub-level open stoping (SLOS)
Production rate/life	6.9 Mtpa (Run-of-Mine ore)/22 years (2045)
Main access	Decline
Secondary access	Conveyor decline
Commodities	Copper, gold, silver
Primary crushing	Initially surface then underground
Ore handling	Incline conveying
Approved alternative	Extensions of mine life (up to 27+ years)
Approved alternative	Use of SLOS for the extraction of ore from satellite and regional mineralisation
Approved alternative	Depressurisation of the mining area via a network of surface wells
Processing	
Product	Copper, gold and silver in concentrate
Production rate	Annual average of ~65,000 to 75,000 tonnes copper and ~90,000 to 120,000 ounces gold per year
Comminution	Semi-autogenous grinding (SAG) mill, ball mill and pebble crushing
Flotation	Rougher flotation followed by three-stage cleaning
Approved alternative	Establishment of the concentrate treatment plant (CTP) onsite at Carrapateena, and associated neutralisation plant and evaporation ponds
Tailings	
Tailings disposal method	Valley fill thickened tailings storage facility
Tailings storage facility	Up to Stage 4B or Stage 5A, depending on as-built beach profile. Up to a total capacity of 144.9 million tonnes (Mt) and/or 72.4 million cubic metres (Mm^3)
Waste management	
Domestic and industrial	Segregation of waste onsite. During the operations phase, inert waste disposed of in a landfill facility established on MPL 149 or ML 6471. All other waste disposed through licensed waste transporters to licenced offsite facilities
Key demands and supply	
Power	132 kV, 55 MW high voltage connection to South Australia's electricity network and 1 MW solar farm to meet Project demand of up to 410 GWh per annum
Water	Approved abstraction of up to an annual average of 14.5 ML/d (consisting of 7.5 ML/d from the Radial Wellfield and 7.0 ML/d from the Northern Wellfield) to meet an operations demand of up to an annual average of 12.9 ML/d
Workforce	An operations workforce of 450 personnel (peaking at 525 – 600) plus varying number of construction and shutdown personnel, depending on site activities. Average personnel onsite at any one in 2023 was approximately 700 personnel
Accommodation village	An accommodation village comprising 176 beds, known as the Exploration Village. Originally constructed to support Advanced Exploration Works under RL 127, now supplements the Tjungu Village on MPL 149
Approved alternative	Construction and operation of an offsite water supply pipeline connecting to a pipeline within the Western Infrastructure Corridor MPL 152

Project element	Summary
Approved alternative	Installation of onsite electricity generation in the form of renewable energy at Carrapateena
Logistics	
Site access	Western Access Road, with Southern Access Road as an alternative should this be required
Concentrate transport	Road transport from site to distribution point. Transport from site occurs via the Western Access Road. Approval would be sought from the Government of South Australia's Department for Infrastructure and Transport (DIT) to access the previously used Southern Access Road as an alternative should the Western Access Road be unavailable
Approved alternative	Construction of a bypass road around Pernatty Homestead as a component of the Southern Access Road

ES Table 2 | Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure MPL 149 key project elements

Project element	Summary
Airstrip	Sealed 1,600 m long x 30 m wide runway and associated taxiway, suitable for use by Avro RJ100 (or similar) aircraft capable of carrying approximately 100 passengers
Workers' accommodation village	A second accommodation village (Tjungu Village) comprising 714 beds (plus current anticipated expansion for a further 64 rooms) in addition to the 176 rooms available at the older Exploration Village on ML 6471. Common facilities including wet mess facility, ablutions, laundry, crib rooms, bus/car parking, pedestrian pathways and landscaping, roads and workshops
Ancillary infrastructure	Access road, electricity generation and distribution infrastructure, wastewater treatment plant and associated land application areas, waste management facilities, landfill, reverse osmosis plant and surface water management infrastructure
Access road	Current access to the airstrip and accommodation village is via the Western Access Road (MPL 152), including provision of a site access gatehouse within the MPL to provide site security. The access road includes designated parking zones, bus pick-up areas and service access

ES Table 3 | Western Infrastructure Corridor MPL 152 key project elements

Project element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and localised distribution network, including turkey's nest dams, piping, pumps and an independent power supply
Transmission line	132 kV transmission line to connect to South Australia's electricity network at Mount Gunson. The transmission line design is based on the use of steel poles of approximately 26 m height at a spacing of 250 m with an associated maintenance access track
Access road	Unsealed (all-weather) primary site access has been established to the west of ML 6471, intercepting the Stuart Highway near Mount Gunson, approximately 52 km south-east of Pimba by road. The Western Access Road is used for the supply of consumables and the export of concentrate
Approved alternative	Construction and operation of an offsite water supply pipeline connecting to a pipeline within the Western Infrastructure Corridor MPL

ES Table 4 | Eastern Radial Wellfield MPL 153 key project elements

Project element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and distribution network including turkey's nest dams, piping, pumps and an independent power supply

ES Table 5 | Southern Access Road and Radial Wellfield MPL 154 key project elements

Project element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and distribution network including turkey's nest dams, piping, pumps and an independent power supply
Southern Access Road	Existing Southern Access Road to the site via a gazetted road from Pernatty Homestead to the Stuart Highway. The Southern Access Road is used as a back-up for site access and the export of concentrate in the event the Western Access Road is unavailable. Should BHP wish to undertake maintenance of the road following use, this would be managed in accordance with a Deed signed by both BHP and the Government of South Australia's Department for Infrastructure and Transport.

ES Table 6 | Northern Wellfield MPL 156 key project elements

Project element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and distribution network including ponds/dams, scour pits, piping, pumps, communications infrastructure (telemetry) and an independent power supply. Access via a borefield road connecting to ML 6471

Declaration of accuracy

I, Anna Wiley, the applicant, have taken the following steps to review the information in this application to ensure its accuracy.

- implementing an audit process against the terms of reference to ensure the minimum requirements have been addressed
- an internal process for review, endorsement or sign off by a suitably qualified and experienced company employee.

The information contained in this Program for Environment Protection and Rehabilitation is, to the best of my knowledge, a true and accurate representation of the activities undertaken by OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd, for the Carrapateena operations.

Name	Anna Wiley
Position	Asset President, Copper South Australia
Signature	
Date	18 June 2025

Document history

Document title	Date	Reference citation
PEPR for MPL 149 Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure (Airstrip)	August 2017	OZ Minerals 2017b
PEPR for ML 6471 Mineral Lease, MPL 152 Western Infrastructure Corridor, MPL 153 Eastern Radial Wellfield and MPL 154 Southern Access Road and Radial Wellfield	March 2018, updated June 2018	OZ Minerals 2018a
PEPR for MPL 156 Northern Wellfield	January 2019	OZ Minerals 2019
PEPR for ML 6471 Mineral Lease, MPL 149 Airstrip, MPL 152 Western Infrastructure Corridor, MPL 153 Eastern Radial Wellfield and MPL 154 Southern Access Road and Radial Wellfield and MPL 156 Northern Wellfield	February 2020	OZ Minerals 2020a (Consolidated PEPR)
PEPR for ML 6471 Mineral Lease, MPL 149 Airstrip, MPL 152 Western Infrastructure Corridor, MPL 153 Eastern Radial Wellfield and MPL 154 Southern Access Road and Radial Wellfield and MPL 156 Northern Wellfield	June 2024	BHP 2024a
PEPR for ML 6471 Mineral Lease, MPL 149 Airstrip, MPL 152 Western Infrastructure Corridor, MPL 153 Eastern Radial Wellfield and MPL 154 Southern Access Road and Radial Wellfield and MPL 156 Northern Wellfield	June 2025	BHP 2025 (this document)

Minerals Australia

On 2 May 2023, BHP Group Limited (Company) announced the completion of the acquisition of OZ Minerals Limited and the implementation of a scheme of arrangement for BHP Lonsdale Investments Pty Ltd, a wholly owned subsidiary of BHP Group Limited, to acquire 100% of the shares in OZ Minerals Limited. As a result of the acquisition, BHP Group Limited is now the ultimate parent company of OZ Minerals Limited.

The Carrapateena operation has been developed and operated by OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd, wholly owned by OZ Minerals Limited. The Carrapateena site has been integrated into the BHP Copper SA asset, also incorporating BHP's Prominent Hill mine, Olympic Dam mine and Oak Dam exploration sites. Copper SA falls under the BHP Minerals Australia business portfolio which also incorporates Western Australia Iron Ore, Nickel West, Coal, Mt Arthur Coal and Operations Services.

References to BHP in this Program for Environment Protection and Rehabilitation are context sensitive however, in the main, refer collectively to OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd unless otherwise stated.

Acknowledgements

Kokatha Aboriginal Corporation

The Kokatha People have a direct, unbroken and unique relationship with the land on which the Carrapateena operation is located.

BHP recognises the sense of place and belonging of the Kokatha People is linked to their identity, creation stories, travel, trade, ceremonies, family and places held sacred. We recognise the deep and ongoing feelings of relationship and attachment they hold for their lands.

BHP acknowledges the Kokatha People's connection to 'country', the contribution of the Kokatha People to their region and the enduring importance to the Kokatha People of values, cultural authority, cultural norms and customary laws.

BHP places great value on our relationship with the Kokatha People. BHP and the Kokatha Aboriginal Corporation seek to work in partnership, as equals, to further develop the Partnering Agreement *Nganampa palyanku kanyintjaku 'Keeping the future good for all of us'*. This collaborative agreement encapsulates, recognises and values the ongoing contribution of both partners, and will inform the relationship between the Kokatha People and BHP throughout and beyond the development of the Carrapateena operation.

Arcoona Station, Pernatty Station, Bosworth Station and Oakden Hills Station Owners

The Far North region of South Australia has a long and rich history of pastoralism. The Carrapateena mine is located on Pernatty Pastoral Station with supporting infrastructure also located within Arcoona Pastoral Station, Bosworth Pastoral Station and Oakden Hills Pastoral Station. BHP recognises the importance of the land to its owners and their operations and acknowledges their cooperation in the ongoing operation of the Carrapateena mine.

Contributors

BHP would like to thank those consultants and contributors whose work has informed and assisted in the development of this Program for Environment Protection and Rehabilitation and in particular Lathwida Environmental (document development) and EMM Consulting (project management and spatial support).

Currency

Where possible, the contents of the Program for Environment Protection and Rehabilitation (Document) are up to date as at 16 June 2025. This was not possible where parts of the Document were prepared from information provided by third parties (as discussed below) prior to the third-party documents being finalised.

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The Program for Environment Protection and Rehabilitation (Document) has been prepared for submission to the South Australian Minister for Energy and Mining under the *Mining Act 1971* (SA), and no one other than the Minister should rely on the information contained in the Document to make, or refrain from making, any decision.

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1. Introduction

1.1 PEPR overview

The Carrapateena operation (Project) has been developed and operated by OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd, wholly owned by OZ Minerals Limited. On 2 May 2023, BHP Group Limited (Company) announced the completion of the acquisition of OZ Minerals Limited and the implementation of a scheme of arrangement for BHP Lonsdale Investments Pty Ltd, a wholly owned subsidiary of BHP Group Limited, to acquire 100% of the shares in OZ Minerals Limited. As a result of the acquisition, BHP Group Limited is now the ultimate parent company of OZ Minerals Limited. References to BHP in this Program for Environment Protection and Rehabilitation (PEPR) are context sensitive however, in the main, refer collectively to OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd unless otherwise stated.

The Carrapateena operation is located approximately 160 km north of Port Augusta (see Figure 1.1). The Carrapateena operation operates under the granted tenements listed in Table 1.1, which are shown on Figure 1.1. This PEPR consolidates the approved activities from these tenements.

Table 1.1 | Tenements and key project elements

Tenement	Key project elements
Mineral Lease (ML)	
Carrapateena Mineral Lease 6471(1)	Mining, processing, tailings storage facility (TSF), onsite water supply and ancillary infrastructure
Miscellaneous Purposes Licences (MPL)	
Airstrip, Workers' Accommodation Village and Ancillary Infrastructure MPL 149	Airstrip, Workers' Accommodation Village, access road and ancillary infrastructure
Western Infrastructure Corridor MPL 152	Transmission line, access road and common services
Eastern Radial Wellfield MPL 153(1)	Water supply (east)
Southern Access Road and Radial Wellfield MPL 154(1)	Access road and water supply (south)
Northern Wellfield MPL 156	Water supply (north)

(1) A number of activities on these tenements are approved or existing because of the activities of previous Retention Lease 127 and transfer over to the respective tenement, see Chapter 4 for further information.

The primary approvals documentation associated with the tenements listed in Table 1.1 is summarised in Table 1.2.

Table 1.2 | Primary approvals documentation summary

Approval documents	Submitted	Approved
Airstrip and Workers' Accommodation Village (Tjungu Village)		
MPL Management Plan (OZ Minerals 2016)	2/12/2016	Not applicable
MPL Management Plan Response Document (OZ Minerals 2017)	16/3/2017	Not applicable
Tenement MPL 149	Not applicable	5/7/2017
PEPR August 2017 (OZ Minerals 2017b)	16/8/2017	15/9/2017
Mineral Lease, Western Infrastructure Corridor, Eastern Radial Wellfield, Southern Access Road and Radial Wellfield		
Mining Lease Proposal and MPL Management Plans (MLP) (OZ Minerals 2017a)	26/5/2017	Not applicable
MLP Response Document (OZ Minerals 2017c)	22/9/2017	Not applicable
Tenements ML 6471, MPL 152, MPL 153 and MPL 154	Not applicable	3/1/2018
PEPR March 2018 (OZ Minerals 2018a)	9/2/2018	29/3/2018
PEPR March 2018, updated June 2018 (OZ Minerals 2018a)	22/6/2018	Not applicable
Northern Wellfield		
MPL Management Plan (OZ Minerals 2018c)	25/6/2018	Not applicable
MPL Management Plan Response Document (OZ Minerals 2018d)	11/10/2018	Not applicable
Tenement MPL 156	Not applicable	11/12/2018
PEPR January 2019 (OZ Minerals 2019)	15/1/2019	13/2/2019
Mineral Lease, Airstrip and Workers' Accommodation Village (Tjungu Village), Western Infrastructure Corridor, Eastern Radial Wellfield, Southern Access Road, Radial Wellfield and Northern Wellfield		
Consolidated PEPR February 2020 (OZ Minerals 2020a)	10/07/2020	12/11/2020
Consolidated PEPR June 2024 (BHP 2024a)	17/07/2024	01/10/2024

This PEPR provides the following:

- establishment of the approved Project scope and current impact and risk profile of the Project, upon which any future Project variations can be assessed against
- a statement of the Outcomes from the Second Schedule and Sixth Schedule of the respective ML and MPL tenement documents provided in Appendix A
- demonstration of compliance with Non-Outcome based lease and licence conditions
- a monitoring program to demonstrate ongoing compliance.

Figure 1.1 | Project location

Carrapateena BHP

1.2 PEPR review

Generally, operational and closure strategies for a mine, as well as environmental monitoring arrangements, may evolve during the life of the mine as further information and site knowledge is acquired. In these instances, it may be necessary or desirable to perform a PEPR review occasionally to reduce uncertainty and assumptions in the PEPR and to ensure the PEPR accurately reflects the as-built and as-operated operation and demonstrate how Environmental Outcomes will continue to be achieved.

In accordance with Minerals Regulatory Guideline MG2b Preparation of a PEPR for metallic and industrial minerals (DEM 2023b) and Minerals Regulatory Guideline MG35 Applying for a change in operations (DEM 2023a) reflecting Section 70C of the *Mining Act 1971* (SA) (Mining Act), a PEPR review is required where there are proposed changes which:

- without requiring an environmental impact assessment, proposes changes to environmental outcomes or measurement criteria in the existing lease, license or PEPR
- alter the description of mining operations or control strategies but does not affect achievement of approved outcomes
- increase the operation's rehabilitation liability to a higher level than the bond currently in place for the site
- relate to an existing control strategy that is essential for achieving environmental outcomes i.e. there is a high reliance on this strategy to prevent impact to the environment and if it is changed, the tenement holder will no longer be able to achieve the environmental outcome
- requires native vegetation clearance and/or provision of significant environmental benefit (SEB).

In addition to this, a change in operations application will require a corresponding PEPR review if the proposed change is inconsistent with the current approved PEPR.

Since the approval of the June 2024 PEPR (BHP 2024a), there has been a decision, following detailed engineering design, to change the construction methodology associated with Stage 3 of the approved TSF. Consultation with Government of South Australia's Department for Energy and Mining (DEM) has determined that a PEPR Review is the appropriate approvals pathway to enable this change.

1.2.1 Self-assessments

Section 3.6 details the process for the assessment of changes to approved operations. There have been no self-assessed changes to approved operations since submission of the June 2024 PEPR (BHP 2024a).

1.2.2 Verification of assumptions and uncertainties

As a result of the short timeframe between the submission of the June 2024 PEPR (BHP 2024a) and the development of this document, there have been no changes to BHP's understanding of assumptions and uncertainties associated with the impact assessment framework and in the context of the conditions of the lease/licences associated with the Carrapateena operations.

1.2.3 Compliance actions

Carrapateena develops several compliance reports annually, including:

- Annual PEPR Compliance Report for compliance with the approved PEPR
- Annual EPBC Compliance Report for compliance with the Conditions of Approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act)
- Annual TSF Independent Inspection Report for compliance with ML 6472 Schedule 2, Condition 3 and Condition 4.3, the Operations, Maintenance and Surveillance Manual (OM&SMP) and the Tailings and Waste Rock and Ore Performance Standards
- Annual Radiation Protection Report for compliance with the requirements of the Carrapateena EPA Licence to Carry Out Mining or Mineral Processing (Licence No. 51113).

Changes to approved operations and/or monitoring and management systems in response to non-compliance corrective actions or study findings are detailed in the above reports. Table 1.3 details the outcomes from compliance reports developed since submission of the June 2024 PEPR (BHP 2024a) and describes, where relevant, where these have been incorporated into this PEPR.

Table 1.3 | Compliance report findings resulting in changes to approved operations

Tenement (operational aspect)	Non-compliance or finding	Corrective or preventative action
2023 PEPR Compliance Report (BHP 2024c)		
ML 6471 (TSF)	Non-achievement of OMC (OMC – TSF1, GW1, TSF2, GW2). Groundwater and surface water OMCs associated with the TSF have not been achieved largely due to higher than predicted lateral and vertical seepage from the TSF during early operation. Standing water levels in groundwater monitoring locations within the TSF seepage zone are outside of OMC Achievement Values determined from the assessment of the Updated Groundwater Model (OZ Minerals 2017c; Appendix H) and water quality at these monitoring locations is in exceedance of OMC Achievement Values determined from the assessment of the TSF Surface Water and Groundwater Geochemical Effects Assessment (OZ Minerals 2017c; Appendix F).	Currently being addressed. Corrective actions currently being progressed include: • Update the assumptions and inputs in the Tailings Storage Facility: Surface Water and Groundwater Geochemical Effects Assessment presented in the MLP (OZ Minerals 2017c; Appendix F) to determine if there is likely to be any ongoing change to the predicted effects and impacts and to derive new water quality targets in shallow and deep TSF monitoring wells. • Review seepage modelling with observed rates, new assumptions and new parameters from TSF Stage 2 operations. • Review the Seepage Fate Analysis (OZ Minerals 2017c; Appendix H) to confirm that vertical seepage still reports to the subsidence zone. • Review relevant OMCs to determine suitability of existing monitoring locations and achievement values. • Develop site specific guideline values for groundwater and surface water as an alternative to ANZECC/ARMCANZ (2000) freshwater and limited baseline ranges to update relevant Leading Indicators. • Update the PEPR to reflect new controls, Leading Indicators and OMCs reflecting the outcomes of the above investigations where relevant.
ML 6471 (TSF)	Breach of Leading Indicator (Leading Indicator – TSF21, TSF23 and TSF24). Monthly operational monitoring of tailings water, specifically supernatant and decant, saw metal composition continue to trend outside of the +/- 10% range adopted within MPEPR 2019/026 (OZ Minerals 2020a) throughout 2023.	BHP engaged an independent third-party to review the data and comment on whether the risk profile adopted in development of the MPEPR 2019/026 (OZ Minerals 2020a) had changed. Three metals (uranium, copper and molybdenum) were recorded at concentrations above limits established within the PEPR (OZ Minerals 2020a). Elevated concentrations of these elements against predicted composition were determined to be due to model input limitations. Observed tailings water quality is deemed to be representative of steady state operations. Key assumptions of the Assessment of Effects (OZ Minerals 2017c) were reviewed, and a preliminary impact assessment completed, which determined there was no increased risk of actual or potential harm based on the nature and magnitude of reported concentrations and Tier 2 toxicology considerations. No significant elevation of risk profile is evident relative to previous approved impact assessments (OZ Minerals 2017c). The site seepage model has been revised, and an updated geochemical assessment of effects and associated impact assessments will be presented in a proposed Change in Operations Proposal (CiOP) and associated PEPR update.
2023 EPBC Compliance Report (BHP 2024d)		
No non-compliances. No changes to approved operations, monitoring or management proposed		
2023 Carrapateena Project Environmental Radiation Impact Assessment: Non-human Biota and Member of Public Doses (RCA 2024)		
No non-compliances. No changes to approved operations, monitoring or management proposed		

1.2.4 Changes to the understanding of the baseline environment

Since submission of the previous PEPR in June 2024 (BHP 2024a), further environmental surveys have been undertaken as part of ongoing operational monitoring and management. Specific updates to the baseline environment are summarised in Table 1.4. Updates to the understanding of the baseline environment are described in greater detail in Chapter 6.

No other changes to BHP's understanding of the existing environment or environmental data have been identified in the time between submission of the MLP and MPL Management Plans, Response Documents or PEPRs.

Table 1.4 | Changes to the understanding of the baseline environment (all tenements)

Environmental aspect	Description of update	PEPR reference
Radiation	Update of radiation monitoring and dose to members of the public estimations as reported in the 2023 Radiation Impact Assessment: Non-human Biota and Member of Public Doses (RCA 2024)	Section 6.2.3
Ecology	Additional Autumn ecology survey report delivered since June 2024 (Appendix C1)	Section 6.8.2

1.2.5 Proposed changes to approved operations

Following reviews of the construction and operation of Stage 1 and Stage 2 of the TSF, and in response to increases in tailings generation associated with the approved increase in ore throughput (to approximately 6.9 million tonnes per annum (Mtpa)), a revised life-of-mine (LOM) TSF design has been developed (Appendix B1). The TSF design, amongst other aspects, incorporates a change in configuration of the Stage 3 TSF embankment, the subject of this PEPR review as summarised in Table 1.5.

This change has been self-assessed and does not affect the ability of the operations to achieve the prescribed Environmental Outcomes. No new impacts, changes in the impact profile or risk events have been identified.

Any further changes as result of increasing production over 7 Mtpa or progressing tailings deposition beyond the approved capacity of 145 Mdt will be subject to relevant further approvals processes (see Section 3.6).

Table 1.5 | Proposed changes to approved operations

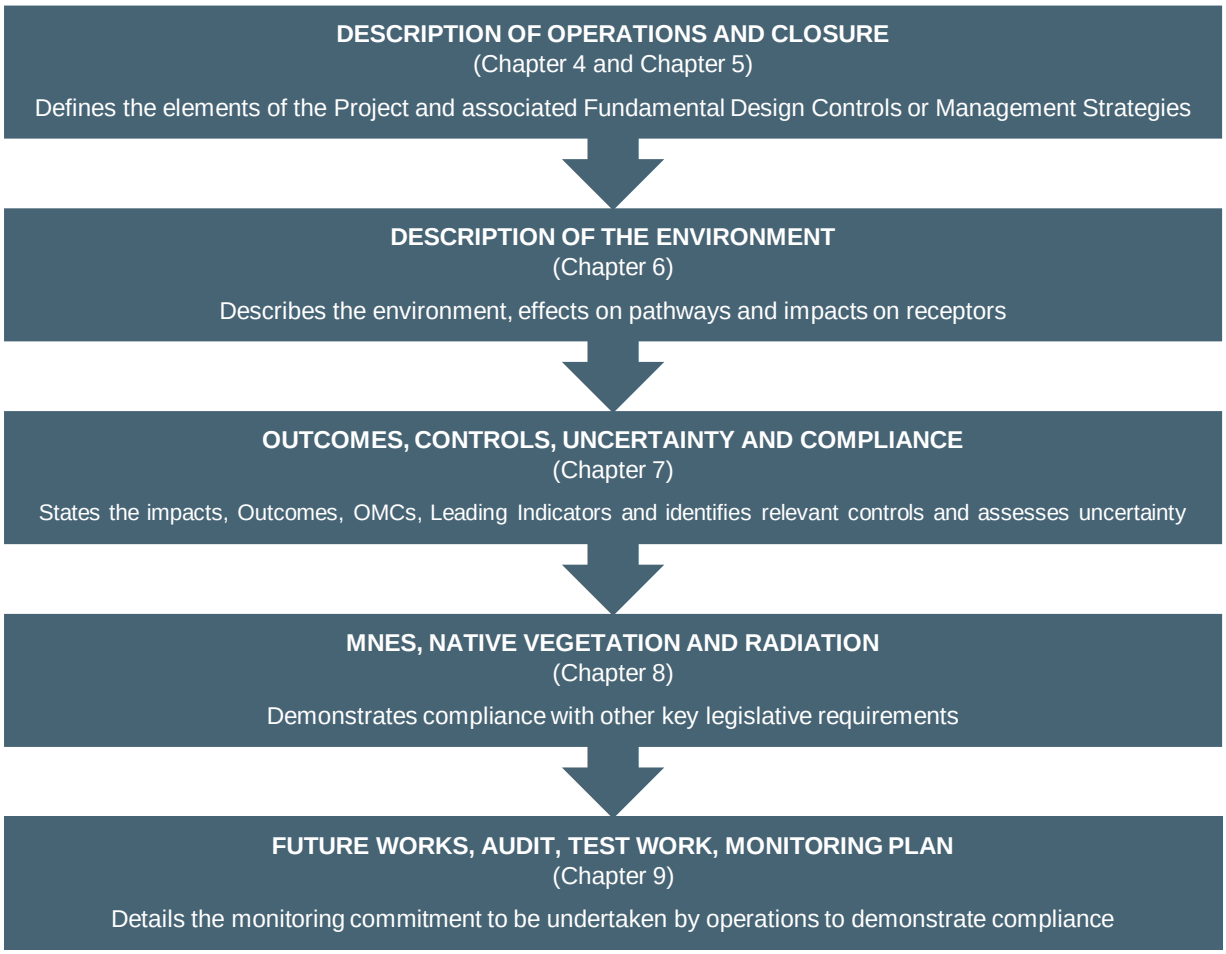
ID	Operational aspect	Description of proposed change	PEPR reference
Mineral Lease ML 6471			
1	TSF Stage 3	Change in the construction methodology and layout of the Stage 3 TSF embankment, consistent with the revised LOM TSF design	Section 4.10
Miscellaneous Purposes Licence MPL 149 (Airstrip and Workers' Accommodation Village (Tjungu Village))			
-	Nil		
Miscellaneous Purposes Licence MPL 152 (Western Infrastructure Corridor)			
-	Nil		

ID	Operational aspect	Description of proposed change	PEPR reference
Miscellaneous Purposes Licence MPL 153 (Eastern Radial Wellfield)			
-	Nil		
Miscellaneous Purposes Licence MPL 154 (Southern Access Road and Radial Wellfield)			
-	Nil		
Miscellaneous Purposes Licence MPL 156 (Northern Wellfield)			
-	Nil		

1.3 PEPR structure

This PEPR meets the statutory requirements for environmental management under the Mining Act and has been developed consistent with Determination Terms of Reference 005 Metallic and Industrial Mineral PEPRs referred to as the TOR 005 (DEM 2021). The content of this PEPR has been subject to internal review by suitably qualified and experienced BHP personnel. The content of this PEPR has also been cross-checked against the TOR 005 and provided as Appendix E.

The PEPR has been structured into five components, summarised below, with a document map provided within each of the subsequent chapters.



The Mining Act provides a two-stage assessment process to enable mining operations to commence. The first stage is for the granting of the mineral tenement supported by a Proposal/Management Plan, which utilised BHP's Impact Assessment Framework (IAF). The IAF was used to determine the impacts and risks relevant to the Project and develop a series of fit-for-purpose Draft Outcomes and Outcome Measurement Criteria (OMC). The subsequent stakeholder consultation and assessment process by government agencies has concluded in the granting of the tenements (ML 6471, MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156) with a set of regulatory conditions and Outcomes that the Project must achieve. Following the granting of the tenement, the tenement holder must have an approved PEPR in place to enable operations to commence.

The purpose of a PEPR is to enable the tenement holder to demonstrate achievement of the construction, operation, and closure outcomes for each tenement. This PEPR describes how BHP can, and will continue to be able to, achieve those Environmental Outcomes throughout the life of the Project.

The PEPR also details the process for the tenement holder to manage future changes to the approved operations (variations). Variations may be required, due to changes in operations or increased understanding of the environment, leading to new, or changes to, the approved environmental impacts or risks. Based on the changes, the variation process allows for assessment of whether the current Environmental Outcomes remain appropriate. The variation assessment process is discussed in Section 3.6.2.

Throughout this document, highlighted text boxes are used to call out important information. Two different colours are used, as follows.

Orange text boxes are used for **definitions, interpretations or specific information** that is important in understanding the related discussion or the context of the information.

Green text boxes are used for key information and examples relating to **primary approvals** or **secondary permitting,** including:

- provide clarification of the assessment process
- describe a **proposed change to approved operations**
- highlight how compliance will be met with **non-Outcome based conditions**
- where design and management controls are applicable in ensuring compliance with **Outcomes**.

2. Proponent details

2.1 Project proponent

The proponent for the tenements is OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd (collectively referred to as BHP throughout this PEPR). Proponent details are summarised in Table 2.1.

Table 2.1 | Proponent details

Mine name	Carrapateena		
Tenements	• ML 6471 • MPL 149 Airstrip, workers' accommodation village, access road and ancillary infrastructure • MPL 152 Western Infrastructure Corridor • MPL 153 Eastern Radial Wellfield • MPL 154 Southern Access and Radial Wellfield (together, the Tenements) • MPL 156 Northern Wellfield including borefields, pipelines and access roads and associated infrastructure		
Site location	Located approximately 160 km north of Port Augusta, 65 km east of Woomera and 90 km south-east of Roxby Downs. Refer to Figure 1.1		
Applicant (Licence Holder and Operator)	OZM Carrapateena Pty Ltd (58%) and OZ Minerals Carrapateena Pty Ltd (42%), wholly owned by BHP Lonsdale Investments Pty Ltd, a subsidiary of BHP Group Limited		
Site contact	Elton Peebles	Position	Carrapateena General Manager
Address	2 Hamra Road	City (Postcode)	Adelaide Airport (5950)
Email	elton.peebles@bhp.com	Telephone	+61 8 8422 3713

2.2 Landholders and land use

2.2.1 Tenements

BHP maintains tenements underlying or adjacent to the tenements detailed in Table 2.1 and shown in Figure 2.1.

To satisfy Section 80(2) of the Mining Act, Overlapping Tenement Agreements have been signed with OZ Minerals Carrapateena Pty Ltd and OZM Carrapateena Pty Ltd or OZ Exploration Pty Ltd as the holder of EL 6452, EL 6528, EL 6684, EL 6685, EL 5863, EL 5919 and EL 6686. The Overlapping Tenement Agreements enable the granting of simultaneous tenements and provide rights and obligations for the respective tenement holders. These licence numbers (also shown in Table 2.2) remain subject to change with the grant of subsequent licences, and the South Australian Resources Information Gateway (SARIG) should always be reviewed to ensure the latest tenement details, including expiry date and ownership.

Third-party land ownership interests that overlap the tenements are also provided in Table 2.2 with land ownership shown on Figure 2.2.

The area of the tenements is subject to the Kokatha People (Part A) Native Title Determination (Federal Court Reference SAD 90/2009). The Kokatha Aboriginal Corporation (KAC) is the Registered Native Title Body Corporate who acts as an agent for the Kokatha People in relation to their native title rights and interests.

OZ Minerals and KAC had a Native Title Mining Agreement (NTMA) in place for Retention Lease (RL) 127, which was registered on 5 March 2013. BHP and KAC entered into a Partnering Agreement called *Nganampa palyanku kanyintjaku 'Keeping the future good for all of us'* to inform the relationship throughout and beyond the development of Carrapateena. Subsequent to negotiation of the Partnering Agreement, the parties negotiated an NTMA pursuant to Part 9B of the Mining Act in relation to the tenements. The NTMA was executed on 31 July 2017 and registered in the Mining Register on 28 August 2017.

All of the tenements, except for the Western Infrastructure Corridor MPL 152 and Northern Wellfield MPL 156, are situated within the Pernatty Pastoral Lease, which shares boundaries with Bosworth, Arcoona, South Gap and Oakden Hills Pastoral Leases. The Western Infrastructure Corridor MPL 152 is located within Pernatty Pastoral Lease and the neighbouring Oakden Hills Pastoral Lease. The Northern Wellfield MPL 156 lies primarily within the Arcoona Pastoral Lease and also within the Bosworth and Pernatty Pastoral Leases. These pastoral leases are predominantly used for sheep grazing, however limited water resources in the area necessitate low stocking rates and some areas are only grazed when surface water is present in dams, creeks and waterholes.

Table 2.2 | Land tenure and interests

Third-party land ownership	Relevant tenement	BHP land access requirements
Native Title Determination		
Kokatha People (Part A), Tribunal Reference SCD2014/004	• ML 6471 • MPL 149 (Airstrip and Village) • MPL 152 (Western Infrastructure Corridor) • MPL 153 (Eastern Radial Wellfield) • MPL 154 (Southern Access and Wellfield) • MPL 156 (Northern Wellfield) • EMLs (6480, 6481, 6482, 6483, 6484, 6485, 6486, 6487, 6488)	• NTMA in respect of the Tenements executed on 31 July 2017 and registered in Mining Register on 15 August 2017 • Notice of Entry served on 18 November 2016 for ML 6471, MPL 152, MPL 153, MPL 154 and up to 25 EMLs • Notice of Entry served on 29 September 2016 for MPL 149 • Notice of Entry served on 21 December 2017 for MPL 156 (Northern Wellfield)
Pastoral Lease: Pernatty Pastoral Station		
Station Operators: trading as Billa Kalina Pastoral Company Pastoral Lessee: Colin and Jill Greenfield as trustees of Millers Creek Trust	• ML 6471	Notice of Entry served on 18 November 2016
	• MPL 149 (Airstrip and Village)	Notice of Entry served on 25 October 2016
	• MPL 152 (Western Infrastructure Corridor) • MPL 153 (Eastern Radial Wellfield) • MPL 154 (Southern Access and Wellfield)	Notice of Entry served on 18 November 2016
	• MPL 156 (Northern Wellfield)	Notice of Entry served on 10 April 2018
	• EMLs (6481, 6482, 6483, 6484, 6485, 6486, 6487, 6488)	Notice of Entry served on 18 November 2016
Pastoral Lease: Arcoona Pastoral Station		
Crown Lessee: Handbury Asset Management Pty Ltd	MPL 156 (Northern Wellfield)	Notice of Entry served on 21 December 2017
Pastoral Lease: Bosworth Pastoral Station		
Pastoral Lessee: Handbury Asset Management Pty Ltd	MPL 156 (Northern Wellfield)	Notice of Entry served on 21 December 2017
Pastoral Lease: Oakden Hills Pastoral Station		
Pastoral Lessee: Coondambo Nominees	MPL 152 (Western Infrastructure Corridor)	Notice of Entry served on 18 November 2016

Third-party land ownership	Relevant tenement	BHP land access requirements
Exploration Licence (EL) Holding		
EL6452: OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd	• MPL 156 (Northern Wellfield)	Overlapping Tenement Agreement 15 December 2016
EL 6528: OZ Minerals Carrapateena Pty Ltd	• MPL 152 (Western Infrastructure Corridor) • MPL 156 (Northern Wellfield) • EMLs (6484, 6485, 6486, 6487)	Overlapping Tenement Agreement 2 January 2018
EL6684: OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd	• ML 6471 • MPL 152 (Western Infrastructure Corridor) • MPL 153 (Eastern Radial Wellfield) • MPL 154 (Southern Access and Wellfield) • MPL 156 (Northern Wellfield)	Overlapping Tenement Agreement signed with OZ Minerals Carrapateena Pty Ltd and OZM Carrapateena Pty Ltd on 15 December 2016
EL 6685: OZ Exploration Pty Ltd	• MPL 156 (Northern Wellfield)	Overlapping Tenement Agreement 2 January 2018
EL 5863: OZ Exploration Pty Ltd	• MPL 156 (Northern Wellfield)	Overlapping Tenement Agreement 2 January 2018
EL 5919: OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd	• ML 6471 • MPL 153 (Eastern Radial Wellfield) • MPL 156 (Northern Wellfield)	Overlapping Tenement Agreement signed with OZ Minerals Carrapateena Pty Ltd and OZM Carrapateena Pty Ltd on 15 December 2016
EL 6686: Yandan Gold Mines Pty Ltd	MPL 152 (Western Infrastructure Corridor)	Overlapping Tenement Agreement not required as tenement was in place post granting of MPL 152
EL 6675: Olympic Domain Pty Ltd; Cohiba Minerals Limited	MPL 152 (Western Infrastructure Corridor)	Overlapping Tenement Agreement 7 April 2017
EL 6035: Red Metal Limited	MPL 154 (Southern Access and Wellfield)	Farm-in/Joint Venture HOA 20 December 2017

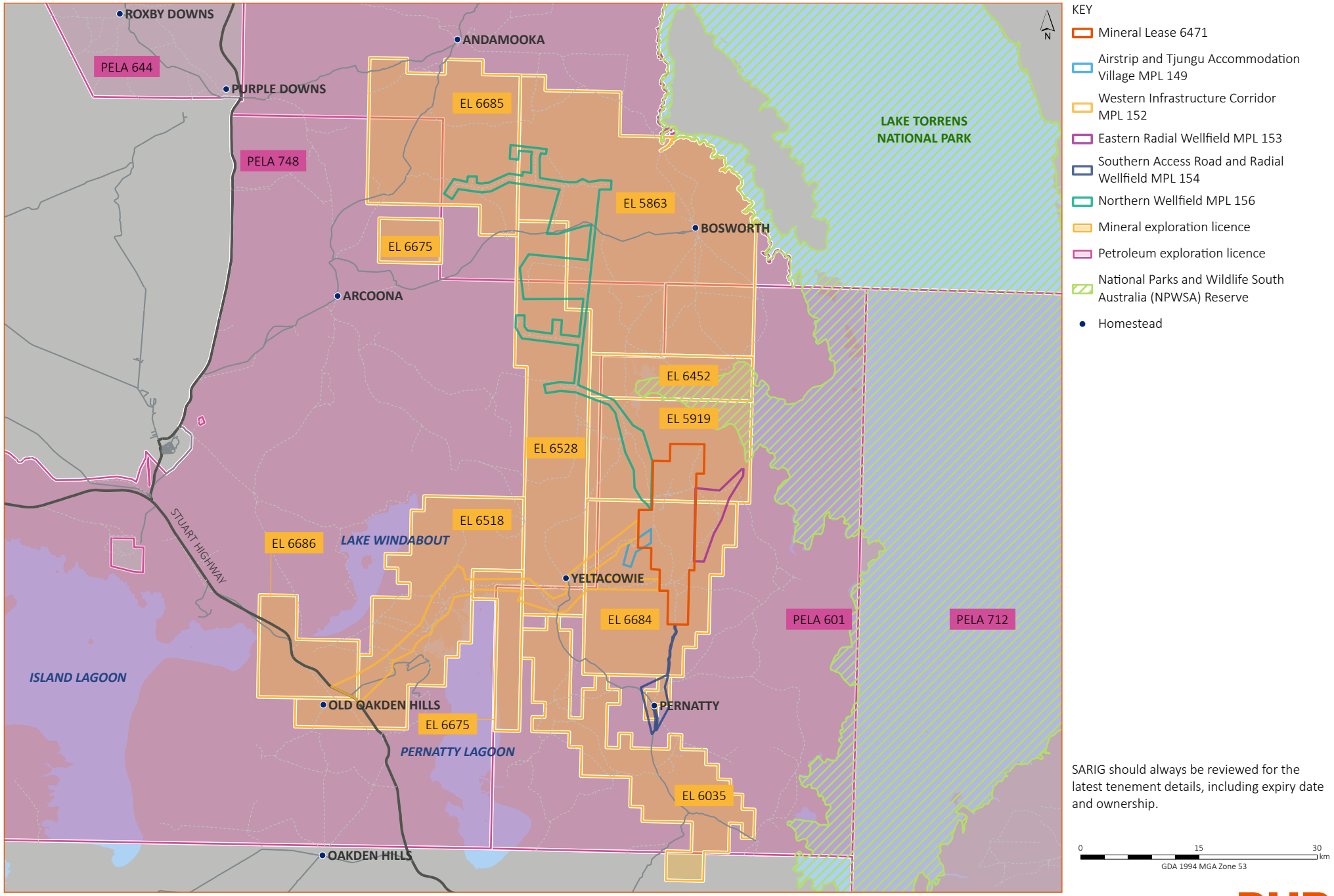


Figure 2.1 | BHP tenements and underlying Exploration Licences

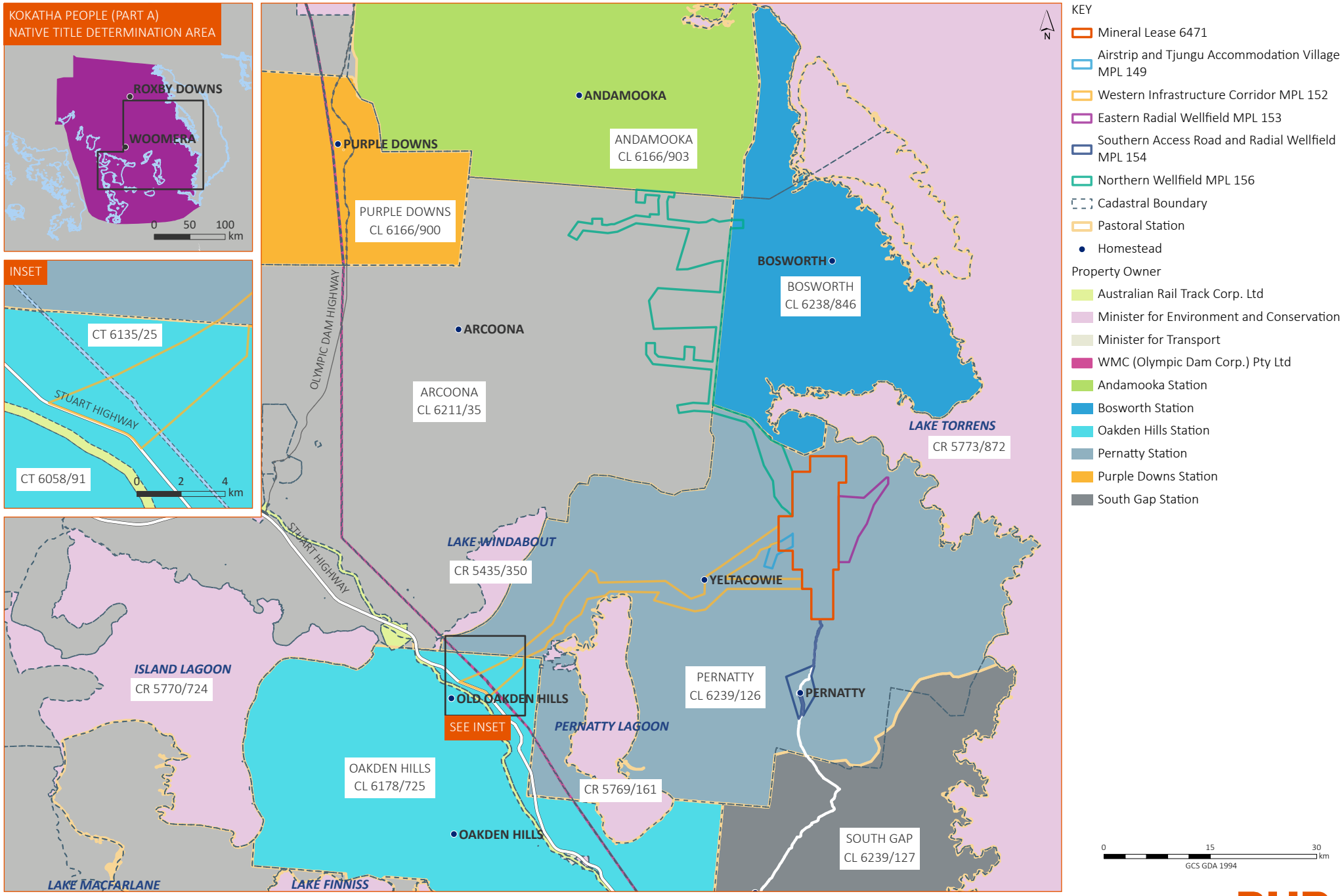


Figure 2.2 | Land ownership

Carrapateena BHP

2.2.2 Exempt land

The exempt land (as defined in Section 9 of the Mining Act) within the boundary of the tenements, is summarised in Table 2.3 to Table 2.7 and shown in Figure 2.3. There are no areas of identified exempt land within the boundary of MPL 149. As required by Section 9AA of the Mining Act, waivers of the benefit of the exemption from mining operations have been negotiated with the 'owners' of the land. The status of these negotiations is provided in the tables below. Exempt land identification (ID) numbers for particular structures correspond to the numbering in Figure 2.3.

Since the development of Carrapateena, changes to Section 9 of the Mining Act have been made, specifically with respect to the description of exempt land:

- the area considered exempt land with respect to residential properties has increased from 400 m to 600 m distant from the property
- the distance to industrial/pastoral infrastructure remains the same at 150 m, but the minimum value for the industrial/pastoral infrastructure to be considered as exempt land has increased from $2,000 to $2,500.

Transitional provisions within the Mining Regulations 2020 (SA) (Mining Regulations) note that "*The amendments made to section 9 of the Act by the Amendment Act do not apply in relation to an application for a mineral tenement made before the commencement day (and those sections will continue to apply in relation to the application as if the amendments made to those sections had not been enacted)".*

With specific consideration to the changes to approved operations described within this PEPR, BHP has undertaken assessments for exempt land as follows:

- Anything retrospectively considered exempt land (by way of the increase in buffer distance and/or infrastructure value) is waived in accordance with the original waivers of exemption (see Table 2.3).
- Any pastoral infrastructure constructed subsequent to the construction of approved Carrapateena infrastructure is not considered exempt land.
- Any new or proposed Carrapateena activities or infrastructure that occur within areas defined as exempt land and for which a waiver of exemption has not been obtained will be considered in accordance with the relevant sections of the Mining Act.

There is no new **exempt land** introduced as a result of the proposed changes to approved operations as described in this PEPR. Further, BHP's Land Access and Compensation Agreements with the pastoral leaseholders contain provisions relating to the waiver of any exemptions for exempt land within the pastoral lease land.

Table 2.3 | Carrapateena ML 6471 exempt land

ID	Structure	Area (ha)[1]	Status of waiver	Reason waiver is/is not required	BHP land access requirements
Entitled to Exemption: Pernatty Pastoral Lease (CL 6213/672)					
1	South Eliza Hut and Dams	27.5	Granted	Located within 150 m of existing Southern Access Road and borefield road and pipeline	Provided in Access and Compensation Agreement
2	Stockyard	10.1		Located within 150 m of access road and common services trench near the minerals processing plant (MPP) and mine surface infrastructure. Location of infrastructure is required in this location to provide mines access and services	
3	North Eliza Dam	19.7	Not required	Distance between mining operations and structure is greater than 150 m	Not applicable
4	Well	7.6			
5	Well or borehole	7.7			
6	Dawson Dam	15.5			

(1) Area of exemption includes the footprint of the structure and the buffer of exemption as per Part 9(d) of the Mining Act

Table 2.4 | Eastern Radial Wellfield MPL 153 exempt land

ID	Structure	Area (ha)[1]	Status of waiver	Reason waiver is/is not required	BHP land access requirements
Entitled to Exemption: Pernatty Pastoral Lease (CL 6213/672)					
7	Anzac Dam and stock yard	21.4	Granted	Located within 150 m of existing pastoral track and existing groundwater supply wells	Provided in Access and Compensation Agreement
8	Tadpole Waterhole	14.7	Granted	Located outside the tenement and distance between mining operations and structure is greater than 150 m	Not applicable

(1) Area of exemption includes the footprint of the structure and the buffer of exemption as per Part 9(d) of the Mining Act

Table 2.5 | Southern Access Road and Radial Wellfield MPL 154 exempt land

ID	Structure	Area (ha)[1]	Status of waiver	Reason waiver is/is not required	BHP land access requirements
Entitled to Exemption: Pernatty Pastoral Lease (CL 6213/672)					
9	Airstrip	87.2	Granted	Located within 150 m of existing pastoral track and existing groundwater supply wells	Provided in Access and Compensation Agreement
10	Pernatty Homestead and outbuildings	83.8			
11	Accommodation, stock yard and sheds	75.9			
12	Waterhole	15.6	Granted	Distance between mining operations and structure is greater than 150 m	Not applicable
13	Pernatty Dam	60.0			
14	Tank	7.5			
15	Pernatty Well and tanks	18.6			

(1) Area of exemption includes the footprint of the structure and the buffer of exemption as per Part 9(d) of the Mining Act

Table 2.6 | Western Infrastructure Corridor MPL 152 exempt land

ID	Structure	Area (ha)[1]	Status of waiver	Reason waiver is/is not required	BHP land access requirements
Entitled to Exemption: Pernatty Pastoral Lease (CL 6213/672)					
16	Parkes Dam	13.1	Granted	Location optimised to take advantage of existing pastoral tracks	Provided in Access and Compensation Agreement
17	Camel Dam	18.2		Located within 150 m of existing pastoral track within tenement	
18	Cattle Yard, Shed and Dam	25.2			
19	Kyolia Dam	14.4		Located within 150 m of Western Access Road	
20	Elizabeth Dam	14.3			
21	Yeltacowie Racecourse Dam	18.2	Not required	Located inside tenement but distance between mining operations and structure is greater than 150 m	Not applicable
22	Cattle yard and sheds	14.0			
23	Canegrass Dam and Trap Yard	15.6			
24	Stockyard	9.4			

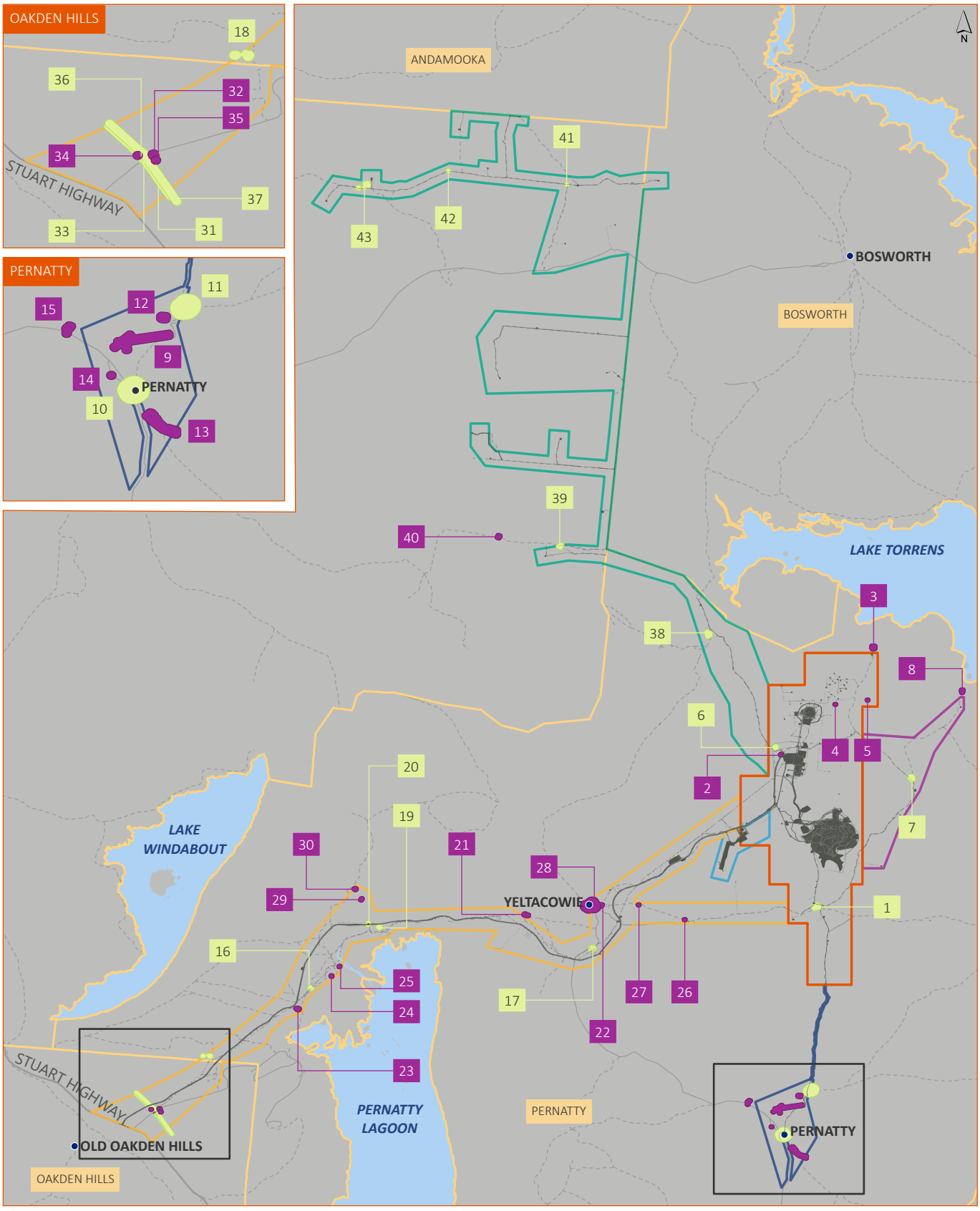
ID	Structure	Area (ha)[1]	Status of waiver	Reason waiver is/is not required	BHP land access requirements
25	Cement Bank	8.4			
26	Wilsons Tank	7.6			
27	Pressure tank	7.6			
28	Yeltacowie Homestead and outbuildings	105.5			
29	Surface Waterhole 9	11.1			
30	Elizabeth Catch Waterhole	11.9			
Entitled to Exemption: Oakden Hills Pastoral Lease (CL 6178/725)					
31	Electrical transmission pole	104.9	Granted	Located within 150 m of mining operations	Provided in Access and Compensation Agreement
32	Borrow pit	10.4		Western Access Road and 132 kV transmission intersects Electrical transmission line – ElectraNet	
33	Electrical transmission line - ElectraNet	11.6			
34	Solar Monitoring Station	7.3	Not required	Distance between mining operations and structure is greater than 150 m	Not applicable
35	Tower	7.3			
Entitled to Exemption: Western Mining Company (WMC) (Olympic Dam Corp) Pty Ltd (CT 6135/25)					
36	Substation	10.3	Granted	Location optimised next to existing transmission infrastructure (within 150 m)	Provided in Access and Compensation Agreement
37	Electricity transmission line – WMC	115.3		Western Access Road and 132 kV transmission intersects Electrical transmission line – WMC	

(1) Area of exemption includes the footprint of the structure and the buffer of exemption as per Part 9(d) of the Mining Act

Table 2.7 | Northern Wellfield MPL 156 exempt land

ID	Structure	Area (ha)[1]	Status of waiver	Reason waiver is/is not required	BHP land access requirements
Entitled to Exemption: Pernatty Pastoral Lease (CL 6213/672)					
38	Hogan Dam	25.87	Granted	Proposed well access/pipeline near Hogan Dam	Provided in Access and Compensation Agreement
Entitled to Exemption: Arcoona Pastoral Lease (CL 6211/35)					
39	Bosworth Hut, Stockyard, Tank and Well NC	18.11	Granted	Proposed well access/pipeline near Bosworth Hut, stockyard, tank, Well NC	Provided in Access and Compensation Agreement
40	Hickman Dam	NA	Not required	Located over 2000 m from the MPL 156 tenement boundary following partial tenement reduction (CA-APR-REP-1008) and is no longer classed as exempt land; not reflected on Figure 2.3	Not required
41	Hilda Tank and Infrastructure	7.76	Granted	Proposed well access/pipeline near Hilda Tank/Infrastructure	Provided in Access and Compensation Agreement
42	Alexander Tank	8.36		Proposed well access/pipeline near Alexander Tank	
43	White Dam, Stockyard, Tank and Pipeline	37.58		Proposed well access/pipeline near White Dam, stockyard, tank, pipeline	

(1) Area of exemption includes the footprint of the structure and the buffer of exemption as per Part 9(d) of the Mining Act



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint
- Pastoral station

Exempt Land buffer (waiver required)

- No
- Yes
- Homestead

0 7.5 15 km

GCS GDA 1994

Figure 2.3 | Exempt land

Carrapateena BHP

2.2.3 Development Plan zoning

The area comprising the tenements is zoned as Remote Area in the Development Plan for Land Not within a Council Area Eyre, Far North, Riverland and Whyalla. This zone encompasses significant parts of remote areas of South Australia. It contains extensive areas that are of cultural significance to people of Indigenous and non-Indigenous heritage. Established pastoral and grazing activities take place within this zone and significant growth and development in the mining industry is anticipated due to the presence of extensive mineral resources.

The Remote Area zone includes a diverse range of uses including pasture growing, grazing, farming, agricultural processing and transportation, mining and petroleum, energy generation and storage, pipeline infrastructure, aerospace and defence-related facilities, Aboriginal lands and related activities, tourist development, workers' accommodation and settlements.

The zone and policy intent for the remote Far North seeks to guide sustainable growth and development of mining-related activities and the development of new mining-related settlements to facilitate growth.

There are no known plans for changes in land use by other parties in the area surrounding the tenements.

3. Operator capability

With respect to this PEPR, and as of the date of this revision of the PEPR, Carrapateena continues to operate in accordance with the overarching legacy-OZ Minerals corporate governance frameworks described in the following sections. As the process of integrating the Carrapateena operations into BHP's Copper South Australia (Copper SA) asset (including Olympic Dam and Prominent Hill mines and the Oak Dam deposit), Carrapateena is expected to transition to BHP governance systems.

For completeness, the overarching BHP Copper SA approach to environmental management is also described within this chapter.

3.1 Management capability

This section demonstrates that the Carrapateena operation has the capability to operate the tenements in a manner that consistently ensures ongoing achievement of the nominated Environmental Outcomes. It discusses the approach taken to understand its obligations and ensure all employees, contractors and visitors know their obligations and work within the site rules and requirements.

Figure 3.1 demonstrates the alignment between the primary approvals and secondary permitting requirements and the operating environment. In order to ensure effective allocation of resources, limited duplication of documentation, and clear and concise compliance requirements, Carrapateena will have a single on-site Consolidated Monitoring Plan as detailed in Chapter 9.

Carrapateena is progressing integration with existing BHP systems as a component of the development of the Copper SA asset. In that context, the approach of BHP to sustainability and environmental management is described in the following sections.

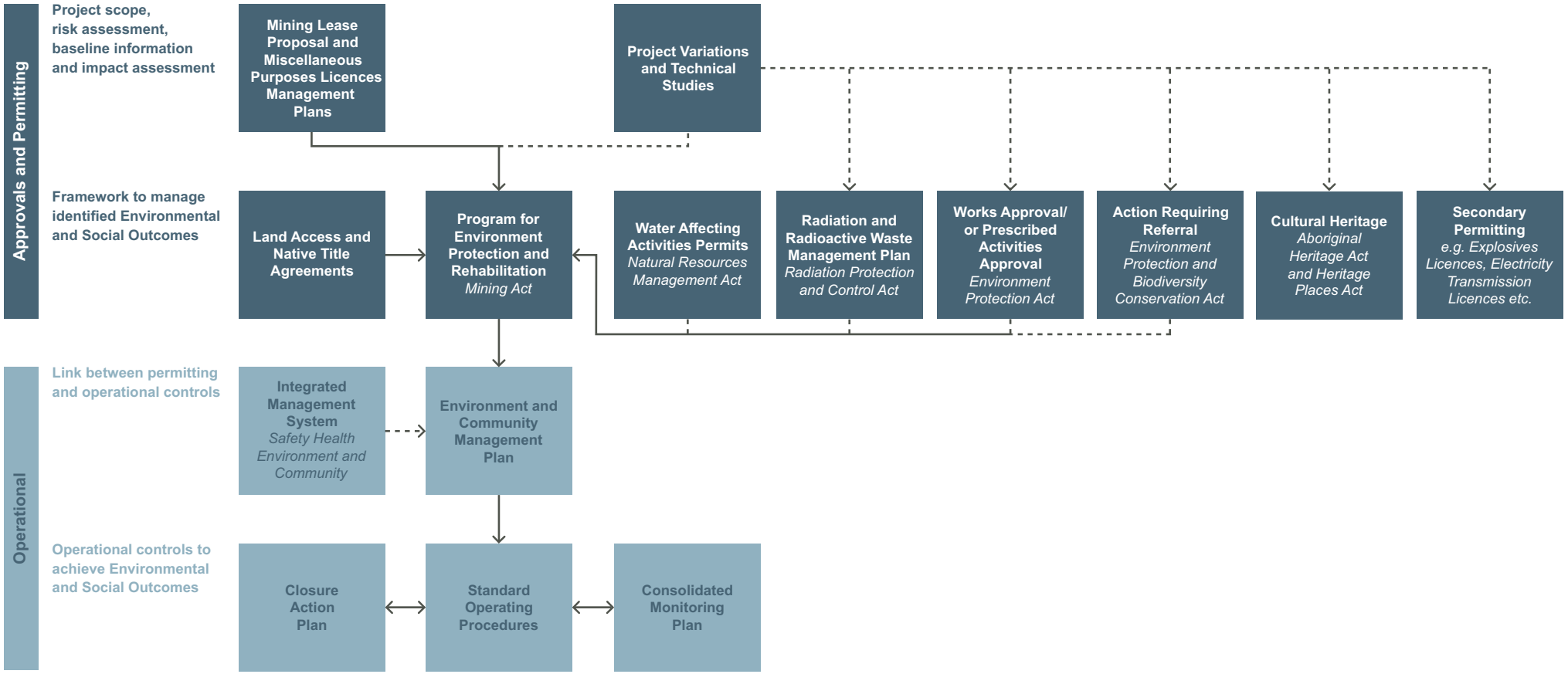


Figure 3.1 | Approvals, permitting and operational management framework

3.1.1 Ambition

BHP are committed to finding new ways of operating more sustainably while supplying products that are essential for the global transition towards a more sustainable future. BHP recognises that it can only achieve this purpose through collective effort, and BHP values the opportunity of partnering across the value chain to make their business more sustainable and to contribute to global sustainable development goals.

3.1.2 Approach

BHP's approach to sustainability includes identifying opportunities to create a positive contribution to society through social value. Social value is BHP's positive contribution to society – their people, partners, the economy, the environment and local communities and is about creating enduring, mutual benefit for the company, their shareholders and the broader community.

BHP's social value framework, approach to governance and annual performance against the social value scorecard are detailed on the social value webpage and discussed in BHP's Annual Reports.

BHP defines the approach to sustainability through Our Charter, which is governed through the Our Requirements standards. These standards describe our mandatory minimum performance requirements and provide the foundation to develop and implement management systems at our operated assets.

3.1.3 Materiality assessment

Each year, BHP identify the sustainability topics most material to business, partners and stakeholders, by assessing the economic, social, environmental and cultural impact of BHP activities and business relationships. In alignment with the recommendations of the Global Reporting Initiative (GRI), BHP consider the actual and potential negative and positive impacts of their business in order to determine material sustainability topics.

As part of this assessment, consideration is given to a broad range of inputs, including BHP's priority and emerging risks, information recorded in internal event management system, social value framework, insights from interviews with senior leaders and subject matter experts across the business. BHP seek to ensure external partners' and stakeholders' perspectives inform the assessment by including consideration of issues raised at BHP's Annual General Meetings and investor roundtables, industry sustainability standards and guidance, sustainability-related regulatory focus areas, relevant media articles about impacts and input from the Forum on Corporate Responsibility. Material sustainability topics are reviewed by the Sustainability Committee.

BHP has been conducting sustainability materiality assessments for many years and has a well-developed understanding of the organisation's context, and are actively involved in sector-specific initiatives such as the International Council on Mining and Metals (ICMM) and regularly engage with our stakeholders.

The materiality assessment process has the following key inputs:

- Identification of negative impacts: BHP's event management system is used to identify both actual and potential negative impacts arising from our operations. Specifically, the system is designed to capture events that have or could have resulted in adverse consequences to people (health and safety), the environment or local community, and to our legal, reputational or financial standing. Hazard reporting is also encouraged as a proactive measure to help reduce the likelihood of actual and high potential impacts.

- Assessing the significance of the negative impacts: BHP uses an internal severity rating scale (tiered from one to five by increasing severity), as defined in internal mandatory minimum performance requirements for risk management, to assess the significance of actual or potential negative impacts. For actual negative impacts, all events recorded in the event management system are assigned a severity level based on their actual or potential impact. BHP considers actual events from our event management system with a severity level of three or above to be 'material' for GRI reporting purposes.
- Identification and assessment of positive impacts: Positive impacts on the economy, environment and people are captured through the social value framework and social investment. The social value framework was developed through extensive consultation and identified the opportunity to build value, beyond minimum compliance, through proactive initiatives and investments that focus on sustaining long-term, mutual value with those who help to enable the realisation of BHP's sustainability purpose.

3.1.4 Governance and oversight

The BHP Board has oversight of the approach to, and delivery on, sustainability and is supported by each of its committees:

- The Board's Sustainability Committee advises and assists the Board in its oversight of BHP's management and performance in relation to health, safety, environmental, climate and community matters.
- The Sustainability Committee also advises the People and Remuneration Committee in setting safety and sustainability-related scorecard targets and evaluating performance against those targets.
- The Board's Risk and Audit Committee is responsible for assisting the Board in overseeing and reviewing emerging and priority group risks, risk management and internal controls. The Risk and Audit Committee also reviews and recommends to the Board public financial disclosures related to sustainability matters.
- The Nomination and Governance Committee is responsible for reviewing and making recommendations to the Board on BHP's significant social, community and sustainability policies. The Nomination and Governance Committee also reviews and makes recommendations to the Board on BHP's public sustainability targets and goals.
- The People and Remuneration Committee is responsible for considering and assessing the performance measures for the Executive Leadership Team and performance outcomes against those measures. In doing so, the People and Remuneration Committee considers recommendations from the Sustainability Committee in relation to health, safety, environment, climate and community measures.

3.1.5 Engagement

As a global company, BHP interacts with a range of partners and stakeholders. The methods, frequency of engagement and approach to listening to partners and stakeholders are diverse, and BHP use a range of formal and informal communication and engagement channels to understand partner and stakeholder views.

BHP also seeks advice from external experts and forums on issues relating to sustainability as inputs into our policy development and decision-making processes. The BHP Forum on Corporate Responsibility (FCR) is a key part of the governance approach and stakeholder engagement program. The FCR comprises independent civil society leaders in various fields of sustainability, who make an important contribution to the sustainability approach over a range of social and environmental issues and to the development of BHP Group policies, strategies and standards. They provide insight into current and emerging issues, challenge our thinking and allow BHP to understand and consider the broader impacts of BHP actions.

3.1.6 Performance

BHP use various metrics to measure sustainability progress and performance. Sustainability performance metrics are independently audited, and a copy of the independent assurance report is available in the BHP Annual Report.

Further information with respect to sustainability performance data and social values is available within environmental, social and governance (ESG) Standards and Databook and the Social Value webpage (www.bhp.com/about/operating-ethically/social-value).

3.1.7 Risk management

Under the Group-wide Risk Framework, BHP's aim is to identify risks (both threats and opportunities) associated with business and activities, including risks and potential impacts that relate to sustainability issues. This enables the prioritisation and management of risks that matter most.

All risks to which BHP is exposed are classified using the Group Risk Architecture. This is a tool to identify, analyse, monitor and report risk, which provides a platform to understand and manage risks. Similar risks are considered together in categories, such as 'people and culture', 'health and safety' and 'environment, climate change and community'. Each category is then further comprised of groups of risks, which include 'occupational safety', 'human rights', 'climate change' and other sustainability risks. This gives the Board and management visibility over the aggregate exposure to risks, including sustainability risks, on a Group-wide basis and supports performance monitoring and reporting against BHP's risk appetite.

When BHP assess the materiality of a current risk, the Risk Framework requires consideration of all potential impacts, including to health and safety, the environment, communities, human rights and social value. This is designed to support the consideration of all potential impacts in risk assessments and means potential sustainability impacts are required to be considered in the context of all identified risks.

Risk management is embedded into work processes and critical business systems to help develop a risk-informed approach to sustainability. Workplace health, safety, environment and community standards are set for operated assets and their application enforced. Contractors working at BHP operated assets must comply with BHP standards and requirements, and BHP seek to ensure that suppliers, agents and service providers maintain business practices and workplace standards comparable to theirs.

The Internal Audit team is responsible for providing independent and objective assurance over the control environment (governance, risk management and internal controls) to the Board and Executive Leadership Team. Third-party assurance providers visit selected operated assets and evaluate the sustainability approach to ensure we accurately represent our commitments and actions.

3.2 Environmental management

Carrapateena has developed an operation-specific Environmental Management System (EMS) to facilitate the management of environmental responsibilities for all phases of Carrapateena (construction, operation, and closure) and to enable continuous improvement of the site's environmental performance. Over the life of the project, the EMS would enable BHP to systematically assess and review its environmental effects, in addition to implementing programs for the management of environmental impacts and obligations.

3.2.1 Safety, Health, Environment and Community Model

Supporting the EMS, the Safety, Health, Environment and Community (SHEC) model used has four tiers, which are 'Leadership', 'Risk Management', 'Safe Workplace' and 'Safe Behaviour' as illustrated in Table 3.1. The effectiveness of each tier is dependent on the effectiveness of the underlying tier and is supported in continuous improvement by the process of Plan – Do – Check – Act.

Contractors have the discretion to establish specific procedures and training packages where Performance Standards, guidelines and procedures do not cover areas specific to their business or where their SHEC systems provide an equivalent or greater level of protection for their workers, the environment or the community. Where BHP does not have operational control but has an equity stake where significant BHP assets are involved, or the activity is deemed to be a 'monitored activity', the Performance Standards would form the basis for the appropriate level of due diligence to be applied.

Table 3.1 | Safety, Health, Environment and Community Model

HSEC aspect	Description
Leadership	Strong leadership is the foundation for a positive culture at Carrapateena
Risk management	Risk Management is critical to minimise potential harm to people, the environment or equipment. All risks must be identified, evaluated, and managed to minimise all identified actual and potential adverse impacts
Safe workplace	We have a duty of care to provide a safe workplace to our workforce by ensuring that plant and equipment is fit for purpose, people are adequately trained and that systems of work are effective
Safe behaviour	Safe behaviour of all workforce and awareness of environment and community is a culture that Carrapateena wants to develop by coaching and rewarding people and providing them with appropriate safe work instructions

3.2.1.1 Roles and accountability

All Carrapateena employees and contractors have a role in complying with the EMS and have accountability in achieving the environmental Performance Standards and environmental management objectives. By outlining roles and responsibilities for key positions in the implementation of the EMS, BHP can ensure that all stakeholders comprehend their obligations and work together to a common objective.

3.2.1.2 Environmental Management Plans

Environmental Management Plans (EMPs) underpin the adaptive environmental management approach and are used for the life of the project to implement the EMS at an operational level. EMPs cover the design, construction, commissioning, operation phases and maintenance activities of Carrapateena. They identify key environmental issues across Carrapateena and provide strategies and plans for managing them effectively, in addition, the define the legal requirements relevant to that environment aspect, identify regulatory permits and licences required for various construction and operational activities and would also govern roles and responsibilities of employees and contractors.

EMPs are developed and documented through a systematic and consultative process to address environmental factors and risks. Technical input is sought from a variety of sources including design, construction and operational personnel, conditions of approvals and legislative requirements and industry standards. The EMPs currently employed at Carrapateena include:

- Air quality EMP
- Biodiversity EMP
- Contaminated land EMP
- EPBC offset EMP
- Firearms management plan
- Greenhouse gas EMP
- Mine closure management plan
- Ore and waste rock EMP
- Radiation transport EMP
- Radioactive waste EMP
- Water EMP
- Waste and wastewater EMP.

3.2.2 Sustainability reporting

BHP are committed to a number of sustainability frameworks, standards and initiatives and disclose data both as required by law and according to the requirements of those frameworks, standards and initiatives. Sustainability performance data is included in relevant sections of the BHP Annual Report, Operating and Financial Review, and in BHP's ESG Standards and Databook.

3.3 Stakeholder engagement

3.3.1 Approach

BHP is committed to creating value in the communities in which it works and to developing Carrapateena in a manner that reflects what is important to stakeholders. It is important to BHP that engagement is maintained with stakeholders who have raised specific concerns and/or have a specific interest in outcomes. This forms part of the ongoing management and how stakeholder engagement is approached throughout the operation's life.

Following lodgement of the Airstrip MPL MP (OZ Minerals 2016), MLP (OZ Minerals 2017a) and Northern Wellfield MPL MP (OZ Minerals 2018c), submissions were received from government agencies, which were responded to in the Airstrip Response Document (OZ Minerals 2017) on 16 March 2017, Carrapateena Project Response Document (OZ Minerals 2017c) on 22 September 2017 and Northern Wellfield Response Document (OZ Minerals 2018d) on 11 October 2018. No formal submissions were received from the public.

Opportunities for further engagement are provided to all stakeholders through formal regulatory communication mechanisms (e.g. formal circulation of information to stakeholders as required under legislation via local and state media channels). Where stakeholders are directly affected, BHP has and will, personally provide information regarding this PEPR and work through any concerns, issues or opportunities they may have.

BHP's commitment to creating value for stakeholders is evident through the investment of significant resources to ongoing engagement including, regular visits to the region by senior and executive members of the BHP team, and continuous support for Carrapateena from full-time environment and community resources to ensure ongoing compliance with regulatory outcomes, stakeholder engagement and protection of Aboriginal cultural heritage. BHP captures stakeholder engagement activities and feedback on an ongoing basis through a stakeholder management system database. The existing monitoring and evaluation mechanisms have been applied and, where required, tailored to enable the ongoing, effective delivery of BHP engagement activities and the incorporation of, and response to, stakeholder feedback.

BHP maintains a program of ongoing engagement with stakeholders, and this will continue over the life of Carrapateena. BHP will continue to work with stakeholders to ensure engagement activities are meaningful, transparent and occur in a manner that facilitates genuine stakeholder participation.

BHP's engagement is monitored, measured and reported as part of its publicly available sustainability reporting process. BHP maintains the Local Area Agreement – Operating Protocols between itself and owners of land adjacent to, and on the land (specifically Pernatty, Bosworth and Arcoona Pastoral Leases), which include the following:

- interaction with landowner operations
- emergency procedures
- communications and issue management processes
- land management
- dispute resolution
- ongoing communication about the tenement holder's operations
- receiving and considering feedback
- safety procedures and access protocols
- any matters identified by the Director of Mines (or other authorised officer) in writing.

3.3.2 Engagement outcomes

In accordance with the DEM Mineral Regulatory Guideline MG2b (DEM 2023b) and the requirements of the Mining Act, Mining Regulations and the TOR 005 (DEM 2021), when updating the PEPR for Carrapateena, BHP is required to summarise the results of any previous consultation about the existing operations and any proposed changes to approved operations.

Consultation and engagement on previous approvals was detailed in the MLP (OZ Minerals 2017a), MPL Management Plans (OZ Minerals 2016; 2018c) and associated PEPRs (OZ Minerals 2017b; 2018a; 2019; 2020a; and BHP 2024a) and is not repeated in this PEPR update. Table 3.2 provides a summary of the consultation undertaken in support of this PEPR update and includes the following details:

- the individual or, if not practical, a group description of similarly affected persons
- type of interested or affected party such as resident, council, government agency etc.
- the concerns and issues raised
- the response to those concerns.

Table 3.2 | Stakeholder engagement and consultation outcomes

Stakeholder	Engagement date	Discussion/considerations	Engagement outcome
Pastoralists			
Pernatty Station	11 October 2024	BHP initiated meeting to discuss the proposed CiOP for the greater Carrapateena expansion project, particularly the findings of the revised impact assessments which demonstrate no change to environmental impacts, outcomes, OMCs and management measures expected in connection with the proposed changes, and to seek feedback. Specific discussion was had regarding the height of the TSF, and proposed CiOP footprint and continuation of the current monitoring program. Additional discussion was had regarding current operational and future management measures for preventing erosion and saline water runoff into pastoral dams.	Sentiment was considered neutral, with no further comments regarding the proposed CiOP or TSF design. Responses to questions were considered acceptable to address stakeholder queries, with a commitment to ongoing discussion on these matters, as required.
	3 April 2025	Annual operating protocol meeting. BHP presented on compliance and interactions with Pernatty Station including operation of the TSF and changes to the TSF Design.	Pernatty requested ongoing updates on management of decant water to limit seepage and expressed interest in furthering their understanding of impacts from reported saline spills.
	Monthly (ongoing)	Pastoral Update Newsletter including general project/operational information.	N/A
Arcoona Station and Bosworth Station	23 August 2024	BHP initiated meeting to discuss the proposed CiOP, particularly no change to environmental impacts, outcomes, OMCs and management measures expected in connection with the proposed changes, and to seek feedback. Specifically discussed water supply and demand scenarios and associated infrastructure, and the assessment of groundwater effects.	Sentiment was considered neutral. Stakeholders were comfortable with the information provided and had no concerns regarding the proposed CiOP, including changes to the TSF design.
	Monthly	Pastoral Update Newsletter including general project/operational information.	N/A
Traditional Owners			
KAC	13 and 14 August 2024	Partnering Health Check: BHP presented an overview of the plans for growth for the Carrapateena operations and led a general discussion on the proposed expansion. Changes to TSF design, including stage 3 was included in the discussion and a visit to the TSF.	No feedback provided. Overall sentiment was considered neutral.
	7 November 2024	Partnering Management Committee (PMC) meeting: BHP presented the key components of the proposed CiOP, impact assessment methodology and the findings of the impact assessments and sought feedback and discussion. Changes to the TSF design, including Stage 3 were included in the discussion.	No feedback provided. Overall sentiment was considered neutral.
	15 May 2025	PMC meeting: BHP presented comprehensive TSF update and further detail on changes to the TSF design, including Stage 3. Ongoing TSF engagement in line with the Global Industry Standard on Tailings Management (GISTM) and best practice.	KAC requested to be involved in future closure planning and to be engaged prior to any recovery efforts in the unlikely event of a dam breach.
Regulators			
DEM, DEW, LandscapeSA, EPA, BHP, Responsible Tailings Facility Engineer (RTFE), groundwater consultant	12 December 2024	BHP, with two groundwater consultants (lead groundwater modelling consultant) presented an overview to all stakeholders on the proposed CiOP, specifically addressing the proposed change in operations, TSF design, updated impact assessments (groundwater, GDEs, air quality, ecology) and supporting documentation.	BHP gathered proposed CiOP pre-lodgement feedback and responded to questions.

3.4 Legislative requirements

BHP is required to comply with all South Australian and Commonwealth legislation and regulations applicable to the activities undertaken as a part of the development, operation and closure of Carrapateena. The alignment between secondary permitting and the PEPR allows for an all-inclusive operational document that meets legislative requirements and ultimately reduces the burden of duplication on the operation.

BHP understands and complies with all relevant South Australian and Commonwealth legislation and regulations applicable to Carrapateena.

An example of the current legislative requirements and their associated secondary permit or licence is listed in Table 3.3.

Table 3.3 | Key legislative requirements

Stakeholder/department	Legislation	Approval/licence
EPA (SA)	*Environment Protection Act 1993* (SA)	Works Approval
		Licence to Undertake Activities of Prescribed Environmental Significance
		Alteration to Plant and Equipment
	Radiation Protection and Control Act 2021 (SA)	Radiation Licence(s)
SafeWork SA (SA)	*Dangerous Substances Act 1979* (SA)	Licence to Keep a Dangerous Substance
		Licence to Convey a Prescribed Dangerous Substance
	Work Health and Safety Act 2012 (SA)	All operations must comply with relevant provisions under the Act
DEM (SA)	*Aboriginal Heritage Act 1988* (SA)	Permission to damage, disturb or interfere with an Aboriginal Site, Object or Remain
Attorney-General's Department (Commonwealth)	*Native Title Act 1993* (Cth)	
Department for Environment and Water (DEW) (SA)	*Landscape South Australia Act 2019* (SA)	Licence for Water Affecting Activities Permit
	Native Vegetation Act 1991 (SA)	Approval to clear native vegetation
	National Parks and Wildlife Act 1972 (SA)	Permit to take native plants and protected animals or eggs of protected animals
Department of Climate Change, Energy, the Environment and Water (DCCEEW) (Commonwealth)	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)	Referral of proposed action of National Environmental Significance
		Environmental offsets
	National Greenhouse and Energy Reporting Act 2007 (Cth)	Registration of controlling corporation
Country Fire Service (CFS) (SA)	*Fire and Emergency Services Act* 2005 (SA)	Permit to light or maintain a fire in open air circumstances (total fire ban)

Stakeholder/department	Legislation	Approval/licence
Department for Infrastructure and Transport (DIT) (SA)	*Road Traffic Act 1961* (SA)	Permit for over mass and/or oversize vehicle to travel on certain roads
		Deed and S.221 Authorisation
		Road works approval/notification
SA Health (SA)	*South Australian Public Health Act 2011* (SA)	Approval for Wastewater Treatment Plant
		Approval for use of Recycled Water for Dust Suppression
	Safe Drinking Water Act 2011 (SA)	Approval to provide drinking water
Native Title Holders	Mining Act Part 9B	NTMA
Civil Aviation Safety Authority (Commonwealth)	*Civil Aviation Act 1988* (Cth)	Certification of Airstrip
Essential Services Commission of South Australia	*Electricity Act 1996* (SA)	Electricity Transmission Licence
Pastoral Station	Mining Act	Land Access and Mining Compensation Agreement

3.5 Impact assessment framework

BHP has developed an impact assessment framework that supports Carrapateena throughout its lifecycle to manage environmental and social impacts and risks in a transparent and repeatable manner. This framework was used in the development of the Carrapateena MLP (OZ Minerals 2017a) and will continue to play a critical role in the environmental management of the site and for the assessment of future variations as detailed in Section 3.6.2. The assessment framework draws on the requirements of ISO 14001 Environmental Management (ISO 2015), Government of South Australia and Australian Government regulation and internationally recognised frameworks such as those established by the International Finance Corporation of the World Bank Group. The assessment methodology is consistent with TOR 005 (DEM 2021) and Ministerial Guideline MG2b (DEM 2023b), to ensure it meets the requirements of the Mining Act and associated regulations.

The Impact assessment framework wheel (see Figure 3.2) supports the process by assisting with the identification of potential impacts across the source-pathway-receptor (SPR) model at each of the phases in the Carrapateena lifecycle.

The assessment framework has been the basis of development of the Outcomes identified for Carrapateena and in the development of OMC and Leading Indicators as stated in Chapter 7.

To provide further context and to ensure the framework is consistently applied when considering any future changes to approved operations, a description of the framework is provided in the following sections.

3.5.1 Source-pathway-receptor model

The framework builds upon the foundation of a SPR model, adjusted to articulate the effect to pathways and impacts on receptors. When an SPR linkage is confirmed an impact significance assessment is required to be undertaken for a receptor.

It is important that the reader understands the definitions of source, pathway and receptor applied at Carrapateena.

Source: A project element that can interact with the environment.

Pathway: The pathway, means or route (with consideration of any natural barriers) by which an identified receptor can be exposed to, or may reasonably be expected to be impacted by, an identified source.

Receptor: A discrete, identifiable attribute or associated entity that can be measurably impacted by an effect to a pathway.

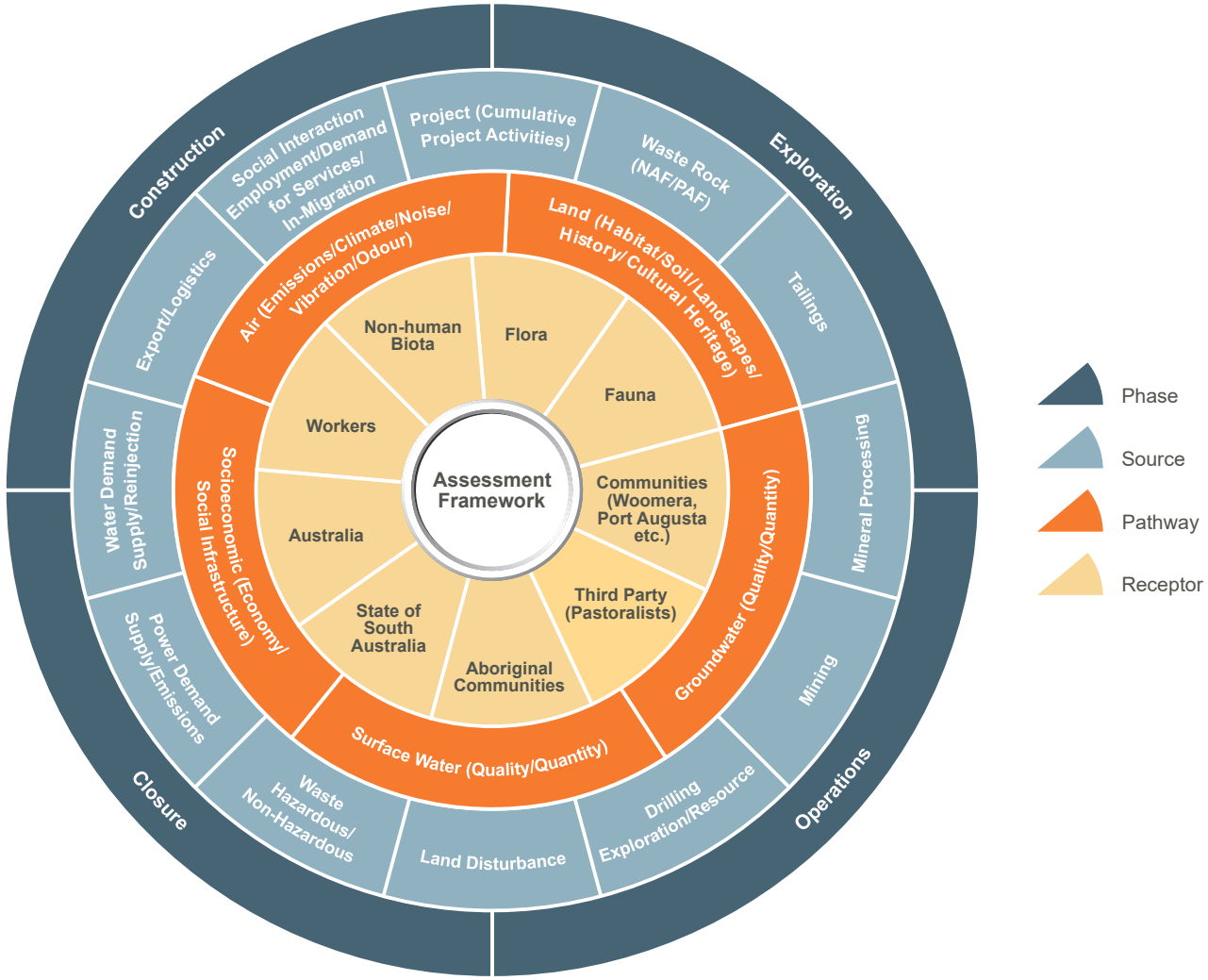


Figure 3.2 | Impact assessment framework wheel

3.5.2 Effect (pathway) and impact (receptor)

BHP takes the approach to pathways and receptors as per the definitions in Section 3.5.1. Whilst an effect on a pathway may occur and not result in an impact, there may still be legislation that sets guidelines and protection limits for pathways (such as National Environment Protection Measures). Further, pathways may have values assigned by stakeholders that need to be taken into consideration where, regardless of any impact to receptors, the pathway must still be managed. Environmental or social values have been captured using a materiality assessment and ongoing stakeholder engagement.

Pathways are grouped into five key categories:

- land – habitat, soil, landscapes, history, cultural heritage, vibration
- air – emissions, climate, noise and odour
- groundwater – quality and quantity
- surface water – quality and quantity
- socio-economic – economy and social infrastructure.

Receptors are generally grouped into eight key categories:

- communities – Aboriginal communities and local communities
- third-party – pastoralists and businesses
- state – South Australia
- national – Australia (includes international obligations that Australia has for matters of national environmental significance (MNES))
- flora – common, state or national significant species
- fauna – common, state or national significant species
- workers – for the purposes of health assessment Leading Indicators
- non-human biota – for the purposes of ecological assessment Leading Indicators.

3.5.3 Project phase

Phase: The time at which a specific source (project element) emerges. The phase is selected to reflect when the source occurs and not when a potential or actual impact is anticipated to occur.

The phase of a Project is an important consideration during the assessment process as it identifies when a specific source emerges and hence when it may commence interactions with the environment. It is important in effect and impact assessments that any controls are applied during the phase where the effect or impact may be most reduced or mitigated.

Many SPR linkages present different results over time and as such, understanding the long-term profile of the natural environment helps to understand the decisions being made in the short term.

BHP understands that a number of the effects or impacts presented may extend post closure, however, the controls that determine the extent to which this may occur are applied during construction, operations or closure activities. For this reason, post closure does not appear as a phase in the lifecycle and closure applies to the action of conducting closure, rehabilitation and relinquishment.

As with any modelling, there is an element of uncertainty that arises when the model is run into the long-term future. Although closure has been considered in the assessment approach and is consistent with TOR 005 (DEM 2021) and Ministerial Guideline MG2b (DEM 2023b), BHP has presented the closure scenario with a conservative assessment to allow for the uncertainty driven by the long term.

3.5.4 Planned event (impact) and unplanned event (risk)

The impact assessment framework is based upon the distinction between impact (planned event) and risk (unplanned event). Both play an important part in project definition and form a part of this assessment. There is a key difference between undertaking a risk assessment and completing an impact assessment in the form of either an Environmental or Social Impact Assessment.

Risk: 'The impact of uncertainty on objectives' (ISO 31000:2018) (ISO 2018). It consists of two components – the consequence and its likelihood.

Impact: Any certain and defined change to a receptor, whether adverse or beneficial, wholly or partially resulting from a source affecting a pathway.

Uncertainty that exists through the impact assessment may relate to several areas, including:

- inputs associated with the options that remain as a part of the project description
- the breadth and scope of the baseline studies, or
- the science undertaken in the determination of the magnitude of the effect or the impact.

Importantly, an impact assessment quantifies and allows communication of the impact of a project to all stakeholders if it is constructed, operated and closed in accordance with its scope and design.

Risk emerges when unplanned events that lie outside the previous assessment stages threaten to increase the impact of a project. These unplanned events have a likelihood and consequence that may affect the ability of a project to achieve its Outcomes. The process captures the existing or proposed risk controls and assigns a consequence and likelihood rating to the raw and residual risk. Risk treatments have been developed to reduce the consequence and/or likelihood. Typically, a hierarchy of controls exists based on administrative procedural controls, training and management, and use of protective equipment.

Carrapateena maintains a risk register that provides a basis for the ongoing management of risk for the duration of operations and closure.

3.5.5 Design controls and management controls

BHP has considered the role of design controls and management controls in the assessment process. Where possible, a conservative effect assessment has been undertaken to ensure the potential impacts of the Project consider an uncontrolled scenario. It is proposed that an acceptable uncontrolled scenario allows future flexibility in adjusting controls commensurate with the ongoing management of employee health and safety, leading practice or continual improvement.

Where controls have been considered, BHP has applied a hierarchy (see Figure 3.3) that outlines how controls are applied during the phases of a project and the assessment process. Controls for the mitigation of potential impacts and risks associated with the project have been categorised for each pathway as either design controls or management controls.

A design control that is applied to a project activity for the purpose of preventing an effect from occurring, and subsequently preventing an impact, is termed a Fundamental Design Control (FDC).

Fundamental Design Control: A robust control that prevents an effect to a pathway from occurring, thus preventing an impact.

FDCs break an SPR linkage and therefore prevent an effect on the pathway and impact on an identified receptor. A number of FDCs were identified for Carrapateena.

Where there is a high reliance on an FDC to prevent an impact from occurring, a non-outcome-based lease/licence condition is required. Where there is a high reliance on a management control, a **Leading Indicator** is identified to give an early warning that it may fail or be failing.

The FDCs identified during development of the Carrapateena MLP (OZ Minerals 2017a) were subject to a Layers of Protection Analysis (LOPA). An independent facilitator was used to develop the LOPAs. The LOPAs demonstrate that there are sufficient independent barriers (controls) in place to either prevent the unwanted event from occurring, or in the event it does occur, there are sufficient controls to prevent impacts occurring to identified receptors. The LOPA methodology evaluates the type and independence of each identified control (design or management), utilising a risk matrix and controls ranking system to ensure multiple controls act in isolation of each other to provide back up in the event one control fails. A LOPA was undertaken for Carrapateena and included as Appendix C6 of the MLP (OZ Minerals 2017a). No FDCs were identified for MPL 149 or MPL 156, and as such, no LOPAs were undertaken.

LOPAs are undertaken at the primary pathway level as they present confidence in the ability to prevent the primary pathway effect and therefore any secondary effects are not considered. In the event of failure of a control, an incident investigation and environmental assessment would be undertaken of the primary and secondary pathways and any potential impacts that may arise to determine the appropriate actions because of the failure.

When assessing controls, the hierarchy of controls and the corresponding increasing effectiveness must be considered for the Project. Elimination, substitution and engineering are all considered design controls. BHP utilises the early stage of project planning and engineering studies to work through the elimination and substitution levels of the hierarchy. Elimination was utilised significantly during the design of Carrapateena, with examples such as avoiding areas of high cultural significance and habitat retreats for threatened species. Engineering controls can be either active or passive, and efforts are made to ensure those required at closure are passive. Passive controls are those that do not need operators to be present to ensure effectiveness of the controls.

Design Control: An elimination, substitution or engineering control identified and implemented during the project design and/or construction phase with the intent of eliminating, 'so far as is reasonably practicable' (SFAIRP) or otherwise reducing, 'as low as reasonably achievable' (ALARA), potential impacts and/or raw risks associated with Project activities.

Further down the hierarchy of controls, there is an increasing need to involve people in the effectiveness of the control. Except for active engineering controls, all controls that require people for their effectiveness are referred to as 'management controls'. These controls are in place to ensure that any impact event that has been identified, or any effect that has been stated, is not larger than originally stated.

Onsite behaviours, training, contractor expectations and general operating activities all drive the overall effective implementation of management controls.

Management Control: An administrative control (e.g. the application of personal protective equipment) or procedural control (e.g. work instructions or standard operating procedures) that may be implemented during operations for the purpose of reducing the consequence and/or likelihood of an identified risk event.

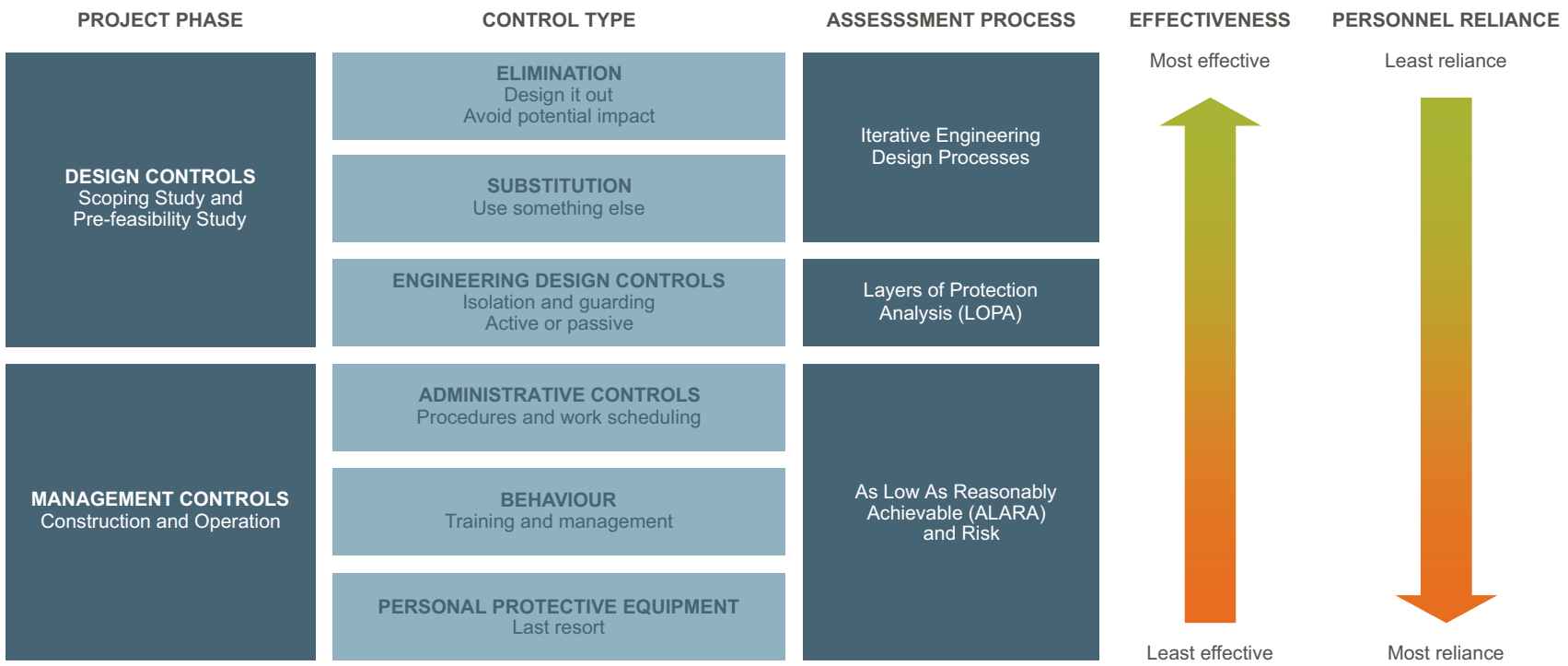


Figure 3.3 | Hierarchy of control

3.5.6 Assessment framework outputs

The assessment framework used during the development of the Carrapateena MLP (OZ Minerals 2017a) allowed BHP to assess information associated with the credible potential impacts originating from each of the Carrapateena development phases, including construction, operation and closure. This will also be used for the assessment of future changes to approved operations.

The key outputs of the assessment framework are summarised as:

- Identify credible potential SPR linkages (planned events) and providing sufficient justification behind the statement of impact, including an explanation of any uncertainty.
- Evaluate the role of controls in the design, their position in the hierarchy, and assessment of those design controls that are fundamental to achieving the Outcomes.
- Identify other legislative requirements.
- Determine materiality of any potential impact as a result of stakeholder consultation.
- Assess the impact significance and justifying why if deemed ‘not significant’ that this is correct, and if ‘significant’ why this is acceptable.
- Assess impact uncertainty by stating any uncertainty, in any element of the assessment, to develop a statement of impact.
- Assess the relevant risks (unplanned events) that may occur that mean an Outcome may not be achieved.
- Develop proposed Outcomes and OMC and providing any consultation that occurred on these Outcomes.

The template for the assessment framework output and the applicable Mining Act requirements are shown in Table 3.4. The individual impact assessments are contained within the Consolidated Assessments (OZ Minerals 2016 Appendix C; OZ Minerals 2017a Appendix D6; OZ Minerals 2018c Appendix E).

The assessment framework has formed the basis of preparation of this PEPR, and changes to the original impact assessments as a result of either changes to the understanding of the baseline environment or proposed changes to approved operations are described in Section 7.1.

Table 3.4 | Assessment methodology compliance

IMPACT ID and Impact Title									
Planned Event	**Potential Impact Description**	Mining Act Section 35 and 53(1)(a)(ii)(A); Mining Regulation 30 and 49(1)(a)(b); 30 and 49(1)(b); MD006 Section 6.1.2.					**Phase (Point at which source emerges)**	Mining Act Section 35 and 53(1)(a)(i); MD006 Section 6.1.2	
	Source	Mining Act Section 35 and 53(1)(a)(i); MD006 Section 6.1.2.1							
	Pathway	Mining Act Section 35 and 53(1)(a)(ii)(A); MD006 Section 6.1.2.2							
	Receptor	Mining Act Section 35 and 53(1)(a)(ii)(A); MD006 Section 6.1.2.3							
	Design Controls (Elimination, Substitution, Engineering)	Mining Act Section 35 and 53(1)(a)(ii)(B); MD006 6.2.1	**Fundamental Design Control (Engineering)**	Yes/No	**FDC Description**	Mining Act Section 35 and 53(1)(a)(ii)(B); MD006 6.2.1	**LOPA Description**	Mining Act Section 35 and 53(1)(a)(ii)(B); MD006 6.2.2	
	Is the Linkage Confirmed (Impact) (Description of the Impact)	Yes/No	Mining Act Section 35 and 53(1)(a)(ii); MD006 Section 6.1.2.5			**Uncertainty associated SPR, impact statement/control measure**	Mining Regulations 30 and 49(2); MD006 Section 6.1.2.4 and 6.1.2.5		
	Is the SPR Material?	Yes/No	**Justification**	Mining Act Section 35 and 53(1)(a)(iv); MD 006 Section 6.1.1			**Legislative Requirements**	MD 006 Section 6.1.1	
	Impact Significance Mining Regulation 30 and 49(1)(b) EPBC Act Assessment for MNES; MD006 6.1.1	**Resilience**	Aligned to EPBC Significant Impact Guidelines 1.1						
		Importance	Aligned to EPBC Significant Impact Guidelines 1.1						
		Duration	Aligned to EPBC Significant Impact Guidelines 1.1						
		Significance Rating (0–125)		Significance (>48)/Not Significant (<48)					
	Significance justification								
	Impact Uncertainty Mining Regulations 30 and 49(2); EPBC Act Assessment for MNES; MD006 Section 6.1.2.4; 6.1.2.5 and 6.2.2	**Inputs**							
		Method							
		Sensitivity							
		Uncertainty Rating (0–25)		Uncertain (Change to Impact Significance >48)/Not Uncertain (No change to Impact Significance <48)					
	Uncertainty Justification								

Unplanned Event									
	Risk Assessment Referred to in Section 3.6.1.4 in the Minerals Regulatory Guidelines (MG2a) only	**Risk Event**	**Raw Risk (Pre-Controls)**			**Management Controls**	**Residual Risk (Post Controls)**		
			Consequence	**Likelihood**	**Risk**		**Consequence**	**Likelihood**	**Risk**

Statement of Outcomes		
	Purpose for Outcome	Mining Act Section 35 and 53(1)(a)(ii)(C); Mining Regulation 30 and 49(1)(c); MD006 Section 6.2.3
	Outcome	Mining Regulation 65(2)(b); Mining Regulations 30 and 49.1(d); MD006 Section 6.2.3
	Outcome Measurement Criteria	Mining Act Section 35 and 53(1)(a)(iii); Mining Regulation 65(2)(e); MD006 Section 6.2.4
	Leading Indicator	Mining Act Section 35 and 53(1)(a)(iii); Mining Regulation 65(2)(d); MD006 Section 6.2.5
	Strategy	Strategy to meet Outcomes

3.6 Project variation assessment

Operational and closure strategies for Carrapateena, as well as environmental monitoring arrangements, may evolve during the life of Carrapateena as operational requirements change and further site knowledge is gained. As such, there may be a need to consider changes to approved operations. These variations should:

- ensure that Project activities remain optimised
- reduce uncertainty and assumptions within the PEPR through incorporation of the results of further works, trials, and refinement of strategies
- ensure that the Outcomes and OMC remain relevant.

3.6.1 Regulatory requirements

Part 8B, Division 7 of the Mining Act and Part 12 of the Mining Regulations sets out the process and requirements for a tenement holder to apply to DEM to make a change in authorised operations. These provisions were added to the Mining Act in 2020 so that tenement holders can make changes to their operations that may be considered outside the scope of what was approved as part of the original tenement grant, and which require an environmental impact assessment to authorise the change.

Under the Mining Act, a change may be authorised through:

- a new lease or licence application
- a change in operations application, in accordance with Part 8B Division 7 of the Mining Act
- a PEPR review, in accordance with Section 70C of the Mining Act.

The process for determining the approvals pathway for a proposed change in approved operations is described in Minerals Regulatory Guideline MG35 Applying for a change in operations (DEM 2023a) and summarised in the following sections.

3.6.1.1 Change in operations application

BHP will submit a change in operations application for Carrapateena if the proposed change:

1. Is inconsistent with, or outside the scope of, the operations approved in the original tenement grant(s) (i.e. it is materially different from the operations assessed and approved in the MLP or MPL Management Plan application process).
2. Would result in non-compliance with existing lease or licence terms/conditions.
3. Requires an environmental impact assessment to understand its impact. This is determined on a case-by-case basis, considering factors such as the significance of proposed changes, environmental setting and the likelihood of new or additional unassessed impacts or new receptors being introduced as a result of the change.
4. Is an administrative change in the mineral that is intended to be recovered or to the tenement's terms or conditions.

The change in operations application must be prepared in accordance with the requirements of MG35 (DEM 2023a). A change in operations application also requires a corresponding PEPR review if the proposed change is inconsistent with the current approved PEPR.

3.6.1.2 PEPR review

A PEPR review will be required where there are proposed changes which:

1. without requiring an environmental impact assessment, proposes changes to environmental outcomes or measurement criteria in the existing lease, license or PEPR
2. alter the description of mining operations or control strategies but does not affect achievement of approved outcomes
3. increase the operation's rehabilitation liability to a higher level than the bond currently in place for the site
4. relate to an existing control strategy that is essential for achieving environmental outcomes (i.e. there is a high reliance on this strategy to prevent impact to the environment and if it is changed, the tenement holder will no longer be able to achieve the environmental outcome
5. requires native vegetation clearance and/or provision of an SEB.

3.6.2 Variation process

3.6.2.1 Initial assessment

When a variation is required, the first assessment task requires a review of the proposed variation in the context of the approved Carrapateena activities, as described in Chapter 4. Any change in the described activities is then assessed against the stated impacts detailed in the Consolidated Assessments (OZ Minerals 2016 Appendix C; OZ Minerals 2017a Appendix D6; OZ Minerals 2018c Appendix E). A review of the environmental impacts associated with Carrapateena, including the potential for new impacts that were not previously assessed, and potential impacts to MNES, is undertaken to confirm whether the variation may change the approved impact profile of Carrapateena. The methodology of the impact assessment process is further detailed in Section 3.5.

To provide a line-of-sight, the Impact ID reference numbers from the Consolidated Assessments (OZ Minerals 2016 Appendix C; OZ Minerals 2017a Appendix D6; OZ Minerals 2018c Appendix E) are provided in call out boxes for each element (Chapter 4) and description of the environment and effects (Chapter 6). This allows for cross-referencing during the variation assessment process.

The variation assessment outputs subsequently inform whether the approved Outcomes and OMC remain relevant or require modification or addition. The outcomes of the internal variation assessment process determine the level of consultation required, and the requirement for the submission of further approvals documentation. The variation decision-making process is illustrated in Figure 3.4 (DEM 2023a).

Other primary approvals and secondary permitting requirements are also considered. Consideration includes assessment to ensure the variation is adequately contemplated in the relevant EPBC Act referral, the adequacy of the current SEB provision under the *Native Vegetation Act 1991* (SA) (NV Act) and the need for further Works Approvals or licences under the *Environment Protection Act 1993* (SA) (EP Act) to ensure all subsequent licences and permits for Carrapateena remain valid and appropriate.

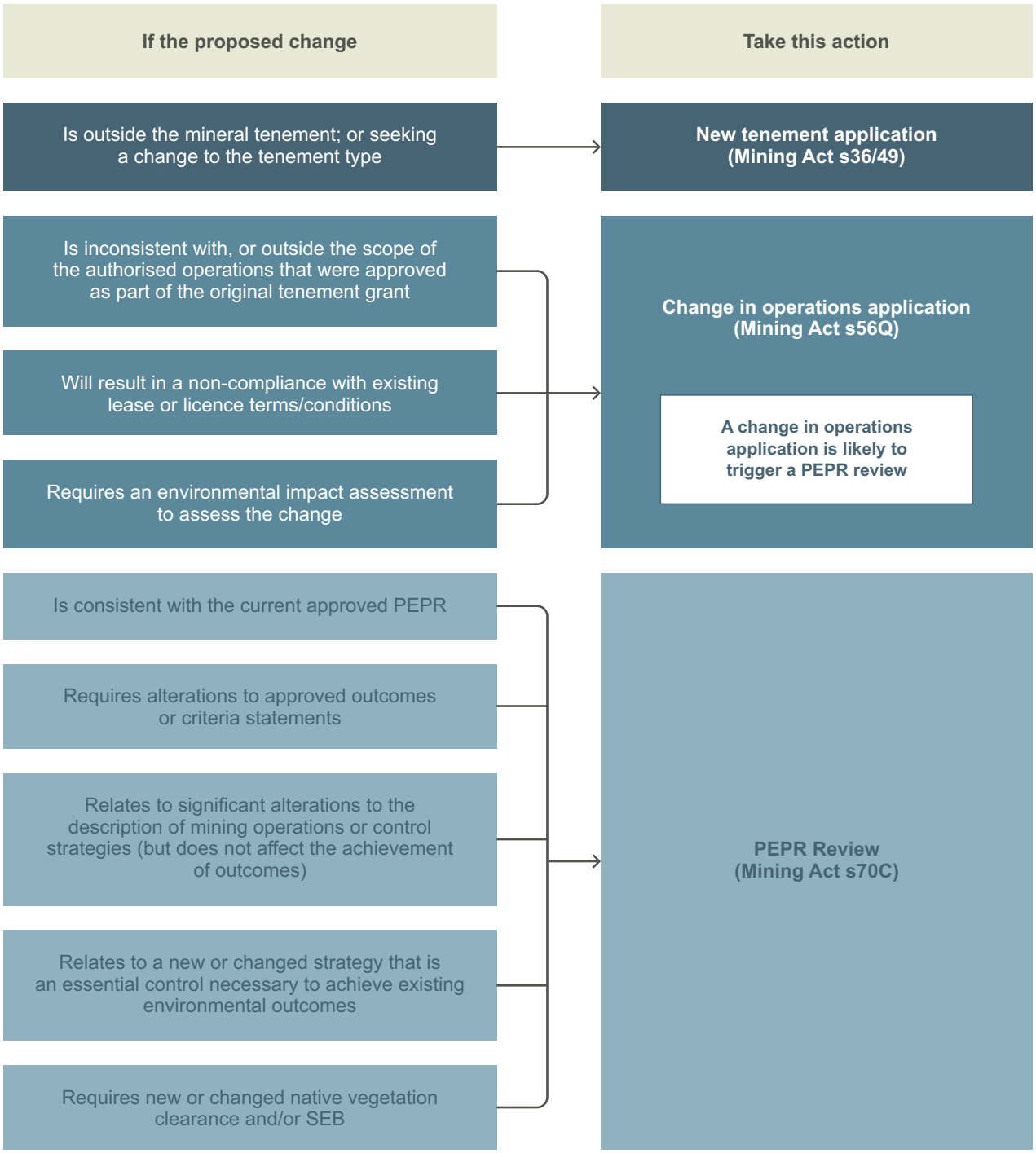


Figure 3.4 | Regulatory pathway to apply for a change

3.6.2.2 Changes to the description of the operations

Where a change to the existing operations or circumstances is required, BHP will undertake an assessment of the proposed change. The assessment will determine if the change is within or out of scope of the approved PEPR, and whether the change is consistent with the description of the operations described in the PEPR (Chapter 4) and the impact and risk assessment provided in the Consolidated Assessments (OZ Minerals 2016 Appendix C; OZ Minerals 2017a Appendix D6; OZ Minerals 2018c Appendix E). The variation assessment will then be submitted to government regulators for confirmation of whether the notification is sufficient or if a PEPR or lease/licence condition review is required.

It is important to note that Project Alternatives discussed in Section 4.2 are not considered to be a change in the description of the operations as they were originally contemplated in the Carrapateena MLP (OZ Minerals 2017a). A decision to proceed with an alternative may however require the need to undertake further detailed design work, ensure adequate offset provisions exist and test the options against various modelling inputs.

3.6.2.3 Changes to the understanding of the environment

Where there has been a change in the understanding of the environment or a change in the description of operations from those detailed in the MLP, MPL Management Plan or approved PEPR, BHP will undertake an assessment of the impacts of the proposed change to determine if the current Environmental Outcomes (as included in the lease/licence and/or the currently approved PEPR) are appropriate and if new or modified Environmental Outcomes are required.

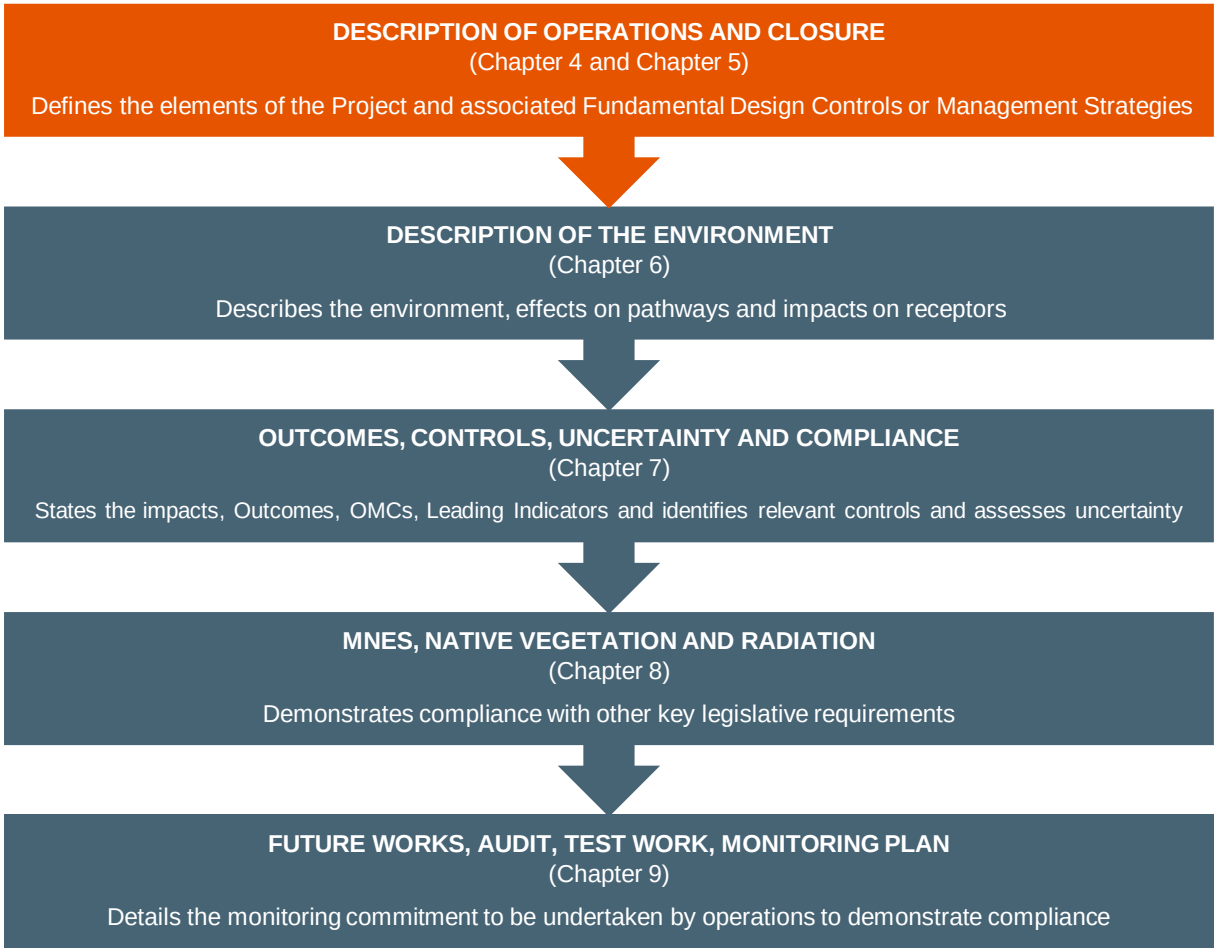
If new or modified **Environmental Outcomes** are required, additional information (as appropriate for the new environmental impact(s)) must be provided as specified in Section 3.5.

3.6.2.4 Clearance of native vegetation

Approved land clearance for the Project is 2,366 ha. To date, Carrapateena has cleared and/or is projected under the current approvals, including the LOM activities described in this PEPR, to clear a total of 2,224 ha of native vegetation. The majority of this land clearance was, and will occur within, Vegetation Association 1 (*Atriplex vesicaria* (Bladder Salt Bush) +/- *Tecticornia medullosa* (Samphire) Low Open Shrubland). Carrapateena undertakes aerial surveys in Quarter Four each year, with clearance reconciled in Quarter One each year in-line with annual reporting requirements and estimates of the following years' native vegetation clearance forecast to ensure the SEB provisions are allocated in advance of clearance activities.

Clearance of native vegetation outside of the approved total land clearance for Carrapateena and/or beyond the allocated SEB provision will trigger a PEPR review in accordance with the requirements of MG35 (DEM 2023a).

4. Description of the operations



This chapter defines the key Project elements (sources) across the construction, operations and closure phases. The information provided in this section is generally consistent with that described in the Carrapateena MLP (OZ Minerals 2017a), Airstrip and Workers' Accommodation Village MPL MP (OZ Minerals 2016) and Northern Wellfield MPL MP (OZ Minerals 2018c) however reflects more recent detailed designs, the as-built project layout, subsequent Program Notifications and proposed changes to approved operations as summarised in Section 1.2.

Source: A project element that can interact with the environment. For the purposes of determining the potential effects and impacts to the natural and social environment, the project elements provide the source in the SPR model.

The MLP was submitted to progress the existing Advanced Exploration Works authorised under RL 127 through to mining and processing of copper ores. Supporting the mining and processing operations, approval was gained to construct and operate an airstrip and workers' accommodation village (MPL 149), Western Infrastructure Corridor (MPL 152), Eastern Radial Wellfield (MPL 153), Southern Access Road and Radial Wellfield (MPL 154) and Northern Wellfield (MPL 156) (together 'the tenements'), all of which are described within this PEPR. An overview of the approved tenements is presented in Figure 4.1, with the location of key Project infrastructure in the context of the granted tenements shown in Figure 4.2 to Figure 4.7.

The following sections describe the activities to be undertaken within the tenements. A summary of key Project elements for each tenement is provided in Section 4.1.

Where environmental assessments provided in the Consolidated Assessments (OZ Minerals 2016 Appendix C; OZ Minerals 2017a Appendix D6; OZ Minerals 2018c Appendix E) were based on the activities described in this chapter, the individual assessments have been identified. Where a change to the approved operations is proposed, this has been reviewed against the current environmental assessments to ensure that any new potential impact events are identified and assessed.

4.1 Tenements and associated project elements

The Carrapateena operation extracts ore via an underground mining operation and processes the ore to produce a high-quality copper/gold concentrate for export to customers both in Australia and overseas. The key elements of Carrapateena described throughout this chapter are summarised in Table 4.1 to Table 4.6 and shown in Figure 4.1 to Figure 4.7 for each tenement.

Table 4.1 | Carrapateena ML 6471 key project elements

Key element	Summary
Mining	
Mining method	Sub-level cave (SLC) and sub-level open stoping (SLOS)
Production rate/life	6.9 Mtpa (run-of-mine (ROM) ore)/22 years (2045)
Main access	Decline
Secondary access	Conveyor decline
Commodities	Copper, gold, silver
Primary crushing	Initially surface then underground
Ore handling	Incline conveying
Processing	
Product	Copper, gold and silver in concentrate
Production rate	Annual average of ~65,000 to 75,000 tonnes copper and ~90,000 to 120,000 ounces gold per year
Comminution	Semi-autogenous grinding (SAG) mill, ball mill and pebble crushing
Flotation	Rougher flotation followed by three-stage cleaning
Tailings	
Tailings disposal method	Valley fill thickened TSF
TSF	Up to Stage 4B or Stage 5A, depending on as-built beach profile. Up to a total capacity of 144.9 million tonnes (Mt) or 72.4 million cubic metres (Mm^3)
Waste management	
Domestic and industrial	Segregation of waste onsite. During the operations phase, inert waste disposed of in a landfill facility established on MPL 149 or ML 6471. All other waste disposed through licensed waste transporters to licenced offsite facilities

Key element	Summary
Key demands and supply	
Power	132 kilovolts (kV), 55 megawatts (MW) high voltage connection to SA's electricity network and 1 MW solar farm to meet Project demand of up to 410 gigawatt hours (GWh) per annum
Water	Approved abstraction of up to an annual average of 14.5 megalitres per day (ML/d) (consisting of 7.5 ML/d from the Radial Wellfield and 7.0 ML/d from the Northern Wellfield) to meet an operations demand of up to an annual average of 12.9 ML/d
Workforce	An operations workforce of 450 personnel (peaking at 525 – 600) plus varying number of construction and shutdown personnel, depending on site activities. Average personnel onsite at any one in 2023 was approximately 700 personnel
Accommodation village	An accommodation village comprising 176 beds, known as the Exploration Village. Originally constructed to support Advanced Exploration Works under RL 127, now supplements the Tjungu Village on MPL 149
Logistics	
Site access	Western Access Road, with Southern Access Road as an alternative should this be required
Concentrate transport	Road transport from site to distribution point. Transport from site occurs via the Western Access Road. Approval would be sought from DIT to access the previously used Southern Access Road as an alternative should the Western Access Road be unavailable

Table 4.2 | Airstrip and Workers' Accommodation Village MPL 149 key project elements

Key element	Summary
Airstrip	Sealed 1,600 m long x 30 m wide runway and associated taxiway, suitable for use by Avro RJ100 (or similar) aircraft capable of carrying approximately 100 passengers
Workers' accommodation village	A second accommodation village (Tjungu Village) comprising 714 beds (plus current anticipated expansion for a further 64 rooms) in addition to the 176 rooms available at the older Exploration Village on ML 6471. Common facilities including wet mess facility, ablutions, laundry, crib rooms, bus/car parking, pedestrian pathways and landscaping, roads and workshops
Ancillary infrastructure	Access road, electricity generation and distribution infrastructure, wastewater treatment plant and associated land application areas, waste management facilities, landfill, reverse osmosis (RO) plant and surface water management infrastructure
Access road	Current access to the airstrip and accommodation village is via the Western Access Road (MPL 152), including provision of a site access gatehouse within the MPL to provide site security. The access road includes designated parking zones, bus pick-up areas and service access

Table 4.3 | Western Infrastructure Corridor MPL 152 key project elements

Key element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and localised distribution network, including turkey's nest dams, piping, pumps and an independent power supply
Transmission line	132 kV transmission line to connect to South Australia's electricity network at Mount Gunson. The transmission line design is based on the use of steel poles of approximately 26 m height at a spacing of 250 m with an associated maintenance access track
Access road	Unsealed (all-weather) primary site access has been established to the west of ML 6471, intercepting the Stuart Highway near Mount Gunson, approximately 52 km south-east of Pimba by road. The Western Access Road is used for the supply of consumables and the export of concentrate

Table 4.4 | Eastern Radial Wellfield MPL 153 key project elements

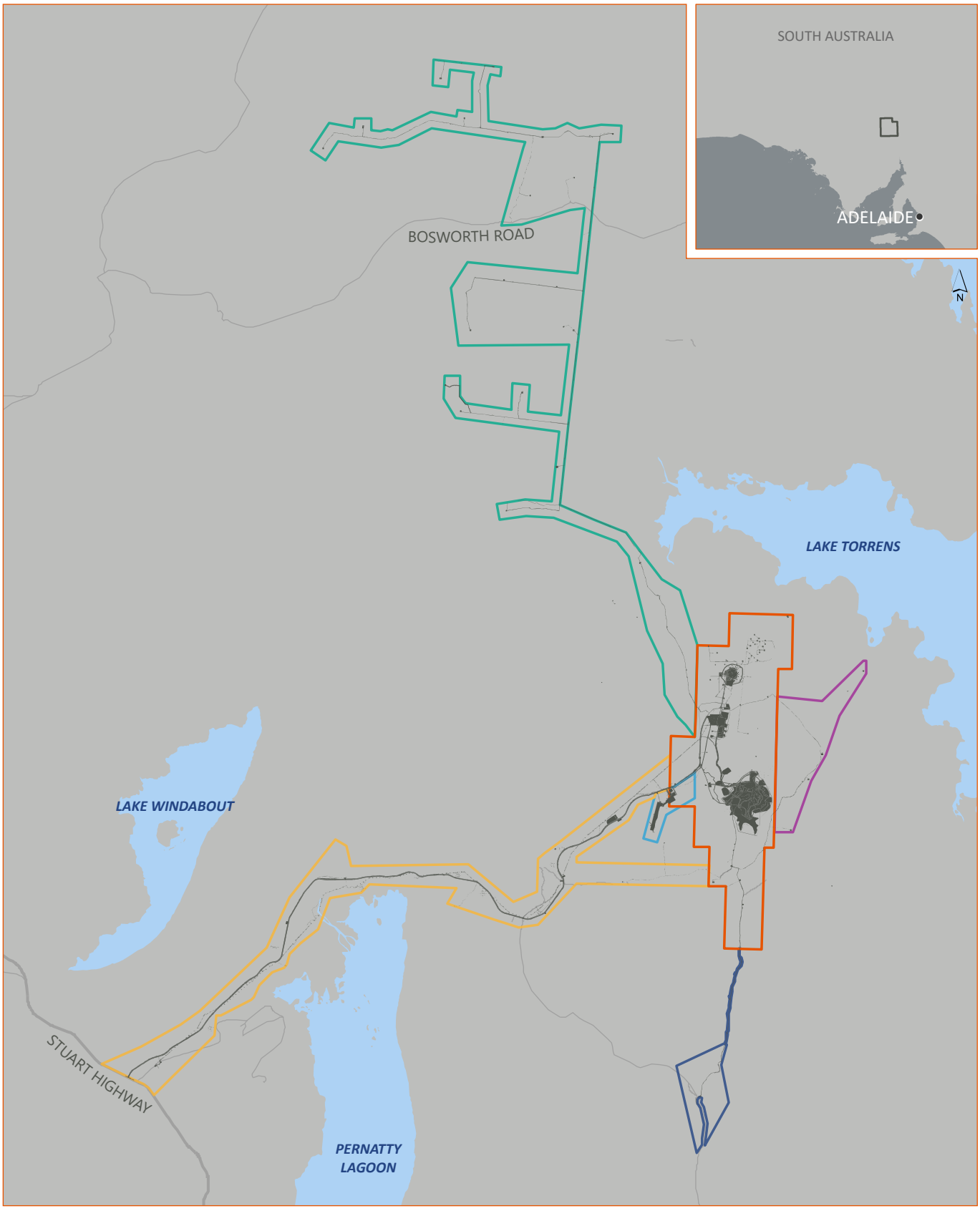
Key element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and distribution network including turkey's nest dams, piping, pumps and an independent power supply

Table 4.5 | Southern Access Road and Radial Wellfield MPL 154 key project elements

Key element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and distribution network including turkey's nest dams, piping, pumps and an independent power supply
Southern access road	Existing Southern Access Road to the site via a gazetted road from Pernatty Homestead to the Stuart Highway. Maintained and managed in accordance with a Deed (CA-APR-AGR-1074) signed by both OZ Minerals (now BHP) and the South Australian Department of Transport, Planning and Infrastructure (now DIT). The Southern Access Road is used as a back-up for site access and the export of concentrate in the event the Western Access Road is unavailable

Table 4.6 | Northern Wellfield MPL 156 key project elements

Key element	Summary
Water supply and distribution	Network of local groundwater wells. Water-holding and distribution network including ponds/dams, scour pits, piping, pumps, communications infrastructure (telemetry) and an independent power supply. Access via a borefield road connecting to ML 6471



KEY

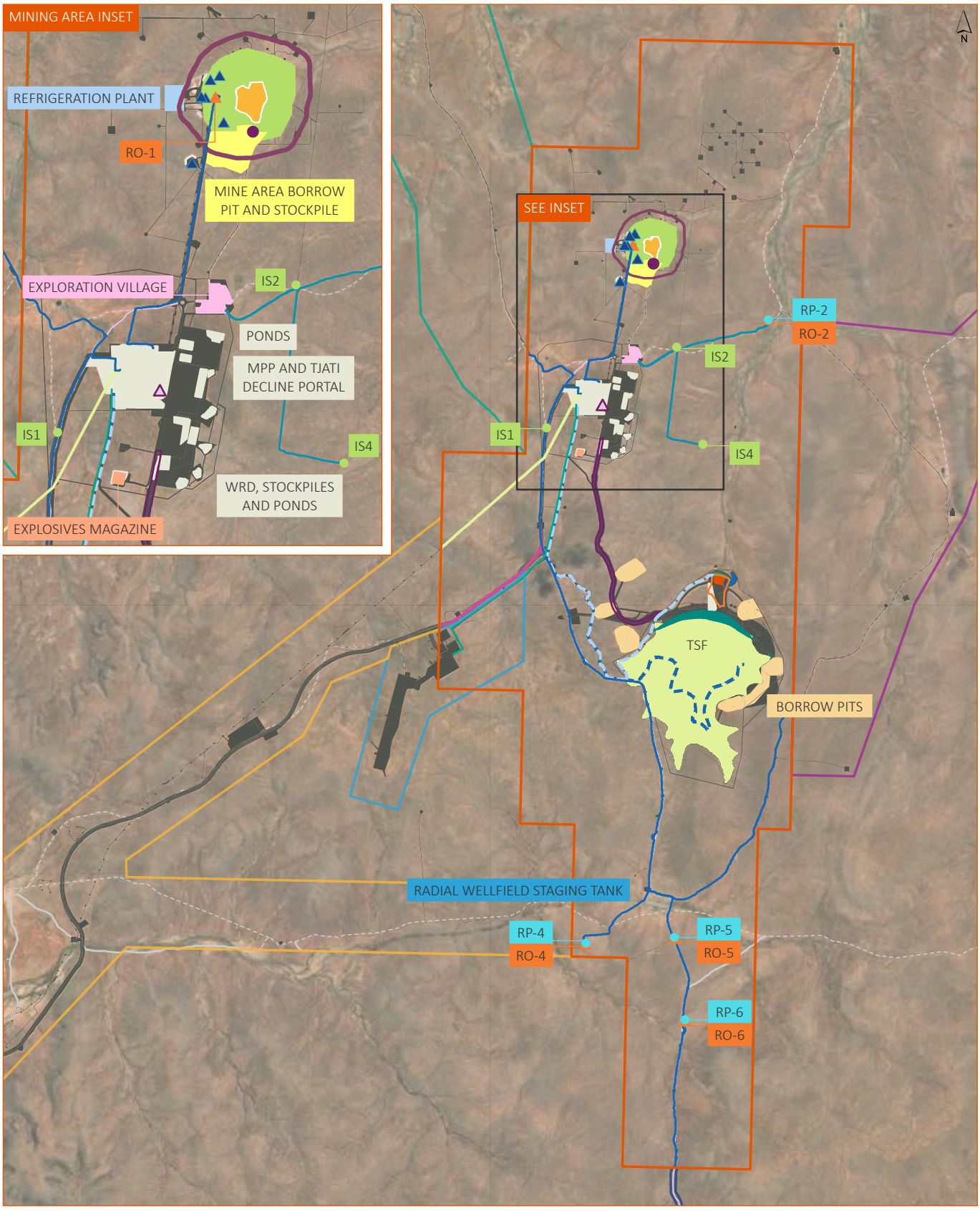
- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 4.1 | Carrapateena tenements

Carrapateena BHP



KEY

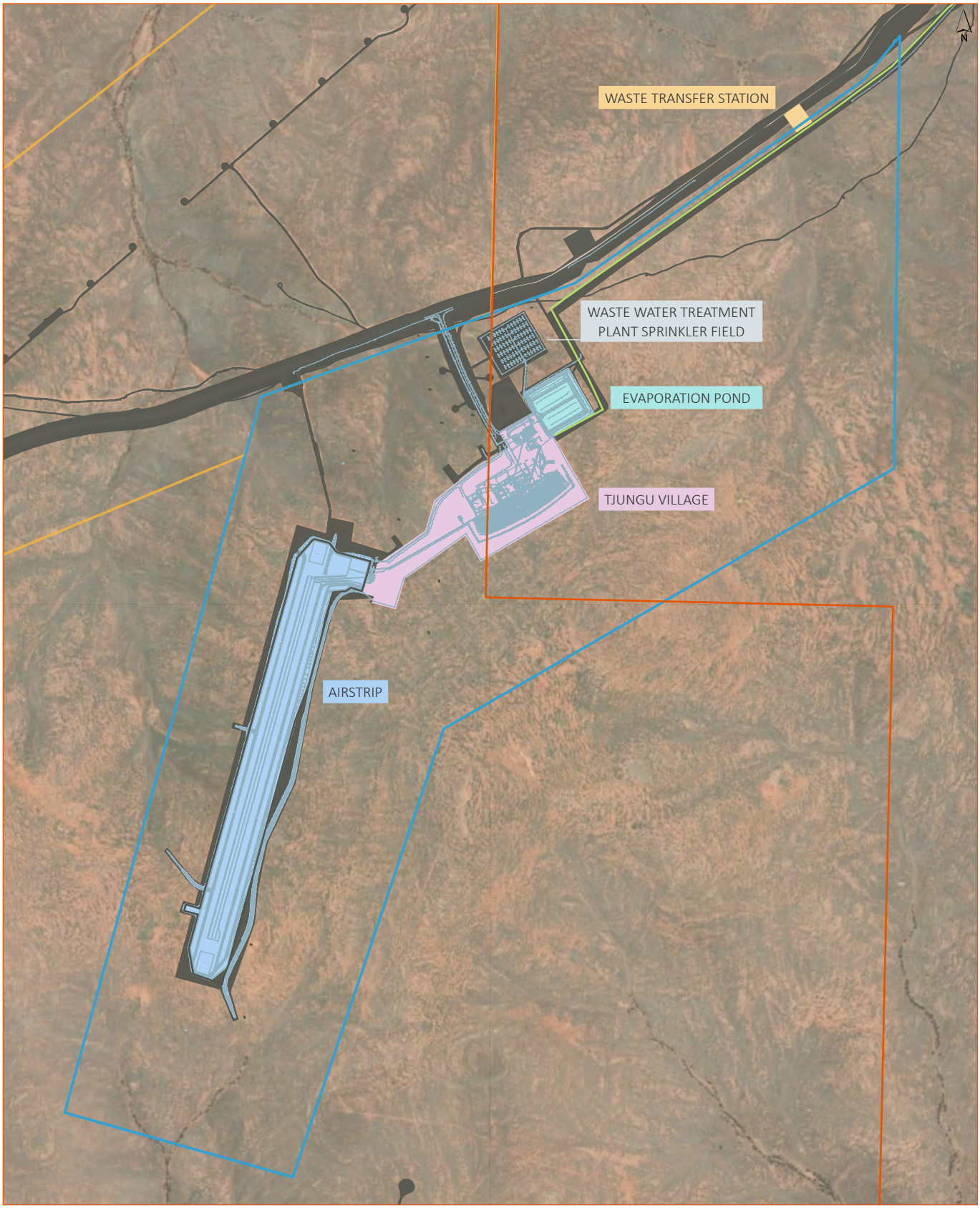
- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint
- ANE storage facility
- Production well
- Injection well
- Observation well
- Vent locations
- Tjati Decline Portal
- Injection well pipeline
- Water supply pipeline and access track
- Tailings disposal pipeline
- TSF decant/water return pipeline
- 132 kV transmission line
- Western Access Road
- Southern Access Road
- Minor road
- Track
- WRD Stockpile to TSF Haul Road and TSF pipeline
- TSF borrow pits
- TSF embankment
- Lined decant cell
- TSF decant dam storage area
- Decant dam embankment
- Decant dam emergency spillway

0 2.5 5 km

GDA 1994 MGA Zone 53

Figure 4.2 | ML 6471 tenement and key project elements

Carrapateena BHP



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Project Layout
- Airstrip
- Evaporation Pond
- Waste Transfer Station
- Tjungu Village
- Airstrip Fenceline
- Airstrip Infrastructure
- Tjungu Village Infrastructure
- Village Transmission Line
- Track

0 0.5 1 km

GDA 1994 MGA Zone 53

Figure 4.3 | MPL 149 tenement and key project elements

Carrapateena BHP

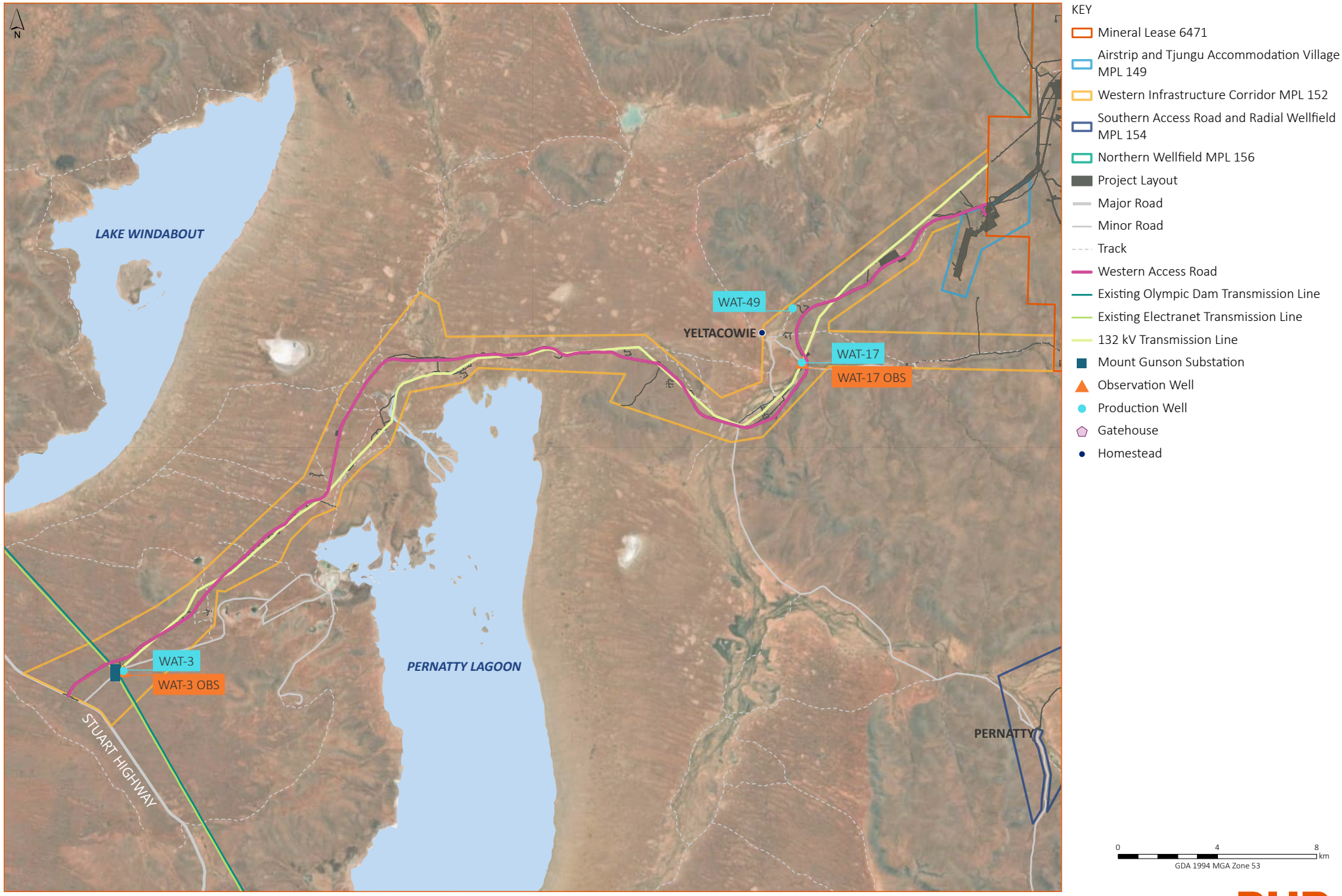
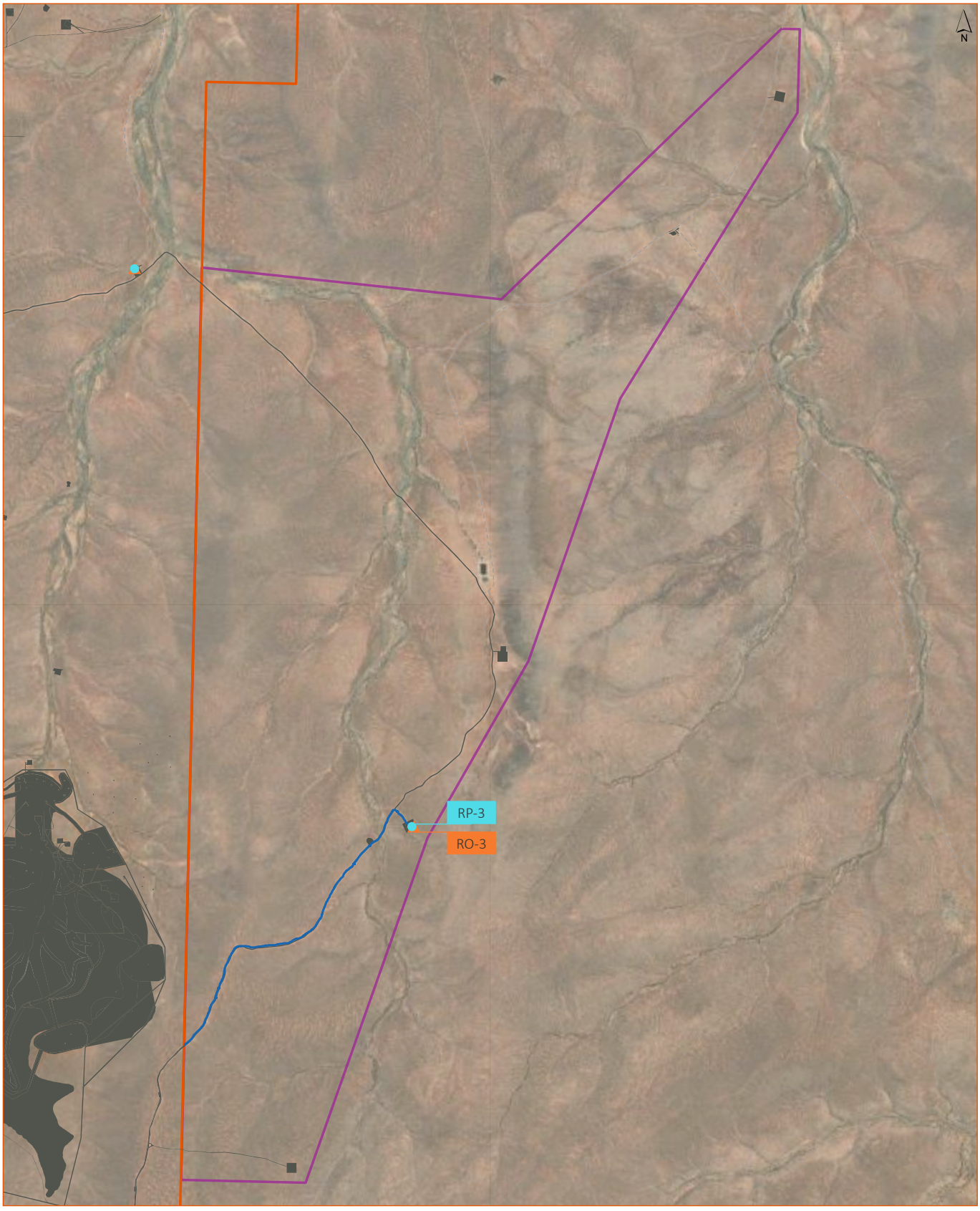


Figure 4.4 | MPL 152 tenement and key project elements

Carrapateena BHP



KEY

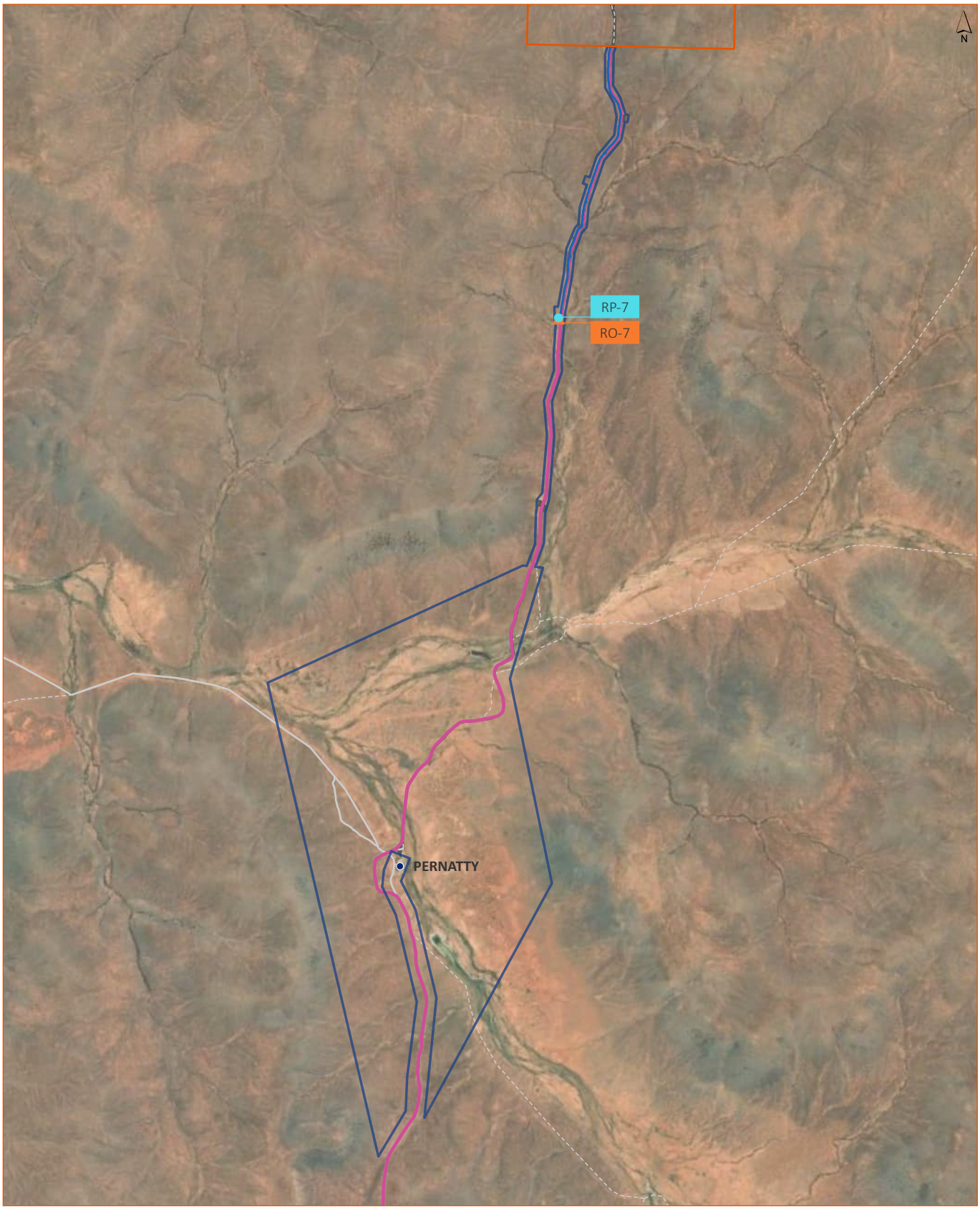
- Mineral Lease 6471
- Eastern Radial Wellfield MPL 153
- TSF Stage 3 PEPR footprint
- Water supply pipeline and access track
- Observation well
- Production well

0 1 2 km

GDA 1994 MGA Zone 53

Figure 4.5 | MPL 153 tenement and key project elements

Carrapateena BHP



KEY

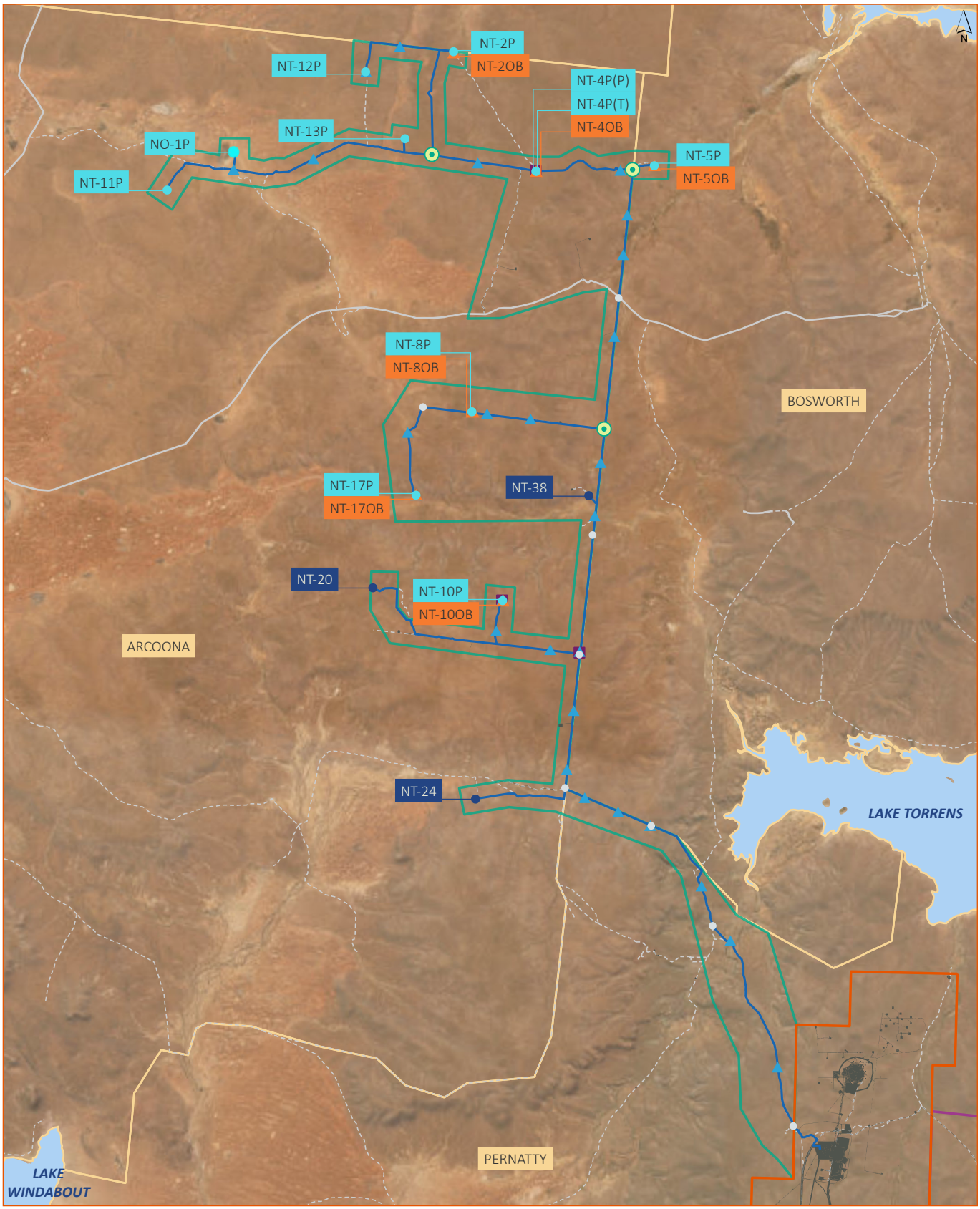
- Mineral Lease 6471
- Southern Access Road and Radial Wellfield MPL 154
- Project Layout
- Road
- Track
- Southern Access Road
- Water Supply Pipeline and Access Track
- Observation Well
- Production Well

0 1.5 3 km

GDA 1994 MGA Zone 53

Figure 4.6 | MPL 154 tenement and key project elements

Carrapateena BHP



KEY

- Mineral Lease 6471
- Eastern Radial Wellfield MPL 153
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint
- Pastoral station
- Road
- Track
- Water supply pipeline and access track
- Truck turnaround / laydown area
- Staging complex
- Observation well
- Production well
- Potential / alternate production well
- Pigging pond
- Scour pit

0 5 10 km

GDA 1994 MGA Zone 53

Figure 4.7 | MPL 156 tenement and key project elements

Carrapateena BHP

4.2 Approved alternatives and options

The Carrapateena MLP and MPL Management Plans described the activities to be undertaken as a part of the Carrapateena operations. In some instances, alternative activities were identified, typically where detailed economic and/or engineering analysis had yet to be completed to an extent that would allow a decision regarding the optimal alternative. The implementation of these alternatives was approved as a component of the granted tenements ML 6471, MPL 152, MPL 153 and MPL 154 and the Environmental Impact Assessments presented in the Carrapateena MLP (OZ Minerals 2017a) and the Response Document Appendix I Updated Consolidated Assessment (OZ Minerals 2017c); which considered these options in the statement of impact and approved Outcomes.

These alternatives remain approved and are described within this PEPR to allow implementation, should this be determined to be required and/or desirable.

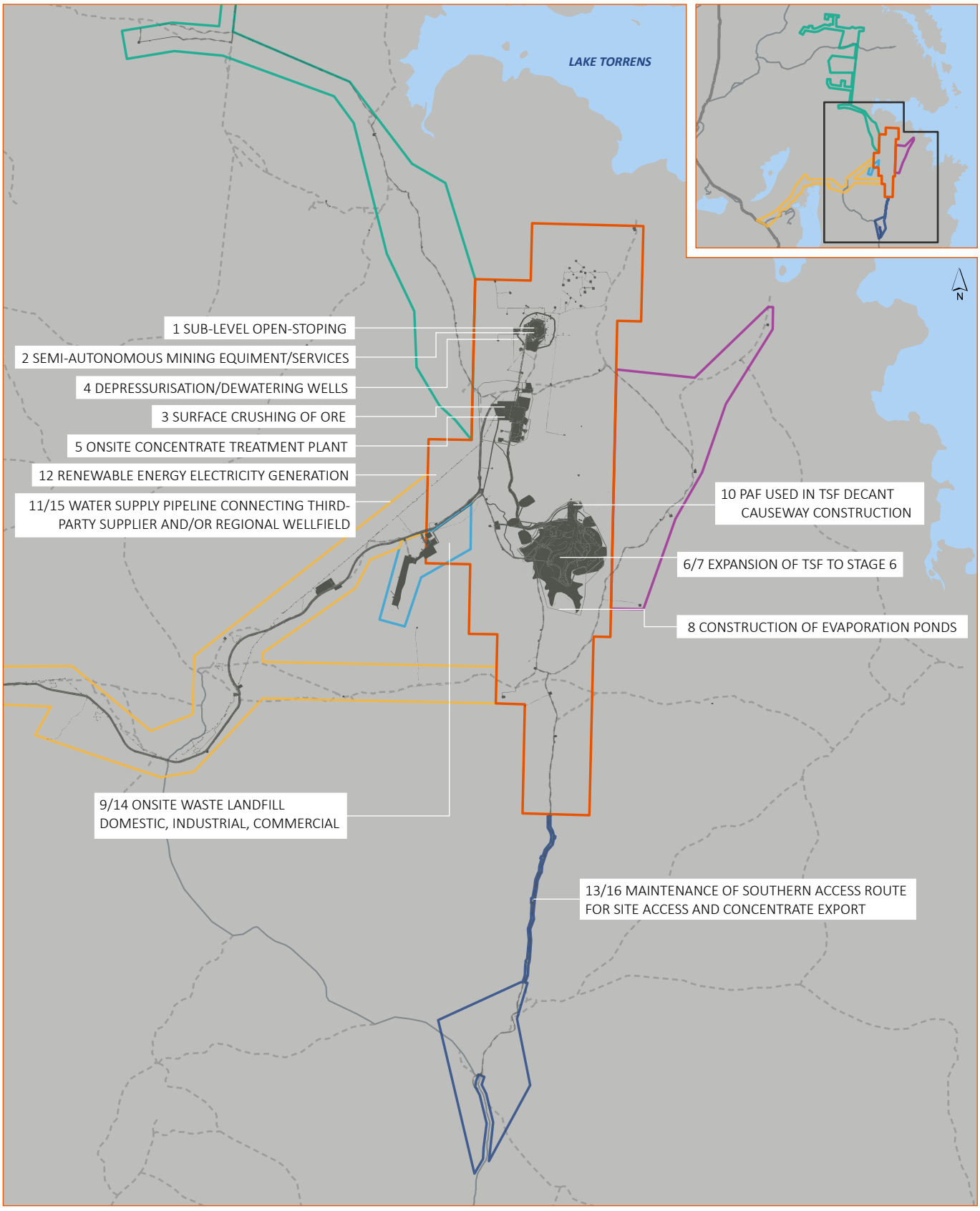
In the event BHP decides to progress implementation of an approved alternative during the period of currency of this PEPR, a notification to DEM would be made, with the PEPR updated as required during the next formal PEPR review (nominally undertaken at five-year intervals or out of cycle at the request of DEM, as required). The decision to proceed with an alternative would also be supported by further design and effects/impact assessment, where relevant. Coupled with this would be a review of the site SEB provision (Section 5.5) and closure liability (Section 5.5.2) to reflect changes (if any) as a result of implementation of the alternative.

Approved alternatives that remain relevant to Carrapateena are described in Table 4.7 and illustrated in Figure 4.8.

Table 4.7 | Approved alternatives and options

Approved alternative	Description
Mineral Lease ML 6471	
Mining	Use of SLOS for the extraction of ore from satellite and regional mineralisation, including the Fremantle Doctor and Saddle prospects
	Implementation of semi-autonomous equipment such as load haul dumps (LHDs) that are capable of navigating between loading and unloading locations and unloading without direct intervention by a remote operator. Long-hole drilling operations may also be automated Automation of monitoring of mine services and infrastructure such as the materials handling system, primary ventilation and primary pumping may also together with the control and monitoring of secondary infrastructure, such as secondary fans, operational dewatering and ventilation on demand systems
Crushing	Surface crushing of ore
Mine dewatering	Depressurisation of the mining area via a network of surface wells. Installation of depressurisation/dewatering wells within the vicinity of the SLC and/or install horizontal wells in the water-bearing stratigraphy. Water produced from the wells would report to the Site Raw Water Dam
Processing	Establishment of the concentrate treatment plant (CTP) onsite at Carrapateena, and associated neutralisation plant and evaporation ponds. Optional onsite concentrate treatment process utilising acid pressure leaching technology, with a design throughput of 200,000 tonnes per annum (tpa) of copper concentrate. Final concentrate would contain an average of between 55% and 60% copper, 15 to 20 grams per tonne (g/t) of gold and 150 to 200 g/t of silver

Approved alternative	Description
Tailings	Environmental impact assessments undertaken on a block cave TSF with sufficient footprint (856 ha) for the storage of the tailings associated with processing of the 240 Mt block cave Ore Reserve Estimate
	Two evaporation ponds of 53 ha and 70 ha, respectively, constructed for the management of treated (pH 4.5) barren liquor from the CTP. These would be high-density polyethylene (HDPE)-lined and would have waste rock embankments similar in design to those of the TSF Stage 1 and Stage 2 embankments, fitted with engineered spillways to avoid overtopping
Waste management	Establishment of onsite waste landfill on ML 6471
	Use of marginal ore potentially acid forming (PAF) for construction materials and use for TSF decant causeway construction within the TSF
Water supply	Supply of water from the operation of an offsite water supply connecting to ML 6471 via a pipeline within the Western Infrastructure Corridor MPL 152
Electricity supply	Installation of onsite electricity generation in the form of renewable energy (solar photovoltaic or equivalent) at Carrapateena. This may include small-scale installations to remove remote diesel electricity generation and/or a large-scale solar farm-style facility to supplement grid-based electricity supply. The land disturbance associated with the construction and operation of these facilities (up to 61.9 ha) has been included in the nominated project footprint
Site access	Maintenance of the Southern Access Road for use for site access and concentrate export should the Western Access Road be unavailable
Airstrip and Workers' Accommodation Village MPL 149	
Waste management	A landfill has been approved under MPL 149 for the disposal of waste material generated under MPL 149. In the event that a landfill is not constructed within ML 6471, industrial and commercial wastes generated within ML 6471 and MPL 152, MPL 153, MPL 154 and MPL 156 would be disposed of to the MPL 149 landfill, which has been sized with consideration to disposal of these waste volumes
Western Infrastructure Corridor MPL 152	
Water supply	Construction and operation of an offsite water supply pipeline within MPL 152 connecting a regional water supply to ML 6471
Southern Access Road and Radial Wellfield MPL 154	
Site access	Maintenance of the Southern Access Road for use for site access and concentrate export should the Western Access Road be unavailable



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint

0 5 10 km

GDA 1994 MGA Zone 53

Figure 4.8 | Approved alternatives and options

Carrapateena BHP

4.3 Hours of operation

Mining and processing operations, including ancillary supporting activities, operate on a continuous 24 hours per day/seven days per week basis.

The operation of the airstrip is scheduled with consideration to the curfew times in place at Adelaide Airport. Most scheduled services into and out of Carrapateena occur between 7:00am and 5:30pm. Emergency flights (e.g. medical evacuations) could occur at any time of the day or night, and on any day of the week, as required.

4.4 Operations schedule and planning

The operations schedule, as illustrated in Figure 4.9, has been structured across the operations and closure phase of Carrapateena, with Figure 4.10 providing greater resolution for the closure phase. The identification of phases for each key project element forms a critical component of the phase-specific Outcomes, OMC and Leading Indicators (see Chapter 6). The identification of phases defines when potential design controls need to be considered and implemented to be effective and BHP will establish appropriate management capabilities (see Chapter 3) to ensure that Outcomes are achieved.

Phase: The time at which a specific source (project element) emerges. The phase is when the source occurs and not when a potential or actual impact is anticipated to occur.

Management Control: Progressive rehabilitation will occur as early as possible throughout the operation of Carrapateena.

Assessments associated with progressive rehabilitation, demonstrating post-completion land use can be achieved, are within Consolidated Assessment IDs ID016*, ID017*, ID041*, ID042*, ID043* and ID047* (Airstrip and Accommodation Village), L13*, L14* and L15* (Carrapateena), L17*, L18* and L19* (Northern Wellfield).

*Non-Outcome or Outcome Based Lease Condition

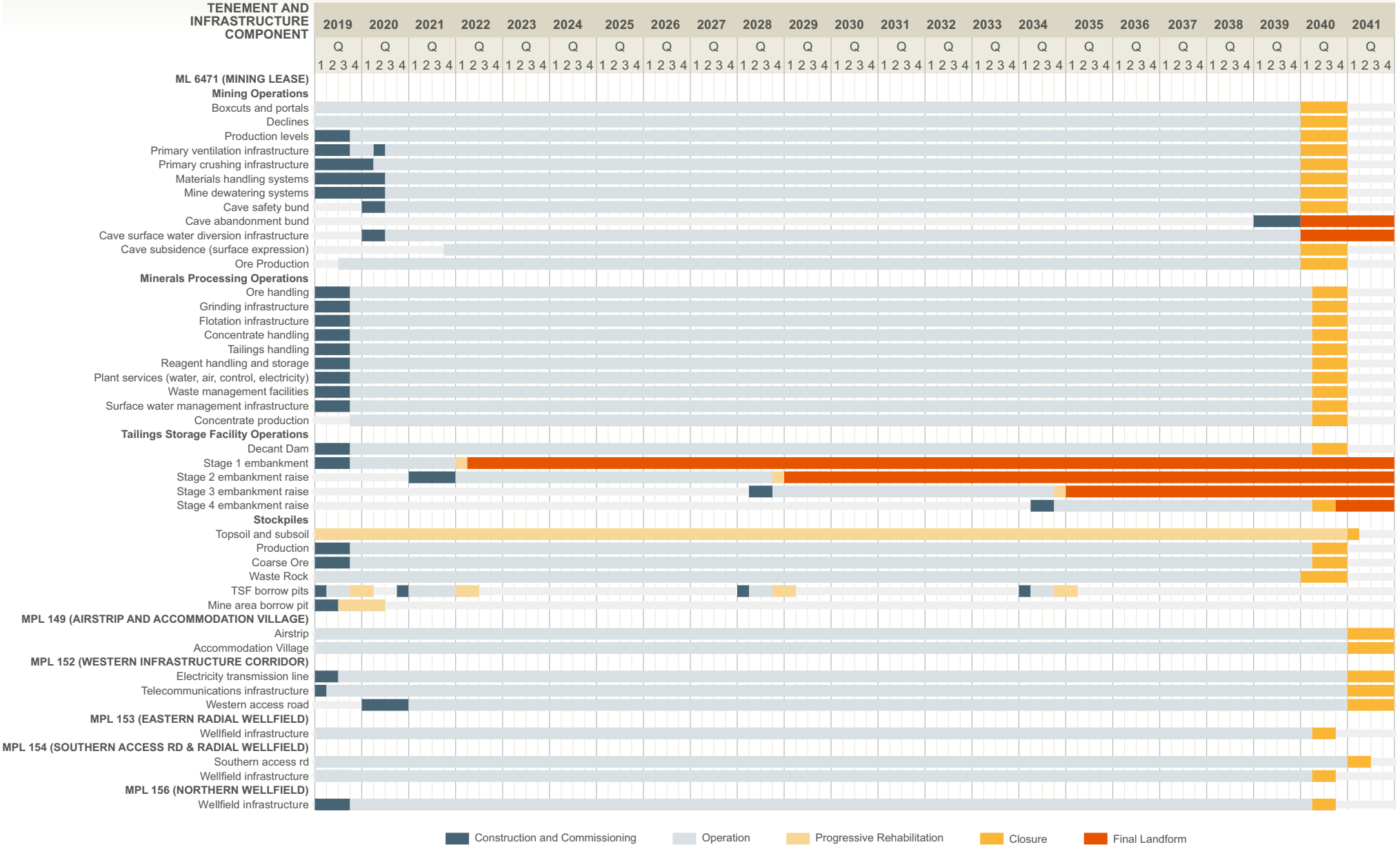


Figure 4.9 | Carrapateena operations schedule

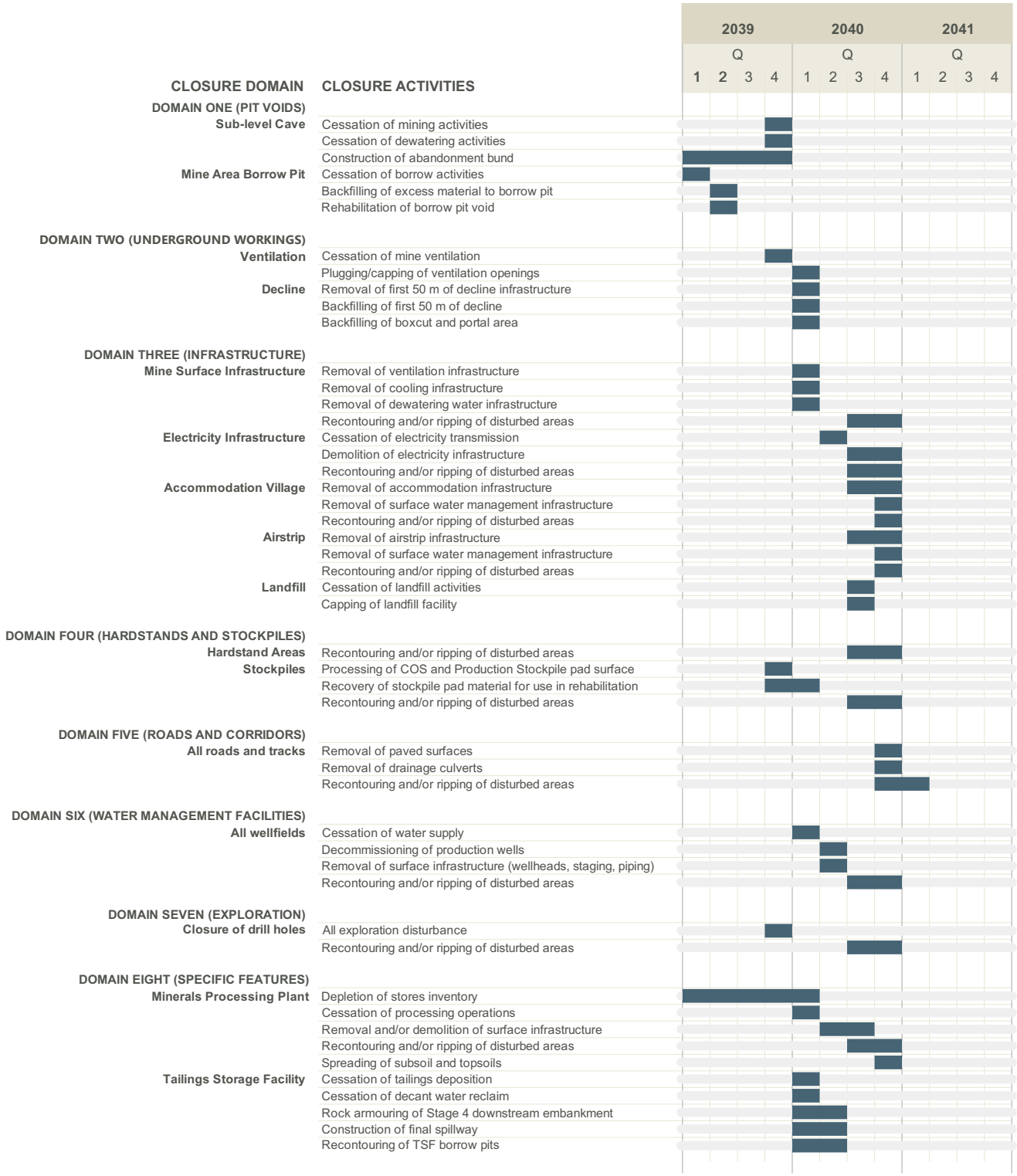


Figure 4.10 | Carrapateena closure schedule

4.5 Project footprint

The key Project elements, as summarised in Section 4.1, would require the clearance or disturbance of land, as described in the following sections.

The approach to native vegetation clearance and management, including the provision of an SEB, is described in **Appendix D Native Vegetation Management Plan**.

4.5.1 Pre-operations land disturbance

Prior to the granting of the previous RL 127 in 2013, pastoral activities had resulted in 96.7 ha of disturbance that overlapped the Project footprint within the tenements. An estimate of this disturbance includes:

- 2.2 ha associated with the pastoral track that would become the Southern Access Road
- 32.5 ha associated with the pastoral track that would become the Western Infrastructure Corridor
- 10.6 ha associated with the pastoral track that would become the Northern Wellfield water supply pipeline and access track corridor
- 51.4 ha associated with pre-RL 127 mineral exploration and associated access track development that would become a component of the Retention Lease works.

The area of the tenements has historically been used for pastoral activities, with some mining exploration activities undertaken more recently. Unrehabilitated disturbance associated with the previous exploration activities is included in the tenement disturbance footprint. Baseline ecology surveys undertaken for development of the Carrapateena MLP describe the land as having vegetation in good condition with little disturbance, low weed cover, but with some existing grazing pressure.

Design Control: Preferential use of previously disturbed land will minimise the requirement for new disturbance.

4.5.2 As-built and proposed land disturbance

Selection of infrastructure locations was undertaken using a multi-criteria analysis based on performance against available areas, site topography, earthwork requirements, and environmental and social constraints. Considerable time was spent in the field, with both the Kokatha People and the pastoralists, to ensure that where possible, infrastructure locations follow existing pastoral tracks and fence disturbance lines.

As-built and proposed land disturbance areas for Carrapateena are summarised in Table 4.8 and illustrated in Figure 4.11. A disturbance buffer has been added to some surface infrastructure land clearance areas in order to account for edge effects, including habitat degradation from dust deposition, saline aerosol emissions and inadvertent vehicle, plant or machinery access.

The total disturbance footprint (including buffers) associated with the construction, operation and closure of authorised activities on the tenements will be approximately 2,224 ha. This excludes 45.3 ha of pre-mining pastoral land disturbance within the tenements.

Land disturbance has been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2016 Appendix C; OZ Minerals 2017a Appendix D6; OZ Minerals 2018c Appendix E). Table 4.9 provides a summary of relevant Impact IDs and design and management controls that have led to the development of Outcomes, OMC and Leading Indicators as provided in Chapter 7.

Land disturbance associated with the proposed changes to approved operations (refer Section 1.2.5) is consistent in terms activities, total disturbance and quantities of vegetation associations however the small changes to disturbance location has been incorporated into the land disturbance footprint described in the previous section and reflected in the updated site Native Vegetation Management Plan (see Appendix D).

Table 4.8 | As-built and proposed land disturbance footprint

Disturbance description	Land disturbance footprint (ha)*
Mineral Lease ML 6471	
Access tracks	21.35
Ammonium nitrate emulsion (ANE) storage	0.10
Crusher station	1.08
Electranet poles and access tracks	3.49
Existing accommodation village	11.02
Exploration drill pads and access tracks	37.65
Groundwater infrastructure	11.95
Injection well infrastructure	2.63
Light vehicle (LV)/heavy vehicle (HV) parking and gatehouse	0.04
Magazine storage	0.28
Mine borrow pit	19.69
Mine power	5.37
MPP (including waste rock dump (WRD))	151.21
MPP fenceline	9.42
Northern Wellfield infrastructure	1.91
Radial Wellfield infrastructure	11.66
Refrigeration plant	8.95
Renewable energy	0.63
Southern Access Road 10 m buffer	16.89
Southern Access Road/Western Access Road intersection	0.41
Southern Access Road/Western Access Road turkey’s nest dam	0.01
Southern Access Road	17.63
Surface water diversion drain	0.31

Disturbance description	Land disturbance footprint (ha)*
Surface water drainage ponds	1.20
Tailings disposal pipeline	6.55
Tailings pipeline corridor	48.61
Telstra optic fibre	4.10
Tjungu Village associated infrastructure	1.54
Truck fill	0.02
TSF, associated infrastructure and TSF borrow pits	793.06
Vent areas	8.53
Viewing platform	0.23
Village services corridor	1.47
Waste transfer station	0.30
WRD to TSF haul road	23.56
Western Access Road	21.59
Western Access Road to MPP road expansion	11.63
WiFi towers	1.34
Zone of influence 50 m bund	18.54
Zone of influence cave fracture	34.40
Zone of influence (subsidence zone fracking)	12.25
Zone of influence (subsidence zone piezometers)	0.21
Total	1,322.82
Airstrip and Workers' Accommodation Village MPL 149	
Airstrip	54.05
Telstra optic fibre	0.35
Tjungu Village and associated infrastructure	36.58
Tjungu Village services corridor	7.56

Disturbance description	Land disturbance footprint (ha)*
Tjungu Village sprayfield	4.97
Tjungu Village gatehouse service corridor	0.002
Waste transfer station	0.02
Western Access Road	3.90
Total	107.43
Western Infrastructure Corridor MPL 152	
Access tracks	6.94
Exploration drill pads and access tracks	0.42
Extractive Mineral Lease and ancillary infrastructure	22.85
Groundwater infrastructure	7.98
Mount Gunson Substation	0.27
Telstra optic fibre	25.02
Tjungu Village and associated infrastructure	0.37
Transmission line infrastructure	45.36
Western Access Road	400.38
Total	509.58
Eastern Radial Wellfield MPL 153	
Access tracks	9.90
Groundwater infrastructure	0.40
Radial Wellfield infrastructure	7.44
Total	17.74
Southern Access Road and Radial Wellfield MPL 154	
Groundwater infrastructure	0.97
Radial Wellfield infrastructure	2.13
Southern Access Road	16.28

Disturbance description	Land disturbance footprint (ha)*
Southern Access Road 10 m buffer	9.52
Total	28.90
Northern Wellfield MPL 156	
Northern Wellfield scour pit	3.25
Truck turnaround	1.52
Northern Wellfield well pad (including Stage 3 expansions)	9.84
Northern Wellfield creek crossing	0.03
Northern Wellfield access track and pipeline corridor (including Stage 3 expansions)	195.41
Northern Wellfield junction and telemetry tower	0.01
Northern Wellfield telemetry tower	0.08
Future access, expansion, exploration works	27.37
Total	237.51
Total Carrapateena land disturbance footprint	**2,223.98**

*Includes the following buffers:

- 40 m buffer around the TSF and associated infrastructure to allow for dusting and potentially micro-topography that may mean an expansion of the TSF extent due to local effects
- 40 m buffer (from centreline) around the Western Access Road to account for construction access tracks, laydown disturbance and edge effects (e.g. dusting and/or wayward vehicle disturbance etc.)
- 10 m buffer around the Southern Access Road to account for edge effects
- 15 m buffer around mine transmission line poles for access, laydown and maintenance disturbance
- 5 m buffer around groundwater wells, refrigeration plant, mine area borrow pit, waste transfer station and landfill, TSF borrow pits, solar farm and Mount Gunson Substation to allow for edge effects.

Table 4.9 | Land disturbance Impact IDs, design and management controls and uncertainty

Land disturbance footprint		
Carrapateena Impact IDs[1]	Airstrip and Workers' Accommodation Village Impact IDs[2]	Northern Wellfield Impact IDs[3]
L01*, L02*, L03, L04, L05, L06, L10*, L11*, L12*, L13*, L14*, L15*, L16*, L17*, L18*, L19* SW01, SW03, SW05, SW07*, SW09*, SW38, SW39, SW40, SW41, SW42*, SW43, SW45*, SW46 SW48, SW49, SW50 AQ01, AQ02, AQ03, AQ04, AQ05, AQ06*, AQ07* and AQ08	ID01*, ID02*, ID03, ID04, ID05, ID06, ID07*, ID08, ID09*, ID010, ID013*, ID015, ID017*, ID018*, ID019, ID020, ID021*, ID022, ID023, ID024*, ID025, ID026, ID027*, ID028, ID029, ID030, ID031, ID032, ID033, ID034, ID035, ID036, ID037, ID038, ID042*, ID043* ID044*, ID045, ID047*	L01*, L02*, L03, L04, L05, L06, L10*, L11*, L12, L13, L14, L15, L16, L17*, L18*, L19*, L20*, L21*, L22*, L23*, L27* SW01, SW02, SW03, SW04, SW05, SW06, SW07*, SW08*, SW09*, SW10* SE11*

Design controls

- Avoid sites of cultural heritage significance as determined in consultation with the Kokatha People.
- Complete pre-construction 'clearance' surveys to identify any critical and preferred habitat of plains mouse (e.g. cracking clays on run-ons, drainage channels or gilgais), thick billed grasswrens (e.g. patches of taller and dense shrubland habitat, often associated with drainage channels) and night parrots (e.g. spinifex hummock grasslands) by a suitably qualified and experienced ecologist.
- Flag any populations sensitive fauna identified during the pre-construction 'clearance' surveys or areas of their preferred habitat in close proximity to the disturbance footprint.
- Incorporate flow disruptors and diversion drains to minimise erosion as part of access road upgrade or construction.
- Separate overland surface water flows originating from undisturbed areas of the Project Area from the surface water runoff that has interacted with stockpiles and access roads.
- Construct sediment basins/ponds and appropriate drainage on roadways adjacent to surface water bodies or catchments for the collection of sediments in surface water transported along the roadway (longitudinal flows).
- Design and install fords, culverts, diversion drains, bunding and sedimentation/event basins in accordance with a Best Practice Operating Procedures endorsed by the SA Arid Lands Natural Resources Management Board or a Water Affecting Activity Permit under the *Landscape South Australia Act 2019* (SA).
- Minimise the Project footprint to reduce effects to existing pastoral land uses.
- Minimise the width of Western Access Road in the location of the plant, *Sclerolaena* sp. Yeltacowie.

Management controls

- Conduct cultural heritage surveys with the Kokatha People.
- Maintain a Cultural Heritage Obligations Register and supporting geographical information system (GIS) information (shapefiles) to record/identify clearance areas and status.
- Ensure the land disturbance approval process is implemented and followed*.
- Conduct regular cultural respect training.
- Provide area-specific and site inductions and training.
- Employ people who are suitably qualified for their respective roles.
- Implement the Cultural Heritage Management Plan, including new discovery reporting procedures.
- Identify and fence sites of cultural heritage significance.
- Conduct a land disturbance reconciliation on a monthly basis during construction and then annually during operations.
- Flag the population of *Sclerolaena* sp. Yeltacowie. with flagging tape during construction.

Land disturbance footprint

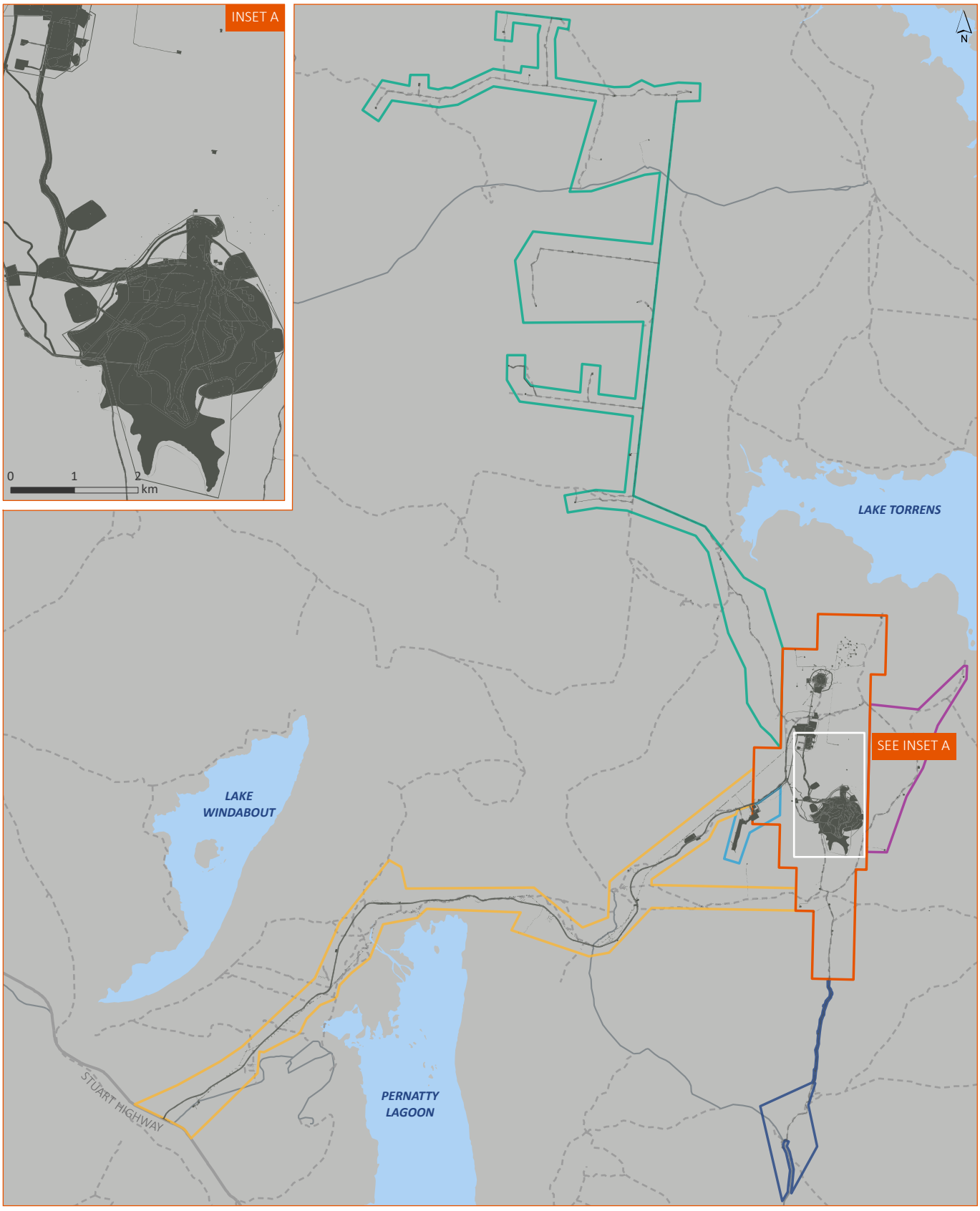
- Maintain a Land Disturbance Register and supporting GIS information (shapefiles) that records/identifies clearance areas and status.
- Destock TSF, MPP, accommodation villages and landfill.
- Ensure waivers are in place for any water point infrastructure constructed in close proximity (i.e. 150 m) to Project activities.
- Rehabilitate land to achieve a landscape function equivalent to the surrounding landscape or ensure that it is trending towards achievement of landscape function.
- Apply a buffer to disturbance footprint to account for edge effects on native vegetation and habitat.
- Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation).

* Non-Outcome or Outcome-based lease condition proposed

(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

(2) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

(3) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- Land disturbance footprint

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 4.11 | As-built and proposed land disturbance footprint

Carrapateena BHP

4.6 Reserves, production rates and products

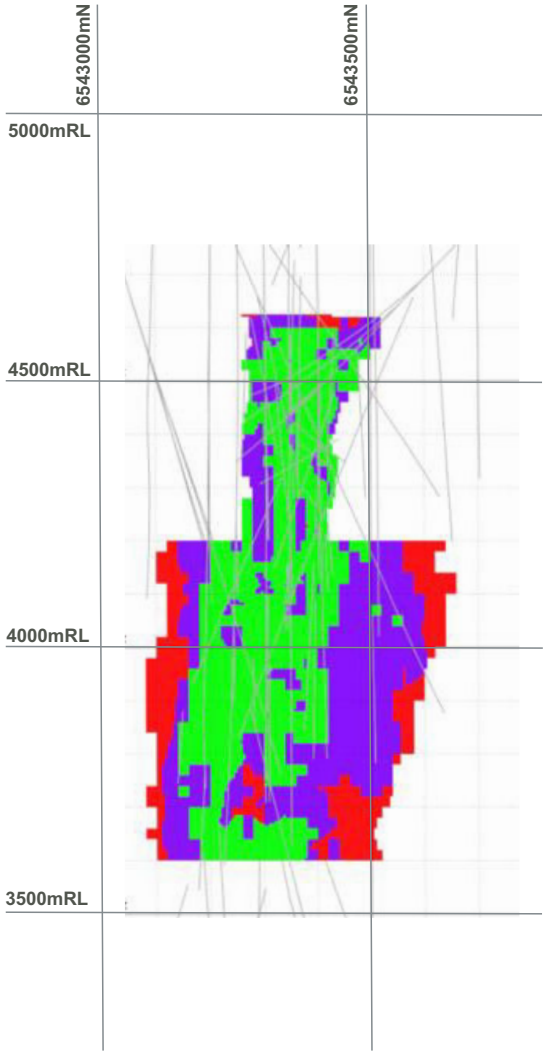
4.6.1 Geology and mineralisation

Carrapateena is located within the Olympic Dam copper-gold (Cu-Au) Province. This is a metallogenic belt along the eastern margin of the Gawler Craton in South Australia, which hosts the Prominent Hill mine, Olympic Dam mine and the Moonta-Wallaroo historic mining district. The Gawler Craton comprises variably deformed and metamorphosed sedimentary, volcanic and plutonic rock, spread from the late Archean to Mesoproterozoic, and it has been subdivided into a series of domains – the Carrapateena deposit being part of the Olympic Domain. The age of the iron oxide copper gold (IOCG) mineralisation in the Gawler Craton is uncertain, though it is interpreted in the literature to be associated with Mesoproterozoic magmatism of the Hiltaba Suite and the Gawler Range Volcanics.

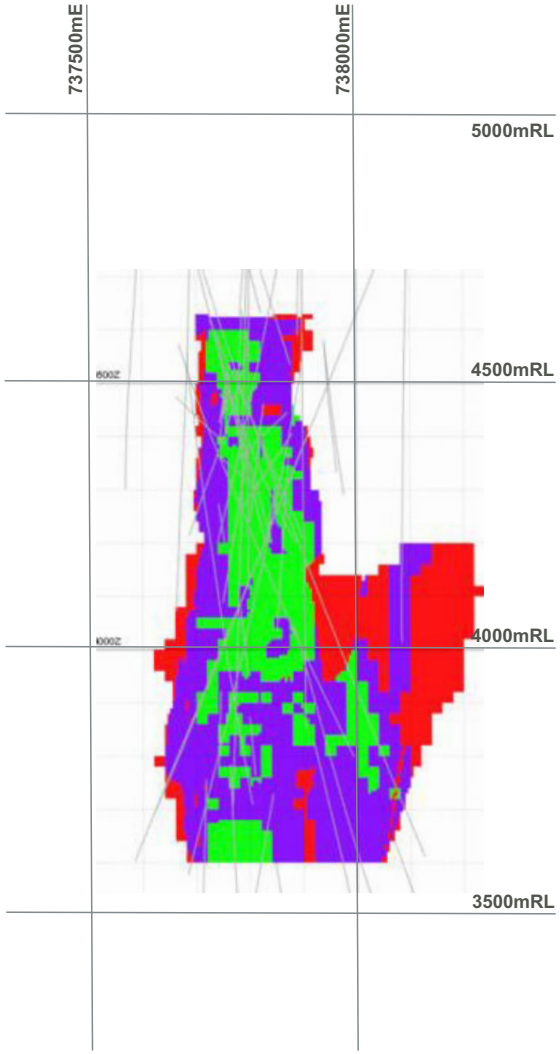
The Carrapateena Cu-Au mineral deposit is hosted in a brecciated granite complex, with both bornite and chalcopyrite copper mineralisation present – the bornite being a distinct higher-grade zone of mineralisation. The top of the SLC Resource lies approximately 470 m below the ground surface, as illustrated in Figure 4.12.

Most of the copper and gold mineralisation within the deposit is hosted by hematite-dominated breccias with moderate mineralisation occurring within hematite-altered granite breccias (Eastern Cu domain). Sulphides are the primary copper-bearing minerals in the Carrapateena Breccia Complex. Copper and gold mineralisation is structurally and chemically controlled, with subsequent alteration destroying mineralising structures. The most abundant sulphides are chalcopyrite, pyrite and bornite, and these constitute the majority of sulphides at Carrapateena. The less common sulphides are chalcocite, digenite and covellite, and in smaller amounts sphalerite and galena.

Gold mineralisation at the Carrapateena orebody is almost exclusively hosted by hematite-altered breccias. Gold grains are usually very small (10 micrometres (µm)), and when seen in polished section, are often intimately associated with copper sulphides. Gold grains are commonly a combination of gold and minor silver (electrum). The Ore Reserve range of uranium (U) grades varies from a low of 5 parts per million (ppm) to a high of approximately 2,300 ppm, with an average of 280 ppm. This uranium grade and radon emission is closer to that at Prominent Hill than it is to the levels experienced at Olympic Dam, however, with different mineral association.



LOOKING WEST



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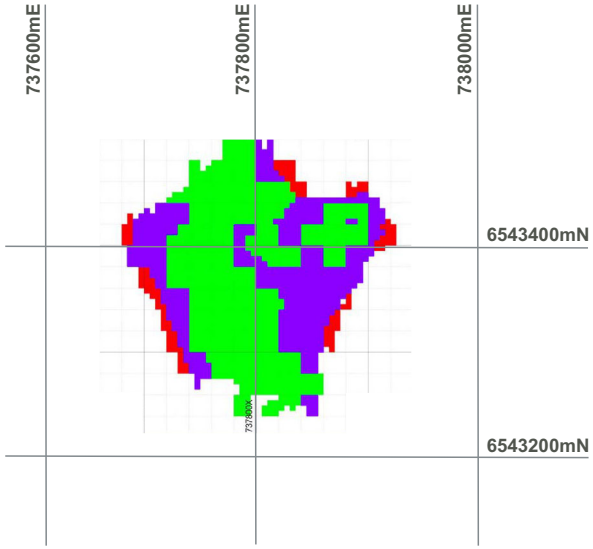


PLAN VIEW

Resource drillholes

Measured

Indicated

Inferred

Source: Carrapateena Project Mineral Resource Statement and Explanatory Notes as at 6 March 2019 showing Block Classification within the Nominal A$70/t NSR Cut-Off Shape for Blocks Above 4,200m RL and within the Nominal A$20/t NSR Cut-Off Shape for Blocks Below 4,200m RL

Figure 4.12 | Cross-section through the Carrapateena deposit

4.6.2 Estimate of Mineral Resources

The current Estimates of Mineral Resources for the Carrapateena deposit (Table 4.10) was presented in the BHP Annual Report 2024 (BHP 2024b) and supersedes that previously presented in the Carrapateena MLP (OZ Minerals 2017a) and previous PEPRs. The Mineral Resources estimate has been reported in accordance with the 2012 edition of the Joint Ore Reserves Committee (JORC) Code (JORC 2012).

Table 4.10 | Carrapateena Mineral Resources Estimate

Mineral Resources	Mt	% Cu	g/t Au	g/t Ag
Measured	130	0.98	0.40	4
Indicated	470	0.62	0.26	3
Inferred	300	0.26	0.13	2
Total resource	900	0.55	0.24	3

4.6.3 Ore Reserve

The current Ore Reserve Estimate for the Carrapateena deposit (Table 4.11) was presented in the BHP Annual Report 2024 (BHP 2024b) and supersedes that previously presented in the Carrapateena MLP (OZ Minerals 2017a) and previous PEPRs. The Ore Reserves estimate has been reported in accordance with the 2012 edition of the Joint Ore Reserves Committee (JORC) Code (JORC 2012).

Table 4.11 | Carrapateena Ore Reserves Estimate

Ore Reserve	Mt	% Cu	g/t Au	g/t Ag
Proved	-	-	-	-
Probable	185	1.03	0.41	4
Total reserves	185	1.03	0.41	4

4.6.4 Production rates

4.6.4.1 Mine production schedule

The LOM mine plan has between two to four production levels active at any one time, depending on the size of the level footprint and SLC draw rates. This approach aims to have a new level starting production as an old level is finishing. The mine also has one to two levels in development ahead of the production front, to assist with continuity of ore supply, and will maintain a focus on the main decline being ahead of level requirements.

The current five-year SLC mine production forecast is described in Table 4.12 and illustrated in Figure 4.13.

Under the current five-year mine plan reflected in Table 4.12, mine production will transition from SLC mining operations to block cave mining operations between 2027 and 2029, subject to further regulatory and internal approvals.

Table 4.12 | Mine production forecast

Mined material	Annual average (t)	Peak rate (tpa)*
Ore		
SLC production ore	5,411,000	up to 6,279,000
Development ore	532,000	up to 698,000
Total	**5,943,000**	**up to 6,877,000**
Waste		
SLC mine waste	203,000	up to 570,000
BC decline development waste	712,000	up to 1,014,000
Raisebore waste	89,000	up to 151,000
Total	**1,004,000**	**up to 1,324,000**

* Totals differ from mined material due to differences over the years across the forecast period

4.6.4.2 Concentrate production schedule

Carrapateena concentrate is a desirable product for most copper smelters, with a relatively high copper content by world standards and low impurity content. The copper grade (30% to 45%) is suitable as a custom feed stock. BHP has experience in marketing copper concentrate of various grades and has mature mine-to-market access via established logistics routes to domestic export ports.

The current five-year SLC mill production forecast is described in Table 4.13 and illustrated in Figure 4.13.

Table 4.13 | Concentrate production forecast

Mined material	Annual average	Peak
Concentrate production		
Concentrate production (t)	244,100	up to 269,200
Metals production		
Copper (t)	72,300	up to 78,500
Gold (oz)	107,600	up to 119,500
Silver (oz)	807,300	up to 1,001,200

4.6.4.3 Extractive minerals

Extractive materials are sourced from within ML 6471 and the associated MPLs for use in construction and ongoing maintenance activities undertaken within the tenements. The extraction of materials from within the ML is approved as part of the ML. The extraction of materials from within the MPLs was subject to the granting of separate Extractive Mineral Leases (EMLs), specifically:

- Mount Gunson 1 (EML 6480) and Mount Gunson 2 (EML 6481)
- Elizabeth Creek 1 (EML 6482) and Elizabeth Creek 2 (EML 6483)
- Bonney Bluff 1 (EML 6484) and Bonney Bluff 2 (EML 6485)

- Yeltacowie A (EML 6486) and Yeltacowie B (EML 6487)
- Midway (EML 6488).

These borrow pits on the Western Access Road were established to support the development of the Western Access Road and provide dolomite for ongoing maintenance of the Western Access Road (see Section 4.11.5.3).

From within ML 6471, borrow pits will be established for the recovery of up to 1.35 Mm^3 of clay and up to 1.77 Mm^3 of weathered rock (Arcoona Quartzite) over the life of the TSF (see Section 4.11.5.2). Additionally, a mine area borrow pit was established outside of the subsidence zone for the extraction of approximately 1 Mm^3 of weathered and unweathered Arcoona Quartzite, gravels and sands (see Section 4.11.5.1).

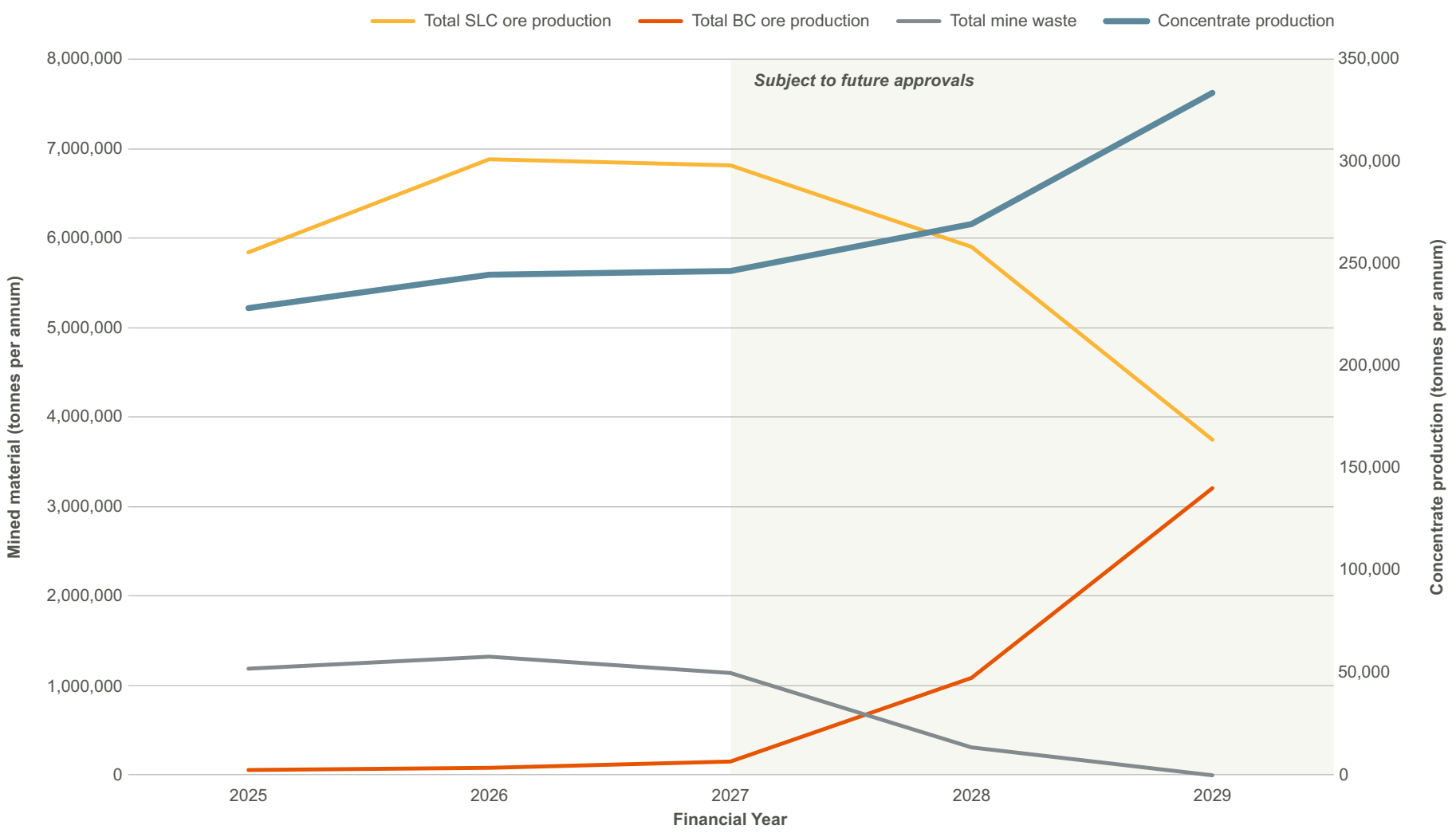


Figure 4.13 | Mine and concentrate production forecast

4.7 Exploration and resource drilling

BHP maintains 14 ELs on and surrounding the ML and MPLs associated with Carrapateena within the eastern Gawler Craton (see Table 4.14). These have been established for the purpose of understanding the surrounding geology and identifying opportunities to extend the mine life and/or establish new mining operations.

Regional exploration, near-mine and resource drilling activities have been subject to impact and risk assessments presented in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 4.14 | BHP exploration tenements in the eastern Gawler Craton

Tenement	Tenement holder
EL 5835	OZ Exploration Pty Ltd
EL 5863	OZ Exploration Pty Ltd
EL 5907	BHP Olympic Dam Corporation Pty Ltd
EL 5919	OZM Carrapateena Pty Ltd (58%); OZ Minerals Carrapateena Pty Ltd (42%)
EL 5941	BHP Olympic Dam Corporation Pty Ltd
EL 5959	BHP Olympic Dam Corporation Pty Ltd
EL 6068	OZ Exploration Pty Ltd
EL 6452	OZM Carrapateena Pty Ltd (58%); OZ Minerals Carrapateena Pty Ltd (42%)
EL 6684	OZM Carrapateena Pty Ltd (58%); OZ Minerals Carrapateena Pty Ltd (42%)
EL 6528	OZ Minerals Carrapateena Pty Ltd
EL 6685	OZ Exploration Pty Ltd
EL 6527	OZ Minerals Carrapateena Pty Ltd
EL 6596	OZ Exploration Pty Ltd
EL 6429	BHP Olympic Dam Corporation Pty Ltd

4.7.1 Regional exploration drilling

Regional exploration activities outside of ML 6471, including drilling associated with the Khamsin prospect and other regional mineralisation will be undertaken under the respective EL in accordance with the approved Exploration PEPR for these activities.

4.7.2 Near-mine drilling

Near-mine drilling is used to explore for new areas of on-tenement mineralisation that have not yet been identified. As near-mine drilling is conducted from within the ML the Outcomes, OMC and Leading Indicators applied to the ML are relevant to these drilling activities.

4.7.3 Resource drilling

Resource drilling is used to provide greater confidence in the nature of already identified ore bodies such as Carrapateena and other areas of on tenement mineralisation including the Saddle and Fremantle Doctor prospects (see Section 4.7.5).

Resource drilling also informs the current ore reserve, provides definition of the primary orebody and the other areas of on-tenement mineralisation and assists in identifying opportunities for the extraction of satellite ore. This additional information will feed into updated block models for the Carrapateena resource, as well as the development of production geology models for operational use.

Due to the depth of the Carrapateena orebody, resource drilling is more cost effective if undertaken from underground locations. Resource definition drilling near underground infrastructure locations and definition drilling for the initial production levels has been factored into the mine design and mine schedule for the operation.

4.7.4 Drilling methodology

4.7.4.1 Surface drilling

Construction of surface drill sites is undertaken in accordance with information sheets ‘M21 Mineral exploration drillholes – General specifications for construction and backfilling’ (DSD 2012) and ‘M33 Statement of environmental objectives and environmental guidelines for mineral exploration activities in South Australia’ (DSD 2004).

Diamond drilling is typically adopted to conduct exploration works, with reverse circulation percussion (RCP) occasionally utilised. Geophysical techniques employed, either airborne or downhole, include:

- downhole surveys
- magnetics
- gravity
- seismic
- induced polarisation
- magneto-telluric
- electromagnetic.

Mineral exploration sites are selected and prepared to avoid unnecessary land disturbance, and in accordance with cultural and heritage clearance requirements. Access to drill sites is provided wherever possible by established roads and tracks however some short off-road driving may be necessary to gain access to new drill sites remote from existing infrastructure. In instances where new access tracks are required, rolling of the track is the preferred method. Water supply is from existing approved wellfields, and fuel is obtained from the existing storage facilities.

Drill pad preparation typically does not require land disturbance, however ground that is highly uneven may need to be levelled to enable safe operations. Drill pads are typically 80 m x 80 m in size. Drilling typically consists of diamond core drilling to depths greater than 1 km. Drilling fluids used for mineral resource drilling include a mixture of water and muds. These fluids aid as a coolant to the drilling equipment, lubricate the core, and help with stabilising the hole. Muds are circulated through the drill rig and the hole in a closed circuit to allow mud reuse. To contain the drilling muds at surface for reuse, a

series of sumps are excavated and lined with plastic sheeting to prevent seepage. Each of these sumps are 12 m x 2 m x 1.2 m in size and can hold up to approximately 28,000 L in volume, as is required when drilling to large depths. Using this process water is able to be recycled whilst the cuttings settle out to the bottom of the sumps. This system is highly cost effective and prevents the release of fluids to the environment.

Drillholes are a combination of vertical and angled in order to obtain the best intersections. In addition, wedges and down-hole motors may be used to drill daughter holes from a single parent hole, reducing the number of surface collars required.

Where exploration activities are undertaken at a distance from existing infrastructure, a track is established to permit access, and sumps installed for the containment of drilling water. In some instances, creek crossing upgrades are constructed to allow all-weather access. An assessment of the potential for environmental impacts (generally related to surface water management) as the result of the installation of exploration-related infrastructure is undertaken for each EL and contained within the related E-PEPR.

In general, the following equipment is used to conduct surface exploration activities:

- diamond and RCP drill rigs (up to 30 t in weight)
- support vehicles to transport drill rods
- fuel for the day's usage
- water tanker for drill water supply and dust suppression
- light vehicles for personnel transport and drill core recovery
- ground gravity or magnetic survey equipment
- large thumper trucks and support vehicles for seismic surveys
- graders
- front-end loaders (FEL)
- backhoes
- a bulldozer for sites with difficult access and/or where crossings are required.

4.7.4.2 Rehabilitation activities

Rehabilitation of surface drill sites is undertaken in accordance with information sheets 'M21 Mineral exploration drillholes – General specifications for construction and backfilling' (DSD 2012) and 'M33 Statement of environmental objectives and environmental guidelines for mineral exploration activities in South Australia' (DSD 2004).

At the conclusion of drilling, casings, including surface casings, are removed from the hole wherever possible. A Van Ruth plug is installed at least 20 m below the bottom of the Whyalla Sandstone and the hole grouted from here to at least 20 m above the base of the Woomera Shale. Approximately 2 m of polyvinyl chloride (PVC) casing is pushed into the hole to below ground surface, and a PVC cap placed until such time as it is determined that the hole will not be re-entered. In instances where two aquifers are present, the Van Ruth plug is installed 20 m below the top of the basement rock units and grouted to 20 m above the base of the Woomera Shale. A second Van Ruth plug is installed 20 m below the top of the Woomera Shale and grouted from here, through the Corraberra Sandstone, to 20 m into the base of the Arcoona Quartzite.

Once it has been determined that an exploration drillhole will not be re-entered, the drillholes are back filled with cuttings and capped. Prior to final site completion all rubbish is removed from the area, new access tracks are scarified and the stones/gibbers re-spread, flagging and non-permanent stakes are removed, all sumps are backfilled, and the areas levelled to match the surrounding topography.

With orebodies amenable to mining from underground, it is often more economic to undertake resource delineation drilling from underground. This is especially true when there are significant depths to reach the mineralisation, difficult ground conditions to negotiate (for example, overburden sediments) and consideration of environmental and social issues at the surface, which can all lead to significant clearing, preparation and rehabilitation costs.

4.7.5 Regional mineralisation

Previously identified mineralisation in the immediate vicinity of Carrapateena may allow the opportunity to grow Carrapateena as a longer-life mine. Within the Carrapateena region, there are a number of known mineralised bodies that will be included in future resource studies and exploration and near-mine drilling programs. The following sections describe the main areas of regional mineralisation (as of this PEPR), the locations of which are illustrated in Figure 4.14. The Saddle and Fremantle Doctor prospects occur within the boundaries of ML 6471. Near-mine drilling activities that are undertaken on ML 6471 will be undertaken in accordance with the Outcomes, OMC and Leading Indicators applied to ML 6471. BHP will submit to DEM exploration reports, data and samples in accordance with the requirements of Ministerial Regulations ‘MG13 Mineral exploration reporting’ (DEM 2023c).

The term **block cave** is used throughout this PEPR to refer to the greater area of mineralisation within the Carrapateena deposit, reflecting the potential for the implementation of a block caving mining methodology for the extraction of this greater resource. At this time, primary approvals are well advanced and, to preserve optionality, continued to reference this **block cave** resource in the assessment of effects and impacts. This was reflected in the approved MLP for the Project and subsequently is reflected in this PEPR. In this context, the term **block cave** when applied with reference to mineralisation or resource within this PEPR (e.g. Figure 4.14) should be interpreted as referring more generally to the greater area of mineralisation surrounding the SLC orebody, and not be interpreted as an indication of the areas of the resource and/or mining methodologies associated with future extension/expansion plans for Carrapateena.

4.7.5.1 Fremantle Doctor

Fremantle Doctor is located to the north-east of the Carrapateena deposit. It lies within the boundary of ML 6471.

To date, a number of drillholes have been drilled into Fremantle Doctor, however, there remains insufficient data to support firm planning assumptions. It is likely that due to its depth from surface, ore, if defined, would likely be accessed from underground and fed into the existing Carrapateena materials handling system via a 2.7 km long incline. Depending on the grade of the deposit, this could either be a high-grade SLOS operation or lower-grade SLC. No Mineral Resource Estimate has been produced for this deposit.

4.7.5.2 Saddle

Mineralisation has been intercepted historically between Fremantle Doctor and the Carrapateena Mineral Resource, within ML 6471. No tonnes or grade information are available, leaving this as an exploration target for future growth potential.

4.7.5.3 Khamsin

Khamsin is the largest of the inferred deposits in the area and is located to the north-west (and outside of) ML 6471. A Resource was released to the market in 2014, however it was downgraded in 2017 as a result of the change in mining scope of Carrapateena from block caving to SLC. When compared to Carrapateena and other Australian caving operations, this mineralisation has the potential to support a 5 to 10 Mtpa caving operation with a mine life of 15 to 20 years. Given its proximity to the mine, its development could leverage Carrapateena infrastructure.

The Khamsin target would require additional approvals from the Government of South Australia and KAC and is not a component of this PEPR. However, it demonstrates the potential of the region to support extensions to the current mine life and the province approach BHP takes with its operating mines, development sites and exploration projects.

4.7.5.4 Satellite deposits

There are a number of areas of mineralisation immediately surrounding, but not within the footprint of, the SLC mining operations. A scoping study has been completed on one of the larger higher-grade Carrapateena satellite orebodies, which suggest it could support a SLOS operation with a total inventory of approximately 2 Mt. Mining of the satellite orebody could utilise the existing mobile equipment and materials handling system and would provide additional tonnes to the Carrapateena operation. The open stopes may also be utilised for underground waste storage over the LOM.

4.7.6 Sterilisation of potential future resources

After extensive exploration efforts between 2012 and 2016 and targeted drilling at identified geophysical anomalies, BHP has determined that the placement of infrastructure (see Figure 4.15) avoids any future exploration interests, including Khamsin, Saddle and Fremantle Doctor mineralisation.

The MPP is located approximately 3.2 km south-west of the Carrapateena deposit on a weak, north-west trending gravity response, which is associated with a low amplitude magnetic response (see Figure 4.15). Previous studies (Murphy et al 2013) interpreted the gravity feature to be associated with a basement high comprising Donington Suite Granite and the magnetics associated with a mafic, north-west trending intrusive dyke. In 2012, two holes intersecting the basement were drilled into the gravity and magnetic trend within 1 km to 2 km of the MPP. One was a geotechnical hole for the decline in 2012 and the other, an exploration hole targeting a discrete low-amplitude gravity anomaly. Both hole locations did not discover any mineralisation.

The TSF is located approximately 5 km south-east from the MPP, on a relatively uniform, slightly elevated gravity response, which previous studies have interpreted as a basement block of Donington Suite Granite. The magnetics show a weak north-south trending anomaly splitting into a north-south and north-west trending anomaly at the northern margin of the TSF (see Figure 4.15). This is interpreted to be due to a mafic intrusive – the north-west dyke being the strike extension of the dyke beneath the MPP. The basement is likely 400 m to 600 m below surface at this point, and there is no geophysical signature that would suggest economic mineralisation.

Overlapping Tenement Agreements signed with underlying exploration tenement holders have considered any potential future resource identification. With present knowledge, both parties agree the infrastructure avoids any potential future resource, however, if this were deemed to not be the case, BHP would relocate infrastructure to enable mining of any identified and approved resource.

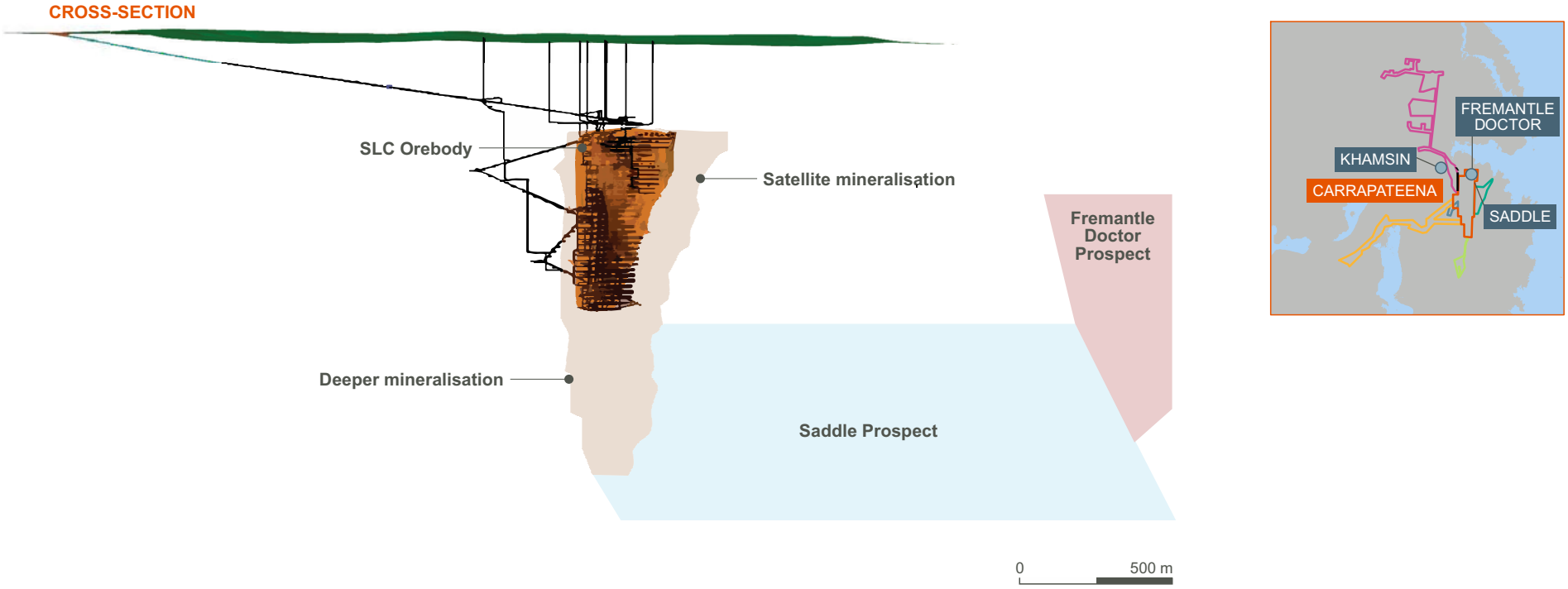


Figure 4.14 | Indicative locations of regional mineralisation

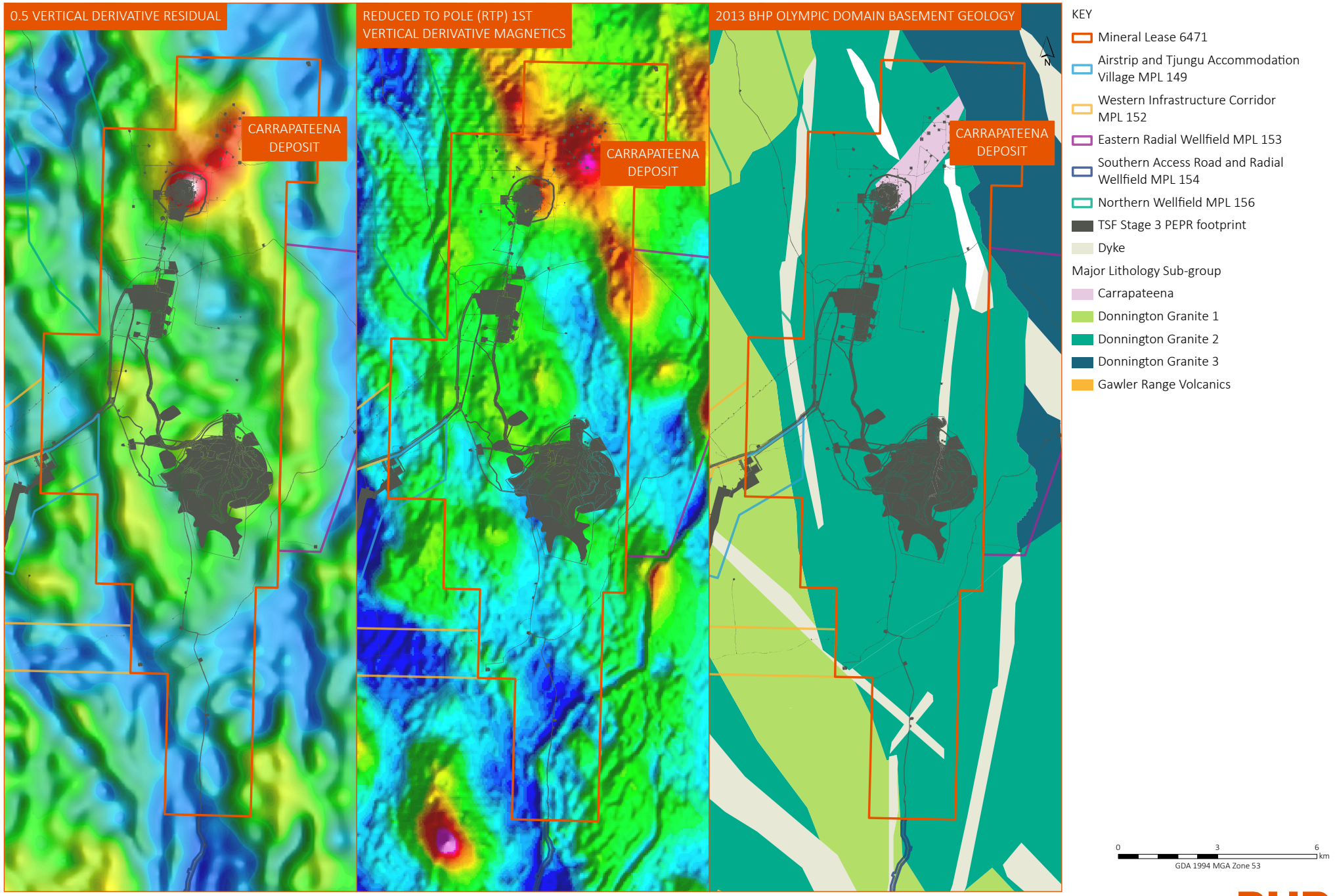


Figure 4.15 | Sterilisation of potential future resources

4.8 Description of mining operations

Carrapateena is a large resource amenable to bulk mining. SLC is the mining method employed for the bulk of the Carrapateena orebody, which may transition to block caving in future. Mineralised zones immediately adjacent to the orebody and outside of the SLC zone of influence may be mined in future using SLOS methodologies.

4.8.1 Key elements

A description of the key elements of the mining operations are described in Table 4.15. These elements have been subject to impact and risk assessments as presented in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c). Table 4.16 provides a summary of relevant Impact IDs and design and management controls that have led to the development of Outcomes, OMC and Leading Indicators as provided in Chapter 7.

Table 4.15 | Mining key project elements

Key element	Summary
Mining method	SLC
Mineable inventory	The Mineable Inventory is 189 Mt (see Section 4.6.3)
Mining rate	6.9 Mtpa (nominal throughput)
Mine life	22 years of ore production (to 2045) at a nominal 6.9 Mtpa of ore production plus decommissioning and closure
Commodities	Copper, gold, silver
Primary access and development rate	Tjati Decline consisting of two parallel access drives supported by independent box cuts and portals, development rates at 6 km to 8 km per annum
Crushing	Underground, consisting of 2 x 725-1,000 tph gyratory crushers (Crusher 2 and Crusher 3) and a smaller (650 tph) jaw crusher (Crusher 1)
Ore and waste transport	Ore conveying from Crusher 1 and Crusher 2 (and Crusher 3, when commissioned) with waste material trucked to the surface
Ventilation system type	Negative pressure primary vent with top of cave extraction for the SLC
Refrigeration	Refrigeration needed at depths greater than 930 m. Installation of refrigeration plant proposed as a component of this PEPR
Mine dewatering	Mine dewatering through the use of area and level sumps within the mine and use of operational pump stations, discharging water to surface mine water settling ponds prior to reuse

Table 4.16 | Mining Impact IDs, design and management controls and uncertainty

Mining
Carrapateena Impact IDs[1]
L36, L37, L38, AQ35, AQ36, AQ45, AQ46, AQ48 and AQ49
Design controls
• None applicable
Management controls
• Development, implementation and maintenance of a Production Management Plan • Development, implementation and maintenance of a Cave Monitoring Plan • Installing a dust suppression system on crushing operations • Installing dust suppression on conveyor transfer points

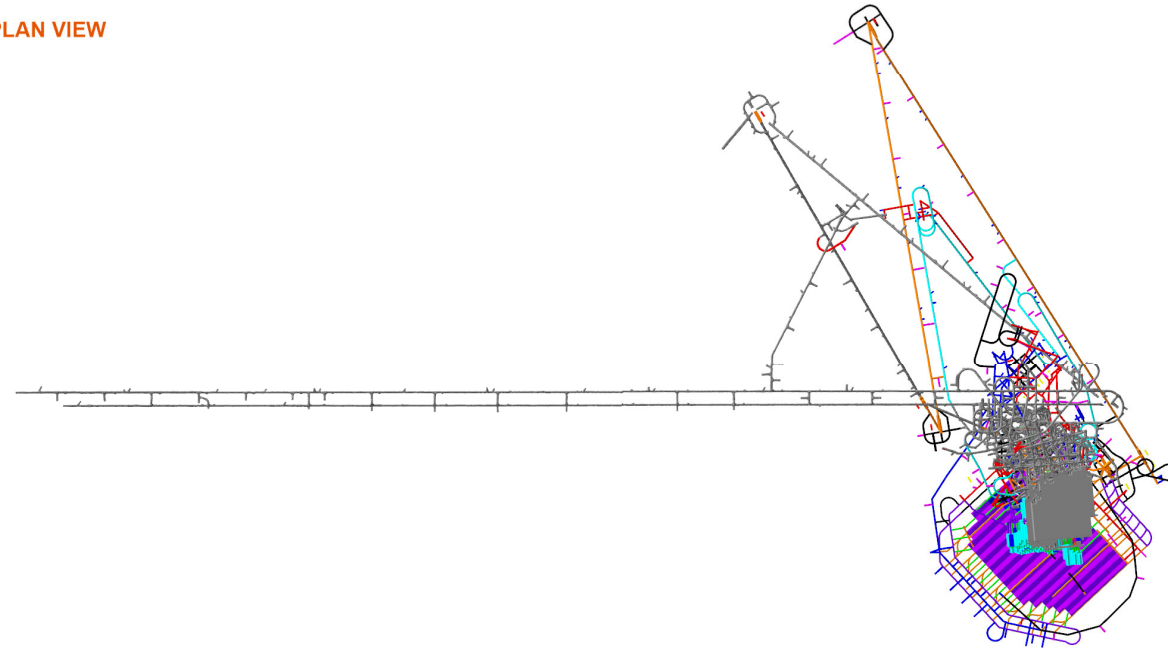
* Non-Outcome or Outcome-based lease condition proposed
(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

4.8.2 Mine design

4.8.2.1 Overview

The as-built and proposed SLC mine layout for Carrapateena is shown in Figure 4.16 with a flow diagram of the mining process illustrated in Figure 4.17.

PLAN VIEW



ELEVATION VIEW (LOOKING NORTH-WEST)

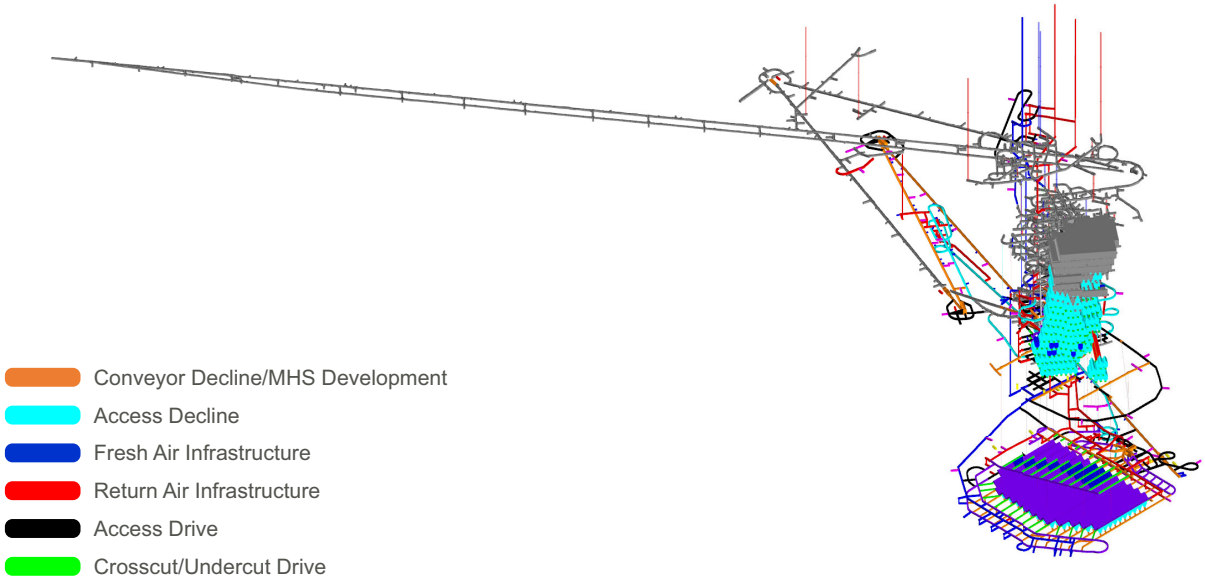


Figure 4.16 | Carrapateena mine layout

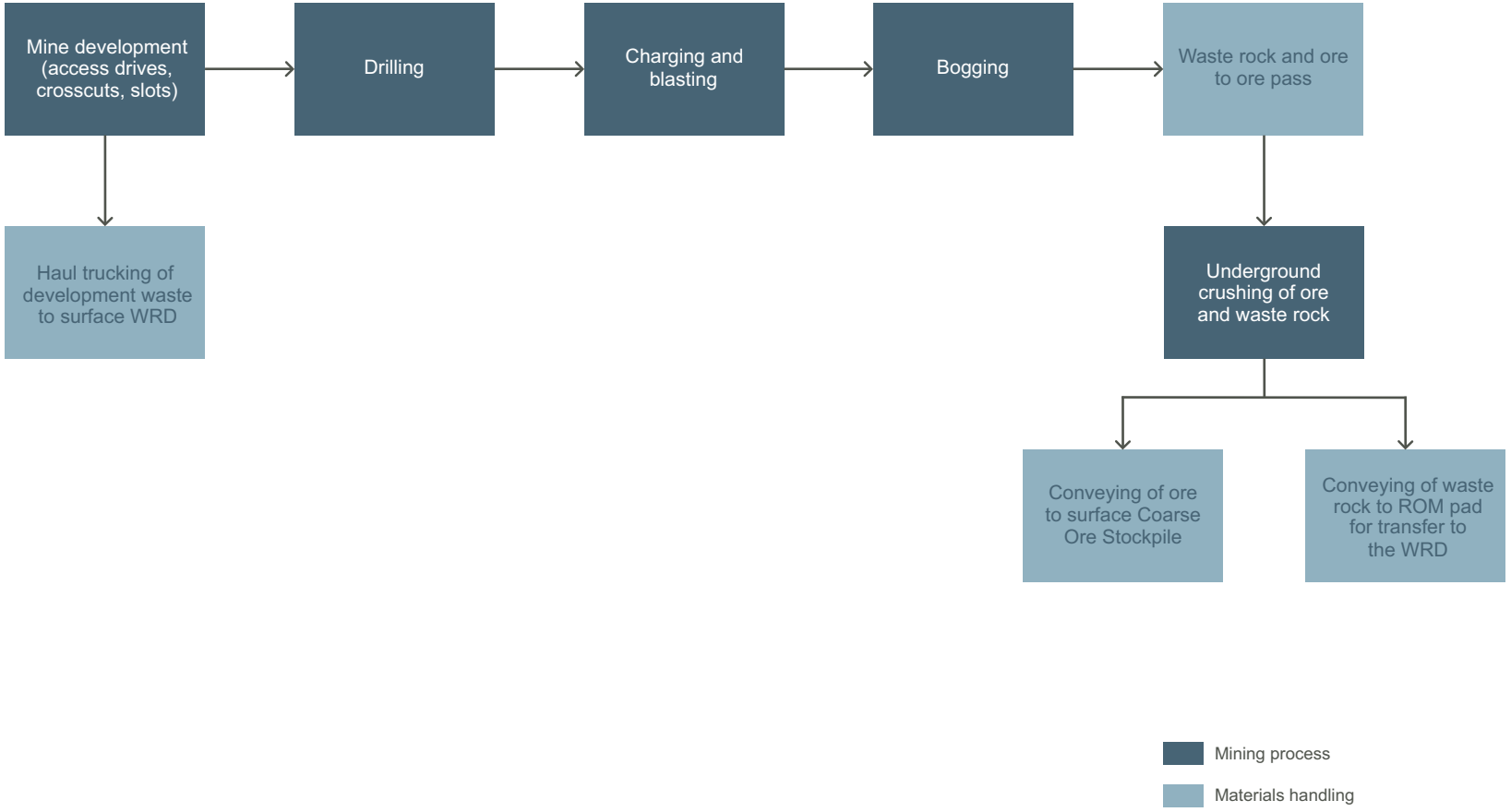


Figure 4.17 | Carrapateena mining process flow diagram

4.8.2.2 Decline development

Access for personnel and equipment is via the Tjati Decline. A separate conveyor decline runs parallel with the Tjati Decline for the first 2 km and provided primary ventilation during the advanced exploration works period. The Tjati Decline route has a number of stockpiles that will enable planned future resource definition and diamond drilling programs (see Section 4.7.3). Construction of the box cut commenced in August 2016 under previous RL 127, with construction of the Tjati Decline commencing 30 September 2016. The Tjati Decline has been developed using drill and blast techniques with robust ground support installed in-cycle.

In January 2017, additional underground development adjacent and parallel to the existing Tjati Decline access drive, and a second smaller box cut and portal approximately 130 m east of the existing box cut, was undertaken under previous RL 127 to provide ventilation and emergency egress to the decline. This additional development provides dual mine access for the ongoing mining operations, allowing for production to continue safely in the event of one of the access drives becoming inaccessible; either due to conveyor maintenance or an emergency situation. Moving the conveyor from the mine access decline to a separate decline significantly reduces risks to mine workers over the life of the project, as no work would need to be undertaken under a moving conveyor, and ongoing maintenance does not need to be completed using elevated work platforms. The conveyor decline comprises a number of straight sections designed to house single conveyors with transfer points located at each end. The conveyor decline is located further from the mineralisation than the Tjati Decline, except for the sections that meet the underground crusher installations.

The Tjati Decline provides access to each production level. An intake raise was extended with the Tjati Decline in 25 m vertical increments to provide fresh air to the decline. The decline fresh air intake consists of a 3.0 m diameter raisebore.

LOM infrastructure such as the crusher chambers, conveyor decline, orebody decline, and ventilation raises are offset from the orebody and located outside the modelled major deformation zone to reduce the threat of cave-initiated damage.

Standard decline/incline design properties include:

- The gradient for truck haulage route is no steeper than 1:7 gradient.
- The gradient for conveyor haulage route is no steeper than 1:5.3 gradient.
- The gradient is measured on the centreline and does not flatten off at intersections.
- The curvature radius is no smaller than 25 m at the centreline. Larger radii are preferable as they increase the line of sight for turning vehicles.
- The decline loops shall allow accesses, services and vertical development to be aligned between levels where practical.
- The conveyor decline sections are designed straight, with transfer stations at changes in azimuth.
- The angle between decline/incline and other haulage drives is generally 90 degrees or greater.

4.8.2.3 Sub-level caving

Lateral development

Lateral development forms the backbone of the mining operations, and includes the following excavations:

- conveyor decline for conveying ore
- decline adjacent to the orebody for level access (the Tjati Decline)
- decline adjacent to the orebody for proposed block cave production level access
- total of 17 production levels, nominally spaced at 25 m vertically, with the lower five levels at 30 m spacing
- first (or top) production level at 4,585 metres relative level (mRL) level (approximately 485 metres below surface (mbs))
- last (or bottom) production level at 3,635 mRL level (approximately 1,425 mbs)
- Crusher 1 located at the top of the SLC production levels
- Crusher 2 located in the middle of the SLC production levels
- Crusher 3 located at the lower of the SLC production levels
- main workshop, refuelling bay, wash bay and crib room located at 4,430 mRL level.

The dimensions and gradients of the lateral development are described in Table 4.17.

Table 4.17 | Lateral development dimensions and gradients

Development	Dimensions	Profile	Gradient
Access declines	5.8 m wide, 6.2 m high (34.2 m^2)	Semi-arched	1:6
Conveyor declines	7.0 m wide, 6.2 m high (41.7 m^2)	Semi-arched	1:5.3
Trucking areas	5.8 m wide, 6.2 m high (34.2 m^2)	Semi-arched	1:6 – 1:40
Loading areas	5.0 m wide, 5.0 m high (23.3 m^2)	Semi-arched	1:6 – 1:40
Mass excavations (crusher chambers, by lift)	10.8 m wide, 5.5 m high (59.4 m^2) maximum	Rectangular	Flat
Mass excavations (transfer chambers, by lift)	11.2 m wide, 5.5 m high (61.6 m^2) maximum	Rectangular	Flat

Vertical development

Vertical development encompasses any vertical or steeply inclined excavation from or to underground workings and does not include lateral development or production (stopes or cave). Vertical development is used for:

- ventilation (shafts and level raises)
- materials handling (ore passes, finger passes, hoisting, crusher stations)
- personnel access (escape-way raises)
- service holes (electrical, communications, raw water, drainage, seismic monitoring).

There are two types of vertical development – large openings (greater than 0.5 m diameter) and small openings (less than 0.5 m diameter). Large diameter openings are generally mined for provision of ventilation (i.e. shafts and level raises), materials handling (i.e. ore passes, finger passes, hoisting shafts etc.), and personnel access (i.e. escape-way raises). Small diameter openings are generally mined for the provision of mine services between levels or between adjacent development.

The majority of the large diameter openings are developed using a raisebore at 3.0 m and 5.0 m diameters. Shorter raises between 25 m levels have been developed as long-hole raises. Large diameter (5.0 m) raises developed through the Woomera Shale require remotely sprayed shotcrete (or fibrecrete) linings to prevent degradation of the rock unit over the mine life.

The design dimensions and gradients for vertical development are provided in Table 4.18. The raises with surface expressions are detailed in Table 4.19.

Table 4.18 | Vertical development dimensions and gradients

Development	Dimensions	Profile	Gradient
Ore pass (finger raise)	2 m x 2 m long-hole raise	Square	60°
Slot rises	2 m x 2 m long-hole raise	Square	Vertical
Ventilation raise	3.0 m diameter	Circular	Vertical (max. dev. 1.0%)
Ore pass (main)	3.0 m diameter	Circular	80°
Ventilation raise	5.0 m diameter	Circular	Vertical (max. dev. 0.2%)
Crusher bins	6.5 m diameter	Circular	Vertical (max. dev. 0.2%)
Long-hole raise	5.0 m diameter	Circular	50° – 90°

Table 4.19 | Vertical development elements with a surface expression

Element	Dimensions
Fresh air sources	4 raises (VR2, VR4, VR8 and VR10) plus access decline and conveyor decline
Return air discharge	5 raises (VR1, VR3, VR5, VR7 and VR9)

Ground control

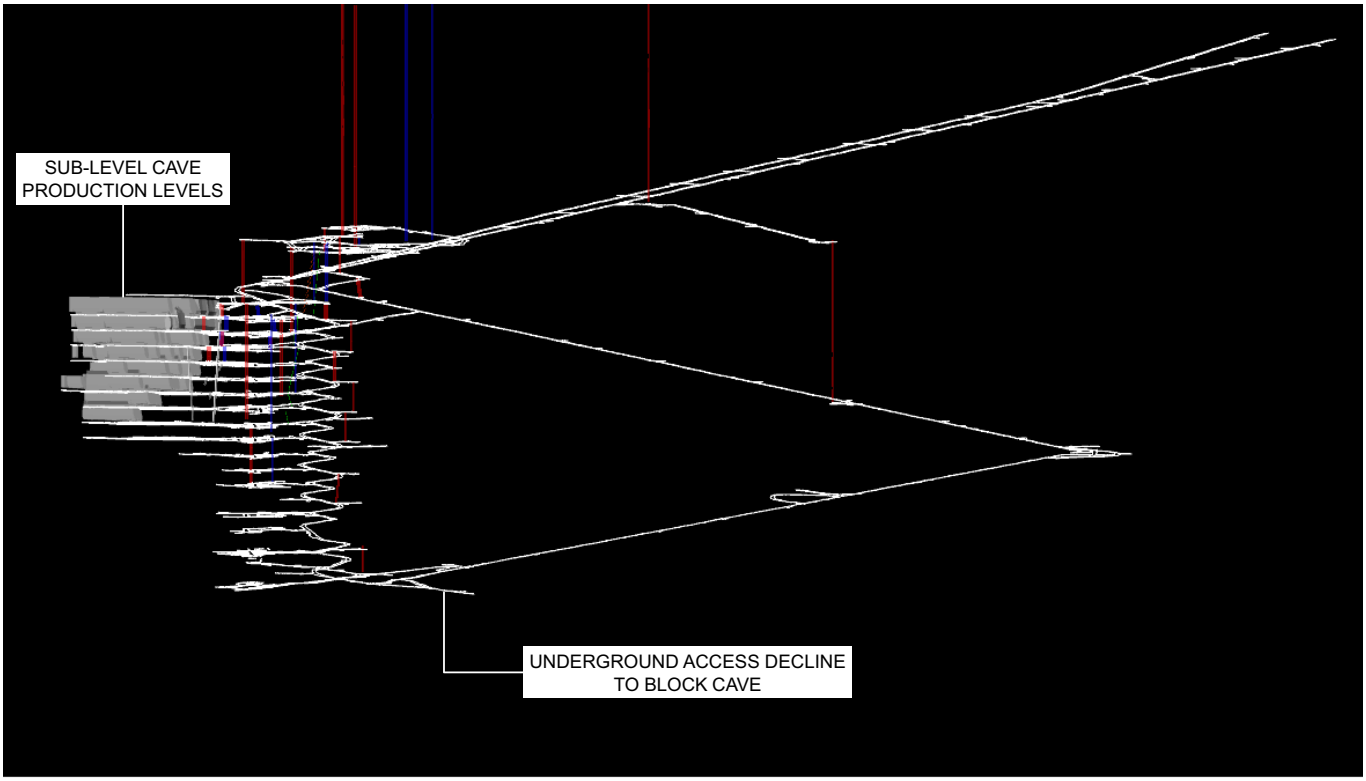
The north face of the two box cuts is supported by cable bolts and fibrecrete. The Tjati Decline box cut is fitted with an Armco tunnel structure to reduce water inflow into the mine. The area between the Armco and the box cut is backfilled with waste rock generated during underground development. Underground development is supported with fibrecrete and rock bolts, however some short-life development is supported with mesh and rock bolts. Cable bolts are installed where necessary.

Fibrecrete is manufactured using an onsite fibrecrete batch plant using fresh Arcoona Quartzite from the lower section of the box cut. This material is crushed by portable crushers to produce the required aggregate grading sizes. When the fresh Arcoona Quartzite material is exhausted, selective mine development waste from the basement rocks is used for the construction of fibrecrete.

4.8.2.4 Block caving

Block cave mining or the greater Carrapateena orebody is not proposed in this PEPR and is subject to further approvals. The development of a block cave production level access decline is proposed under this PEPR (see Section 4.8.2.2 and Figure 4.18).

SUB-LEVEL CAVE DEVELOPMENT AS AT MID-2023



ESTIMATED MINE DEVELOPMENT AT END OF 2025 TO BLOCK CAVE PRODUCTION LEVELS

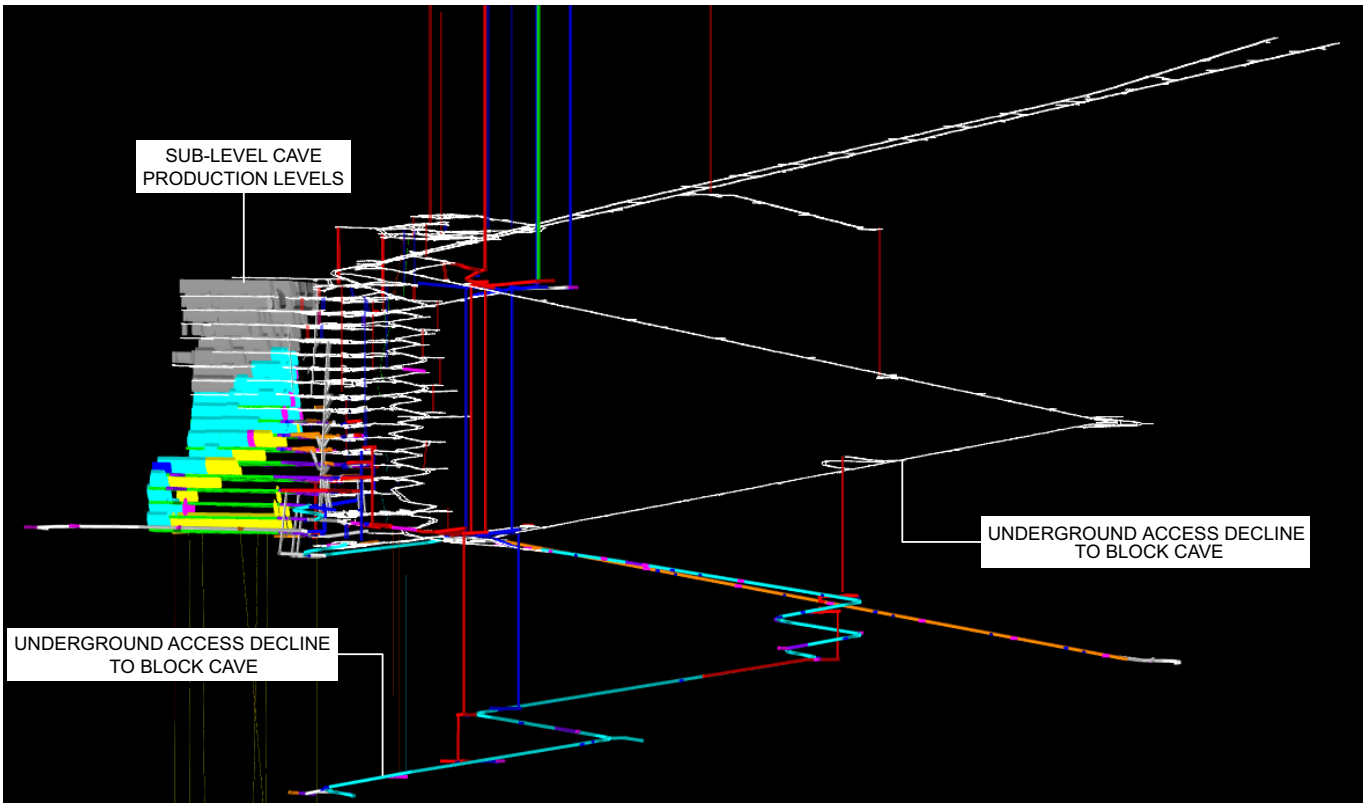


Figure 4.18 | Conceptual block cave decline alignment

4.8.2.5 Pre-conditioning

Overburden post-conditioning

Post-conditioning of the overburden materials was undertaken above the SLC to encourage movement within the Whyalla Sandstone. This rock unit was identified as the one zone that required engineering assistance for the SLC to adequately cave. Post-conditioning is commonly used to facilitate caving operations, during the cave propagation phase of construction, with examples at North Parkes and Cadia in Australia and Freeport Grasberg operation in West Papua.

Post-conditioning activities were initiated within the overburden units to aid cave propagation, once monitoring platforms identified a stall situation was occurring, where cave growth was no longer responding to production draw. In addition to the pre-conditioning activities the underground monitoring platforms were expanded to provide finer data resolution, and direct feedback on the impact of the post-conditioning activities.

The post-conditioning approach involved the drilling of small diameter diamond drillholes from surface into the targeted geological formations. Water, under high pressure, is forced into the surrounding rock mass, creating fractures to form and grow outwards to a point of pressure equilibrium. This high pressure injection process, using water is repeated around 50 times at different positions within each drillhole, but only within the Whyalla Sandstone formation. Micro-seismic monitoring systems track the extent of fracturing in conjunction with pressure and flow monitors. This conditioning method also supports re-engaging the cave should it stall at any point during production.

Post-conditioning was undertaken from new and existing drill pads located to the flanks of the cave.

Block cave pre-conditioning

To support potential future block cave mining operations, it is proposed to undertake pre-conditioning of the block cave orebody. This would be undertaken underground from the lower SLC production levels using a methodology consistent with that described for overburden post-conditioning, the difference being that the conditioning work would commence before the initiation of the block cave and not post-initiation, as in the situation detailed above. The pre-conditioning would also be targeting the block cave orebody to enhanced caving performance and reduce the risk of interruptions and adverse safety outcomes that may be caused by failure of the orebody to cave as predicted.

This pre-conditioning was contemplated in the MLP and has been subject to impact and risk assessments as presented in the consolidated assessment (OZ Minerals 2016: 2017a; 2018c).

4.8.2.6 Underground fill

The mining operations do not require any engineered fill materials, with the nature of the caving operation filling the mined voids via subsidence of the above rock material. Some development drives and sub-level accesses may remain following caving and are preferentially filled with waste rock material.

4.8.2.7 Materials management

Materials handling

The underground materials handling system has been developed in three phases to coincide with the commissioning of each of the three crushers, with each phase consisting of:

- A crushing station (CS) comprising run-on slab, ROM ore bin with grizzly, rock breaker, vibrating grizzly feeder with stepped grizzly sections and jaw or gyratory crusher with an appropriately sized feed opening and switchroom.
- Tramp metal collection system including self-cleaning tramp removal magnet, metal detector and manual picking station.
- A number of transfer stations (TS) comprising transfer conveyors, walkways both sides in elevated areas, belt weigh scale and safety lockout system for safe tramp recovery, rotable chutes segments for high wearing elements, overhead cranes for maintenance, drive and belt take-up station and switchrooms.
- Prior to transfer to surface, a bifurcated bunker will be installed for waste and pre-production ore segregation.
- Water services comprising two tanks for dust suppression and fire water including foam suppression over hydraulic oil power packs, sprinklers over equipment in chambers, ring main piping, pressure control stations and connections for future mine expansion.
- The decline conveyors will be hung from the drive backs from chains fixed to rock bolts grouted into the drive backs. Other conveyors are mounted from ground in a conventional manner. All conveyors are equipped with safety features comprising pull wire switches, belt drift switches, rip detection, blocked chute switches and guarding to Australian Standards (AS4024). Conveyors within declines are hung at a low level and fitted with remote isolation systems at 200 m intervals to permit enhanced maintenance accessibility and light vehicle traffic alongside the conveyor.

Crushers

Three underground crushers will be established during the mine life, with the first installed five levels below the top of the orebody. Details of the crushers are provided in Table 4.20. Ore materials are transported to surface via conveyor with waste rock in excess of that used as underground fill in areas of underground development that are no longer required (such as stope backfill for the satellite SLOS mining voids) being trucked to the surface for storage in the WRD.

Table 4.20 | Crusher details

Element	Type	Location
Crusher 1 (CS01)	Jaw	Top of SLC production levels
Crusher 2 (CS02)	Gyratory	Middle of SLC production levels
Crusher 3 (CS03)	Gyratory	Bottom of SLC production levels

Conveyors

The conveyor system comprises a series of conveyors that transfer ore from the underground crushers to the surface ROM stockpile. This system consists of:

- a feeder at the base of the crusher ore bin feeding onto a tramp conveyor
- sacrificial tramp conveyor containing tramp magnets feeding the trunk conveyor
- trunk conveyor and discharge chute feeding onto the lower conveyor
- an 8.5 km back-mounted conveyor system discharging into a surface stockpile.

The upper conveyor leg is contained in one of the two declines. The crushing and conveying infrastructure operate in combination with limited waste rock haulage via trucks and provides ore and waste rock handling alternatives in the event that the conveyor system is unavailable.

The construction of a shaft and installation of associated infrastructure for ore hoisting is a future consideration for the operation.

Materials movements

The movement of ore and waste rock (assuming all waste rock is brought to the surface) was shown in Figure 4.13. This indicates that total extracted ore and waste rock will be approximately 121 Mt and 9.3 Mt, respectively, over the life of the operation covered by this PEPR and subject to change via future approvals.

4.8.3 Subsidence zone

The nature of a caving mine (SLC or block cave) operations results in subsidence of the ground surface above the cave. This reduces operating costs by significantly reducing the need for backfilling and/or overburden removal operations, which would be limited to rock filling of disused development drives and satellite SLOS voids.

The development of a subsidence zone interacts with local aquifers and captures incident rainfall, resulting in water inflows into the mine workings via fractures and the subsidence zone crater. The cave associated with the SLC breached the Tent Hill Aquifer (THA) in 2021, with surface expression of the cave occurring in late 2022.

4.8.3.1 Deformation

Rock deformation associated with the SLC mining operations were simulated using two numerical modelling packages, specifically:

- The first package simulates deformation in the discontinuous rockmass by solving the stress and elastic and plastic strain fields. This deformation solver is also used to estimate the extent of the unstable zone that will make the transition to caved material at each model step.
- The second package simulates gravity flow within the cave due to the draw of fragmented rock from the drawpoints according to the past production history and scheduled production.

Deformation modelling was undertaken using the Abaqus Explicit Finite Element Solver, with gravity flow modelling undertaken using CaveSIM. The two packages were coupled, in that they exchanged data at each modelled mining step and a mutual equilibrium was reached at each step.

An output of the numerical modelling simulation showing the forecast displacement and damage at the end of the proposed mining sequence is presented as Figure 4.19. This figure shows the general deformation regimes at a mine scale, specifically:

- caved rock zone, which is the vertical zone of deformation directly above the SLC workings
- scarp zone, which is the transitional zone between the caved rock zone and the fracture zone consisting of steep cliffs
- fracture zone, which is the zone of plastic deformation, graduating from steep cliffs to slight surface tension cracking
- continuous deformation zone, which is the zone of elastic deformation where some movement may occur as rocks de-stress following caving, but no fracturing is predicted.

Subsidence zone: for the purposes of this PEPR, refers to all areas of plastic deformation (i.e. it represents the discontinuous deformation zone shown on Figure 4.19).

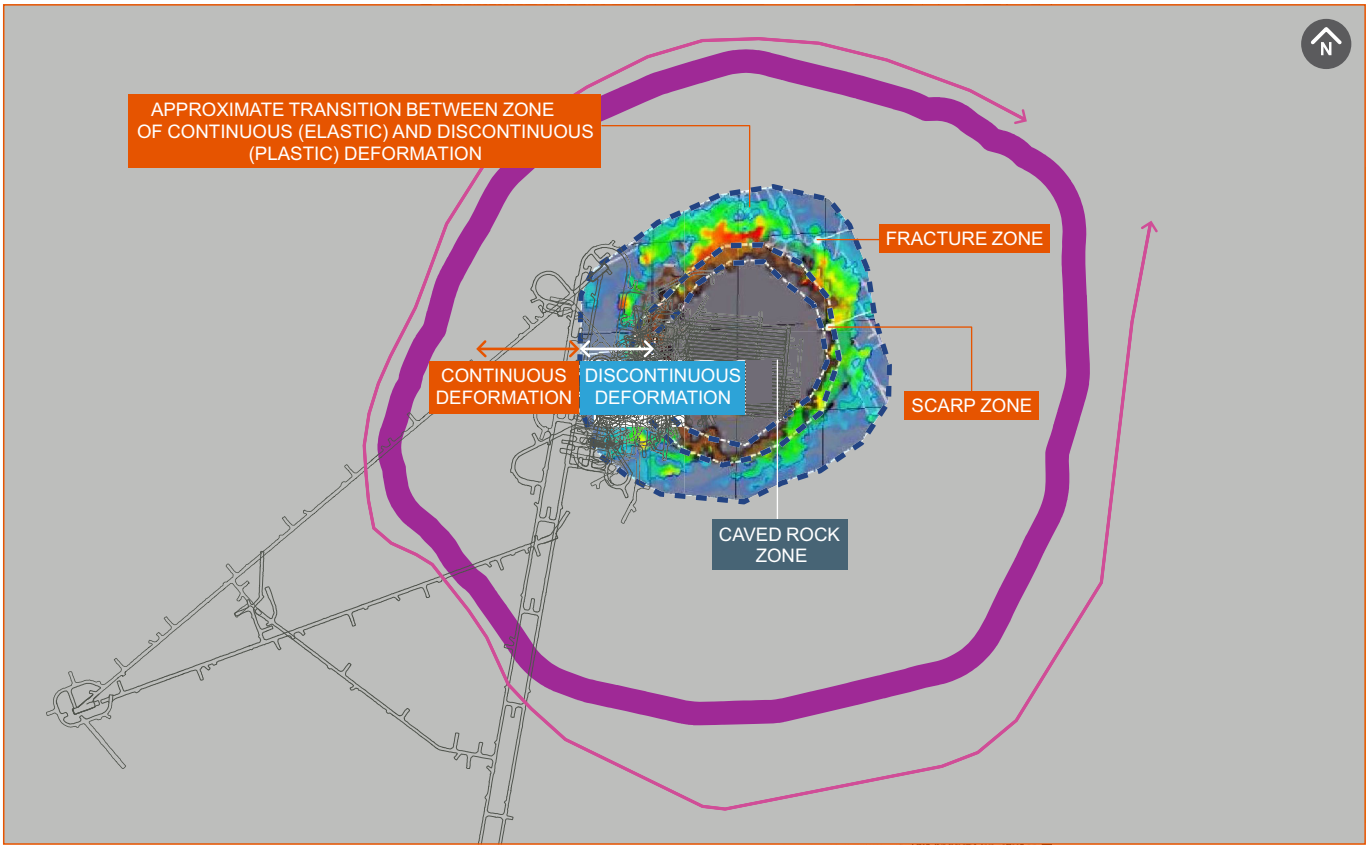
4.8.3.2 Safety bund and abandonment bund

The subsidence zone will remain as an area of potential geotechnical instability and access to it will be controlled to prevent access by people or fauna. In order to limit access to the subsidence zone during operations, a safety bund was established around the subsidence zone operation prior to surface expression of the cave.

Post-closure, an abandonment bund would be established, broadly aligned to the predicted zone of continuous deformation, to limit access to the subsidence zone to ensure the safety of members of the public, livestock and native fauna. The bund will be developed with a suitable stand-off distance to the edge of the fracture zone to ensure its long-term integrity (indicative location provided in Figure 4.19). The abandonment bund, together with excavated drains (used to avoid surface water progressively deteriorating the bund over the longer term), will be used to direct surface water flows around the subsidence zone to eliminate hazards associated with water inflows to the underground workings, including risks associated with mud rush and to reduce the requirements associated with the mine dewatering system.

The abandonment bund has road width openings at a number of locations to enable access to monitoring points during mining. These openings will be gated to restrict access during mining and post-closure monitoring.

The final closure abandonment bund would be constructed in accordance with the Guideline ‘Safety Bund Walls Around Abandoned Open Pit Mines’ (Department of Industry and Resources 1997), which states the bund should be a minimum two metres in height with a base width of five metres, and wherever possible, should be constructed from unweathered, freely draining, end-dumped rockfill. The addition of topsoil to the bund during construction may assist in the recruitment of vegetation that will further assist in the stabilisation of the surface water diversion infrastructure. Following construction of the final abandonment bund and decommissioning of infrastructure and cessation of the mining and processing operations, the surface water management infrastructure would be left to integrate into the environment. Once post-closure monitoring ceases, any openings in the bund would be permanently closed with rock. Signage would be erected to warn of the hazardous conditions inside the bunded area. Post closure, an audit to ensure the abandonment bund design and integrity would be undertaken as a requirement of the Decommissioning and Rehabilitation Plan.



KEY

- Zone boundaries
- Abandonment bund
- Surface water diversion infrastructure
- Tjati underground decline projection

Approximate transition between zones (displacement)

High — Low — Zero

0 — 500 m

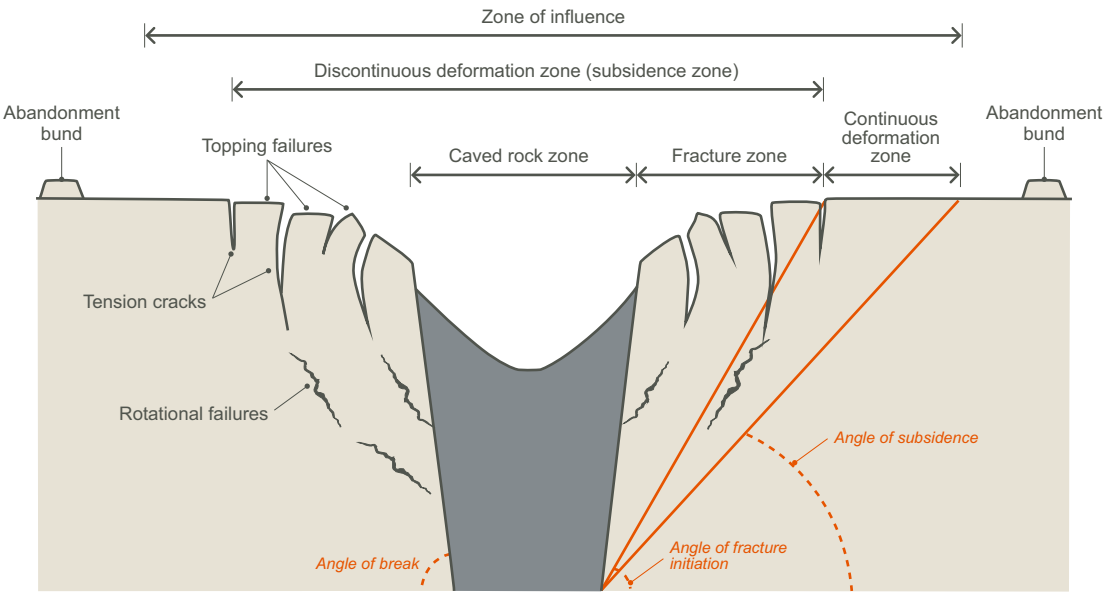


Figure 4.19 | SLC mine surface subsidence zone and abandonment bund

4.8.4 Mine ventilation

The primary design criteria for the ventilation system is that the system would be single pass with no re-use of air. This ensures that fresh uncontaminated air is provided to all active workplaces. An adequate quantity of fresh air must be supplied to the commencement of the drives, and as such, the ventilation system has been designed to provide sufficient airflow in all active drives. Recirculation of exhaust air is avoided because it would lead to an increase in radon decay product (RnDP) concentrations in working areas.

In the event of elevated RnDP concentrations, which could be the result of recirculation, insufficient maintenance of the system or fan failure, the response considers the measured RnDP concentrations. Generally, the area would be restricted access until remedied, however, respiratory protection may be used temporarily. The Radiation Management Plan approved by the South Australian Environment Protection Authority (EPA) under the *Radiation Protection and Control Act 2021* (SA) (RPC Act) and associated Regulations outlines the operational controls implemented and includes monitoring programs, action levels and responses.

4.8.4.1 Primary ventilation

The mine ventilation system includes primary exhaust fans on the surface return air with secondary fans to draw from a fresh air backbone and provide uncontaminated clean air to working areas. Positively pressuring the SLC production levels helps minimise the contamination of radon entering the SLC levels. This approach is used at Telfer mine in Western Australia to manage heat and dust. The primary ventilation system incorporates an exhaust type system with centrifugal fans on the return air raises (RARs). VR1, VR3, VR7 and VR9 provide exhaust for the production and development levels whilst VR5 provides exhaust for the conveyor decline. Vent raises VR2 and VR4, and proposed vent raises VR8 and VR10, provide sources for fresh intake air. The access decline exhausts via the production and development levels.

Installation of primary ventilation infrastructure has been staged to align primary ventilation infrastructure needs with construction and operational activities, while minimising upfront capital expenditure. The current primary ventilation system is shown schematically in Figure 4.20.

4.8.4.2 Secondary ventilation

Workplaces in the mine are ventilated either directly from air from the primary ventilation circuit, or more commonly by a secondary system of smaller fans and rigid and flexible ducts that take fresh air from the primary circuits. The system is designed to provide fresh, uncontaminated air to all workplaces, with contaminated air directed away from workplaces and exhausted. Secondary fans assist in creating positive pressure work locations in the production zone. The fan stations double as a Fresh Air Base to be accessed in the event of an emergency.

A ventilation on demand system actively controls airflow to each of the mining areas and therefore minimise the amount of airflow and power consumption. Features of the secondary ventilation system include:

- fibrecrete lining of ventilation shafts through the upper 20 m of the Arcoona Quartzite
- level development sized to reduce air velocities and minimise airborne water, with precipitated water collected by the mine dewatering system

- automation for remote start-up and monitoring of atmospheric conditions – visible in the central control room.

Secondary ventilation within the SLC production levels is provided as shown in Figure 4.21. This setup shows secondary fans installed in a wall of the fresh air backbone and drawing clean air to the working locations in the cave footprint. Secondary ventilation quantities for SLC levels have been calculated based on equipment requirements as well as a minimum amount to prevent the build-up of radon contamination.

This system results in fresh air being supplied to working locations where people are most likely to be outside of cabs. The secondary air is then returned to the return airways located at either end of the SLC footprint having only been used once in an active working location.

4.8.4.3 Refrigeration

A cooling plant capable of delivering 21 MW(R) of cooling power cools working areas of the mine as required due to the heating effect associated with adiabatic compression.

The Carrapateena refrigeration plant is a bulk air cooler facility located approximately 3.2 km north of the non-process infrastructure area and contains approximately 7,000 L of anhydrous ammonia (NH_3) and an additional 4,400 L of Lubrizol CP-1009-68 mineral oil in total, split evening into two refrigeration trains. The plant is powered by an 11,000 volt (V) substation located adjacent to the main building and consists of four structures: a condenser bank, a refrigeration plant and chilled water tanks, the electrical substation and the bulk air cooler (BAC) system containing the fresh air raise bore VR4.

The ammonia refrigeration system is designed as an indirect cooling system and consists of a complete screw compressor driven refrigeration circuit with air cooled condensers and plate type evaporators. The refrigeration circuit takes off heat from a separate chilled water circuit which cools air through closed type BACs. Cooling coils, which are water/air heat exchangers, are installed in the BACs at the mine air intake shaft with warm ambient air drawn through the cooling coils, and the air temperature reducing as the air passes through the coils. The chilled air then enters the mine shaft, provided cooling to the mine. The cooling coils contain chilled water, and the water circuit is a closed loop system.

Additionally, transportable air refrigeration units are used for spot cooling of specific underground development faces as necessary.

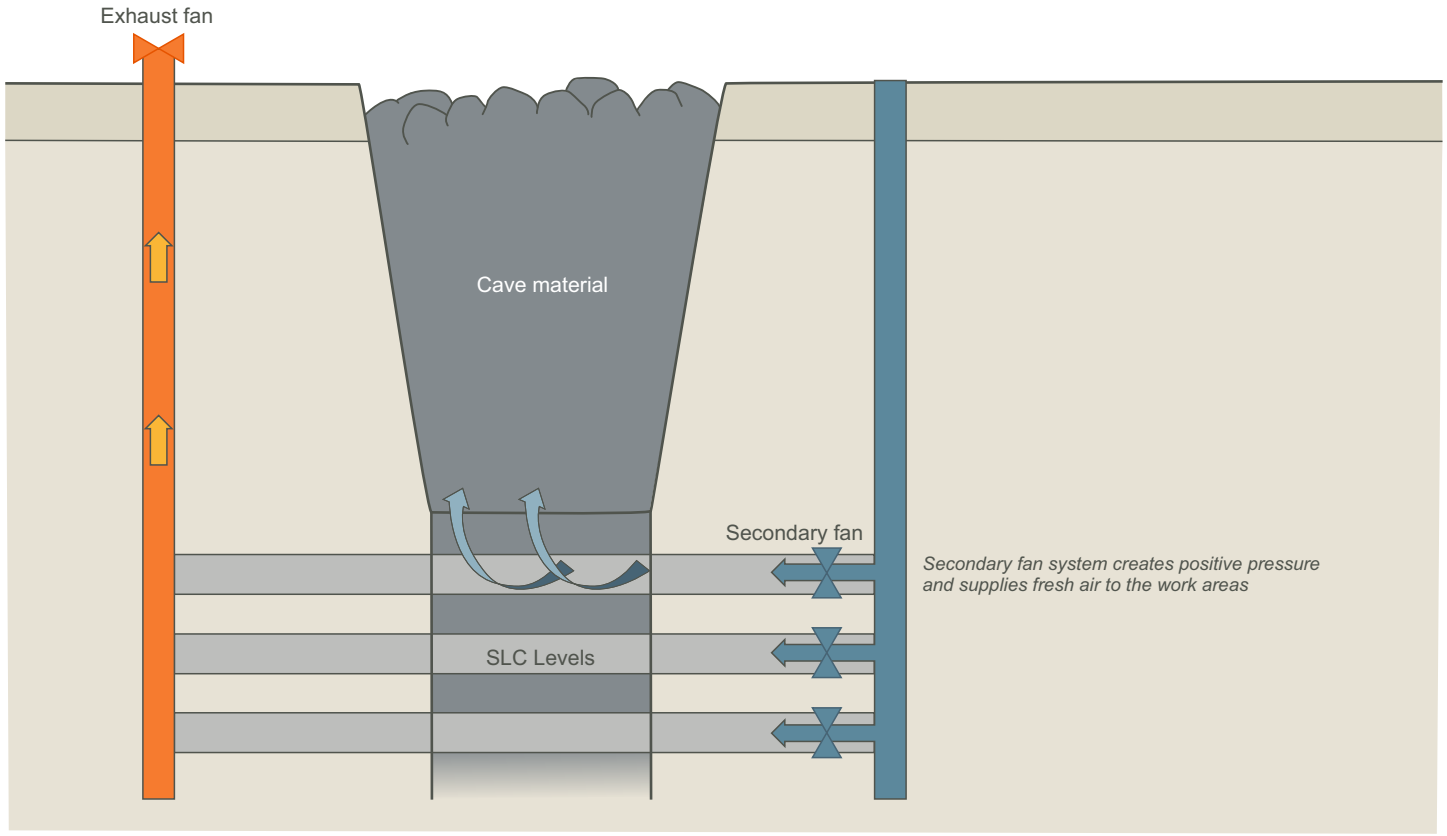


Figure 4.20 | Schematic mine primary ventilation cross-section

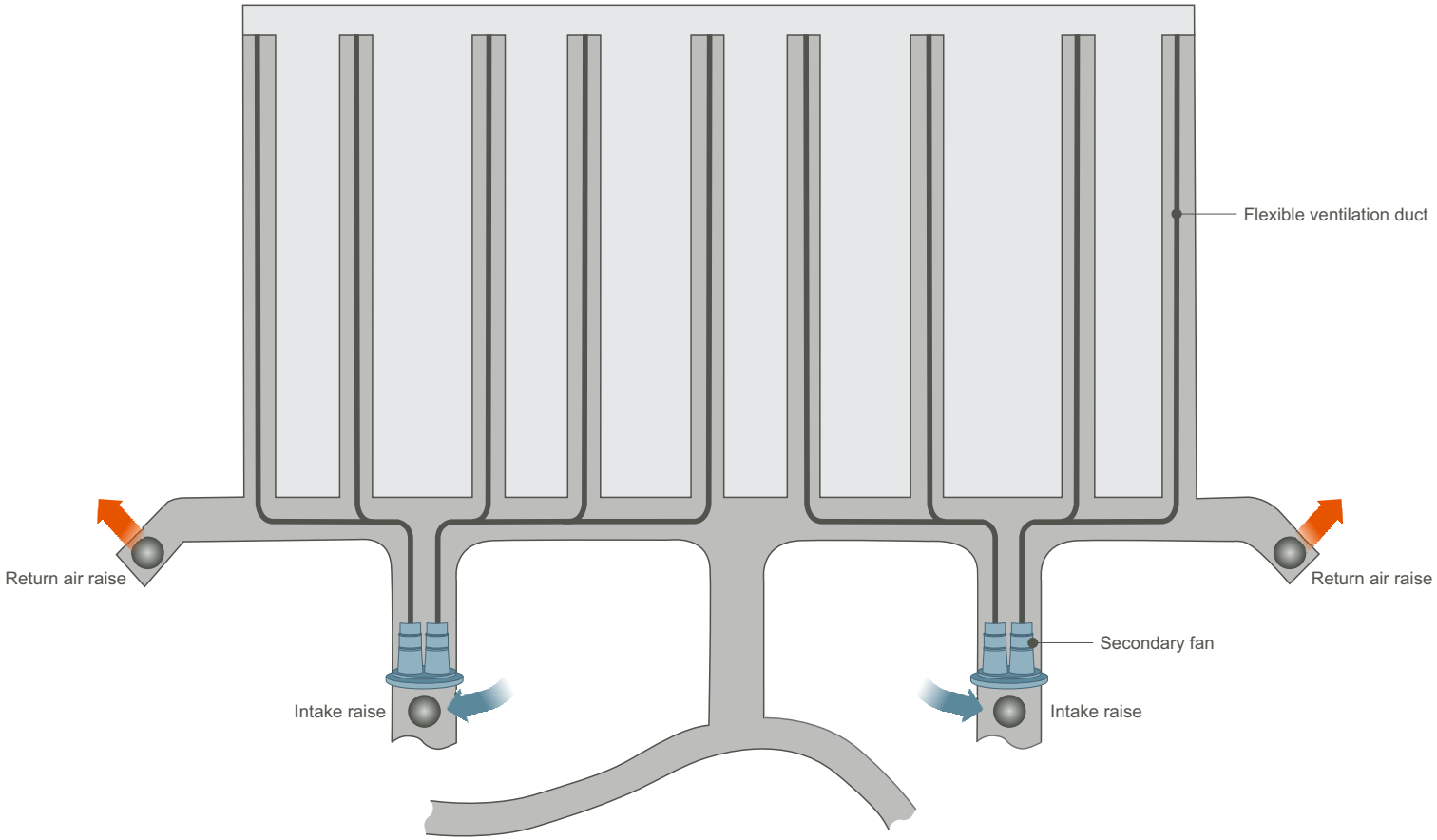


Figure 4.21 | Schematic mine secondary ventilation layout

4.8.5 Mine water management

4.8.5.1 Mine dewatering

Mining activities extend below the water table and subsequently, groundwater inflows occur into the underground workings. During mining activities undertaken to date, groundwater inflows to the underground workings from the THA and Whyalla Sandstone Aquifer (WSA) have been in the order of 1.5 to 1.8 ML/d, primarily from the ventilation raises. Minor volumes of stormwater also flow into the underground workings with volumes reduced through diversion infrastructure around the subsidence zone.

Dewatering requirements for the start of production have been based on a maximum requirement of up to 90 L/s, and an average requirement of 25 L/s. On each sublevel of the mine, water drains from the production and perimeter drives towards the dewatering mining sumps. A borehole connects the mining sumps on each level to the level below. The sump on RL4505 contains submersible pumps which pump water to the RL4505 Pre-Screen Facility. Water pumped from the conveyor and access declines is also pumped to the RL4505 Pre-Screen Facility. Additional incoming pipelines are available to the collection box for future expansion.

Within the RL4505 Pre-Screen Facility, the dirty water is screened via two trommel screens. This is the primary protection to the primary dewatering pumps in the pump station. Rejects from the trommel screens report to trash bins for collection. The trommel screens discharge into a vertical dam of approximately 4 m diameter. An agitation pump prevents settling within the dam.

Positive displacement diaphragm pumps in a duty/standby arrangement pump the mine water to the surface via two rising mains. The rising mains discharge into the surface settling ponds. Sediment settles to the base of these ponds, with clean water overflowing into the secondary pond. Clean water is then pumped to the process plant to be processed by the oily water separator.

The collected mine water has total dissolved solids (TDS) of 68,500 mg/L, salinity of 78,300 microsiemens per centimetre (µS/cm) and pH of 7.65 and is used for dust suppression and construction water.

4.8.5.2 Mine water supply

Water supply requirements for the underground operation are based on the peak mining requirements, such as mobile equipment and dust suppression, as well as water requirements for underground infrastructure such as the material handling system.

Potable water is fed from the surface or may, as required, be transported underground in pods to crib rooms and ablution facilities and is also used for fire suppression systems on the material handling system and within the permanent underground magazine.

Mine water is pumped from the underground decline and sent to the mine settling ponds located east of the portal. The settling ponds are lined using 1.5 mm thick HDPE liners. Settled recycled water will be directed into the raw water supply tanks for the decline, located immediately east of the portal. Excess flows may be directed to the MPP permanent settling pond. To prevent over-topping in the event of high-intensity rainfall events, or other abnormal situations that may result in the process water dam reaching capacity, water may be transferred to the site surface water sedimentation ponds via drainage channels for management prior to discharge into existing watercourses. Further information about the design of surface water storages can be found in Section 4.12.6.

During operations, the mine water supply operates a closed system with all water collected, settled out and recycled back underground for re-use. Water tanks on the surface supply water underground through water droppers. The underground reticulation comprises nominal 100 mm HDPE pipe in combination with underground break tanks and pressure reducers to control the head pressure.

4.8.5.3 Excess mine water infrastructure and management

During construction and early phase operations, mine water in excess of dust suppression and construction requirements was managed via transfer to a temporary TSF sprinkler bed to facilitate evaporation. The TSF sprinkler bed has been decommissioned.

As a contingency option, BHP also obtained approval to establish injection wells IS1 (0.3 ML/d), IS2 (0.1 ML/d), IS4 (0.1 ML/d) and RP2 (0.3 ML/d) to manage additional excess water, with water transferred via pipeline under gravity feed to the injection wells. The three injection wells have not been commissioned at this time.

Any excess mine water generated during operations will go to the MPP permanent settling pond and hydrocarbon interceptor, before overflowing into the process water pond for re-use.

4.8.5.4 Surface water management

The subsidence zone is within the Eliza Creek catchment, which is described further in Chapter 6. For safety reasons the surface water is diverted around the subsidence zone to minimise water inflows to the underground workings and avoid post-closure degradation of the abandonment bund. This occurs via a network of containment and diversion drains consisting of unlined excavations and bunding. Drains are approximately 4.0 m wide by 0.5 m deep, with a wall angle of approximately 30 degrees, for a total flow area of approximately 2.3 m^2. The location of the bunds/drains are indicatively shown in Figure 4.22. Topsoils and subsoils removed from the mine area borrow pit (see Section 4.11.5.1) are used, together with mined waste rock, to create the subsidence zone abandonment bund and surface water diversion infrastructure. Diversion of water runoff from disturbed areas is described in Section 4.12.6, and the capture and management of sediment from stockpiles is described in 4.11.4.

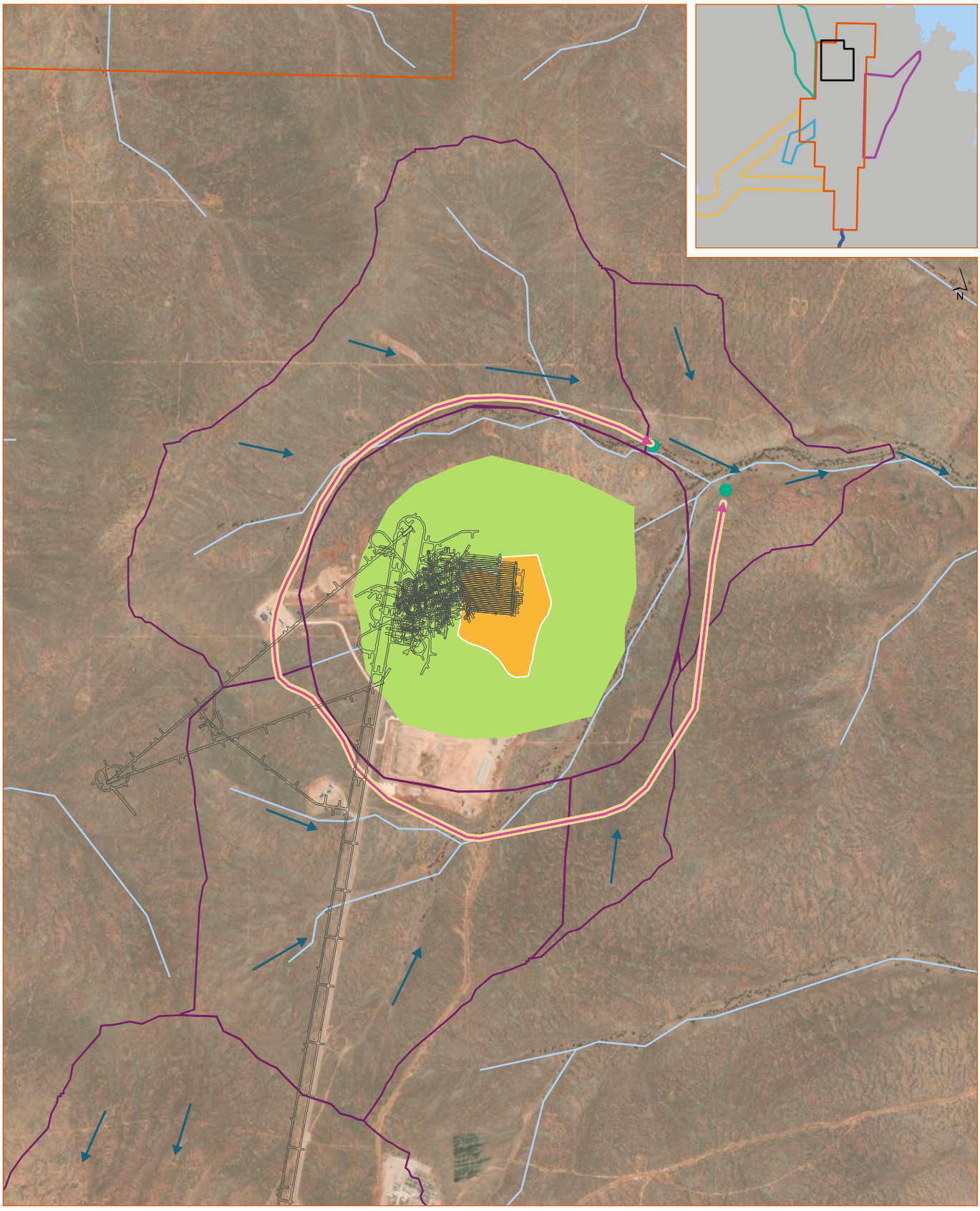


Figure 4.22 | Mine area surface water management infrastructure

Carrapateena BHP

4.8.6 Underground supporting infrastructure

4.8.6.1 Electrical and communications

The mine's electrical requirements are provided by the installation of an 11 kV ring main, which utilises the main or conveyor declines as well as a services hole to surface. This establishes power to the infrastructure and mining operational areas underground. Substations are installed as required for permanent infrastructure and will be progressively moved for mining operations as it continues to depth. Power would then be stepped down using transformers and reticulated through the mine at either 1,000 V, 690 V or 440 V, depending on the intended duty.

Communications within the mine includes a fibre optics backbone for communication to, and control of, underground infrastructure and future technology requirements, including automation. This fibre optic circuit will be established as a ring main to ensure continuity of communication. Within working areas, a leaky feeder system is installed to support the use of digital radio within the mine.

A digital radio system is installed within the mine, with leaky feeder cabling provided throughout the mine. All mobile fleet is fitted with a cabin-mounted digital radio unit. Personnel actively working outside of mobile equipment have access to a hand-held digital radio.

4.8.6.2 Compressed air

Compressed air is included for the workshops where a stand-alone high-pressure unit (HPU) is provided for general workshop tools and inflating tyres. Compressed air for use on mobile equipment, such as shotcrete spraying rigs, is supplied with air compressors feeding a pressurised airline leading into operational areas. Refuge chambers are also supplied low pressure fresh clean air.

4.8.6.3 Workshops

The mine design consists of a single major workshop situated below the Crusher 2 (CS02) installation. Light vehicles and trucks are serviced and maintained in the surface workshops. Major overhauls of underground equipment, such as 2,000-hour services, are also performed in the surface workshops.

4.8.6.4 Crib rooms and offices

An underground office, crib room and ablutions facilities are provided at the crusher tip horizon. The crib room provides crib facilities for all personnel underground during the shift, and includes potable water, ice machine, fridges, pie oven and microwave. Male and female ablution facilities are provided. Sewerage is pumped from the ablution tanks and subsequently brought to the surface for treatment in the site wastewater treatment plant (WWTP), located at the Tjungu Village on MPL 149.

Underground offices allow pre-shift and end-of-shift changeovers to be performed as well as on-shift training.

4.8.6.5 Technology and automation

The BHP strategy is to be early adopters of automation and technology. The business case for automation is measurable improvement in safety, productivity and efficiency. The operation will look to build on an innovative culture when implementing technology and automation.

Carrapateena has focussed on the system capability, equipment selection, operational and implementation aspects, and concluded that mining automation is feasible and practical, with other mines having successfully implemented a range of systems. Automation will not be the sole focus, but rather the value-add that can be obtained by prudent and timely application of automation technologies to a well set up and effectively managed underground mining operation. This will see the mine be an early adopter of technology and automation where it adds value to the operation as opposed to installing maximum upfront functionality.

A fully owned, robust, generic and independent (i.e. open source) communication network backbone will be installed in the mine. This will allow BHP to maximise optionality and enable a staged approach to add new functionality. This staged plan is linked to technology installed during the pre-production project phase of Carrapateena, as well as the automation of key mining functions during appropriate production and operational phases within the mining operations. Short interval control and shift planning are integrated into the mine control system.

Collection of equipment, cave and location performance data, such as availability, utilisation, delays and productivity, enables analysis and improvement through operational excellence processes. Collection of data in the mine will progress from manual to semi-automated to fully automated and increase the quantity of information stored over time.

4.8.6.6 Mining plant and equipment

The peak surface fixed plant and mobile fleet associated with the mining operations are summarised in Table 4.21. Apart from the surface fixed plant, the majority of the listed equipment and associated activities are conducted within the underground mine. As such, noise, dust and emissions sources are typical for underground mining operations and are effectively contained within the underground workings and are not visible or audible at the surface. Equipment meets exhaust air quality standards and is maintained and serviced in accordance with manufacturer's recommendations and/or in accordance with site procedures.

Fire ignition sources may include electrical faults in fans, refrigeration plant and other mining equipment on surface, and fire on diesel equipment while on surface. Ignition sources are managed in accordance with any permits and requirements of the *Fire and Emergency Services Act 2005* (SA).

Table 4.21 | Mining plant and equipment

Category	Equipment	Type/capacity	Number*
Surface fixed plant	Surface ventilation fans	Twin horizontal or equivalent	5
	Underground paste fill plant	Specific, purpose designed	1
Underground fixed plant	Compressor	Atlas Copco (1,000 V, 10 bar) or equivalent	2
	Lighting plants	As required	6
	Underground pump station	Purpose designed	4
	Secondary ventilation fans	Vertical or equivalent	18

Category	Equipment	Type/capacity	Number*
	Substations	0.5–1.5 megavolt-amperes (MVA)	4
	Crushers	Jaw and gyratory	3
Drilling equipment	Jumbo	Sandvik DD421-60C or equivalent	9
	Production rigs	Sandvik DL421-15C or equivalent	
	Cable bolter	Sandvik DS421 or equivalent	
Loaders	Loaders	Sandvik LH621 (21 t) or equivalent	13
Haulage trucks	Trucks	Sandvik TH663 (63 t) or equivalent	14
Charge-up equipment	Charge vehicles	Normet Charmec MC 605D or equivalent	3
Auxiliary equipment	Integrated tool carriers	Caterpillar 930 M or equivalent	10
	Graders	Caterpillar 12 M or equivalent	
	Water cart	Normet LF600 or equivalent	
	Service trucks	Normet MF100 or equivalent	
Shotcrete equipment	Concrete agitator trucks	Normet LF700 (7 m^3) or equivalent	9
	Fibrecrete machine	Normet MF050D or equivalent	
Miscellaneous	Light vehicles	Toyota Landcruiser or equivalent	15
	Raise bore machine	As required	1

* Number refers to average fleet number of the LOM

4.8.7 Explosives management

4.8.7.1 Explosives demand

The average decline development rate over the mine life would be between 6 and 8 km per year, equating to approximately six development blasts per day. Development explosive requirements are detailed in Table 4.22. Underground development blasting occurs as required (approximately once every 12-hour shift). Blasting may also occur on an as-needs basis in areas that are isolated from the rest of the operations and where ventilation reports directly to exhaust airways.

The underground operation uses ANE as well as pre-packaged products, such as stope primers and emulsion-type explosives for priming and perimeter charging. Approximately 1,300 t of Amex is used per annum for combined operations of development and production. For production blasting, the explosives demand is detailed in Table 4.23. Underground production blasting occurs on an as-needed basis during designated firing times. Production blasting occurs about four times per week with approximately 6,000 t of ore per blast.

Table 4.22 | Typical development explosives demand per blast

Explosive	Demand (per blast)	
	3.0 m blast	4.0 m blast
Ammonium nitrate-fuel oil (ANFO)	170 kg	233 kg
ANFO (low density)	78 kg	106 kg
Detonating cord	0.3 kg	0.3 kg

Explosive	Demand (per blast)	
	3.0 m blast	4.0 m blast
Non-electric detonators	62	62
Electric detonators	2	2
Packaged emulsion (32 mm x 700 mm)	22 kg	30 kg
Packaged emulsion (32 mm x 200 mm)	11 kg	11 kg

Table 4.23 | Typical production explosives demand

Explosive	Demand (per blast)	
	SLC ring blast	SLC slot blast
Emulsion	1,260 kg	3,383 kg
Detonating cord	0.3 kg	0.3 kg
Non-electric detonators	16	38
Electric detonators	2	2
Primers	4 kg	10 kg

4.8.7.2 Explosives magazines

Under previous RL 127, a combined surface explosive magazine was constructed to store up to 40 t of ANFO and high explosives (HE) and up to 320 kg of detonators (equivalent to 20,000 units) under Magazine Licence No. 623886. A revised Magazine Licence (No. 675245) for the surface explosive magazine was issued in June 2019, permitting the storage of up to 10 t of packaged Class 1 explosives (ANFO and HE). This facility is sufficient to support the Tjati Decline mine access development and additional underground development.

The explosive storage facilities have been designed and located in accordance with AS2187.1 and the required separation distances are illustrated in Figure 4.23. As the facilities are housing both Class 1 and Class 2 explosives, the separation distances for both are shown. There are no proximal defined ‘vulnerable facilities’, however this separation distance is also displayed.

The magazine compounds are managed by a licensed contractor, and meet the requirements of the relevant Australian Standards, with features including:

- specifically designed and fabricated explosives magazines
- dedicated access roads
- exclusion fencing and lockable gates
- appropriately signed vehicles and signage.

Additional storage is provided for the management of related oxidising agents, with that storage facility licensed to store bulk emulsion (270 t) and ammonium nitrate (AN) (120 t) plus other support chemicals.

Prior to use, explosives for underground production and development blasting are stored in an underground magazine (under Licence No. 741074) licenced to store up to 5 t of packaged HE and 160 kg of detonators.

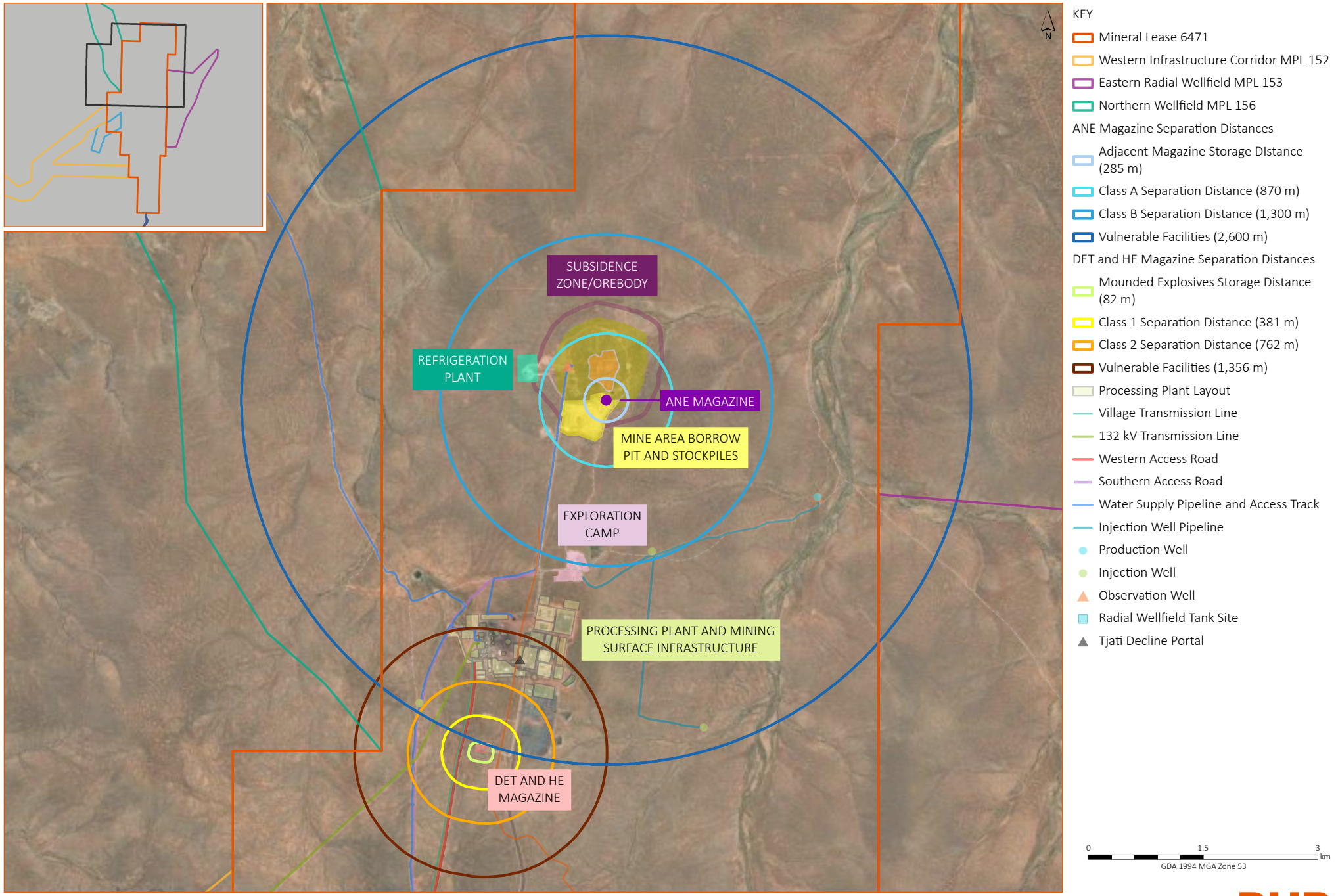


Figure 4.23 | Explosives magazine location and separation distances to infrastructure

Carrapateena BHP

4.8.8 Mine operations

Mine operations are informed by a number of key documents, including:

- Mine Production Management Plan
- Cave Monitoring Plan.

These documents are summarised in the following sections.

4.8.8.1 Production Management Plan

A Production Management Plan (PMP) has been written to establish the operating guidelines and parameters for SLC mining operations. The PMP covers the planning and operating aspects of level and crosscut development, production drilling and blasting, and drawpoint extraction. Consideration has been given to the initial cave propagation and steady state caving.

The PMP covers activities required to measure performance and assigns responsibilities and authority levels to key mining personnel. The PMP specifically addresses mud rushes (identified as a key threat to the Carrapateena SLC). The mud rush risk can be controlled by limiting water runoff into the caved zone and by adhering to the controls covering the operating aspects of the SLC set out in the PMP and associated Trigger Action Response Plans (TARPs).

The PMP is a starting point for the mine and will remain a live document that will improve over time as the understanding of Carrapateena-specific cave flow increases, production strategy changes or as new technologies become available.

4.8.8.2 Cave Hazard Management Plan

When implementing a caving-based mining method such as SLC there exists some uncertainty with respect to what is happening within the cave as a result of not being able to directly observe the response to mining operations. Flow models are used to estimate the cave performance to manage this uncertainty.

The purpose of the Cave Hazard Management Plan is to define cave monitoring policies and procedures for specific scenarios to establish trigger points for corrective actions, especially in relation to major hazard management. A key component of the Cave Hazard Management Plan is a series of TARPs to enable the operational team to have planned responses to possible cave or geotechnical events.

The two specific scenarios requiring monitoring are:

- The initial propagation of the cave including the caving of the ~470 m of overlaying barren sedimentary cover through to surface (now completed).
- The cave flow during steady state operation.

The monitoring of the cave propagation is important to:

- Avoid the development of an extensive air gap between the cave back and the extraction point which creates a severe air blast threat.
- Understand the timing and location of the subsidence breakthrough to the surface and the damage that may occur to surface infrastructure located too close to the subsidence zone. Timing of breakthrough to surface also determined the timing for diversion drains and the abandonment bunds around the subsidence zone.

- Understand if the cave flow is performing as expected, particularly understanding the width and depth of draw and its impact on the height of draw for the first production levels. Understanding cave flow is important in predicting future grade and metal performance from the mine.

Monitoring the cave during steady state operation is important to reconcile the cave flow modelling used to determine draw strategy and to schedule production outputs. The pre-production activities listed in the previous section will include the necessary infrastructure required for cave monitoring, such as a seismic system and extensometers in the cover sequence, as well as a cave marker program.

The Cave Hazard Management Plan has appraised a variety of monitoring methods and recommends specific methods that would be suitable for monitoring specified issues. As with the PMP, the Cave Hazard Management Plan will be a live document and will be updated as the SLC progresses through the LOM.

4.9 Description of the minerals processing operations

This section describes the minerals processing methods that are part of the Carrapateena operation and provides a summary of the major processing stages. The layout of the Carrapateena processing activities is shown in Figure 4.24 and a process flow diagram is presented in Figure 4.25.

The MPP is located to the west of the Tjati Decline box cuts and portals constructed under previous RL 127, and to the south-south-west of the orebody on a relatively flat area of land (see Figure 4.2).

4.9.1 Key elements

A description of the key MPP elements is presented in Table 4.24. These elements have been subject to impact and risk assessments as presented in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 4.25 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators as provided in Chapter 7.

Table 4.24 | Processing key project elements

Key element	Summary
Product	Copper, gold and silver in concentrate
Production rate	6.9 Mtpa ROM ore throughput. Annual average of ~65,000 to 75,000 tonnes copper and ~90,000 to 120,000 ounces gold per year
Comminution	SAG mill, ball mill and pebble crushing
Flotation	Rougher flotation followed by three-stage cleaning, including the addition of hydrofloat to reduce primary grind requirements and increase throughput
Concentrate treatment	Concentrate thickening, filtration and washing

Table 4.25 | Processing Impact IDs, design and management controls and uncertainty

Processing
Carrapateena Impact IDs[1]
AQ01, AQ02, AQ03, AQ04, AQ05, AQ06*, AQ07*, AQ08, AQ31, AQ32, AQ33, AQ34, AQ35, AQ37*, AQ38, AQ47, AQ48, AQ49 and AQ51
Design controls
• Enclosure of concentrate storage and handling facilities • Use of sealed containers for copper concentrate transport
Management controls

• Dust suppression at conveyor transfer points
• Dust suppression on surface crushing operations
• Dust suppression water sprays on coarse ore stockpile (COS)
• Implementing a copper concentrate transport container maintenance and monitoring program that includes:
  ○ Regular visual inspection of the containers, including sealing of the lids
  ○ Container filling procedures, with appropriate training and supervision for personnel involved in this task and the use of weighing/loading information to inform loading activities
  ○ Monitoring of the concentrate moisture content via the process control system (PCS) and on-going sampling prior to shipment

* Non-Outcome or Outcome-based lease condition proposed

(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

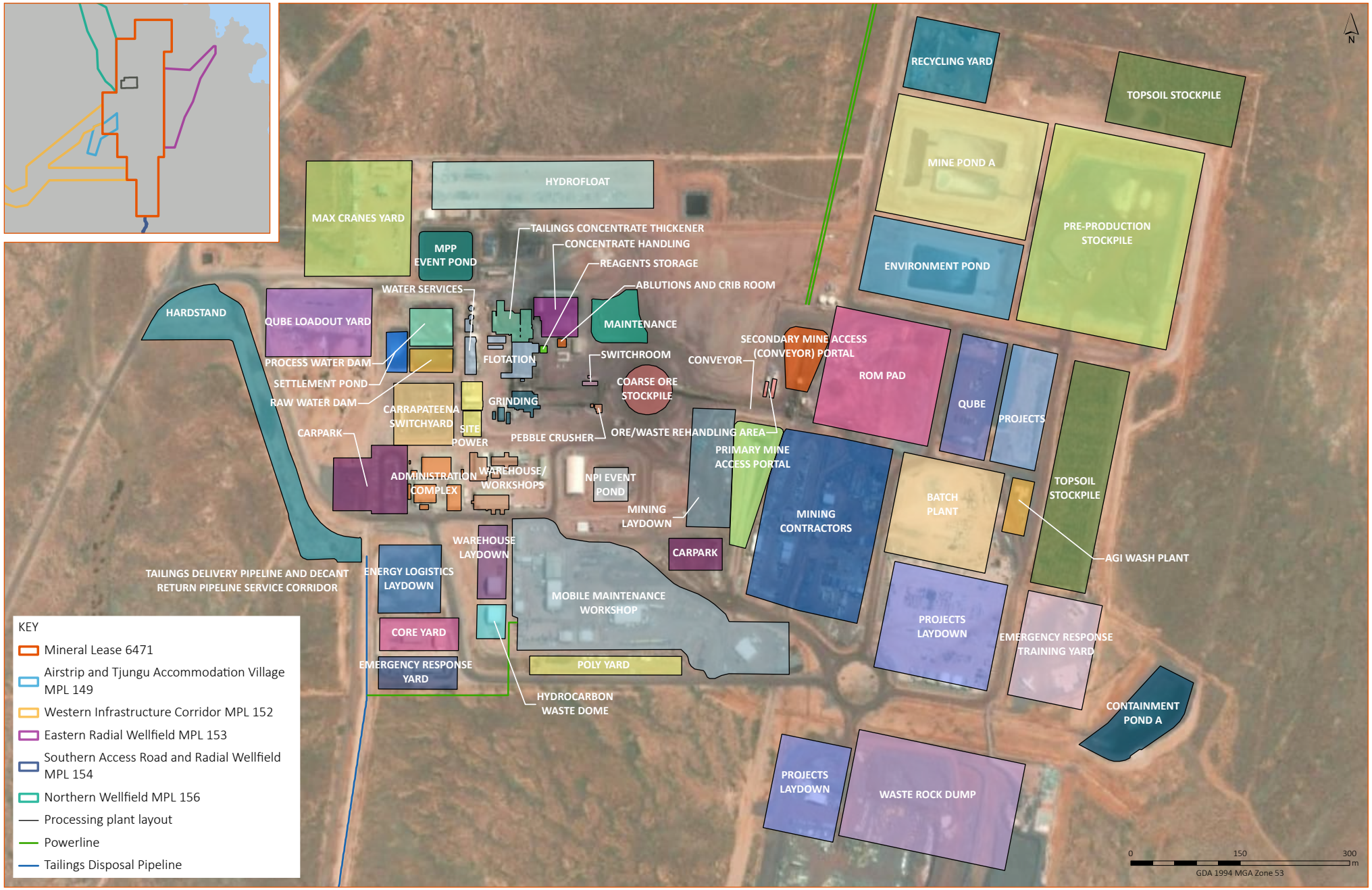


Figure 4.24 | Minerals processing plant operational area

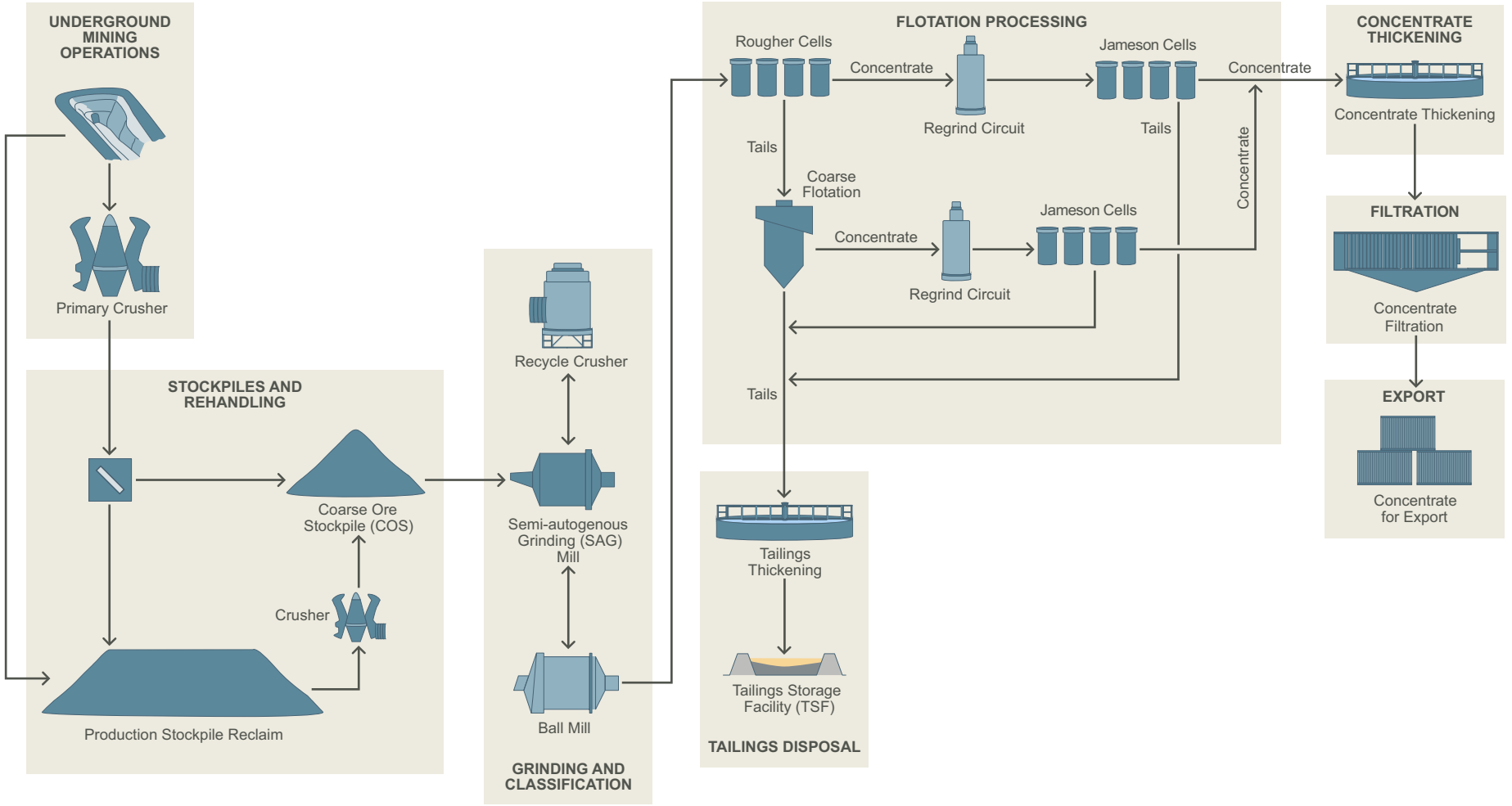


Figure 4.25 | Ore processing process flow diagram

4.9.2 Minerals processing plant design

The design life for the MPP facilities is 20+ years. The design philosophy employed has been to meet the required design criteria (Table 4.26), provide adequate access for operator, clean-up and maintenance activities whilst minimising the overall land disturbance footprint and plant heights.

Table 4.26 | MPP engineering design basis

Aspect	Design basis
Civil and structural	The MPP has been laid out to reduce capital costs and provide good accessibility. Areas where spillages may occur have been bunded, with floors sloped to a nearby blind sump fitted with pumps to allow reclaim of spilled material.
Mechanical	Mechanical equipment selection, layout and design were performed in accordance with Australian Standards and standard industry practice. Mechanical equipment was selected appropriate for the duty and from reputable suppliers. Where a supplier provides similar equipment to that existing at Prominent Hill mine, that same supplier has been nominated as a potential supplier of new equipment with the plan to rationalise spares where possible. The dry plant equipment was designed and selected to provide a balance between capital cost, operability and maintenance. Conveyors were designed to minimise spillage, with drive size, taking into account normal operating and adverse start-up conditions. In the design and layout of transfer chutes, bins and hoppers in the crushing circuit, consideration has been given to minimising wear and to protecting any receiving equipment from unnecessary loads and wear. Bins and hoppers were fabricated from 8 mm plate and transfer chutes from 6 mm plate. All wear liners were nominated to be 10 mm thick.
Piping	Piping and associated fittings and valves were selected and designed in accordance with Australian Standards and standard industry practice. Pipe sizes were selected based upon liquid velocity to minimise capital costs and provide sufficient velocity to suspend particles.
Electrical	Consideration was given to using identical or compatible equipment and components to those currently used at Prominent Hill mine, to maintain commonality of spare parts. New motor control centres (MCCs) comply with current Prominent Hill mine site standards, incorporating features such as arc containment. A control system similar in architecture to Prominent Hill mine was adopted. The final design may incorporate mobile technology, such as tablet personal computer (PC) control and monitoring.

4.9.3 Ore processing

Ore processing at Carrapateena incorporates the following processing stages:

- conveying, stockpiling and reclaiming of crushed ore
- grinding in an SABC (SAG mill, ball mill and pebble crusher) in closed circuit with cyclones producing a grind size P80 of 75 µm
- recovery in a flotation, hydrofloat and regrind circuit
- thickening and filtering of the concentrate
- stockpiling of the filtered concentrate in the concentrate storage shed prior to placement in containers for storage and load-out
- thickening of tailings in a high-rate thickener and pumping to the TSF.

These are described in the following sections.

4.9.3.1 Surface crushing

The purpose of the production stockpile (see Section 4.11.4.1) was to provide storage of development ore extracted from the mining operation prior to the commissioning of the MPP. Upon the commissioning of the MPP, uncrushed material stored on the production stockpile was crushed in a temporary crusher and directed to the COS prior to processing.

No surface crushing is undertaken at the present time, however there remains the possibility this may be required in future and it remains within the scope of this PEPR.

4.9.3.2 Coarse ore handling

Following commissioning of the underground crushing and conveying system, crushed ore is transferred from the underground crushing and conveying system and discharged onto either the COS feed conveyor or diverted via transfer chute to a transfer conveyor and bunker area, for temporary storage in the production stockpile.

Ore from the COS is reclaimed via two apron feeders to the SAG mill feed conveyor feeding the MPP grinding circuit.

4.9.3.3 SAG mill grinding

The grinding circuit consists of a SAG mill with crushing and recycling of SAG mill pebbles, and a ball mill operating in closed circuit with cyclones to produce a product with a P80 of 75 µm, providing the optimum balance of grinding power and recovery.

The SAG mill is a trunnion-mounted grate discharge mill with 8.5 m diameter (inside shell) and an effective grinding length (EGL) of 4.57 m. The mill is driven by a single 7.0 MW variable speed drive arrangement. The SAG mill circuit has provision to operate with a return slurry bleed stream from the Cyclone cluster.

SAG mill product is screened on a horizontal vibrating screen with the oversize reporting to the pebble crushing circuit. The pebble crushing circuit consists of a self-cleaning tramp magnet and metal detector for crusher protection followed by a surge bin and vibrating feeder to allow the pebble crusher to be choke fed. The coarse cavity, short-head pebble crusher is fitted with a 220 kilowatt (kW) drive, targeting a product P80 of 13 mm with product returning to the SAG mill feed conveyor for recycle back to the SAG mill.

4.9.3.4 Ball mill and classification

Undersize from the SAG mill discharge screen is combined with ball mill discharge and process water for density control in the mill discharge hopper. One of two (duty/standby) pumps feeds the cyclone cluster, consisting of eleven 500 mm diameter cyclones (eight operating, two standby and one blank outlet) to produce a product size of 80% passing 75 to 90 microns. Cyclone overflow gravitates to the trash screen and the cyclone underflow reports by gravity to the ball mill.

The ball mill is a trunnion-mounted overflow type ball mill with a 6.71 m diameter (inside shell) and an EGL of 10.97 m and is fitted with a trommel screen. The mill is driven by dual 4.75 MW variable speed motors. The ball mill operates in closed circuit with the cyclone cluster. Ball mill product gravitates to the mill discharge hopper.

4.9.3.5 Grind circuit rougher and rougher flotation

Rougher flotation

Trash screen underflow slurry gravity flows to the flotation conditioning tank where it is combined with reagents before feeding into the flotation circuit. Recovery of the copper and gold into the flotation concentrate is achieved through rougher flotation, rougher concentrate regrinding followed by a Jameson cell and three stages of cleaning. Reagents are introduced at strategic locations and the main flotation streams are analysed by the on-stream analyser (OSA).

Recovery of the copper and gold into the flotation concentrate is achieved through rougher flotation, then rougher concentrate regrinding to 20 µm followed by three stages of cleaning and cleaner scavenging. The cleaner process flow diagram has been selected to maximise recovery whilst ensuring effective removal of uranium and fluorine from concentrate at a reasonable cost. Reagents are introduced at strategic locations and the main flotation streams are analysed by the OSA. The final concentrate mass recovery, grade and metal recovery varies depending on the dominant copper mineral in the feed.

The rougher flotation circuit consists of five 130 m^3 capacity flotation tank cells arranged in series with a nominal residence time of approximately 30 minutes. Tailings from each cell gravitates through dual dart plugs into the next cell and finally to the flotation tailings hopper. Concentrate from the five rougher cells gravitates, with the assistance of spray water, into the rougher concentrate hopper. The concentrate is then pumped to the regrind circuit.

CiDRA process

Carrapateena is trialling the CiDRA Minerals Processing Inc. (CiDRA) coarse particle separation process with the aim of increasing the MPP throughput by relaxing the primary grind size. The CiDRA process treats the whole MPP tails, including both rougher and cleaner tails via a proprietary coarse particle recovery unit operation which is capable of directly handling the entire size distribution of the incoming tails stream. This recovery technology has very high selectivity such that the resultant mass recovery is as low as 1% to 3% with a concentrate grade equal or greater than the rougher flotation concentrate grade. This coarse particle recovery stream is subsequently directed to the regrind circuit for further processing as per the existing MPP flowsheet. The trial plant would process up to 5 t/day with the material subsequently returned to the existing MPP.

Subject to the outcomes of trials, BHP may implement the CiDRA process within the Carrapateena MPP process flowsheet.

4.9.3.6 Regrind

The regrind circuit consists of eleven 150 mm cyclones (nine operating and two standby), to produce a product size of 80% passing 20 microns. Overflow reports to the regrind mill discharge hopper and the undersize is reground in one of two open circuit 1,600 kW HIG mills. The regrind mill discharge is pumped to the Jameson recirculation hopper. The Jameson cell produces a final concentrate with a high overall copper and gold recovery. Tailings from the Jameson tailings hopper are pumped to Cleaner 1.

4.9.3.7 Coarse flotation

Reducing the volume of material requiring regrind, BHP proposed to apply the hydrofloat process for the treatment of a portion of the rougher flotation tails stream. The hydrofloat process significantly increases the selective recovery of coarse particles by applying flotation fundamentals to gravity separation. In the Hydrofloat process, air bubbles are dispersed by the fluidisation system, percolate through the system and attach to the hydrophobic mineral, altering its density and rendering it sufficiently buoyant to float and be recovered. The use of the dense phase, fluidized bed eliminates axial mixing, increases coarse particle residence time and improves the flotation rate through enhanced bubble-particle interactions. As a result, the rate of recovery is high for both fully-liberated and semi-liberated particles.

At Carrapateena, the hydrofloat process would be fed from the rougher flotation tailings stream and has been demonstrated to have the potential to recover copper from coarse particles within the rougher flotation feed which is otherwise unobtainable from the existing rougher flotation process.

The application of hydrofloat has the potential to enable higher plant throughputs through a relaxation of primary grind size from the current P80 of 75 µm to a coarser P80 of 106 to 150 µm.

4.9.3.8 Cleaner flotation

Cleaner 1 consists of a Jameson cell and three 50 m³ tank flotation cells in series in a 3+3 configuration with three Cleaner Scavenger 50 m³ tank flotation cells in series to provide a nominal total residence time of 30 minutes.

Tailings from the Cleaner 1 cells gravitates into the Cleaner Scavenger cells through dual dart plugs and finally into the flotation tailings hopper. Concentrate from the Cleaner 1 cells gravitates, with the aid of spray water, to the Cleaner 1 concentrate hopper where it is combined with process water for density adjustment and pumped to the Cleaner 2 feed box.

Cleaner Scavenger concentrate gravitates, with the aid of spray water, to the Cleaner 2 tailings hopper. Cleaner 2 tailings slurry is recirculated back to the head of the Cleaner 1 flotation circuit for further recovery. Cleaner 2 consists of four 20 m³ tank flotation cells arranged in series to provide a nominal residence time of 30 minutes. Tailings from the first cell gravitates into the next through dual dart plugs and finally into the cleaner 2 tailings hopper where it is pumped, via a variable speed centrifugal pump, to the cleaner 1 feed box. Concentrate from all of the cleaner 2 cells gravitates, with the aid of spray water, to the cleaner 2 concentrate hopper where it is combined with process water for density adjustment and pumped to the head of the Cleaner 3 circuit.

Cleaner 3 consists of three 20 m³ tank flotation cells and a Jameson cell in series to provide a nominal residence time of 30 minutes. Tailings from the first cell gravitate into the next through dual dart plugs and finally into the Cleaner 2 feed box. Concentrate from all of the Cleaner 3 cells gravitates, with the aid of spray water, to the final concentrate hopper.

4.9.3.9 Sampling

The sampling and OSA system analyses critical streams throughout the flotation circuit for iron, copper and slurry density. The elemental assays are used by the operators to optimise the flotation circuit. The slurry density measurement, supported by routine operator checks, is used to adjust the flow control valves to each concentrate hopper and manual water addition valves to the head of each flotation bank to achieve the desired density, minimising entrainment in the concentrate.

4.9.3.10 Concentrate handling and storage

Final flotation concentrate, at a nominal rate of 32 dry tonnes per hour (tph), is pumped over a vibrating trash screen with the undersize gravitating into the 15 m diameter high-rate thickener. Underflow, with a density of approximately 65% water weight (w/w) solids, is pumped into the agitated filter feed tank, which provides approximately 24 hours capacity at nominal concentrate production rates. Concentrates are filtered and washed in the locally controlled pressure filter, producing a cake with residual moisture of approximately 8.9%, which is then be loaded into half height containers, weighed and trucked offsite. Concentrates may be separated based on grades, allowing the production of two product streams to better meet customer requirements.

A concentrate storage shed with open frontage is provided to store up to five days of total concentrate production, with dividers in place as necessary to enable the separate of concentrates of different grades and to enable blending of concentrates during the container loading process. The concentrate storage shed may be upgraded to a fully enclosed shed in future, coinciding with an increase in storage capacity to approximately 17 days of concentrate production.

The container handling system, situated opposite the concentrate storage shed, is a semi-automated process involving placing the empty container into the weigh frame, lifting the container lid, manually filling with concentrate to a weight by an FEL, manually sampling, replacing the lid and then initiating a wash cycle to remove all external contamination. The full containers are then either stacked in the designated area by a reach stacker or similar container-handling machine or loaded onto transport for offsite delivery. The FEL operator in the concentrate storage shed oversees the system and has digital display of the container load during the filling operation.

4.9.4 Processing supporting infrastructure

4.9.4.1 Processing equipment

Noise sources include activities such as grinding (mills), blowers, pumping (e.g. tailings slurry disposal pumps) and surface crushing and conveying. Dust sources are predominantly hardstands, materials handling (e.g. conveyor transfer points), stockpiles and roads. Emission sources are predominantly mobile equipment, with other aspects actively managed as part of the MPP design. Equipment will meet exhaust air quality standards and be maintained and serviced in accordance with manufacturer's recommendations and/or in accordance with site.

Fire ignition sources associated with processing activities and the plant itself may include electrical faults in switch rooms, transformers, equipment and mobile fleet, and faulty conveyor idlers. Ignition sources would be managed in accordance with any permits and requirements of the *Fire and Emergency Services Act 2005* (SA).

4.9.4.2 Mobile fleet

The surface mobile fleet associated with mineral processing and concentrate export operations is summarised in Table 4.27.

Table 4.27 | Non-mining surface mobile equipment

Equipment	Type/capacity	Number
Bus	24-seat coaster or equivalent	4
Commercial (trucks)	Hiab 5 t or equivalent	6
Crane	50 t, 120 t, 20 t Franna or equivalent	4
Forklift	5 t, 2.5 t or equivalent	7
Grader	Caterpillar 12 M or equivalent	1
Excavator	<450 kW or equivalent	1
Wheeled loader	Cat 966 or equivalent	5
Reachstacker	Kalmar DRT 450 or equivalent	2
Road train	A-type triple road train or equivalent	3
Light vehicles	Toyota Landcruiser or equivalent	92
Ancillary (miscellaneous)	Ambulance	1

4.9.4.3 Conveyors

There are a number of conveyors associated with operations at Carrapateena, transporting ore from the primary crushers located underground, up the Tjati Decline to the COS, and subsequently feeding the grinding mills.

The decline conveyor has two or three enclosed transfer points along the length of the decline, depending on the depth of mining activities, and one enclosed surface transfer point. The total length of this conveyor is in the order of 10.5 km, and ultimately feeds a stockpile feed conveyor delivering ore to the COS. A reclaim feeder would transfer material from under the base of the COS. A vibrating feeder would transfer material from under the base of the COS to a separate conveyor for transfer of coarse ore to the MPP grinding mills. The approximate length of this conveyor is 130 m. Both conveyors would be open (i.e. not enclosed), with dust suppression misting sprays fitted to the stacker (output) end of the decline conveyor, and water added to the grinding mills at the end of the grinding mill feed conveyor prior to grinding operations.

Conveyor motors are generally enclosed to reduce noise emissions, and conveyor transfer points are enclosed for the mitigation of potential dust emissions. Fire protection systems are installed as required.

4.9.4.4 Chemicals, reagents and consumables

The flotation reagents used at Carrapateena, their nominal addition rate, and their respective environmental considerations, are described in Table 4.28.

Table 4.28 | Reagent demand and considerations

Reagent	Typical addition rate (g/t)	Management considerations
Sodium Ethyl Xanthate (collector)	50	Sodium ethyl santhate decomposes during flotation via a series of chemical reactions to form the odorous and gaseous compound carbon disulphide (CS_2). The effect of CS_2 emissions was assessed within Appendix C1 of the MLP (OZ Minerals 2017a), in the worst-case assumption that all of the Sodium Ethyl Xanthate decomposed. The results of the air quality modelling indicate that respective ground-level concentration criteria nominated in the Environment Protection (Air Quality) Policy 2016 (SA) would be met at all times, for all locations within ML 6471 (see Chapter 7).
AN905SH (flocculant)	30	This reagent is added to the flotation tailings to settle the solids, allowing pumping of the solids to the TSF. Analysis of the specific Material Safety Data Sheet (MSDS) for the product suggests that it is not classified as either hazardous nor a dangerous good, and is a stable product, producing nitrogen dioxides and carbon oxides when heated. Ecological sensitivity suggests that the LC_{50} (96 hours) dose to fish is 100 mg/L. The concentration added to the tailings is expected to be around 50 g/t (around 25 g/m^3, or 25 mg/L) as a worst case.
Interfroth F228N (frother)	40	A flotation frother, functions to promote froth stability during the flotation process. It is not classified as a dangerous good, however is noted as being hazardous on the basis of potential health impacts to humans. The MSDS ecological sensitivity suggests that the LC_{50} (96 hours) dose to fish is 375 mg/L. The concentration added to the tailings is expected to be around 15 g/t (around 7.5 g/m^3, or 7.5 mg/L) as a worst case as this reagent will generally report to the flotation tailings thickener overflow and report back to the MPP in the process water, rather than be distributed to the TSF.
Intercol C4450 (collector)	15	A flotation collector and functions to promote hydrophobicity of sulphide minerals during the flotation process. It is classified as a dangerous goods (Class 8), and hazardous substance with eye irritation and skin irritation classifications. The MSDS ecological sensitivity suggests that the acute aquatic toxicity estimate is >100 mg/L. The material is classified as not hazardous for chronic aquatic exposure. The concentration added to the tailings is expected to be around 15 g/t (around 7.5 g/m^3, or 7.5 mg/L) as a worst case.
Intercol C6096 (collector)	5	A flotation collector and functions in a similar manner to C4450. Classified as not a dangerous goods, and hazardous substance with harmful if swallowed and skin irritation classifications. The MSDS ecological sensitivity suggests that the acute aquatic toxicity estimate is >100 mg/L. The material is classified as not hazardous for chronic aquatic exposure. The concentration added to the tailings is expected to be around 5 g/t (around 2.5 g/m^3, or 2.5 mg/L) as a worst case.
Aerophine 3418A (collector)	5	A flotation collector and functions in a similar manner to C4450. Classified as not a dangerous goods, and hazardous substance with eye irritation and skin sensitiser classifications. The MSDS ecological sensitivity suggests that the LC_{50} (96 hours) dose to fish is 375 mg/L. The concentration added to the tailings is expected to be around 15 g/t (around 7.5 g/m^3, or 7.5 mg/L) as a worst case. The material is noted as readily biodegradable.

Reagent	Typical addition rate (g/t)	Management considerations
Interfoam 5245 (defoamer)	40	A flotation defoamer, and functions to reduce froth stability in the flotation and dewatering processes. It is not classified as a dangerous good, nor as being hazardous on the basis of potential health impacts to humans. The MSDS ecological sensitivity suggests that the acute aquatic toxicity estimate is >100 mg/L. The material is classified as not hazardous for chronic aquatic exposure. The concentration added to the tailings is expected as a worst case to be around 40 g/t (around 2.5 g/m^3, or 2.5 mg/L). The concentration within the tailings likely much less, as this reagent will generally be used in concentrate dewatering and report to the concentrate thickener overflow and report back to the MPP in the process water, rather than be distributed to the TSF.
Sodium metabisulfite (SMBS)	Up to 400	Used for depression of pyrite. The increase in pyrite fraction to tails and residual sulphate from SMBS may affect the acid and metalliferous drainage (AMD) classification of the tailings. If geochemical testing (being undertaken at time of this PEPR) demonstrates that the non-acid forming (NAF) classification of tailings may change then further discussions with DEM and EPA and approval, if required, will occur prior to long-term use of SMBS.

Consumables associated with the processing operations, and their expected annual consumptions, are detailed in Table 4.29. Reagents are stored in accordance with the requirements of relevant Australian Standards, with storages bunded in accordance with relevant EPA and Australian Standards guidance.

Table 4.29 | Consumables demand

Consumable	Annual consumption
Primary crusher and mill liners	3 sets
SAG and ball mill grinding media	3,000 t
Regrind mill ceramic grinding media	75 t
Filter medium	350 cloths
Anti-scalant	80 kL
Lubricants and general consumables	300 t

4.9.5 Processing operations

The concentrator has a PCS receiving inputs from the field instruments and output signals to the field control devices. The PCS performs the control functions and provides the human machine interface (HMI). Operators are able to view and adjust the process from operating terminals provided with standard software at future offsite control centres.

The operator terminals display a graphical representation of the plant on a number of screens and the plant would be controlled from these screens. Drives are able to be started and stopped and their status displayed. Control loops are displayed as a controller faceplate and the controller operating mode, set point and output are adjustable and their values displayed. The adjustment of controller parameters are made from the controller faceplate and this adjustment is password protected to prevent unauthorised adjustments.

Display screens are configured for the trending of individual or related parameters and a number of alarm pages have been developed to allow the setting of alarm points attached to various parameters. Control of external plant equipment, such as the raw water harvesting pumps and decant return water pumps at the TSF, are via radio telemetry.

4.10 Description of the TSF operations

Tailings material generated and thickened within the MPP (see Section 4.9.3.8) is pumped to the onsite TSF. The proposed TSF would be located at the head of the Eliza Creek valley, which drains to the north and is approximately 16 km upstream of Lake Torrens (Figure 4.2). The gradient of the valley floor varies between approximately 7% in the upper reaches and 1% in the lower reaches. The valley slopes vary between approximately 10% near the top of the valley, decreasing to approximately 2% in the lower areas.

Change to approved operations: Tailings generation has increased as a result of the increase in ore production and MPP throughput, described in the June 2024 PEPR (MPEPR 2024/009), and envisaged under an expanded block cave mining and minerals processing scenario (subject to further approvals). Based on this increased tailings generation, the current approved TSF design (OZ Minerals 2018a, Appendix B) has been refined to ensure the TSF remains suitable for the disposal of the LOM tailings (Appendix B1).

For the purposes of this PEPR revision, the described changes have been limited to the change in the construction methodology associated with the Stage 3 TSF embankment. Total approved TSF capacity remains 72.4 Mm^3 (144.9 Mt dry tailings) which, under the revised TSF design, would be achieved at either the end of Stage 4B (assuming a flatter beach profile) or at the end of Stage 5A (assuming a steeper beach profile scenario).

4.10.1 Key elements

A description of the key project elements is provided in Table 4.30. These elements have been subject to impact and risk assessments as presented in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) and in the Program Notifications described in June 2024 PEPR (BHP 2024a). Table 4.31 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators as provided in Chapter 7.

Table 4.30 | Tailings storage key project elements

Key element	Summary
General	
Total tailings volume	Up to 72.4 Mm^3 – Stage 4B (flatter beach profile scenario) or Stage 5A (steeper beach profile scenario)
Tailings supply rate	Up to approximately 6.9 Mtpa
Solids concentration	Average of approximately 62% w/w (at the time of deposition)
Tailings deposition life	27 years (last deposition in 2046)

Key element	Summary
Mined Resource/Reserve	The current Mineable Inventory is 185 Mt (see Section 4.6.3). Additional TSF expansion, beyond the 4 to 5 stages described in this PEPR, may be required to store the tailings generated from the processing of the whole of the mineable inventory. Any such expansion would be subject to further regulatory approvals as required.
Design summary	
Impoundment type	Cross-valley embankment
Rate of rise	1.9 to 2.4 m/year
Beach slope	0.7% (flatter beach profile scenario) to 1.5% (steeper beach profile scenario)
Consequence category	• Significant, environmental spill consequence category under Australian National Committee on Large Dams (ANCOLD) (2019) • High C, dam breach consequence category under ANCOLD (2019)
Final beach surface area	556 ha to the end of Stage 4B (flatter beach profile scenario) to approximately 600 ha at the end of Stage 5A (steeper beach profile scenario)
Catchment area	1,500 ha (including the Decant Dam storage area)
Embankment construction stages	
Stage 1	16 m high, 1.0 km long, primarily formed with weathered rock and clay soil. Mine waste rock would also be used for erosion protection of the embankment slope and to produce crushed rock to form the wearing course on the embankment crest. Downstream slope built to 2H:1V to reduce construction material requirements
Stage 2	12.9 m downstream lift, 1.4 km long, constructed of weathered rock and clay soil, with waste rock erosion protection on the downstream slope and a crushed rock wearing course on the crest. Downstream slope built to 3H:1V
Stage 3	10.8 m downstream lift constructed of moderately to slightly weathered rock. Downstream slope built to 3H:1V with coarse rockfill on the downstream face, for erosion protection
Stage 4	5.5 m upstream lift, constructed of a layer of coarse rockfill placed into tailings surface to form a pioneer layer over the footprint of the upstream embankment raise, which would be constructed of moderately to slightly weathered rock. Rock armouring for erosion protection and a downstream slope of 3H:1V
Stage 5A (if required)	1.5 m upstream lift, constructed of a layer of coarse rockfill placed into tailings surface to form a pioneer layer over the footprint of the upstream embankment raise, which would be constructed of moderately to slightly weathered rock. Rock armouring for erosion protection and a downstream slope of 3H:1V
Freeboard criteria and design event	
ANCOLD	• Flood discharge, 1:100,000 annual exceedance probability (AEP) rain event and 1:10 AEP wind event for wave runout freeboard, or PMP event • Operational design earthquake, 1:2,000 AEP earthquake event • Post-closure design earthquake, larger of Maximum Credible Earthquake (MCE) or 1:10,000 AEP earthquake event • Extreme storm surge allowance, 1:100 AEP, 72-hour rain event, and 1:10 AEP wind event, and 0.5 m contingency freeboard

Key element	Summary
GISTM	High consequence category: • Operations and closure (active care), 1:2,475 AEP rain event and 1:2,475 AEP earthquake event • Passive closure (passive care), 1:10,000 AEP rain event and 1:10,000 AEP earthquake event
	Very High consequence category: • Operations and closure (active care), 1:5,000 AEP rain event and 1:5,000 AEP earthquake event • Passive closure (passive care), 1:10,000 AEP rain event and 1:10,000 AEP earthquake event

Table 4.31 | Tailings storage Impact IDs, design and management controls and uncertainty

Tailings storage
Carrapateena Impact IDs[1]
SW02, SW04, SW06, SW08*, SW10*, SW11, SW12, SW13, SW14*, SW15, SW16, SW17, SW18, SW19*, SW20, SW21, SW22, SW23, SW24*, SW25, SW51*, SW52*, SW53*, SW54* GW21*, GW22, GW23, GW24, GW25 and GW26.
Design controls
• TSF embankment and decant collection dam and ponds in accordance with international best practice • Final detailed TSF design in accordance with ANCOLD design criteria (flood storage capacity 1-in-100 AEP rain event including wave freeboard, freeboard capacity 1-in-1,000 AEP critical duration event) • A central compacted clay core, extending into a cut-off key trench where in situ soil is present • Dental concrete on fractured bedrock at the contact of the central clay core with the watercourse, i.e. where in situ soil is not present • An upstream sloping zone of compacted clay in the Stage 1 and Stage 2 TSF embankment, extending into a cut-off key at the toe, where in situ soil is present • A geosynthetic lined cell in the Decant Dam, at the upstream toe of the embankment to manage seepage and decant water from the TSF • A clay liner in the drainage channel where exposed bedrock exists. Approximately 3,500 m by 1 m thick by 30 m wide in the Stage 1 Footprint. Extra disturbance footprint around the TSF has been included to allow additional extraction of material • A seepage cut-off drain at the downstream toe of the embankment. A geosynthetic liner on the upstream slope of the Stage 1 TSF embankment* • Decant outfall pipe extension from the TSF embankment to the lined decant cell
Management controls
• Embankment foundation assessments • Embankment stability assessment • Dam Safety Monitoring Program • Quality assurance/quality control (QA/QC) procedures • Daily inspections • Alarmed pressure indicators • Remote isolation valves on delivery infrastructure • Auditing of critical construction stages • Seepage volume monitoring in cut-off drain • Continual characterisation of chemical and physical properties of the tailings

* Non-Outcome or Outcome-based lease condition proposed

(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

4.10.2 TSF design

4.10.2.1 Standards

The regulations, standards and guidelines related to the design and operation of the TSF include:

- Mineral Policy 007 Mining Act tailings regulation and standards (DEM 2021c). This document refers to ANCOLD as the primary standard for TSF design in South Australia (see below) and selected sections of the following standards:
  - the International Committee on Large Dams (ICOLD), for various design, operation, and closure measures which are also referenced by ANCOLD
  - the Canadian Dam Association (CDA) with respect to developing a risk-informed approach to emergency preparedness.
- ANCOLD Guidelines on tailings dams: planning, design, construction, operation and closure (ANCOLD 2019). This document is the primary standard for TSF design, detailing design requirements and considerations.
- GISTM 2020 (Global Tailings Review 2020). This is a voluntary standard to which BHP is committed. The Carrapateena TSF is required to comply with GISTM recommendations across each of the 6 risk areas:
  - affected communities
  - integrated knowledge base
  - design, construction, operation, and monitoring of the tailings facility
  - management and governance
  - emergency response and long-term recovery
  - public disclosure and access to information.
- International Council on Mining and Metals (ICMM) Conformance Protocols, including reference to compliance with GISTM and the considerations described in the Tailings Management Good Practice Guide (ICMM 2021).

In addition, BHP has guidelines and requirements related to the design, operation and closure of TSFs, specifically:

- Tailings Storage Facilities, Our Requirements (BHP 2021)
- Closure and Legacy Management, Global Standard (BHP 2024e).

4.10.2.2 Engineering design basis

The approved TSF design comprises a cross-valley embankment at the head of the Eliza Creek valley that has a capacity of 144.9 Mt of tailings material at an average long-term in-situ bulk density of 2.0 t/m^3, equivalent to 72.4 Mm^3 of volume. The revised TSF design (Appendix B1) would have a capacity of 224.4 Mt, with a total tailings volume of up to 119.8 Mm^3. Noting that this PEPR is not seeking approval for the disposal of tailings beyond the volume and quantity previously approved. Depending on the as-deposited tailings beach profile, this is anticipated to occur at the end of Stage 4B (for the flatter beach profile scenario) or Stage 5A (for the steeper beach profile scenario) of the revised TSF design.

Capacity of the TSF is increased through progressive raising of the embankment. The initial starter embankment has been constructed using compacted silt clay, gravel and weathered rock obtained from colluvium collected within the TSF impoundment area. Mined waste rock is used as rock armouring for erosion protection of the downstream face of the embankment, and crushed waste rock is used as a wearing course for the embankment crest.

The starter embankment provided an initial storage capacity of three years, with a nominal maximum embankment height of approximately 16 m. To provide additional storage capacity, the TSF embankment has been raised via the construction of Stage 2A and Stage 2B, with further raises planned until the approved storage volume is achieved. The initial lifts (Stage 2A and Stage 2B) have been constructed using a downstream raise methodology with similar construction materials to that of the starter embankment. The approved TSF design proposed that subsequent raises (Stage 3 to Stage 6) would be constructed using an upstream raise methodology, utilising consolidated tailings with waste rock armouring of the downstream faces.

The revised TSF design (Appendix B1) proposes that the Stage 3 TSF embankment would be constructed in a downstream raise methodology and that subsequent Stage 4A, Stage 4B and Stage 5A (if required, depending on beach profile) embankments would be constructed using an upstream construction methodology, by which time the rate of rise would be sufficiently low to support upstream raises. Upstream raises reduce the need for the excavation of construction materials from borrow pits. The construction of upstream raises is contingent on achieving a suitable tailings beach strength, confirmed via geotechnical investigation prior to construction.

Tailings enter the facility via sub-aerial spigot discharge points at the head of the valley reaches, from the upstream crest of the TSF embankment and from the valley sides. This optionality allows the beach slopes to be created in such a way as to manage the rate of rise, flood storage capacity and progressively position the supernatant pond further away from the embankment.

4.10.2.3 Safety in design

A Safety in Design register was prepared for the Stage 1 TSF design and updated for the Stage 2 TSF design (as outlined below). The general control measures (e.g. embankment crest width and slope gradients) have been carried through to the various stages of the proposed TSF design. The registers considered the following guidance:

- *Work Health and Safety Act 2011* (Cth) and the Work Health and Safety Regulation 2011 (Cth)
- Safe Design of Structures Code of Practice (Safe Work Australia 2018).

Safety in design is addressed by the following features:

- As-constructed 7 m crest width for the Stage 1 TSF embankment and Decant Dam embankment for safe one-way vehicular access and 0.5 m high safety bunds (windrows) at each edge of the embankment crest. This configuration provided a minimum 5 m driving width, noting that the safety bunds straddle each edge of the crest. On the upstream edge of the TSF embankment, the safety bund was formed over the portion of the geosynthetic liner that was extended onto the crest.
- A wearing course was formed on the crest of the embankments to limit damage to vehicle tyres (where rockfill zones are near the crest) and to limit rutting of the roadway (where soil zones are near the crest). The average thickness of the wearing course is 0.3 m. Material for the wearing course is produced by crushing mine waste rock. A drainage cross-fall is provided on the crest of the embankments, to allow for drainage into the respective impoundment areas. Drainage slots are formed in the safety bunds to allow for discharge.

- At least 8 m crest width for the TSF embankment at Stage 2 to Stage 5A, to allow for one-way vehicular access and safe working distance between the tailings delivery pipeline and the upstream edge of the embankment. Safety bunds 1 m in height located at each edge of the embankment crest, and the pipeline located on the access side of the safety bund on the upstream edge, at least 1 m from the actual upstream edge of the embankment crest. Note, although the pipeline is considered a safety barrier to vehicles, the safety bund is provided for safety of personnel working around the pipe, i.e. to access spigot valves.
- At least 7 m width for the decant access causeway, including additional 5 m width on either side of the towers for vehicular access and safety bunds.
- A 3H:1V slope was formed at the upstream side of the Stage 1 embankment to facilitate a safe gradient for geosynthetic liner installation.
- Safety grids placed over the decant inlets and also at the outlet of the decant outfall pipes.
- Safety barriers formed around the inlets to the decant towers.
- The maximum reach distance for placement of collars on the riser pipes is 5 m. This allows personnel to place collars with a tool without the need to descend into the towers. The maximum height of the decant access causeway (at Stage 1) was approximately 12 m. To address operational safety with respect to raising the riser pipe within the decant tower at this height, the riser pipe (steel portion) was initially installed with causeway fill placed around the pipe. This enables the installation of the slotted concrete towers to a maximum height of 5 m at each stage.
- A locally widened zone of the Decant Dam embankment to allow for installation of a return water pump access platform and ongoing safe access to the pump. Access steps and safety railing are formed on one side of the extraction pipe for access to the sump. The 3H:1V slope on the upstream face of the embankment facilitate a safe gradient for the access steps.
- Safety railing around the pump access platform at the Decant Dam.
- An access track to the lined decant cell in the Decant Dam, for liner maintenance throughout operation.

4.10.2.4 Updated tailings deposition modelling

Tailings deposition modelling was undertaken for each proposed TSF stage using the updated parameters (refer Section 4.10.3) and based on the following requirements and conditions:

- the tailings generation schedule and storage volumes for each stage, selected based on an average dry density of 1.9 t/m^3
- providing at least four years of storage capacity by stage
- the storage curves for beach models based on average beach slope gradients of 0.7% (for the flatter beach profile scenario) and 1.5% (for the steeper beach profile scenario) as described in Section 4.10.3.4
- locating the toe of the tailings beach at the supernatant pond area, adjacent to the decant causeway

- locating the supernatant pond at least 600 m away from the embankment, and as close to the northern end of the decant causeway as possible (i.e. around Tower 1) in order to limit the elevation of the tailings discharge points in the valley reaches, thereby minimising the required elevation head for pumping
- phasing tailings deposition between up-valley discharge from the embankment and down-valley discharge to allow time for tailings to consolidate near the embankment and improve conditions for upstream raise construction (for Stage 4 to Stage 6) and relocation of tailings deposition pipelines and installation of new outlets.

A summary of the design basis for both the flatter and steeper beach slope scenarios is presented in Table 4.32.

Table 4.32 | TSF staging, volumes and areas

Stage	Nominal commencement	Deposition phase	Nominal tailings storage volume (Mm^3)	Cumulative tailings storage volume (Mm^3)	Embankment crest elevation (mAHD)	Head of beach elevation (mAHD)	Cumulative beach area (ha)
Flatter beach scenario							
1	December 2019	1	6.6 (as built)	25.3	133.6	N/A	150
2	March 2023	2A and 2B	18.7 (actual plus forecast)		146.7	146.0	336
3	January 2029	3A	15.1	48.3	157.5	156.5	448
		3B	7.9				
4	May 2033	4A	13.0	73.3	163	162	556
		4B	12.0				
Steeper beach scenario							
1	December 2019	1	6.6 (as built)	15.4	133.6	N/A	150
2	March 2023	2A and 2B	8.8 (actual plus forecast)		146.7	146.0	249
3	March 2026	3A	11.8	36.3	157.5	156.5	420
		3B	9.1				
4	June 2031	4A	12.2	61.7	163	162	555
		4B	13.2				
5[1]	August 2035	5A	7.7	87.1	166	165	665
		5B	17.7				

Note 1: Depending on the as-deposited tailings beach profile, the current approved capacity of the TSF (being 144.9 Mt and/or 72.4 Mm^3) is anticipated to occur at the end of Stage 4B (for the flatter beach profile scenario) or Stage 5A (for the steeper beach profile scenario) of the revised TSF design. Approval is not currently being sought for stages beyond the current approved capacity.

4.10.2.5 Radiological risk assessment

Early in the conceptual design phase of the Project, a radiological risk assessment of the proposed TSF was undertaken, using an internationally accepted method for assessing impacts of radioactive waste disposal facilities. The aim of the work was to ensure that the tailings design consultants ensured that radiological considerations were factored into design. The main findings of the work were that radiological risks were low and potential radiation doses in the event of a failure were low. Specific design requirements for the purposes of radiation control were not necessary, given the other controls that have been implemented as defined by the ANCOLD guidelines.

4.10.2.6 Seismic hazard assessment

Carrapateena is in a region of relatively low seismicity, noting that earthquakes in Australia are typically intraplate and relatively low compared to earthquakes at plate boundaries. A site-specific seismic hazard assessment (SHA) was completed in 2017 and indicates the peak ground acceleration (PGA) for the 1-in-1,000 AEP design earthquake event to be about 0.04g (corresponding to an earthquake Magnitude of about 6.1).

An Earthquake Hazard Map of Australia was prepared by Geoscience Australia (2012) and was updated in October 2018 (Geoscience Australia 2018). The 2018 update is limited to data for the 1-in-500 and 1-in-2,500 AEP events, whereas the map prepared in 2012 provides data for a range of AEP events. The 2018 map shows that for the Carrapateena region, the PGA for the 1-in-500 AEP event ranges from 0.015g to 0.02g and the PGA for the 1-in-2,500 AEP event ranges from 0.04g to 0.06g. The Geoscience Australia 2012 Map shows the PGA for the 1-in-10,000 AEP event ranges from 0.15g to 0.20g.

The ANCOLD tailings dam guideline (2019) recommends that for a ‘Significant’ consequence category, the PGA for the 1-in-1,000 AEP event should be adopted for the Safety Evaluation Earthquake (SEE). The deterministic PGA value for the Maximum Credible Earthquake (MCE) is relatively lower than the 1-in-10,000 AEP earthquake event value. As noted in the SHA report, the MCE value results from a Magnitude 7.3 event generated on the Ediacara Scarp, about 70 km north-east of the site.

ANCOLD (2019) recommends the maximum of the MCE and the 1-in-10,000 AEP event is adopted for closure design.

4.10.2.7 Consequence category

Consequence category assessments informed by the dam breach assessment results, and an exposure assessment undertaken for the TSF layout, were undertaken in accordance with ANCOLD (2019) and GISTM (Global Tailing Review 2020) (Appendix B1). The outcomes of these assessments indicated:

- a ‘Significant’ environmental spill consequence category under ANCOLD
- a ‘High C’ TSF dam breach consequence category under ANCOLD
- a ‘High’ TSF dam breach consequence category under GISTM
- the determined consequence category informed the design criteria for the TSF, with specific reference to the ability of the TSF to adequately manage nominated AEP rainfall and earthquake events.

4.10.3 Tailings production and characterisation

4.10.3.1 Tailings slurry concentration

Thickened tailings are currently deposited in the TSF. Solids concentration data for the tailings slurry deposited in 2023 indicated the average solids concentration of the slurry is about 57% w/w with a maximum recorded concentration of 64.7%. Average solids concentrations of approximately 62% w/w have been achieved since commissioning of a new thickener in 2025.

Previous testwork associated with the design and implementation of the hydrofloat circuit indicated that the average solids concentration for the blended (hydrofloat tails plus traditional flotation tails) tailings slurry is 62% w/w, with this value being adopted for the TSF design review (Appendix B1).

4.10.3.2 Particle density and particle size distribution

Particle density and particle size distribution testing of tailings generated via the existing MPP is undertaken monthly. The average particle density for tests undertaken in 2022 was 3.17 g/cm^3. Results of hydrofloat testwork completed in late 2022 indicated a particle density of 3.67 g/cm^3 for blended tailings. These values are within the range of densities (3.21 to 3.76 g/cm^3) presented in the TSF design report supporting the Carrapateena MLP (OZ Minerals 2017a).

Results of monthly particle size distribution tests in 2022 indicate that 80% of particles are smaller than 78 µm (i.e. a P80 of 78 µm). However, BHP has noted the P80 for the blended tailings is expected to be between 90 and 125 µm (with an expected average of about 110 µm) following relaxation of the grind size after hydrofloat implementation.

With respect to uncertainty, a higher particle density may result in a relatively higher average dry density for deposited tailings, however, a coarser tailing is likely to reduce the consolidation performance of the tailings. Coarser tailings also typically result in a relatively steeper beach slope profile, due to a change in settling performance along the beach.

4.10.3.3 Tailings dry density

As-built dry density for the existing tailings within the TSF has been calculated to be approximately 1.9 t/m^3, corresponding to laboratory testwork undertaken on tailings samples that reported a dry density of approximately 1.95 t/m^3 for a 100 kilopascal (kPa) load, equivalent to 5 m of tailing cover. At a 10 m cover equivalent, tailings dry density was indicated to be approximately 2.0 t/m^3. Laboratory testing of hydrofloat fine tails and blended tailings indicated a dry density of 2.0 and 2.1 t/m^3 for equivalent cover thicknesses of 5 m and 10 m, respectively.

To account for the coarser P80 of the proposed blended tailings (~110 µm, instead of 75 µm), an average dry density of 1.9 t/m^3 was adopted for the TSF design review (Appendix B1).

4.10.3.4 Beach slope gradients

The Stage 1 TSF beach slope was measured to be concave with beach slope gradients varying between about 2.4% at the head of the beach and about 0.6% near the toe of the beach.

The following two beach slope gradients were adopted for the tailings deposition modelling used to inform the revised TSF design to simulate the expected range of beach slope performance:

- an average beach slope of 0.7% representing a flatter beach slope scenario with gradients varying between 1% (near the outlet) and 0.6% (near the decant area)
- an average beach slope of 1.5% representing a steeper beach slope scenario with gradients varying between 2% (near the outlet) and 0.8% (near the decant area).

4.10.3.5 Tailings geochemical properties summary

Tailings solids composition

Monthly tailings solids composition sampling is undertaken at Carrapateena, with average concentration data for the period July 2024 to March 2025 inclusive summarised in Table 4.33.

Table 4.33 | Indicative tailings solids properties

Element	Tailings composition (mg/kg)	Element	Tailings composition (mg/kg)
Aluminium (Al)	26,900	Niobium (Nb)	39.15
Antimony (Sb)	3.15	Phosphorus (P)	1,833
Arsenic (As)	29.11	Potassium (K)	10,085
Barium (Ba)	845	Rubidium (Rb)	59.76
Bismuth (Bi)	2.23	Scandium (Sc)	9.33
Cadmium (Cd)	0.20	Selenium (Se)	9.33
Calcium (Ca)	6,633	Silicon (Si)	162,000
Chromium (Cr)	108.9	Silver (Ag)	1.36
Cobalt (Co)	150.7	Sodium (Na)	7,572
Copper (Cu)	1,065	Strontium (Sr)	101.5
Gallium (Ga)	14.52	Sulfur (S)	4,115
Gold (Au)	0.13	Tantalum (Ta)	0.21
Hafnium (Hf)	2.46	Tellurium (Te)	1.07
Iron (Fe)	352,700	Thorium (Th)	30.02
Lead (Pb)	70.0	Tin (Sn)	33.52
Magnesium (Mg)	5,267	Titanium (Ti)	1,370.4
Manganese (Mn)	2,090	Uranium (U)	205.1
Molybdenum (Mo)	22.19	Vanadium (V)	45.37
Nickel (Ni)	36.30	Zinc (Zn)	93.18

Tailings liquid compositions

Analyses of TSF supernatant water and decant dam water are undertaken monthly, with typical results (from April 2025) summarised in Table 4.34.

Table 4.34 | Indicative tailings supernatant and decant water properties (April 2025)

Analyte	Liquid composition	
	TSF supernatant	Decant dam
pH	6.11	6.67
TDS[1] (mg/L)	219,000	179,000
Total alkalinity (as $CaCO_3$) (mg/L)	2,700	3,260
Chloride (mg/L)	142,000	114,000
Calcium (mg/L)	3,980	3,990
Magnesium (mg/L)	4,500	3,690
Sodium (mg/L)	77,500	62,500
Potassium (mg/L)	1,430	1,180
Aluminium (mg/L)	0.3	0.46
Antimony (mg/L)	0.016	<0.010
Arsenic (mg/L)	<0.010	0.02
Beryllium (mg/L)	<0.010	<0.010
Platinum (mg/L)	<0.010	<0.010
Barium (mg/L)	0.2	0.171
Bismuth (mg/L)	<0.010	<0.010
Cadmium (mg/L)	0.0036	0.0018
Cerium (mg/L)	<0.010	<0.010
Caesium (mg/L)	0.256	0.182
Chromium (mg/L)	<0.010	<0.010
Cobalt (mg/L)	0.063	0.047
Copper (mg/L)	1.7	1.22
Lanthanum (mg/L)	<0.010	<0.010
Lead (mg/L)	0.058	0.025
Lithium (mg/L)	6.98	5.57
Manganese (mg/L)	11	7.18
Molybdenum (mg/L)	0.68	0.634
Neodymium (mg/L)	<0.010	<0.010
Nickel (mg/L)	0.032	0.026
Selenium (mg/L)	<0.10	<0.10
Silver (mg/L)	0.02	0.011
Strontium (mg/L)	90.7	78.3

Analyte	Liquid composition	
	TSF supernatant	Decant dam
Thallium (mg/L)	0.024	0.017
Tin (mg/L)	<0.010	<0.010
Titanium (mg/L)	<0.10	<0.10
Uranium (mg/L)	2.14	1.87
Vanadium (mg/L)	<0.10	<0.10
Zinc (mg/L)	0.273	0.077
Boron (mg/L)	5.33	4.33
Iron (mg/L)	0.89	1.62
Bromine (mg/L)	107	87.4
Gold	<0.010	<0.010
Iodine	1.2	2.1
Tungsten	<0.010	<0.010

(1) TDS is a function of the raw water supply for the Project and subject to variation.

Acid generation and metals mobilisation summary

Geochemical studies for the tailings have been undertaken across four campaigns (November 2018, October 2022, March 2024 and June 2024) covering existing and proposed future tailings geochemistry (Appendix B2). The key findings from these studies are:

- Tailings generated from laboratory and plant flotation of chalcopyrite and bornite ores are representative of tailings produced during processing of ores extracted during SLC mining and have low sulphide content and moderate ANC principally derived from dolomite. These tailings are classified as NAF, generally with a high ANC/MPA ratio indicating a low risk of ARD generation.
- Tailings generated from laboratory flotation of block cave (BC) ore have higher sulphide (pyrite) content than SLC tailings and are representative of tailings expected to be produced during processing of ores extracted during BC mining (to be undertaken subject to further approvals). The balance between the acid forming and acid neutralising capacities (ANC) of the BC tailings studied to date were evenly balanced and consequently the sample was classified as Uncertain (NAF).
- Leach column testing of all tailings samples tested to date, including both SLC and BC tailings, have provided leachates with neutral pH and excess alkalinity, suggesting the risk of ARD generation from oxidation of tailings on exposure to air is low.
- Leaching of SLC and BC tailings with hypersaline process water under kinetic leach column conditions resulted in significantly elevated concentrations of a number of metals (Ag, Co, Cu, Mn, Ni, Tl, U, Zn) in leachates, with solution speciation modelling suggesting increased metal solubility at neutral pH is likely due to the high chloride concentration in process water.
- Leaching of SLC and BC tailings with deionised water under kinetic leach column conditions resulted in leachates for all tailings samples containing metals at concentrations near or below the detection limit, with the exception of Mn, possibly reflecting Mn-carbonate dissolution. Uranium was present at elevated concentrations in both process and deionised water leachates.

- Acid-based accounting analysis of plant tailings sampled over 15 months during 2022 and 2023 confirmed that tailings produced during flotation of SLC ore are NAF with a substantial excess of ANC, and consequently low risk of ARD generation.

Together, the results of these studies indicate that tailings generated during processing of SLC ore using hypersaline groundwater for flotation would produce neutral pH seepage with elevated concentrations of a number of metals if exposed to air on dried beaches. Should saline process water be replaced with freshwater, or post-closure when the only water input of the TSF is rainwater/runoff, then the concentrations of metals in tailings pore water is expected to decrease substantially.

For consequence category assessments and potential environmental impacts from a dam breach runout, the tailings have been classified as NAF.

Additional tailings samples were taken during a short-term trial of SMBS for pyrite depression in the MPP, these samples are currently undergoing additional kinetic testing.

4.10.3.6 Tailings geotechnical properties summary

Geotechnical characterisation

Testwork on blended tailings characterised the geotechnical properties of the tailings is summarised in Table 4.35.

Table 4.35 | Tailings geotechnical properties

Parameter		Measurement
Classification		
Particle size distribution (%)	Sand (2 mm to 0.075 mm)	19.9
	Silt (0.075 mm to 0.002 mm)	60.5
	Fines-clay (<0.002 mm)	19.6
Specific gravity of solids	Particle density (g/cm^3)	3.67
Atterberg limits	Liquid limit (%)	20
	Liquid limit (%)	12
	Plasticity Index (%)	8
	Plasticity Index (%)	1.5
Tailings description	Silty clay with sand, low plasticity, dark red, fine-to-coarse grained sand	
Dry density		
Settled void ratio (e0)	Dry density at e0 (t/m^3)	1.28
Settling test with top drainage	Final settled dry density (t/m^3)	1.45
	Approximate time to achieve 95% of final settled dry density (hours)	91 (3.8 days)
	Approximate time to achieve final settled dry density (hours)	216 (9 days)
One dimensional consolidation	Initial solids concentration (% w/w)	62.4
	Initial dry density of slurry (t/m^3)	1.12
	Range of pressures tested (kPa)	10 to 1,600

Parameter		Measurement
	Equivalent thickness of saturated tailings (m)	0.5 to 62
Standard compaction	Dry density (t/m^3)	1.81 to 2.36
	Standard maximum dry density (t/m^3)	2.37
	Standard optimum moisture content (%)	10.0
Void ratio		
Settled void ratio (e0)	Solids concentration at e0 (% w/w)	65.6
	Void ratio (e0)	1.81
One dimensional consolidation	Void ratio	0.99 to 0.53
Volumetric shrinkage		
Volumetric shrinkage (without salt correction)	Initial dry density (t/m^3)	1.11
	Initial water content (%)	61
	Dry density at zero volume change limit (t/m^3)	2.25
	Water content at zero volume change limit (%)	10.25
Volumetric shrinkage (with salt correction)	Initial dry density (t/m^3)	1.07
	Initial liquor content (%)	67.0
	Dry density at zero volume change limit (t/m^3)	2.16
	Liquor content at zero volume change limit (%)	14.5
Permeability		
Falling head permeability (k)	Permeability (m/s) for sample moulded to 95%	3 x 10-9
One dimensional consolidation	Permeability (m/s)	1.2 x 10-8 to 2.2 x 10-9

Tailings and embankment materials strength

Tailings and embankment material strength properties applied for the slope stability assessment (Section 4.10.5.4) are summarised in Table 4.36.

Table 4.36 | Tailings and embankment material strength parameters

Material	Unit weight (kilonewton (kN)/m^3)	Cohesion (kPa)	Friction angle (degrees)	Vertical strength ratio (su/σ'v)	Minimum shear strength (kPa)
Moderately weathered to fresh bedrock	22	20	40	-	-
Extremely to moderately weathered bedrock	22	20	40	-	-
In situ gravelly clay and clay (residual soil and colluvium)	17	-	-	0.25	50
Stored tailings (undrained)	22	-	-	0.24	20

Material	Unit weight (kilonewton (kN)/m^3)	Cohesion (kPa)	Friction angle (degrees)	Vertical strength ratio (su/σ'v)	Minimum shear strength (kPa)
Stored tailings (liquified)	22	-	-	0.11	0
Embankment fill (compacted weathered rock)	22	0	33	-	-
Shear key and upstream toe berm fill (compacted weathered rock)	22	0	33	-	-
Upstream toe berm fill (compacted tailings)	22	0	30	-	-

4.10.3.7 Radiological properties

A summary of the tailings solids activity (measured in becquerel per gram (Bq/g)) and supernatant water radionuclide concentration (measured in becquerel per litre (Bq/L)) is presented in Table 4.37. Activities onsite, as covered by the RPC Act, are managed under a Radiation Management Plan and a Radioactive Waste Management Plan, approved by the EPA.

Table 4.37 | Indicative tailings solids and supernatant water activity

Metals and ions	Solids activity (Bq/g)	Supernatant activity (Bq/L)
Uranium (U^{238})	3.0	144.00
Thorium (Th^{230})	3.8	48.10
Radium (Ra^{226})	3.0	4.17
Polonium (Po^{210})	2.8	2.05
Lead (Pb^{210})	3.1	10.60

4.10.3.8 Tailings generation

Tailings generation for the revised TSF design (Appendix B1) has conservatively assumed a ramp-up from the current 5.3 Mt (dry) per annum to a maximum deposition rate of approximately 12 Mt (dry) per annum (beyond the current approved 6.9 Mtpa ore throughput rate for the operation, and subject to further approvals).

Tailings production at rates below the design assumption would result in a reduced rate of rise and increased timeframes between TSF stages than indicated in Table 4.32 and Table 4.38. For the purposes of this PEPR review, tailings deposition would be consistent with the approved ore throughput (i.e. up to 6.9 Mtpa as an annual average over the life of mine) and the total capacity of the TSF would be consistent with the current approved capacities of up to 144.9 Mt (dry) or 72.4 Mm^3.

Table 4.38 | Nominal forecast tailings generation

Year	Deposited tailings (dry t)	Cumulative tailings (dry t)
Operation commencement to 21 March 2023	12,575,000	12,575,000
Remainder of 2023	3,719,000	16,294,000
2024	5,265,000	21,559,000
2025	6,124,000	27,683,000
2026	6,597,000	34,280,000
2027	6,513,000	40,793,000
2028	6,448,000	47,242,000
2029	6,967,000	54,209,000
2030	9,402,000	63,611,000
2031	11,400,000	75,011,000
2032	11,400,000	86,411,000
2033	11,400,000	97,811,000
2034	11,400,000	109,211,000
2035	11,400,000	120,611,000
2036	11,400,000	132,011,000
2037	11,881,000	143,892,000
2038	12,375,000	156,267,000

4.10.3.9 Rate of rise

The rate of rise for the original TSF design outlined that tailings were going to be deposited in the TSF at relatively higher rate in the initial years of operation due to the small basin area adjacent to the embankment. As the operation advanced, the tailings beach area progressively became larger and therefore the rate of rise reduced. The maximum thickness of tailings at the end of Stage 1, i.e. at the end of Year 4 of operation, is approximately 12 m. The rate of rise was approximately 6 m/year at the end Year 1 of tailings deposition and was approximately 1.5 m/year at the end of Stage 1.

Current rate of rise for Stage 2A (as at December 2024) is approximately 3.4 m/year, relatively higher due to a change in deposition location away from the embankment, and expected to decrease over time as the beach area gets larger to approximately 3 m/year at the end of Stage 2A.

As outlined in the TSF design update (Appendix B1), the predicted rate of rise near the embankment for the flatter beach slope scenario, at the tailings generation rates described in Table 4.38, is 2.5 m/year for Stage 3A, 2.1 m/year for Stage 4A, and 2.0 m/year for Stage 5A. For the steeper beach slope scenario, the predicted rate of rise for tailings near the embankment for Stage 3A is 1.7 m/year, Stage 4A is 2.5 m/year and Stage 5A is 2.4 m/year.

As described in Section 4.10.3.8, tailings generation under this PEPR would be limited to be consistent with the approved ore throughput (i.e. up to 6.9 Mtpa) and thus the rates of rise described above represent the worst case values, with actual rates of rise likely to be lower.

4.10.4 Water management

Water management of the TSF is based on the removal (decant) of supernatant water from settled tailings within the TSF to the decant dam for recovery and reuse within the MPP. Tailings deposition is controlled to maintain the supernatant pond adjacent to the decant causeway located in the southern area of the facility (i.e. away from the TSF embankment). Water is subsequently removed from the supernatant pond via a series of decant towers within the decant causeway and conveyed to the decant dam via the outfall pipe that was installed with the Stage 1 works and extended southward at Stage 2. Because of this perimeter discharge arrangement, large flood surge capacity is available for all stages of the TSF.

4.10.4.1 Water balance

A water balance assessment was undertaken for TSF Stage 3 and Stage 5 for both the flatter and steeper beach slope scenarios and considered inflows to and outflows from the TSF and decant dam. The assessment is presented in detail in Appendix E of Appendix B1.

The water balance indicates that for all scenarios, the water decanted to the decant dam peaks during Stage 3B and decreases progressively with each subsequent stage. This is primarily due to the increased tailings beach area providing more area for evaporation. Some reduction also occurs as climate change reduces the overall rainfall available and increases the evaporation rate.

The water balance indicates that over most stages, the steeper beach scenario results in more decanted water to the decant dam compared to the flatter scenario (except at Stage 6, beyond the scope of this PEPR, when the beach area is relatively larger). It also indicates that in any given year, the monthly net water in the decant dam is expected to be highest between April and September when evaporation rates are relatively lower.

The average pump-out rate from the decant dam to the MPP in 2023 averaged between 3,000 and 4,000 m^3/day. Indicative pump out rates, based on the water balance, indicates that the maximum pump out rates would occur during Stage 3 (steeper beach profile) and total about 9,000 m^3/day under current median rainfall and climate conditions. This could be up to about 11,400 m^3/day under maximum rainfall and a representative concentration pathway (RCPW) 4.5 climate change scenario. The average and maximum pump out rates all decrease from Stage 3, reducing to approximately 1,500 to 2,100 m^3/day during later stages for the steep beach slope scenario under current and RCPW4.5 climate change scenarios.

A summary of water-related inputs and outputs to the TSF is presented in Table 4.39, and the water balance representative of a median rainfall and no climate change scenario presented in Table 4.40. Other scenarios (maximum rainfall and with consideration to the potential impacts of climate change) are presented in Appendix E to Appendix B1.

Table 4.39 | Summary of water inflows and outflows to the TSF

Source
Inflows
Tailings slurry water
Rainfall runoff from: • the crest and upstream slope of the TSF and decant dam embankments • the tailings surface • the catchment area beyond the edges of the tailings surface and the lined decant cell in the decant dam
Direct rainfall onto: • the supernatant pond on the tailings surface • the pond in the lined decant cell
Outflows
Evaporation from: • the tailings surface, considering differences between wet and dry areas of the tailings beach • the supernatant • the pond in the lined decant cell of the decant dam
Seepage losses at the base of the TSF
Interstitial water (water retained in the tailings as pore water)
Return water (water pumped from the lined decant cell to the MPP for reuse)

Table 4.40 | TSF water balance (median rainfall, no climate change scenario)

Parameter		Flatter beach scenario (%)		Steeper beach scenario (%)	
TSF		Stage 3	Stage 5	Stage 3	Stage 5
Inflows	Slurry water	93	92	93	92
	Rainfall	7	8	7	8
	Total	**100**	**100**	**100**	**100**
Outflows	Evaporation	48	55	47	55
	Seepage	1.8	1.8	1.8	1.8
	Interstitial	36	36	36	36
	Discharge to Decant Dam	14	7	15	7
	Total	**100**	**100**	**100**	**100**
Decant dam		Stage 3	Stage 5	Stage 3	Stage 5
Inflows	Discharge from TSF	96	94	97	93
	Rainfall	4	6	3	7
	Total	**100**	**100**	**100**	**100**
Outflows	Evaporation	5	7	4	7
	Seepage	0	0	0	0
	MPP return	95	93	96	93
	Total	**100**	**100**	**100**	**100**

4.10.4.2 Flood storage capacity

The estimated runoff volumes for the 1-in-100 AEP, 72-hour design rain event (without factoring for climate change) for the 1,390 ha catchment of the TSF and the combined 1,500 ha catchment of the TSF and decant dam are 404,000 m^3 and 440,000 m^3 respectively. These runoff volumes assume initial losses of 20 mm, followed by 20% of remaining rainfall draining to the respective pond locations in the TSF and decant dam. With consideration to climate change, these volumes increase to 435,000 to 521,500 m^3 and 470,000 to 562,700 m^3, respectively.

A summary of flood storage capacity for each TSF stage is presented in Table 4.41.

Table 4.41 | TSF flood storage capacity by stage

TSF stage	Spillway invert elevation (mRL)	Flood storage volume available (Mm^3)
Flatter beach scenario		
Stage 3	156.5	31.0
Stage 4	158.2	7.3
Stage 5	165.0	23.9
Stage 6	168.0	19.6
Steeper beach scenario		
Stage 3	156.5	19.1
Stage 4	158.2	18.5
Stage 5	165.0	37.9
Stage 6	168.0	26.9

4.10.4.3 Freeboard

With the original TSF design, the starter embankment included a nominal 3 m of freeboard above the ultimate level of the tailings beach, equating to approximately 10 Mm^3 of rainfall storage. This was sufficient for the storage of a 72-hour probable maximum precipitation (PMP) event of 742 mm of rainfall, assuming the supernatant pond is against the TSF embankment.

During normal operations, the size of the supernatant pond is limited via the use of a gravity decant system, evaporation losses and the recovery of returned water. The expected water storage capacity of the TSF would progressively decrease as the tailings height increases and freeboard decreases until additional capacity is provided by the construction of the additional embankment raise. The Stage 6 TSF water storage capacity is sufficient to retain a 72-hour PMP event in a 95th percentile rainfall year with 0.7 m freeboard (representing an additional 3.1 Mm^3 storage) remaining.

The TSF flood management capacity is based on 1:100,000 AEP critical duration rain event and 1:10 AEP wind-for-wave run-up freeboard, with spillway design criteria of ANCOLD for a ‘High C’ dam failure category (Appendix B1). Noting, the LOM layout for the TSF is shown to have surge capacity which exceeds the estimated flood volume from a PMP, 72-hour event. Considering the large surge capacity, a TSF spillway for LOM layout has been conservatively sized (based on the Stage 3 layout) for a 1-in-1000 AEP critical duration design rain event, assuming water at the spillway invert prior to the event, and allowing for 0.5 m freeboard.

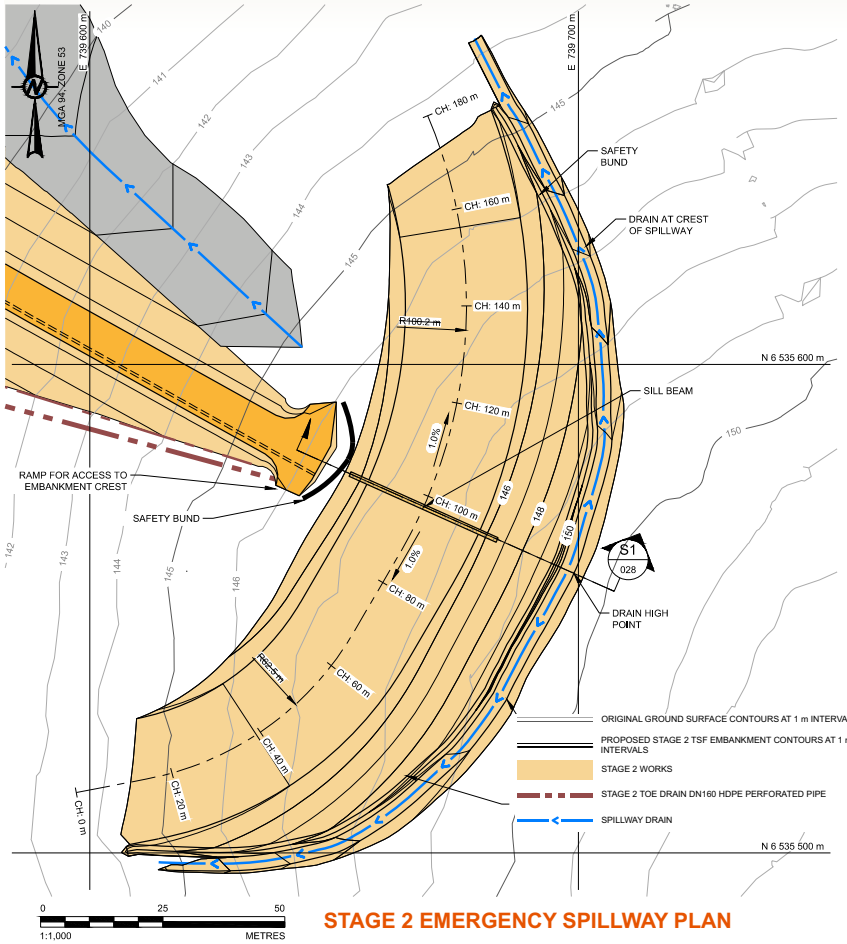
A summary of the designed freeboard criteria was presented in Table 4.30.

4.10.4.4 Emergency spillway

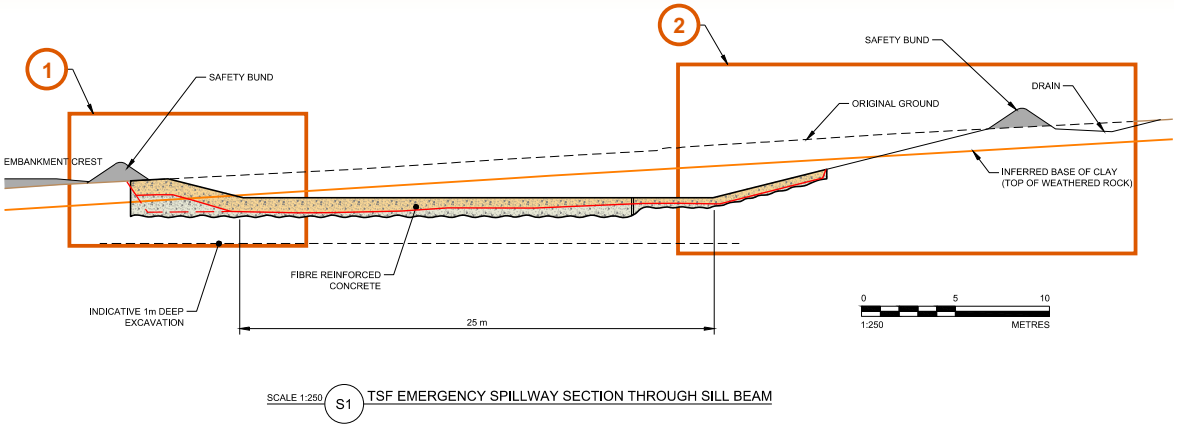
Emergency spillway inverts were provided for TSF Stage 1 and Stage 2 to manage flood waters, such that the TSF embankment does not overtop. These were generally located approximately 1 m below the TSF embankment crest for each stage.

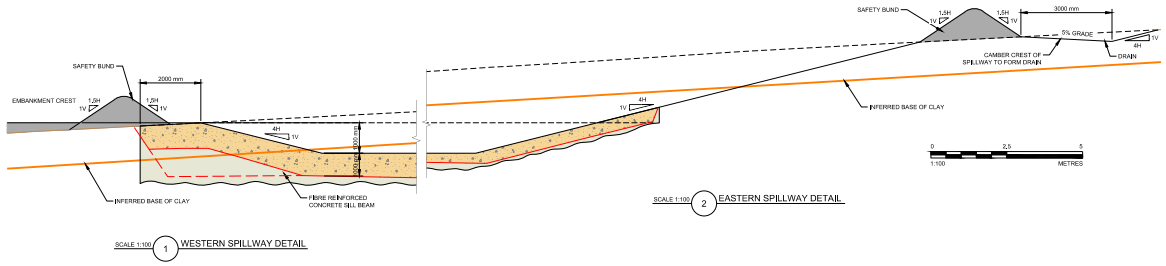
Due to the significant water storage capacity of the tailings during Stage 3 (see Section 4.10.4.2), it is not proposed to construct and operate an emergency spillway for TSF Stage 3. The Engineer of record has stated that ‘overtopping due to an extreme storm event is considered to be inconceivable and that a spillway could be excluded from the Stage 3 design and remain in accordance with ANCOLD and relevant guidelines such as GISTM’. The requirement for spillways for Stage 4 onwards would be reviewed prior to the commencement of construction of these raises, and at closure the facility would have a spillway.

Spillway layout and construction details are provided in Figure 4.26 reflecting the current Stage 2 spillway. These would be representative of future spillway arrangements at closure, or should spillways supporting future stages be determined to be required.



STAGE 2 EMERGENCY SPILLWAY PLAN





STAGE 2 EMERGENCY SPILLWAY DETAIL

STAGE 2 EMERGENCY SPILLWAY LONG SECTION

Figure 4.26 | Stage 2 emergency spillway layout and cross-section

4.10.4.5 Decant and decant dam

On the basis of the water balance for the updated TSF design and deposition schedule and predicted reductions in future net water in the decant dam, it is considered that an upgrade to the decant dam capacity is not required. The arrangement of the TSF decant system is summarised in Figure 4.27, and the supernatant decant and decant dam design and operation remain consistent with current approved practices as described below.

Supernatant water is removed from the TSF via a gravity outfall pipe, equipped with several decant inlets. Tailings is spigotted from the perimeter of the TSF so that supernatant water collects near at least one of the decant inlets. Initially the pond was located adjacent to the TSF embankment, with progressive deposition during Stage 2B directing the pond away from the embankment. Temporary decants are provided during the early stages of TSF formation until the pond is established at its final location. Development of the pond in this manner allows BHP to reduce the tailings rate-of-rise and reduce the size of the initial TSF embankment, correspondingly reducing the amount of construction material required.

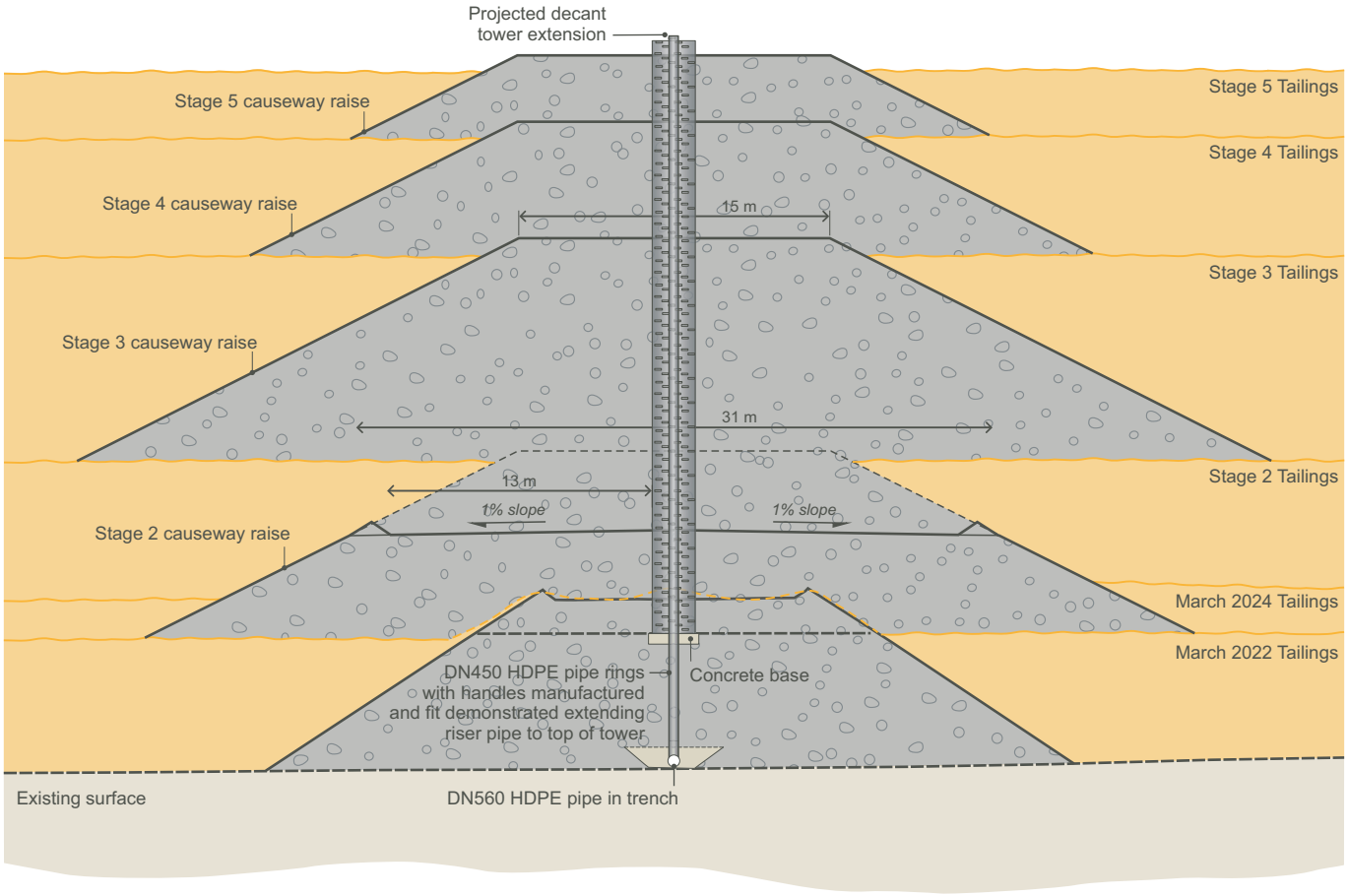
Each decant structure consists of a rock filter surrounding a 1.8 m diameter slotted reinforced tower. Water flows via gravity through the rock filter and tower into a decant riser pipe consisting of slotted or drilled 250 mm diameter PVC pipe that is connected to a buried HDPE decant pipeline. Captured water flows via gravity through this decant pipeline, under the TSF embankment and to a Decant Dam storage area for recovery to the MPP. As the supernatant pond moves away from the embankment during the initial years of operation, temporary decant structures are plugged with concrete and capped to prevent tailings ingress. A schematic of the TSF decant system is presented in Figure 4.27.

As water enters each decant structure, it flows out under gravity through the outfall pipework under the cross-valley TSF embankment and is temporarily stored in the Decant Dam storage area. The Decant Dam storage area, generated through the development of a Decant Dam embankment, has a storage capacity of approximately 500,000 m^3 (plus additional freeboard allowance) designed to store a 1-in-100 year, 72-hour rainfall event in addition to operational decant inventory that may be present in the dam prior to the rainfall event.

This has been calculated for the expected worst-case operational scenario, representing the initial operational phase when the TSF is relatively small and the tailings is being deposited at a 60% w/w solids. In later years, as the TSF surface area increases, water recovery will significantly decrease because of increasing evaporative capacity, and may result in no operational flows to the Decant Dam storage area during significant periods of the year.

A review of decant dam capacity is currently underway in the context of the revised Australian Rainfall and Runoff guidelines (updated in 2019, subsequent to the design of the decant dam). If this requires an increased decant dam freeboard, this will be achieved through a review of the decant dam design and operation during Stage 4 of the TSF operation.

DETAIL OF DECANT TOWER



CUTAWAY DIAGRAM DEMONSTRATING METHOD OF CLOSURE FOR TEMPORARY DECANT TOWER

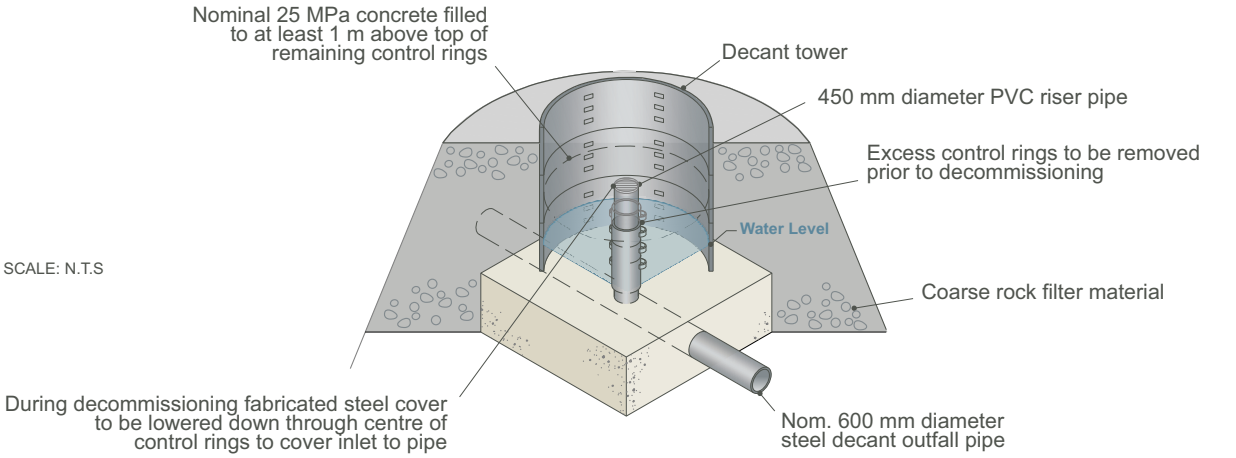


Figure 4.27 | TSF decant system

4.10.4.6 Seepage management

TSF design and management strategies

Management of seepage from the saturated tailings is mitigated through the following controls:

- A 1 m thick compacted clay layer over the watercourses within the Stage 1 tailings storage area.
- An upstream sloping zone of compacted clay in the Stage 1 and Stage 2 TSF embankment, extending into a cut-off key at the toe, where in situ soil is present.
- Dental concrete on fractured bedrock in the watercourse at the contact of the upstream sloping zone of compacted clay zone.
- A geosynthetic liner on the upstream slope of the Stage 1 TSF embankment.
- A seepage collection drain at the upstream toe of the TSF embankment, with two outfall pipes that extend through the foundation of the TSF embankment and along the watercourse of the Decant Dam storage area to the geosynthetic lined decant cell.
- A seepage cut-off drain at the downstream toe of the TSF embankment. The drain is a subsoil drain where in situ soil and extremely weathered bedrock is present. A trench and sump is formed in the fractured moderately-weathered bedrock for monitoring and extraction of shallow lateral seepage water.

The development of the TSF is undertaken in a manner that limits disturbance to the colluvium clay soils that form the TSF base, and act as a confining layer for seepage. This is achieved by establishing construction borrow pits outside the current approved TSF footprint (see Section 4.11.5.2).

As summarised above, a geosynthetic liner is installed in the upstream slope of the Stage 1 TSF embankment, anchored into the cut-off key trench at the upstream toe. The liner, coupled with the compacted clay, limits seepage through the embankment. It also protects the clay from desiccation by sun drying. This liner has an effective permeability of less than 1×10^{-9} m/s and is at least 1.5 mm thick. Coupled with this, an upstream sloping zone of compacted clay has been formed in the Stage 1 and Stage 2 TSF embankments for seepage control. For subsequent raises, where the embankment extends onto natural ground, a central core of compacted clay is formed. The compacted clay zones are protected against piping erosion by compacted weathered rock.

In response to observed lateral seepage (see following sections) a number of additional seepage mitigations were installed, specifically:

- Three temporary sumps were installed in July 2020 to allow for pump extraction to depressurise seepage downstream of the Stage 1 embankment. The sumps were installed in pits that were excavated through the soil and into the weathered bedrock, to a maximum depth of 3 m. The pits encountered seepage flow. Sumps were installed with drainage aggregate and a vertical DN315 HDPE pipe for pump extraction. The measured total rate of pump extraction from the three sumps within the Stage 2 footprint, and the cut-off drain sump downstream of the Stage 2 footprint, steadily declined from about 80 kL/d in December 2020 to 60 kL/d in mid-May 2021. The sumps in the Stage 2 embankment footprint were decommissioned in May/June 2021, to allow for installation of the seepage collection drains and new sump downstream of the Stage 2 embankment footprint.

- A downstream seepage collection system, to depressurise the Stage 2 embankment foundation, was installed between April 2021 and August 2021. The seepage collection system comprises a network of slotted DN160 HDPE pipes surrounded by drainage aggregate and wrapped in filter geotextile. Rockfill shear keys with a coarse rockfill basal layer are connected to the drains. The drains were installed in bedrock and grade downwards towards a sump near the projected toe of the Stage 2 embankment. The sump is formed by a 1.5 m diameter concrete tower, with three connecting DN160 HDPE inlet pipes. Pump extraction from the new sump commenced in mid-2021 and pumping and measurement of pumping rate will continue into Stage 2 operation until seepage ceases. With the upgraded seepage collection system covering a larger footprint, the combined pump extraction from the new sump and the cut-off drain sump averaged about 150 kL/d (1.8 L/s) between June 2021 and early November 2021. As of early November 2021, the total seepage rate was up to about 200 kL/d (2.3 L/s).
- A cut-off drain and collection sump were installed downstream of the Stage 2 embankment footprint, at Stage 1. The drain is formed by a slotted DN160 HDPE pipe surrounded by drainage aggregate and wrapped in filter geotextile, installed nominally 500 mm into the weathered bedrock. Pump extraction is via a vertical DN315 HDPE pipe, located about 50 m downstream of the projected Stage 2 embankment and pumping and measurement of pumping rate will continue into Stage 2 operation.
- A drain was installed along the upstream toe of the Stage 1 embankment and has been extended to near the abutments of the Stage 2 embankment. The drain comprises slotted DN160 HDPE pipe, surrounded by drainage aggregate and wrapped in filter geotextile. Seepage will continue to discharge via the two DN225 HDPE outfall pipes that were installed at Stage 1. These pipes discharge into the pipe junction pit, about 40 m downstream of the Stage 2 embankment toe, which in turn discharges to the Decant Dam via the DN560 HDPE outfall pipe.
- Stage 3 seepage management will include a lateral seepage collection system to be installed under the Stage 3 embankment, and modification, as necessary, of previously installed seepage collection and management infrastructure to allow for the downstream raise Stage 3 construction methodology.

Decant dam seepage design and management strategies

Management of the supernatant water, shallow lateral seepage and accumulated rainfall runoff in the Decant Dam are addressed by the following design and management controls:

- A central compacted clay core, extending into a cut-off key trench where in situ soil is present.
- Dental concrete on fractured bedrock in the watercourse at the contact of the central clay core.
- A geosynthetic-lined decant cell in the Decant Dam, at the upstream toe of the embankment to manage seepage and decant water from the TSF. The lined decant cell has a capacity of approximately 43 ML to provide up to 40,000 m^3 of lined storage capacity.
- A seepage cut-off drain at the downstream toe of the Decant Dam embankment. The drain is a subsoil drain where in situ soil and extremely weathered bedrock is present. A trench and sump is formed in the fractured moderately weathered bedrock for monitoring of and extraction of shallow lateral seepage water.

At the Decant Dam, a central core of compacted clay, protected by compacted weathered rock, is installed for seepage control. A liner is not required on the upstream slope of the Stage 2 (or later) embankment due to the predicted pond location by the time the tailings beach contacts the raised portion of the embankment; however a liner was still included on the as-constructed upstream slope of Stage 2.

The cut-off key trenches are excavated into the foundation of the embankments where contact would be made with the compacted clay zone. The depth is nominally 0.5 m, to limit excavation into the underlying bedrock. The trenches are backfilled with compacted clay as part of the main compacted clay zone in the embankment. Concrete grout is applied to the base of the trench where the bedrock is exposed.

The seepage collection drains are formed by installation of:

- Nominal 160 mm diameter drainage coil pipes along the upstream toe of the TSF embankment, encapsulated in drainage aggregate wrapped in a geotextile.
- Nominal 300 mm diameter solid wall pipes through the foundation of the TSF embankment. One of the pipes (the primary seepage outlet pipe) would be installed adjacent to one of the decant outfall pipes. Reinforced concrete is formed to a trapezoidal shape around the pipes where they pass through the embankment. The reinforced concrete would limit the risk of piping erosion through potentially loose fill that may otherwise be placed around the pipe. It would also be extended for the remaining length of the Stage 1 and Stage 2 embankment footprint for protection of the pipe.
- A larger outlet pipe is proposed relative to the collector pipes, as the outlet pipes would also be used for water management, in conjunction with the coffer dams, during start-up works. Joiners would facilitate the transition between the drainage coil pipes and the larger steel outlet pipes. Puddle flanges would also be included at each joiner, to limit the potential for seepage between the pipe and reinforced concrete interface.

Where bedrock is exposed along the watercourses within the embankment foundation, grout is placed over the cleaned bedrock surface to seal fractures, with the objective to limit seepage flow at the interface with the embankment fill. Seepage management infrastructure is shown in Figure 4.28.

Predicted seepage rates

An analysis of the expected seepage rates from the TSF was undertaken, the results of which are summarised below:

- The rate of seepage through the base of the TSF (i.e. over the tailings storage footprint area) is in the order of 2 L/s.
- The toe drain is expected to discharge seepage flows in the order of 0.005 L/s. However, design capacity for up to 0.5 L/s has been provided to allow contingency for higher flow rates during initial filling when the supernatant pond will be in direct contact with the drain.
- The near-surface (lateral) seepage rate beneath the embankment was estimated to be approximately 1,400 L/d (0.02 L/s) for average conditions during Stage 1 and thereafter the average lateral seepage rate was estimated to be approximately 15 L/d (0.0002 L/s). These rates were significantly less than the estimated (downward) seepage through the base of the TSF, i.e. approximately 4% of vertical seepage for Stage 1 and decreasing to less than 0.01% of vertical seepage in the later stages of operation. This indicates that of the low volume of seepage that does flow through the base, the majority will flow downwards, albeit at a low rate due to the lack of a hydraulic gradient in this zone.

- The higher rate of lateral seepage during Stage 1 was attributed to the relatively large supernatant pond applying a head to the exposed fractured bedrock in the watercourses. The significant decrease after Stage 1 is attributed to movement of the supernatant pond away from the confined area adjacent to the embankment, its diminishing size (and intermittency of ponding) and the accumulation of predominantly unsaturated tailings that will limit it from applying a head to the fractured bedrock in the watercourses.
- A liner over the watercourses in the Stage 1 footprint was predicted to reduce the vertical seepage rate from approximately 35,000 L/d to 7,000 L/d and the lateral seepage rate from 1,400 L/d to approximately 10 L/d. Lining the watercourse past the Stage 1 footprint was not predicted to result in a significant reduction of the seepage rates.
- The sensitivity analyses indicates that the rate of seepage through the base of the TSF is unlikely to vary significantly from the expected conditions. However, there may be less seepage experienced during operations if the hydraulic conductivity of the tailings is lower than adopted for the analyses. Whilst the adopted value has a higher hydraulic conductivity than the values indicated by laboratory testing, it is expected that some macro effects such as desiccation cracking and segregation of the tailings will influence this value in reality. It is therefore expected that the rate of seepage through the base of the TSF will not vary significantly from the reported results.

Seepage originating from the Decant Dam was assessed assuming the dam was full following a 1-in-100 AEP, 72-hour event, the results indicating:

- Between 10% and 15% of the volume of stormwater from the 1-in-100 AEP, 72-hour event is estimated to be lost to seepage if the Decant Dam pond is removed by pumping over a period of 14 days.
- Less than 1% of the seepage volume is expected to flow laterally through the fractured bedrock at the watercourse. The results indicate that the lateral seepage rate is expected to remain consistently low across all scenarios assessed.
- Seepage losses for a 28-day pond removal period are not expected to vary significantly from the 14-day pond removal period results.

Observed lateral seepage

Shallow seepage and measured rates from wet patches of lateral seepage developed near the downstream toe of the TSF Stage 1 embankment in June 2020, about four months after commissioning of the TSF. Temporary sumps were installed and, prior to their decommissioning at end of May 2021, the combined measured rate from all sumps was about 100 kL/day. The temporary sumps were replaced in June 2021 with seepage collection drains in the TSF Stage 2 embankment foundation, and a sump for pump extraction outside the footprint of the projected Stage 2 TSF embankment.

The TSF Stage 2 embankment, including upstream bituminous geomembrane liner was subsequently constructed between November 2021 and December 2022. Following the installation of the Stage 2 seepage collection system, the combined pumped rate from both sumps peaked at approximately 300 kL/day and has subsequently declined to about 225 kL/day at the present time. Investigations into the potential causes of the lateral seepage identified that during TSF Stage 1 operations, the supernatant pond extended over a significant area of natural ground on the eastern side of the TSF, allowing increased infiltration rates.

Wet patches and minor seepage flow also developed near the toe of the TSF Stage 2 embankment during embankment raising activities in March 2022. The extent of seepage declined following the transition to tailings deposition on the TSF embankment that moved the supernatant pond away from the embankment and away from the natural ground on the eastern side of the TSF. Measured lateral seepage collected in the sumps has since remained steady at about 225 kL/day.

Seepage rate assessment

An assessment of the potential seepage rates was reviewed and is presented in detail in Appendix F of Appendix B1.

The seepage assessment was undertaken using the software Seep/W developed by Geostudio, which is an industry-standard two-dimensional (2D) finite element numerical modelling software, widely used for the estimation of seepage from TSFs and water dams. The analyses were conducted using a staged development sequence, in which the foundation, embankment and tailings were simulated in layers based on their estimated hydrogeological properties. The key findings of the seepage assessment were:

- Shallow lateral seepage below the TSF embankment is predicted to reduce from the current observed rates to about 25 kL/day by the end of TSF operations. To support management of this seepage, existing collection systems near the downstream toe of the TSF Stage 2 embankment will be extended downstream of the projected TSF Stage 3 embankment.
- Seepage through the base of the TSF is predicted to reduce from about 350 kL/day currently to about 20 kL/day by the end of TSF operations. However, the seepage rate, combined with the low storativity of the bedrock beneath the TSF is expected to result in groundwater elevation rise (mounding) below the TSF and ultimately leading to a phreatic surface within the tailings mass.

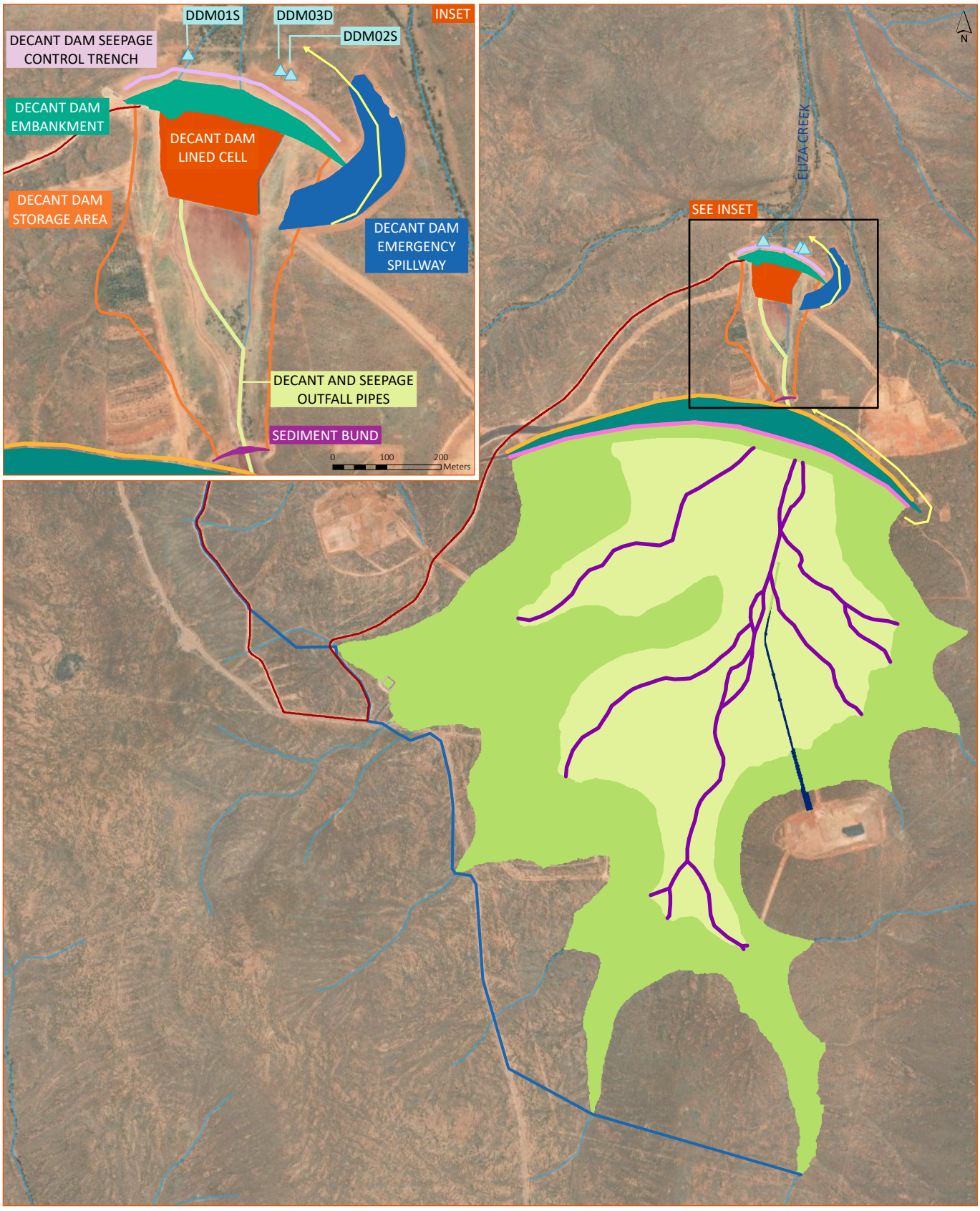


Figure 4.14 | TSF seepage management infrastructure

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4.10.5 TSF and decant dam embankments

Updates to the design of the TSF embankment are described in the following sections, with the TSF Stage 3 embankment cross-section presented in Figure 4.29. There are no proposed changes to the decant dam design and operation.

The embankment staging plan is the same for the flatter and steeper beach slope scenarios, except for the saddle dam that is required at the head of the valley at Stage 5 (and Stage 6, subject to further approvals) for the steeper beach slope scenario to provide the required tailings storage capacity.

The TSF embankment raises will likely be formed with compacted rockfill, sourced from quarries near the TSF and/or reclaimed from the WRD. A geosynthetic liner would be installed on the upstream face of each raise.

The following geometry was adopted for the embankment and saddle dams:

- 3:1 (H:V) downstream slopes
- 3:1 (H:V) upstream slopes
- 8 m crest width
- for the Stage 3 downstream raise, the upstream of the embankment raise is offset 5 m from the upstream crest edge of the Stage 2 embankment, to facilitate liner anchoring
- for the upstream raises, the downstream toe of the embankment raise connects to the upstream crest edge of the existing/previously constructed embankment.

4.10.5.1 Tailings embankment raise design

Stage 1 (as-built)

Stage 1 construction was completed in August 2019 and comprised the starter embankment, the seepage collection and gravity decant systems and the Decant Dam. The works were undertaken in the following sequence, with some activities occurring concurrently:

- Construction of access roads to and around the perimeter of the Stage 1 TSF and Decant Dam impoundments.
- Preparation of subgrade for the TSF starter embankment and coffer dam footprints.
- Construction of the cut-off key for the starter embankment.
- Installation of solid wall outfall pipes (and encasement) in the embankment footprint for the gravity decant and seepage systems, including extension of two pipes upstream of the starter embankment to the upstream toe of the two coffer dams. Downstream of the Stage 2 embankment footprint, the seepage pipes converge into a single outfall pipe that extends to the lined decant cell. The decant outfall pipes also converge into a single outfall pipe, with flanges to allow for decommissioning of the Stage 1 decant outfall pipe during Stage 2.
- Construction of two coffer dams to provide for the passive release of stormwater during initial construction of the starter embankment. The coffer dams are formed with compacted (general) weathered rock. The pipes provide for passive discharge of water and are blanked prior to construction of the Decant Dam, located further downstream. The coffer dams decommissioned following completion of the TSF starter embankment. The portion of pipe between the West Coffer

Dam and the TSF embankment is then removed and the pipe between the East Coffer Dam and the TSF embankment extended further into the impoundment area for the decant system.

- Construction of the Stage 1 (starter) embankment. Construction of the starter embankment proceeded following installation of the aforementioned pipes through the embankment foundation. A reinforced concrete flange was formed around the pipes where they pass through the cut-off key trench at the upstream toe of the embankment to limit seepage related erosion risks. Reinforced concrete was installed around the remaining length of the pipes within the embankment footprint.
- Once the starter embankment was at least 3 m above the crest of the coffer dams, the outfall pipes were blanked to allow for construction of the Decant Dam embankment. Construction of the TSF starter embankment and the Decant Dam embankment then progressed simultaneously.
- Construction of the Decant Dam, located downstream of the TSF embankment, with similar subgrade preparation and cut-off key construction to that described above for the starter embankment. The embankment is predominantly formed with compacted clay and compacted weathered rock, sourced from borrow pits (refer Section 4.11.5). Select mine waste rock is used for erosion protection of the embankment slopes.
- Construction of the lined decant cell in the Decant Dam impoundment. Subgrade preparation is similar to that described above for the TSF starter embankment. A ‘cut-to-fill’ approach, using clay soil within the footprint, is adopted to form the floor and side bunds of the cell. Additional clay is sourced from borrow pits, as required, for construction of the cell. A layer of crushed rock is placed over the geosynthetic liner for ballast and the sump lined with concrete. A return water pipe extends up the slope and to the crest of the Decant Dam embankment. The embankment is locally widened to facilitate a pump access platform.
- The coffer dam outfall pipes are reopened once the height of the Decant Dam embankment is at least 5 m above ground (at the watercourse) and the lined decant cell is constructed. This approach allows for some retention of water at both the starter embankment and the Decant Dam, thus limiting potential stormwater flows downstream of the works area during construction. The potential for erosion of the upstream slope of the Decant Dam embankment is limited as the compacted weathered rock will be relatively resistant to erosion. The compacted clay soil zone on the upstream slope of the starter embankment was overconstructed to allow for subsequent trimming (of a surface potentially degraded by desiccation and/or erosion) prior to decant chute and geosynthetic liner installation.
- Installation of a junction box at the upstream toe of the starter embankment, connecting the outfall pipe with the decant chute, installed on the upstream slope. The junction box and chute are formed by reinforced concrete.
- Installation of a geosynthetic liner on the upstream slope of the starter embankment. As noted above, the compacted clay on the upstream slope was placed wider than the design width to allow for trimming prior to installation of the geosynthetic liner. Trimming of the clay enables a smooth subgrade for liner installation. The liner is anchored into a trench at the crest of the embankment. At the toe, the liner is anchored in a trench or by concrete, subject to ground conditions. The liner is connected to the edge of the decant chute via steel batten bars.
- Installation of the seepage collection drain at the upstream toe of the embankment, inclusive of perforated HDPE pipe, aggregate and filter geotextile and connection of perforated pipe to the solid wall outfall pipes.

- Installation of the seepage cut-off drain and extraction sump at the downstream toe of the Stage 2 embankment footprint, inclusive of trench excavation, drainage coil pipe, aggregate and filter geotextile. The trench into the bedrock for the sump is formed by rock saw trenching machine, and the sump finished with a concrete bund around the rim and reinforced concrete lids.
- Construction of a 1 m thick compacted clay liner over the watercourses within the Stage 1 tailings storage area. Preparatory works included removal of loose soil and rock from the base of the watercourses and compaction at the edges, where in situ soil was loosened by clearing and grubbing. A layer of loose soil is placed over the compacted clay liner to limit desiccation cracking prior to it being covered by tailings. Parts of the clay liner were installed prior to construction of the coffer dams and the causeway.
- The outfall pipe and initial sections of the riser pipes for the second gravity decant system (required for Stage 2 to Stage 6) will be installed prior to construction of the decant access causeway. Compacted weathered rock is installed directly around the riser pipe, i.e. below the towers. Slotted concrete ring-style decant towers and PVC riser pipes are installed at subsequent stages. The remainder of the causeway is formed with compacted weathered rock. Subgrade preparation will be similar to that described above for the starter embankment.
- Installation of concrete ring-style decant towers with surrounding filter rock. The filter rock is produced by screening waste rock. A decant access causeway is constructed to access the temporary and final towers.
- Construction of a wearing course and safety bunds on the crest of the embankments and the decant access causeway with crushed rock

Stage 2 (as-built)

The Stage 2 embankment raises have been formed with compacted mine rockfill and the embankment footprint being partially over the downstream face of the Stage 1 embankment and partially over natural ground. The Stage 2 embankment extends past the Stage 1 embankment abutments by approximately 260 m on the western side and 170 m on the eastern side, for a total length of about 1,500 m. Coarse rockfill has been placed on the downstream face of the Stage 2 embankment for erosion protection, noting that the downstream slope forms part of the final landform (due to future raises being by the upstream method). The upstream slope of the embankment is lined with a bituminous geomembrane.

V-drains have been excavated near the downstream toe of the embankment, with the invert about 10 m offset from the downstream toe, to divert surface drainage away from the embankment. The emergency spillway has been excavated into natural ground at the east abutment.

The Stage 1 decant system was decommissioned in the early phase of Stage 2B operation once the supernatant pond was shifted at least 200 m away from the embankment. The causeway raise was constructed with compacted mine rockfill, with raise construction partially over the existing structure and partially onto the tailings surface.

A general overview of the main works items is provided below:

- TSF Stage 2 embankment, upstream seepage drain extensions, downstream surface drains and emergency spillway:
    - Embankment foundation grubbing and stripping, scarification and compaction, and proof rolling.

  - Construction of the raise to the Stage 1 embankment to form the Stage 2 embankment. The embankment is mostly formed with compacted rockfill, sourced primarily from the WRD but also weathered rock borrow pits as required. Rockfill with a reduced particle size was placed on the upstream slope to form a subgrade for the liner. Coarse (screened) mine rockfill was placed on the downstream slope for long-term erosion protection.
  - Excavation of surface drains near the downstream toe of the TSF embankment to divert drainage away from the toe.
  - Extensions to the upstream seepage collection drain, to the west and east abutments of the Stage 2 embankment, including installation of perforated HDPE pipe, drainage aggregate, non-woven geotextile, and connections to the existing drains.
  - Construction of the emergency spillway at the east abutment of the Stage 2 embankment, including excavation to form the spillway, installation of a reinforced concrete sill beam at the spillway invert and a camber drain at the crest of the eastern batter of the spillway.
- Decant Dam spillway upgrade by way of excavation of a camber drain at the crest of the eastern batter of the spillway.
- Decommissioning of the Stage 1 gravity decant system, nominally in the first year of Stage 2B operation, once the pond shifted away from the embankment, by grouting the outfall pipe backfilling the chute and junction box with either grout or cement stabilised sand.
- Construction of the decant causeway raise to the gravity decant tower system and access causeway by installation of vertical extensions of riser pipes and installation of reinforced concrete foundations and new slotted concrete tower ring units and widening and raise of the causeway using compacted weathered rockfill and filter rock around the decant towers.

Stage 3 (proposed)

The embankment for the Stage 3 downstream raise would be formed with a main zone of compacted rockfill and the following features:

- a 1 m thick layer of coarse rockfill on the downstream face, for erosion protection
- a 0.5 m thick layer of compacted screened rockfill on the upstream face and at the embankment crest, to form a bedding surface for liner installation
- a bituminous geomembrane liner on the upstream face and ballast tubes over the liner
- a 0.3 m thick layer of compacted screened rockfill at the embankment crest to form a wearing course for vehicle traffic and safety bunds at both sides of the crest, with local thickening near the upstream crest edge to facilitate liner anchoring
- upstream toe drains extended to the abutments of the embankment for each stage.

Foundation preparation for the embankment would nominally include the following:

- clearing of the footprint area and stripping of topsoil
- for the Stage 3 downstream raise, stripping of clay downstream of the Stage 2 embankment to expose weathered bedrock, where this may be refined at future design, to removal within a shear key trench
- scarification of in situ clay between the abutments for embankment raises, to a depth of 0.3 m.

Stage 4, Stage 5 and Stage 6 (proposed)

For Stage 4 to Stage 6 upstream raises, the following features would be progressed:

- trenching excavation in tailings at the downstream toe area of each raise, for shear keys
- backfilling trenches with coarse rockfill
- installing seepage extraction pipes at 100 m intervals along the shear keys
- installing a layer of coarse rockfill into the tailings surface to form a pioneer layer over the footprint of each upstream embankment raise and the upstream toe berms
- forming upstream toe berms with compacted tailings, covered with a layer of coarse rockfill for erosion protection.

4.10.5.2 Decant Dam embankment design

Similar to the TSF embankment, the Decant Dam embankment is formed in a cross-valley fashion. The internal geometry comprises a central core of compacted clay, with compacted weathered rock either side for control of piping erosion, rainfall runoff erosion, desiccation by sun drying and to improve geotechnical stability. The crest of the clay core is above the full storage level in the Decant Dam to limit potential seepage through the embankment. A layer of compacted rockfill is placed on the upstream and downstream slopes for additional erosion protection. Figure 4.30 presents a cross-section of the Decant Dam embankment.

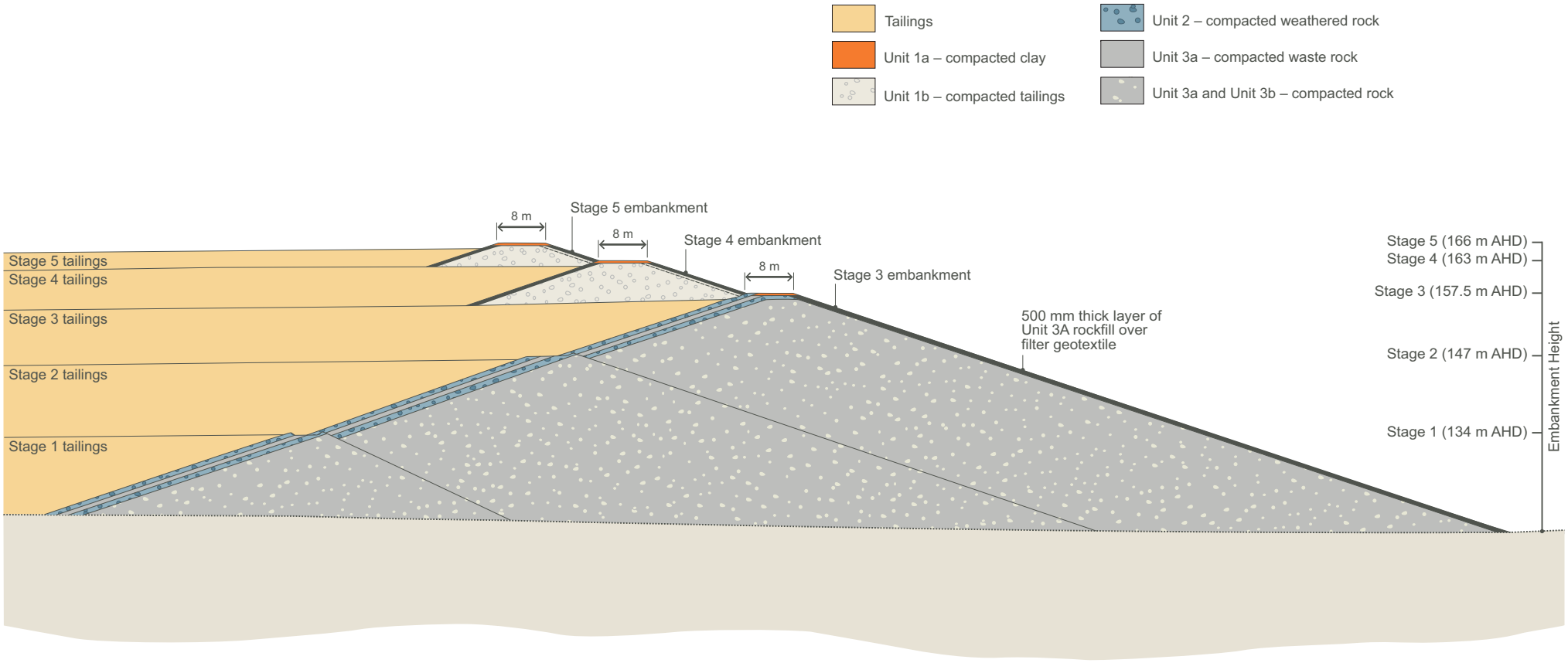


Figure 4.29 | TSF embankment cross-section

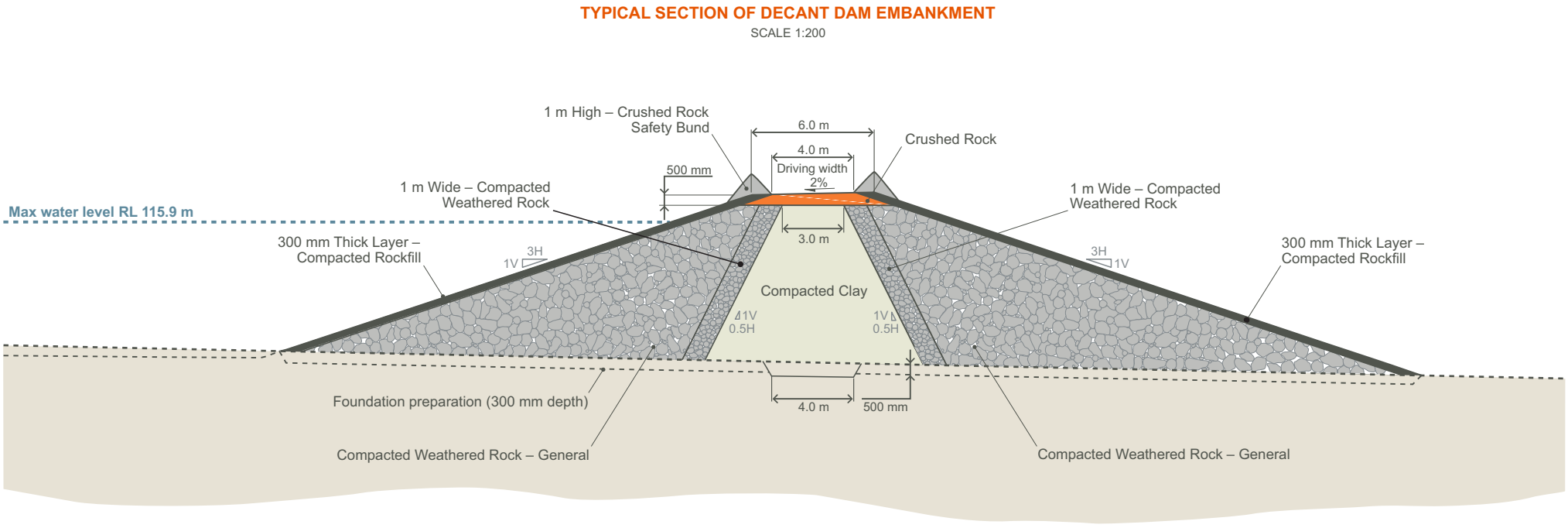


Figure 4.30 | TSF decant dam embankment cross-section

4.10.5.3 Materials requirements

Fill quantities required to enable Stage 3 embankment construction are summarised in Table 4.42.

Table 4.42 | Estimated Stage 3 embankment fill quantities

Embankment aspect	Fill volume (m^3)
Stage 3 embankment raise	
Moderately to slightly weathered rock from borrow pit, screened as required for maximum 250 mm particle size	2,580,000
Moderately to slightly weathered rock from borrow pit, screened to produce stockpiles of screened rockfill (well graded with maximum particle size of 50 mm)	30,000
Moderately to slightly weathered rock from borrow pit, screened to produce stockpiles of coarse rockfill (50 mm to 300 mm particle size)	172,000
Upstream toe drain extensions	
Drainage aggregate (10 mm to 20 mm particle size) from a commercial quarry	700
Moderately to slightly weathered rock from borrow pit	700
Embankment crest	
Moderately to slightly weathered rock from borrow pit, screened to produce stockpiles of screened rockfill (well graded with maximum particle size of 50 mm)	13,800
Moderately to slightly weathered rock from borrow pit, screened to produce stockpiles of coarse rockfill (50 mm to 300 mm particle size)	2,700
Emergency spillway	
Moderately to slightly weathered rock from quarry, and screen to produce stockpiles of coarse rockfill (50 mm to 300 mm particle size)	500
Decant causeway raise	
Moderately to slightly weathered rock from borrow pit	138,600
Moderately to slightly weathered rock from borrow pit, crushed and screened to produce stockpile(s) of filter rock (50 mm to 150 mm particle size)	36,000
Moderately to slightly weathered rock from borrow pit, screened to produce stockpile(s) of screened rockfill (well graded with maximum particle size of 50 mm)	2,500
Moderately to slightly weathered rock from borrow pit, screened to produce stockpiles of coarse rockfill (50 mm to 300 mm particle size)	1,000

4.10.5.4 Embankment stability

Details of the embankment slope stability analyses are presented in detail in Appendix J of Appendix B1 and summarised below.

Criteria and scenarios

The minimum factor of safety (FoS) adopted for the TSF are those outlined in the ANCOLD (2019) guidelines, with the scenario to be modelled based on the consequence category of the TSF, specifically:

- static, short-term undrained and long-term drained strength parameters and loss of containment – an FoS of 1.5 was adopted

- post-seismic, post-liquification strength – an FoS of 1.1 was adopted.

The flatter beach profile was selected for analyses on the basis that it results in more tailings and less embankment fill beneath the upstream raises, representing the most vulnerable scenario. This cross-section was subsequently progressively analysed for slope stability using the Rocscience 'Slide2' program with the General Limited Equilibrium (GLE)/Morgenstern-Price method.

Outcomes

The outcomes of the slope stability analyses are presented in detail in Appendix J to Appendix B1, and demonstrated that:

- downstream slope failure scenarios for the Stage 3 embankment met the required FoS criteria when clay was excluded from the embankment foundation and a shear key added
- upstream slope failure scenarios for the Stage 4 and Stage 5 embankments met the required FoS criteria when an upstream toe berm was added to the embankment design, and downstream slope failure scenarios met the FoS criteria under all design configurations

4.10.5.5 Dam breach assessment

Details of the dam breach assessment are presented in detail in Appendix H of Appendix B1 and summarised below.

Context

Dam breach assessments are performed to inform the TSF consequence classification (Section 4.10.2.7) and to provide input into emergency plans that would be enacted in the hypothetical occurrence of a TSF dam breach.

A dam breach study does not imply that a TSF is unsafe, and specifically excludes any consideration of the likelihood of a failure occurring. Rather, it is a proactive method that uses potential failure modes which assumes that a dam breach is initiated irrespective of likelihood.

Relevant TSF design and construction standards and guidelines, including Mineral Policy 007 (DEM 2021c) (Section 4.10.2.1), require that a TSF dam breach assessment is undertaken for all TSFs in South Australia.

Scenarios

The dam breach assessment was undertaken on 3 credible TSF embankment failure scenarios, specifically:

- Scenario 1 – failure of the Stage 6 TSF embankment via slope instability and the liquefaction of tailings (Figure 4.31)
- Scenario 2 – failure of the Stage 3 TSF embankment resulting from overtopping following a failure of the tailings delivery pipeline that leads to erosion of the embankment crest and a loss of freeboard
- Scenario 3 – failure of the Stage 6 TSF embankment resulting from overtopping following a failure of the tailings delivery pipeline that leads to erosion of the embankment crest and a loss of freeboard.

In each of the scenarios it was assumed that a 72-hour PMP rainfall event had occurred prior to the failure, resulting in the ponding of water on the TSF surface (both Stage 3 and Stage 6 have sufficient capacity to store a PMP event on the tailings beach), and that the decant dam embankment had also failed, and thus provides no additional impediment to flows from a TSF embankment breach.

The failure location was selected to be the point on the TSF embankment that has the greatest elevation above natural ground, generally the point over Eliza Creek.

Outcomes

The runout extents for Scenario 1, Scenario 2, and Scenario 3 were very similar, with all scenarios reaching 15 km downstream of the TSF embankment and presenting relatively consistent maximum velocities and flow depths. This was due to a lack of opportunity for flow attenuation in the Eliza Creek watercourse and the large release volume of stored water mixing with the tailings slurry.

The flow path downstream of the decant dam was on average about 900 m wide, tapering to about 700 m wide near the end of Eliza Creek. In general, depending on topography, the maximum recorded flow depth and velocity decreases along the length of the runout path, as tailings gradually come to a stop.

The results of this dam breach analysis indicate a consistent, but larger inundation extent than that of the previous assessment completed in 2017 (OZ Minerals 2017c), largely because of changes to modelling parameters and assumptions rather than outright changes in released tailings volumes, and specifically:

- The 2017 assessment considered dam breach and runout for sunny day conditions (no significant water pond), whereas the current assessment presents results for a post-flood day scenario, and as such large water pond was present at the time of release.
- A larger total volume of material is released for each scenario and of that, a larger proportion of the released volume is water.
- The current assessment adopted tailings flow parameters (rheology) from recent test data that differ from the assumed tailings flow parameters previously used.
- Tailings material was modelled as a Bingham fluid, whereas the previous assessment adopted data from literature, and used the Carreau model for fluid viscosity and yield stress.
- The inclusion of tailings and water mixing in this current assessment, which acts to reduce the overall solids concentration of tailings slurry dynamically as the model progresses. This level of modelling complexity was not available for the 2017 assessment.

Generally, the flow path between all scenarios was similar, with Scenario 1 and Scenario 2 having a slightly wider flow path compared to Scenario 3 due to the larger release volumes. Model results indicated maximum flow depths were highest near the TSF breach location and reduced towards the end of Eliza Creek. Maximum velocity results followed a similar pattern, generally reducing along Eliza Creek.

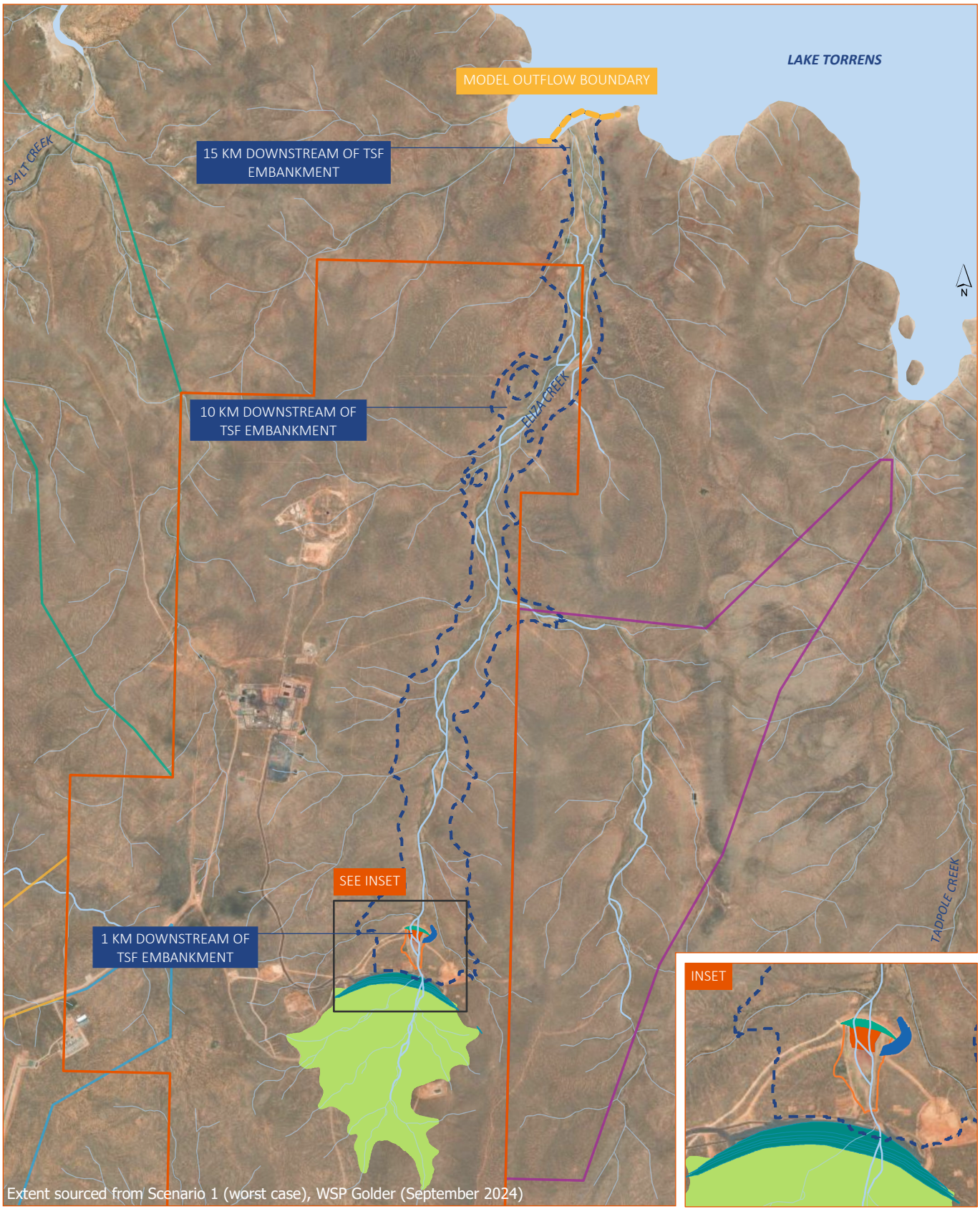
Model results indicated that flood severity classifications remained high for almost all inundated areas. This is attributed to the flow from the TSF being focused within Eliza Creek.

The model results did not indicate inundation of significant infrastructure, except for the decant dam (which was assumed to have failed prior).

Saddle dam failure

Specific assessment of the outcomes of a failure of the southern saddle dam (required at Stage 5 and Stage 6 of the steeper beach TSF scenario) were not undertaken on the basis that the volumes of material

that may be released from such a failure were relatively minor. Nevertheless, such a failure would result in tailings material being released to the south, likely flowing in a minor tributary before joining into Yeltacowie Creek, which terminates in Pernatty Lagoon. It is considered that the initial saddle dam break would be unlikely to directly impact Pernatty Lagoon, however a failure to adequately respond and clean the released material may eventually see surface water flows carry sediments towards Pernatty Lagoon.



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Northern Wellfield MPL 156
- Lined Decant Cell
- Decant Dam Embankment
- Decant Dam Emergency Spillway
- TSF Embankment
- TSF (Stage 6)
- TSF Stage 6 (Scenario 1) Maximum runout

0 2 4 km

GDA 1994 MGA Zone 53

Figure 4.31 | TSF dam breach assessment

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4.10.6 Tailings delivery and return water infrastructure

The TSF is approximately 5 km to the south-east of the MPP, necessitating the development of an infrastructure corridor between the two for the transport of tailings, construction materials, decant return water and general vehicle access.

The tailings delivery and decant water return pipeline is aligned to the Southern Access Road and run above ground. A second tailings disposal line from the MPP to the TSF to allow for greater deposition rates and provide greater operational flexibility was approved in the June 2024 PEPR (BHP 2024a). A number of turkey's nest-style ponds are constructed along the pipelines as required to allow for inspection and maintenance of the lines whilst capturing any tailings that may be released during these operations. The pipelines are not bunded, however the condition of the lines are monitored at regular intervals. The pipelines are remotely monitored (pressure indicator alarms) to provide for the immediate detection of pipeline failures. Remote isolation valves are provided to isolate sections of the pipeline, reducing the volume of tailings released in the event of a pipeline failure.

The tailings are deposited at selected locations around the periphery of the TSF. The tailings delivery main lines are extended to deposition points (spigot pipes) for each stage of the operation. Spigot pipes are managed by valves to enable isolation if necessary.

In Stage 1, the tailings delivery pipeline was installed around the western side of the tailings storage area and around to the south-east area, as shown on Figure 4.32. Deposition points (spigots) are primarily located at the heads of valley reaches, with secondary deposition points in the south-east area.

From Stage 2 onwards, a pipeline is installed across the embankment crest to the east abutment. Spigots are installed on the upstream crest edge of the embankment, on the access side of the safety bund, to allow safe access to the valves throughout operation. Due to the configuration of the cross-valley embankment and the general pipeline route, there will not be a requirement to install pipelines on the downstream slope of the embankment. On this basis, erosion risks associated with potential pipeline breaks are mitigated. Drainage of a potential pipeline break on the embankment crest is managed by the cross-fall formed on the wearing course layer and slots through the safety bunds at the upstream crest edge.

An access road is provided around the perimeter of the TSF for both construction purposes and operation of the tailings delivery pipeline. Rock material generated during the excavation of the access road would be bunded to the upstream side of the roadway, effectively creating a surface water diversion structure that assists in reducing the volume of water entering the area, and therefore requiring management during operations.

As a component of the mine dewatering water management system (see Section 4.8.5), a pipeline from the MPP sedimentation dam to transfer water to the TSF Stage 1 and Stage 2 construction areas was constructed, with the pipeline located within the existing TSF pipeline corridor and adjacent the existing radial wellfield pipeline corridor to minimise overall land disturbance.

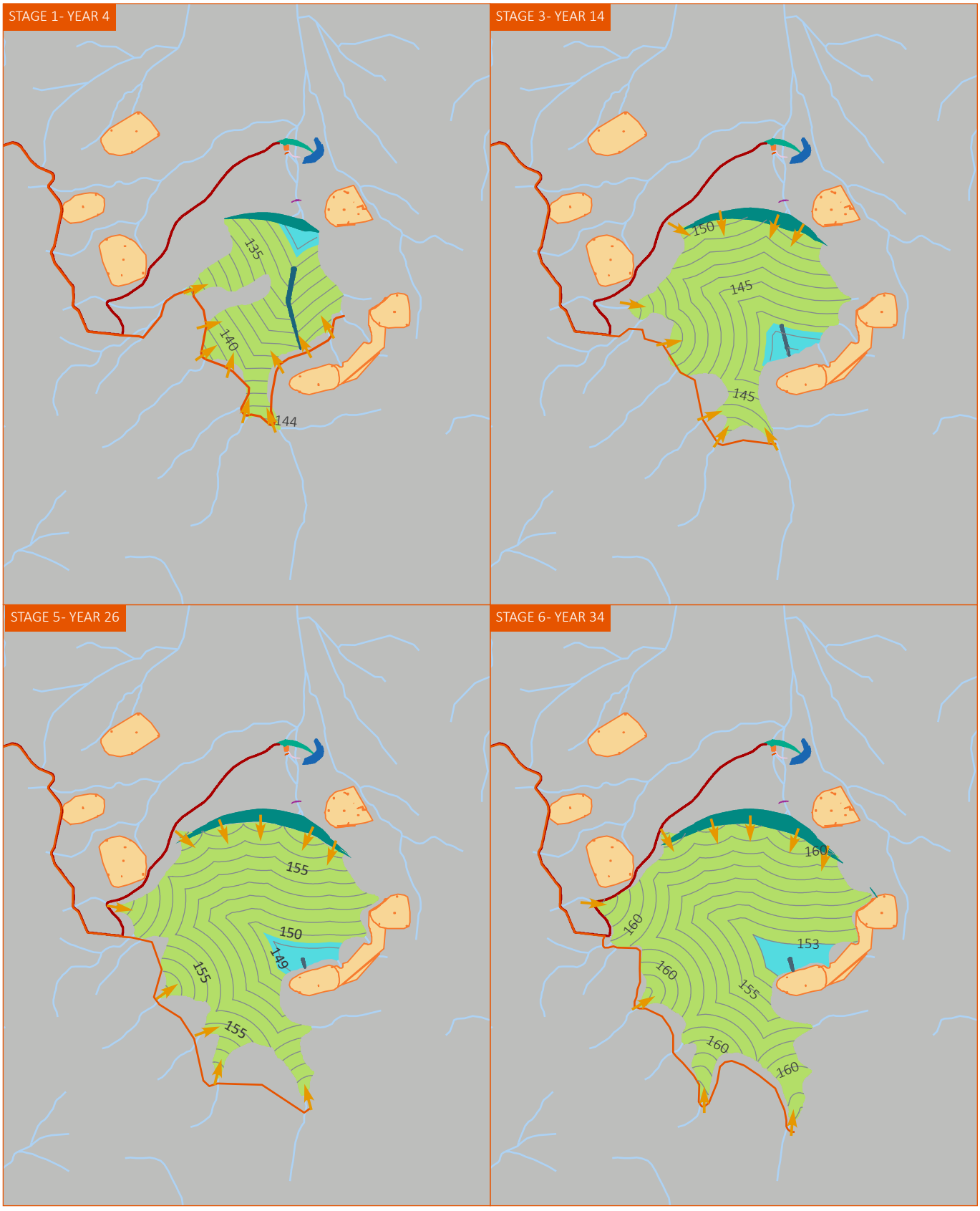

Figure 4.32 | TSF development by stage

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4.11 Materials handling and management

The construction and maintenance of various items of Carrapateena infrastructure requires the use of rock and soil materials of various qualities and quantities. These materials are sourced from onsite and offsite quarries, borrow pits and the waste rock materials from mining, as described in the following sections.

4.11.1 Key elements

A description of key elements is described in Table 4.43. Materials management elements have been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2017a; 2018c). Table 4.44 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators as provided in Chapter 7.

Table 4.43 | Materials management key project elements

Key element	Summary
Materials management	
Materials supply	Construction materials supplied from reclaimed mine development waste rock, TSF and mine area borrow pits, and supply through the purchase of materials from offsite quarries
Marginal ore management	Marginal ore would be crushed and conveyed to surface for storage on the marginal ore stockpile prior to: • blending and processing • backfilling directly to underground voids where available
Topsoil and subsoil management	Locally stockpiled pending use in rehabilitation
Borrow pits	Borrow pits established for use in construction and ongoing maintenance, specifically: • mine area borrow pit • TSF borrow pits • Western Infrastructure Corridor borrow pits
Scour and pigging pits	Approximately 30 pits of up to 687 m^3 required for ongoing maintenance activities. Excavated material will be used for embankments, and pits will be HDPE-lined
Stockpiles	
Production stockpile	Provided storage of development ore extracted from the mining operation prior to the commissioning of the MPP and may be used on occasions where uncrushed ore is trucked or conveyed to the surface
COS	After primary underground crushing, ore is conveyed and stacked to an open COS prior to being reclaimed to the grinding mills
Quartzite stockpile	A stockpile of approximately 33,000 t of fresh/unweathered Arcoona Quartzite was established under previous RL 127 activities in order to provide feed material for fibrecrete manufacture. Remaining material was used to support construction of the TSF Stage 2 embankment and no stocks of quartzite are currently held
WRD	Approximately 5.0 Mt of barren and NAF mineralised waste rock generated during remaining LOM development activities. This material is truck end-dumped to a surface WRD

Key element	Summary
Topsoil and subsoil stockpiles	Local stockpiles are maintained in close proximity to the material origin. Subsoils have been temporarily stockpiled for use in infrastructure construction activities
Acid-generating capacity	
PAF materials management	Approximately 190,400 t of PAF waste material is expected to be generated throughout the remaining LOM mining process. This would be preferentially backfilled to mined-out voids directly. In the event no suitable voids are available, PAF waste material would be reclassified as barren ore and delivered to an orepass underground for crushing prior to being brought to the surface COS for subsequent blending as a component of on-going MPP feed grade control

Table 4.44 | Materials management Impact IDs, design and management controls and uncertainty

Materials management	
Carrapateena Impact IDs[1]	Northern Wellfield Impact IDs
SW02, SW04, SW06, SW08*, SW10*, SW11, SW12, SW13, SW14*, SW15, SW16, SW17, SW18, SW19*, SW20, SW21, SW22, SW23, SW24*, SW25, SW51*, SW52*, SW53*, SW54* GW21*, GW22, GW23, GW24, GW25 and GW26.	L17*, L18*, L19* AQ01, AQ02, AQ03, AQ04, AQ05, AQ06, AQ07, AQ08 SW01, SW02, SW03, SW05, SW07*, SW09*
Design controls	
• Production Stockpile pad design • MPP catchment area for the containment of runoff • Separation of overland surface water flows originating from undisturbed areas of the Project Area from the surface water runoff that has interacted with stockpiles, MPP and mining infrastructure • Stockpiles limited to 2 m in height and kept local to the source • Stockpile management procedures to ensure quality and quantity is maintained	
Management controls	
• AMD Management Plan • PAF material (marginal ore) would be preferentially left underground where possible if brought to surface, marginal ore would be stored on the Production Stockpile pending processing or management • Block modelling of ore and waste units • Sulphur cut-off grade determined • QA/QC procedures and record keeping • Temporary sediment and erosion controls (e.g. mobile sediment booms, sediment fencing) • Surface water management infrastructure maintenance and inspection programs	

* Non-Outcome or Outcome-based lease condition proposed

(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

4.11.2 Materials demand and supply

4.11.2.1 Construction materials

The construction and maintenance of various infrastructure elements, including development of hardstand areas, building and stockpile foundations, underground shotcrete and fibrecrete manufacture and TSF wall raising activities, required the use of rock and soil materials of various qualities.

The demand for construction materials was met through a combination of the re-use of material stockpiled within the WRD developed under decline construction works approved under previous RL 127, use of topsoils and subsoils generated during land clearance activities and fresh and weathered rock generated during surface quarrying activities (both onsite and offsite).

Most construction has been completed at Carrapateena, with construction of the TSF embankment raises considered to represent an operational material demand and discussed in the following section and Section 4.11.5.2.

4.11.2.2 Operational and closure materials

Materials demand and supply for operations (including construction of the TSF Stage 3 embankment) and closure is presented in Table 4.45. The management of mined waste rock surplus to demand following closure is described in Section 4.11.4.4.

Table 4.45 | Operational and closure materials demand and supply

Construction item	Specification	Supply	Amount (t)
TSF (Stage 3)			
Crushed rock (TSF embankment wall raises and armouring)	Compacted weathered rock	Mine waste rock and TSF borrow pits	2,800,400
Crushed rock (decant access causeway raising)	Compacted weathered rock	Mine waste rock and TSF borrow pits	178,000
TSF (Stage 4)			
Crushed rock (TSF embankment wall raises and armouring)	Compacted weathered rock	Mine waste rock and TSF borrow pits	913,200
Crushed rock (decant access causeway raising)	Compacted weathered rock	Mine waste rock and TSF borrow pits	145,000
TSF (Stage 5)			
Crushed rock (TSF embankment wall raises and armouring)	Compacted weathered rock	Mine waste rock and TSF borrow pits	409,200
Crushed rock (decant access causeway raising)	Compacted weathered rock	Mine waste rock and TSF borrow pits	111,600
Crushed rock (saddle dams)	Compacted weathered rock	Mine waste rock and TSF borrow pits	167,330

Construction item	Specification	Supply	Amount (t)
Tailings (upstream raise)	Compacted tailings	TSF	41,000
Closure			
SLC abandonment bund	Weathered rock	Mine waste rock	50,000
Box cut and portal backfilling	Weathered rock	Mine waste rock/reclaimed Western Access Road sub-base and wearing course	215,800
Ventilation shaft backfilling	Crushed rock	Mine waste rock/reclaimed Western Access Road sub-base and wearing course	All remaining rock

4.11.3 Materials management

In general, materials classified as barren or NAF would be directed to the WRD and materials classified as PAF or ore would be combined with ore materials underground and directed to either the COS or the Production Stockpile for processing via the MPP.

4.11.3.1 Geochemical classification

Uncrushed ore and mineralised material brought to the surface during the initial mine development phase (prior to the commissioning of the MPP) was temporarily stockpiled on a Production Stockpile prior to surface crushing and transfer to the COS. Following commissioning of the Tjati Decline underground crushers and conveyor decline system, ore material is crushed underground, and conveyed to the surface for stacking on the COS prior to processing.

Materials proposed to be excavated from the SLC operations were subject to geochemical testwork (see OZ Minerals 2017b; 2017c; 2018b) in order to determine appropriate management requirements. A summary of this testwork is presented in Table 4.46.

Carrapateena operates in accordance with an AMD Management System. Central to this system is the classification of mined material based on the copper and sulphur grades, as described in Table 4.47. BHP is currently progressing a study aimed at understanding the potential risks and impacts of changing these classifications in order to provide greater optionality for mine planning purposes. Specifically, investigations are progressing with respect to raising the copper cut-off grade to 0.5% (from the 0.2% referenced in Table 4.47) and increasing the sulphur cut-off grade above 0.5%. Subject to the outcomes of these studies, changes to the nominated classification system may be implemented, with relevant approvals sought should these changes result in changes to the impact profile of the current operations.

Table 4.46 | Mined materials geochemical characterisation

Rock unit/ composite scenario	Classification	Interpretation
Chalcopyrite Ore	PAF	The pH from the leachate analysis showed a general decreasing trend. Data indicates that sulphur would still be present after the neutralisation potential of the rock type was exhausted. Predicted long-term pH of leachate from the rock would be acidic, and could be generated within 20 weeks of exposure, depending on meteorological conditions. The majority of metals were not leachable even with the onset of acidic conditions. The exceptions were copper, nickel (minor), manganese and uranium (minor), which showed a general increase in concentrations with decreasing pH.
Bornite Ore	PAF	The pH from the leachate analysis showed a general decreasing trend. Predicted long-term pH of leachate from the rock would be acidic. The majority of metals were not leachable even with the onset of acidic conditions, with the exception of copper, nickel and uranium, which showed a general increase in concentrations as pH decreased.
Barren Ore Zone	NAF	The pH from the leachate analysis showed only a minor decreasing trend over the analysis period. Data indicates that sulphur would be depleted before the neutralisation potential of the rock type was exhausted. Predicted long-term pH of leachate from the rock will be circum-neutral. Metals are not likely to be leached in high concentrations from this unit.
Proximal Granite	NAF	The pH from the leachate analysis showed only a minor decreasing trend over the analysis period. Data indicates that sulphur would be depleted before the neutralisation potential of the rock type was exhausted. Predicted long-term pH of leachate from the rock will be circum-neutral. Metals are not likely to be leached in high concentrations from this unit.
Conglomerate	NAF	The pH from the leachate analysis showed a stable, circum-neutral trend over the analysis period. Data indicates that sulphur would be depleted before the neutralisation potential of the rock type was exhausted. Predicted long-term pH of leachate from the rock will be circum-neutral. Metals are not likely to be leached in high concentrations from this unit.
Chalcopyrite Ore/ Whyalla Sands below Dolomite (50/50)	PAF	The analysis indicated that the country rock offers little buffering to the acidity generated by the ore. Leachate analysis indicated that the majority of metals were not leachable even with the onset of acidic conditions, with the exception of copper, manganese and nickel (minor), which showed a general increase in concentrations with decreasing pH.
Chalcopyrite Ore/ Whyalla Sands above Dolomite (50/50)	NAF	The pH from the leachate analysis showed a stable, circum-neutral trend over the analysis period indicating that the country rock offers sufficient buffering to the acidity generated by the ore. Data indicates that sulphur would be depleted before the neutralisation potential of the rock type was exhausted. Predicted long-term pH of leachate from the rock will be circum-neutral. Metals are not likely to be leached in high concentrations from this unit.
Chalcopyrite Ore/ Dolomite (50/50)	NAF	The pH from the leachate analysis showed a stable, circum-neutral trend over the analysis period indicating that the country rock offers sufficient buffering to the acidity generated by the ore. Data indicates that sulphur would be depleted before the neutralisation potential of the rock type was exhausted. Predicted long-term pH of leachate from the rock will be circum-neutral. Metals are not likely to be leached in high concentrations from this unit.

Rock unit/ composite scenario	Classification	Interpretation
Chalcopyrite Ore/ Woomera Shale (50/50)	NAF	The pH from the leachate analysis showed a stable, circum-neutral trend over the analysis period indicating that the country rock offers sufficient buffering to the acidity generated by the ore, and that this mix is unlikely to be acid forming when exposed to atmospheric conditions and precipitation. Data indicates that sulphur would be depleted before the neutralisation potential of the rock type was exhausted. Metals are not likely to be leached in high concentrations from this unit with the exception of uranium, which can be mobilised as a result of the alkaline conditions.
Leached Zone (Hematite Breccia)	NAF	The pH from the leachate analysis showed a relatively, circum-neutral trend over the analysis period. Metals are not likely to be leached in high concentrations from this unit.

Table 4.47 | Mined materials geochemical classification

Classification	Description	Management
Barren	Cu <0.1 wt% and total S <0.1 wt%	WRD perimeter
NAF	Cu <0.2 wt% and total S ≤0.3 wt%	WRD core
PAF	Cu <0.2 wt% and total S >0.3 wt%	COS and/or Production Stockpile
Ore	Cu ≥0.2 wt%	COS and/or Production Stockpile

4.11.3.2 Materials movements

Based on the classifications described in Table 4.47, the current block model for the mining operations has been interrogated to provide an estimate of the likely volumes of ore and waste to be generated over the remaining LOM. These are summarised in Table 4.48 and illustrated in Figure 4.13 and Figure 4.33.

Table 4.48 | LOM waste materials movements

Classification	LOM amount (t)
Barren	4,363,000
NAF	930,000
PAF	190,400

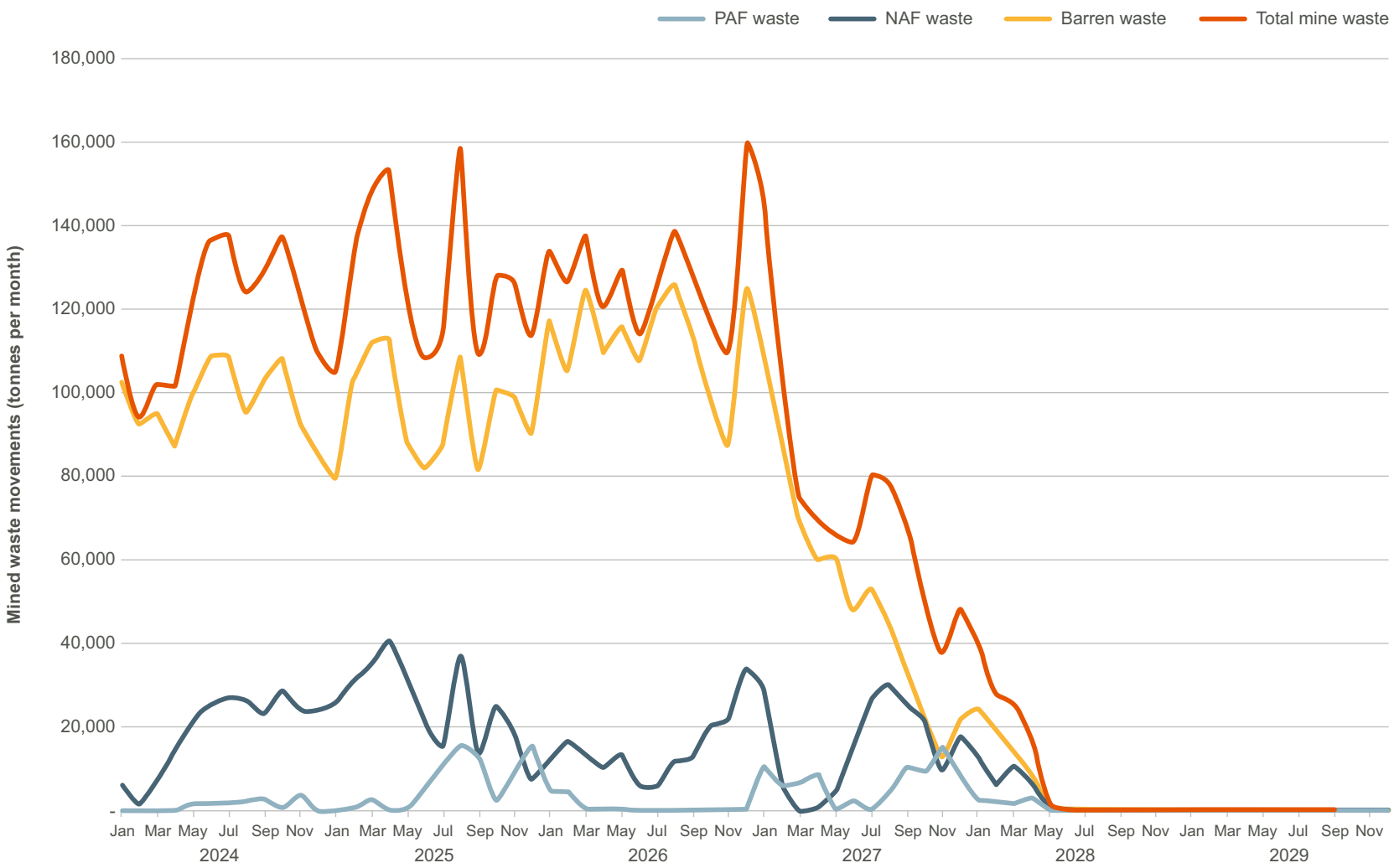


Figure 4.33 | Life-of-mine materials movements by geochemical classification

4.11.3.3 Potentially acid forming waste materials

Approximately 190,400 t of PAF waste material is expected to be generated throughout the mining process. This would be preferentially backfilled to mined-out voids. In the event no suitable voids are available, PAF waste material would be reclassified as barren ore and would be delivered to an orepass underground and crushed prior to being brought to the surface COS or Production Stockpile for subsequent blending as a component of on-going MPP feed grade control.

When this material is stored, or likely to be stored, on the surface for extended periods (i.e. greater than around 20 weeks), it is directed to the Production Stockpile, isolated from the surrounding environment. This stockpile is fitted with an independent runoff collection system (similar in principle to a heap leach pad arrangement) that directs runoff to the process water system for reclaim into the MPP. During operations, PAF waste material stored on the surface is minimised, and every effort is made to process the material within 20 weeks to reduce the potential of acid generation. The Production Stockpile has been sized sufficiently (with a capacity of up to 600,000 t of ore and PAF waste materials) to allow the storage of the maximum volume of PAF waste generated over LOM.

As and where necessary, PAF waste material that is not processed will be disposed of as follows:

- Returned to the underground workings (mined-out voids such as development and access drives) for ultimate storage below the water table. This methodology is an industry-accepted practice.
- PAF waste material is not proposed to be used for construction purposes for the TSF embankment or the SLC abandonment bund. If the material demand for the Project changes, and this is required for construction purposes, the potential for AMD will be addressed and strategies adopted in an updated AMD Management Plan to prevent AMD.

The implementation of the above-mentioned management options avoids the requirement to store PAF material on the surface post-closure. Any PAF material that remains as closure approaches would be returned underground as described above.

4.11.3.4 Soil, waste rock and construction materials

As a component of the previously approved (RL 127) development of Tjati Decline, there was an amount of waste rock generated. This material has been managed as follows:

- Weathered Arcoona Quartzite was stockpiled and was used for construction purposes under RL 127, with the remaining (and any additional generation) used for construction purposes associated with ML infrastructure (e.g. engineered fill material).
- Fresh (unweathered) Arcoona Quartzite was stockpiled for use in both RL 127 and future ML-related fibrecrete manufacture.
- The balance of waste rock material has been stockpiled in a surface WRD (approved under RL 127).

During ML and MPL construction activities, the RL-generated material within the WRD was, where suitable, reclaimed and used for construction activities. However, to address material shortfalls related to construction activities and the timing of waste rock generation from the underground development, a borrow pit was developed to provide additional rock and soil material (see Section 4.11.5.1).

Following initial ML construction activities, barren and NAF waste rock continues to be generated from the development of the underground workings. The remaining mine waste materials still to be mined over the LOM (approximately 5.0 Mt) will be stored in a surface WRD, which is built in the same location and in a similar manner to the RL WRD and incorporates any waste rock materials from previous RL-related activities that could not be used during the ML construction phase.

Material stockpiled to the WRD may be progressively used for TSF wall-raising activities during operations, to supplement material obtained more locally to the TSF from borrow pits. At the completion of operations, any waste rock material on the ML WRD will be reclaimed for use in closure activities, specifically for use in subsidence zone abandonment bunding and/or backfilling of borrow pits and underground mine voids (i.e. ventilation shafts and/or the surface Tjati Decline portals and box cuts).

4.11.4 Stockpiles

Operational stockpiles, consisting of ore stockpiles (Production Stockpile, COS, ROM Stockpile), Quartzite Stockpile, and WRD, are described in this section and shown in Figure 4.34. Topsoil and subsoil stockpiles are described in this section and shown in Figure 4.37.

4.11.4.1 Production Stockpile

The Production Stockpile provided storage of development ore extracted from the mining operation prior to the commissioning of the MPP and continues to be used on occasions where uncrushed ore is trucked or conveyed to the surface. The estimated volume of development ore extracted during the initial mining operations was approximately 1.04 Mt. Ore generated after the commissioning of the underground crushing and conveying infrastructure is directed to the COS (see following section).

Following the commissioning of the MPP, uncrushed material stored on the Production Stockpile was crushed in a temporary crusher and directed to the COS. During operations, the COS provides de-coupling between the mine and the MPP, allowing each to continue operations should the other be subject to downtime, with the Production Stockpile providing intermediate storage for ore and PAF waste materials should the underground crushing and conveying system be unavailable, necessitating truck haulage of mined materials.

The Production Stockpile pad (see Figure 4.35) consists of an engineered base made of a 300 mm clay subgrade with scratch drains to drain vertical seepage to the Production Stockpile Environment Pond. Over the subgrade was placed an 800 mm layer of NAF waste rock, including shale material to neutralise and/or precipitate any mobilised metals from the PAF waste material. Additionally, the stockpile is located within the broader MPP catchment area. To enable storage of PAF waste material, the base of the Production Stockpile is graded to ensure drainage of runoff water via perimeter drains to the Stockpile Environment Pond. Water collected in the pond is reclaimed to the MPP process water system.

4.11.4.2 Coarse Ore Stockpile

After primary underground crushing, the ore is conveyed and stacked to an open COS prior to being reclaimed from the bottom of the stockpile via a conveyor belt up to the SAG mill and ball mill for grinding. The COS has a nominal base diameter of approximately 45 m, and a typical height of 22 m, with a live capacity of approximately 12,000 t. The COS is constructed on a NAF rock foundation similar to that described for the Production Stockpile.

4.11.4.3 Quartzite Stockpile

A stockpile of approximately 33,000 t of fresh/unweathered Arcoona Quartzite was established under previous RL 127 activities to provide feed material for fibrecrete manufacture. The Arcoona Quartzite is NAF and required no specific ongoing management. A second stockpile specifically for weathered Arcoona Quartzite was also established adjacent to the fresh quartzite stockpile for use in initial ML construction activities.

The majority of quartzite stocks have been depleted and only minor volumes of quartzite are currently stockpiled on site.

4.11.4.4 Run-of-Mine Stockpile

A ROM Stockpile is provided adjacent to the decline to allow for the end-dumping and short-term storage of mineralised materials and/or ore that may be extracted and brought to the surface via haul trucks should this be required, prior to the placement of this material on the Production Stockpile pad pending surface crushing.

The ROM Stockpile pad has a nominal capacity of up to 0.5 Mt and may be up to 20 m at full capacity.

4.11.4.5 Waste Rock Dump

Approximately 5.0 Mt of barren and NAF waste rock will be generated during future mine development activities. This material is truck end-dumped to a surface WRD, located on the site of the previous RL 127-approved WRD. The WRD includes waste rock materials from previous RL-related activities (e.g. decline development) that could not be used during the ML construction phase.

Material stored within the WRD is classified as NAF or barren and thus no specific surface water management features are installed, however sedimentation ponds are installed downstream of the WRD to contain any sediment that may be generated during rainfall and surface water flow events. The outer surfaces of the WRD will be formed with ROM waste rock (generally granites and hematites), which are considered durable, with a particle sized that is resistant to erosion (see Figure 4.36).

Rock stored in the WRD is progressively reclaimed for use in on-going TSF construction activities, including:

- TSF embankment raises (including the current Stage 2 raise)
- raising of the gravity decant access causeway during each of the TSF lifts (Stage 2 to Stage 6)
- rock armouring of the downstream face of the upstream raises of the TSF embankment (Stage 3 to Stage 6).

At the completion of operations any waste rock material on the WRD will be reclaimed for use in closure activities, specifically for use in subsidence zone abandonment bunding, as TSF stabilisation where required and/or backfilling of borrow pits and underground mine voids (i.e. ventilation shafts and/or the surface decline portals and box cuts). No waste rock will remain in the WRD following closure.

4.11.4.6 Topsoil and subsoil stockpiles

Topsoils and subsoils at Carrapateena are high in chlorides, salts, boron and sulphur (particularly the subsoils) with very low organic matter content and represent a poor vegetation growth medium as evidenced by the sparse vegetation within the Project Area (as described in Chapter 6). Although stripped topsoil when reinstated immediately shows strong signs of rehabilitation, it is unlikely that this would be the case in 20 years' time following stockpiling. As such, much of the topsoil and subsoil may be unsuitable for use in rehabilitation. Rehabilitation trials will be undertaken to determine the suitability of using topsoil in rehabilitation. During land-clearing activities topsoil will be stockpiled and measures adopted to preserve stockpiled materials until the material is reused or determined to be no longer required.

Local stockpiles are maintained near the material origin. Subsoils have been temporarily stockpiled for use in ongoing infrastructure construction and maintenance activities. Material will be placed using the graders and/or dozers used to clear the land, with stockpile slope angles of around 37 degrees. Stockpiles do not exceed 2 m in height and are, so far as is practicable, located in areas best protected from wind and water erosion.

Vegetative cover is expected to grow on the slopes of the stockpiles and is likely to provide some erosion protection. In addition, the angle-of-repose slopes (containing large volumes of gibber) would be designed such that the large size of the pores between the gibber particles promote infiltration and/or evaporation of surface waters in preference to encouraging surface flows. Subject to health and safety requirements, water would be used sparingly in the topsoil strip process for dust control as this potentially promotes the germination of seeds prior to the rehabilitation works.

Materials excavated during construction activities are not potentially acid-forming materials and therefore have no acid rock drainage (ARD) potential. Sediment is captured using fit-for-purpose erosion management, including silt control fences, hay bales and sediment traps. Stockpiles are not placed directly in drainage lines to avoid water migration through the stockpiles. Where sedimentation ponds are installed, water runoff from disturbed areas has been diverted as described in Section 4.12.6.

Topsoil stockpiles are shown in Figure 4.37.

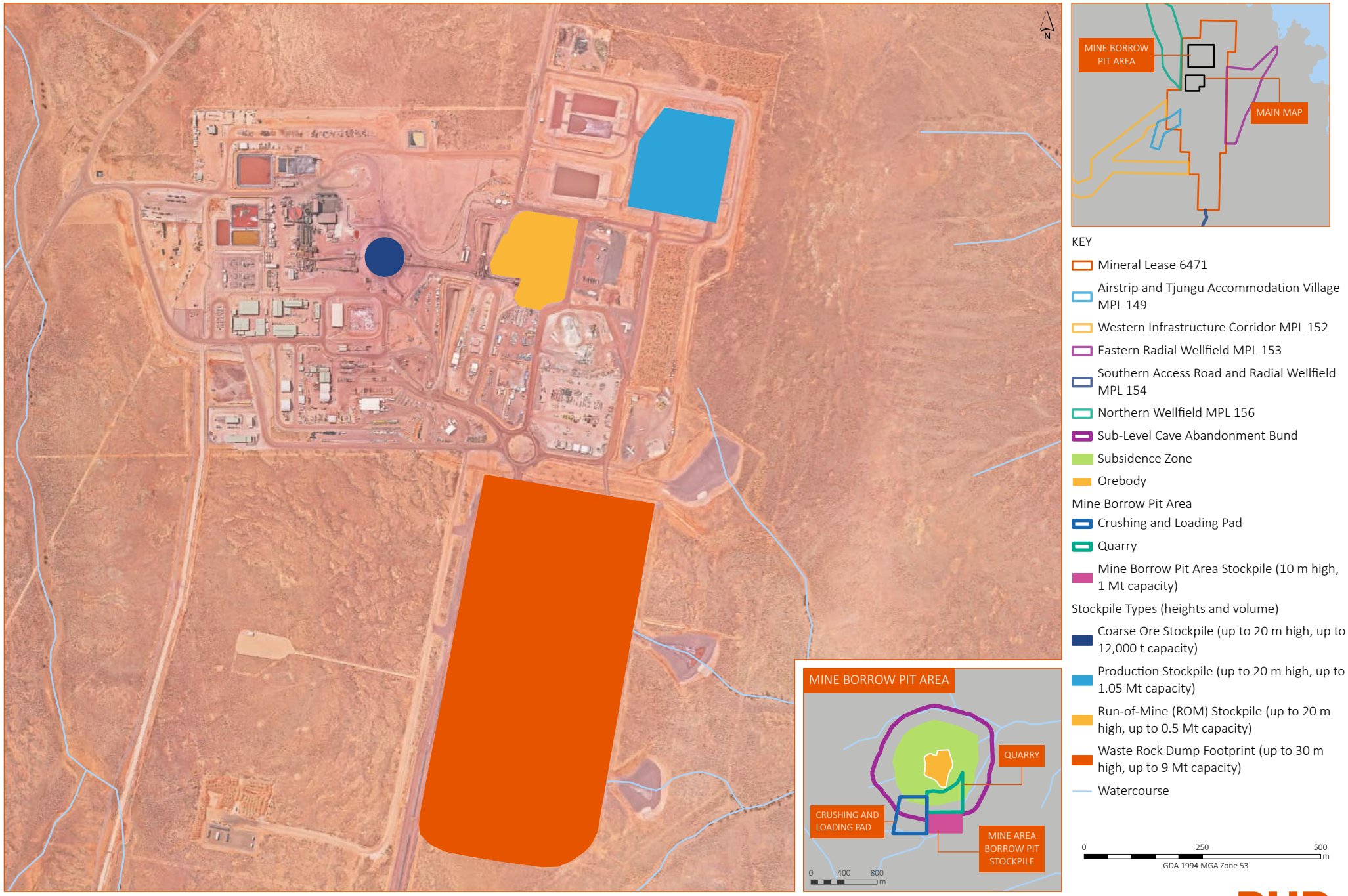
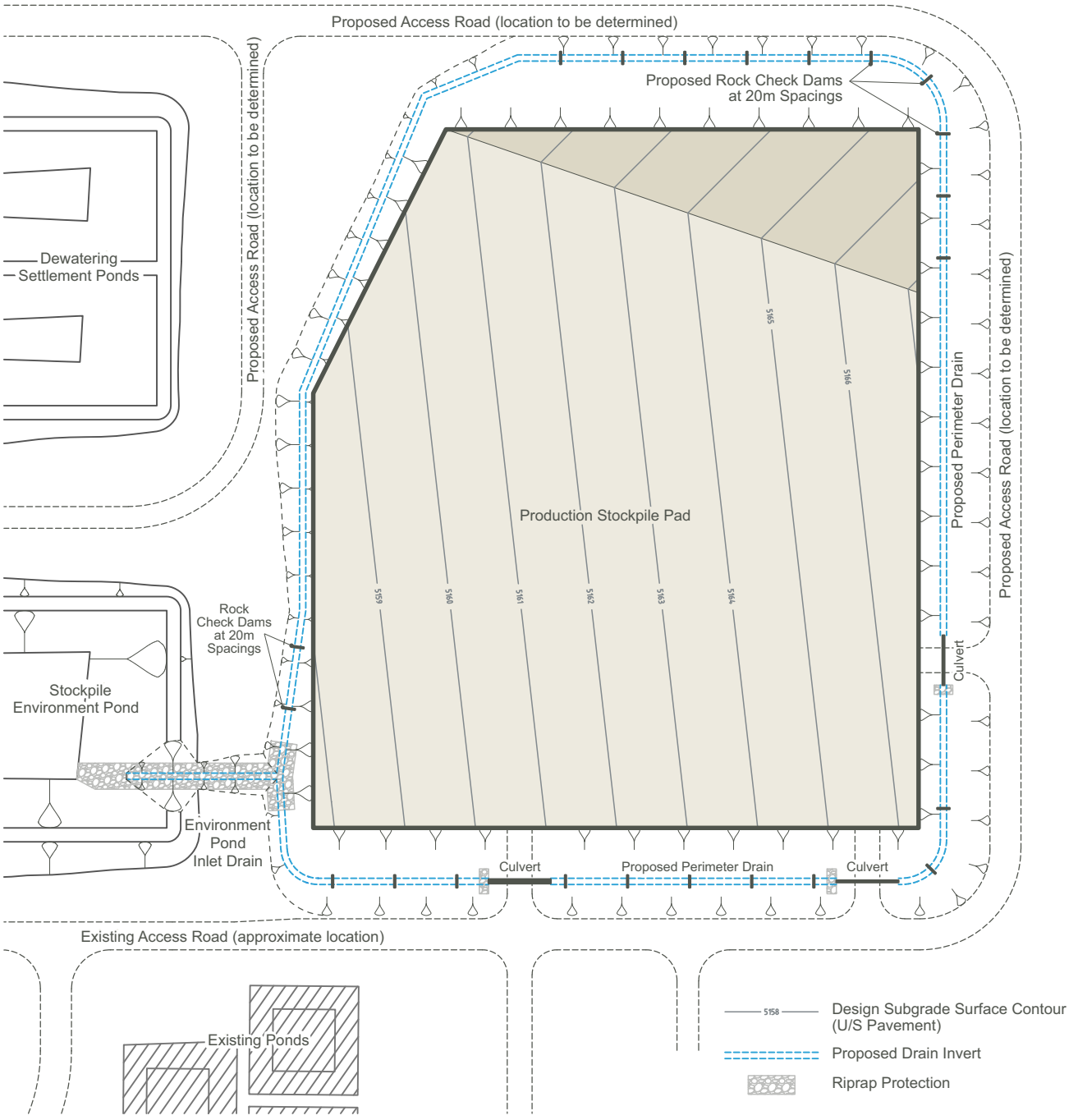


Figure 4.34 | Operational stockpile locations, dimensions and capacities

LAYOUT



PAD CROSS SECTION

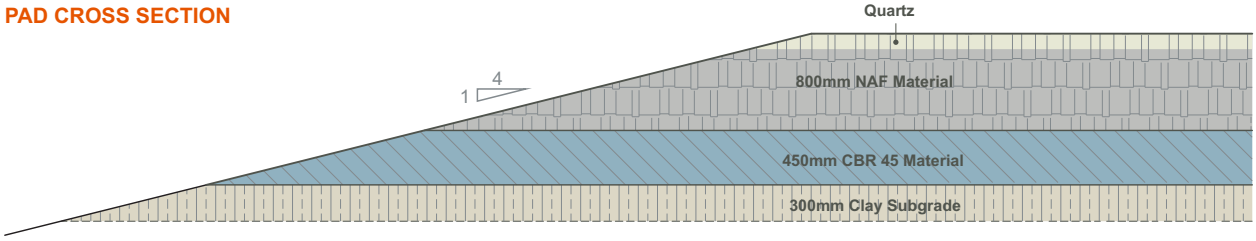
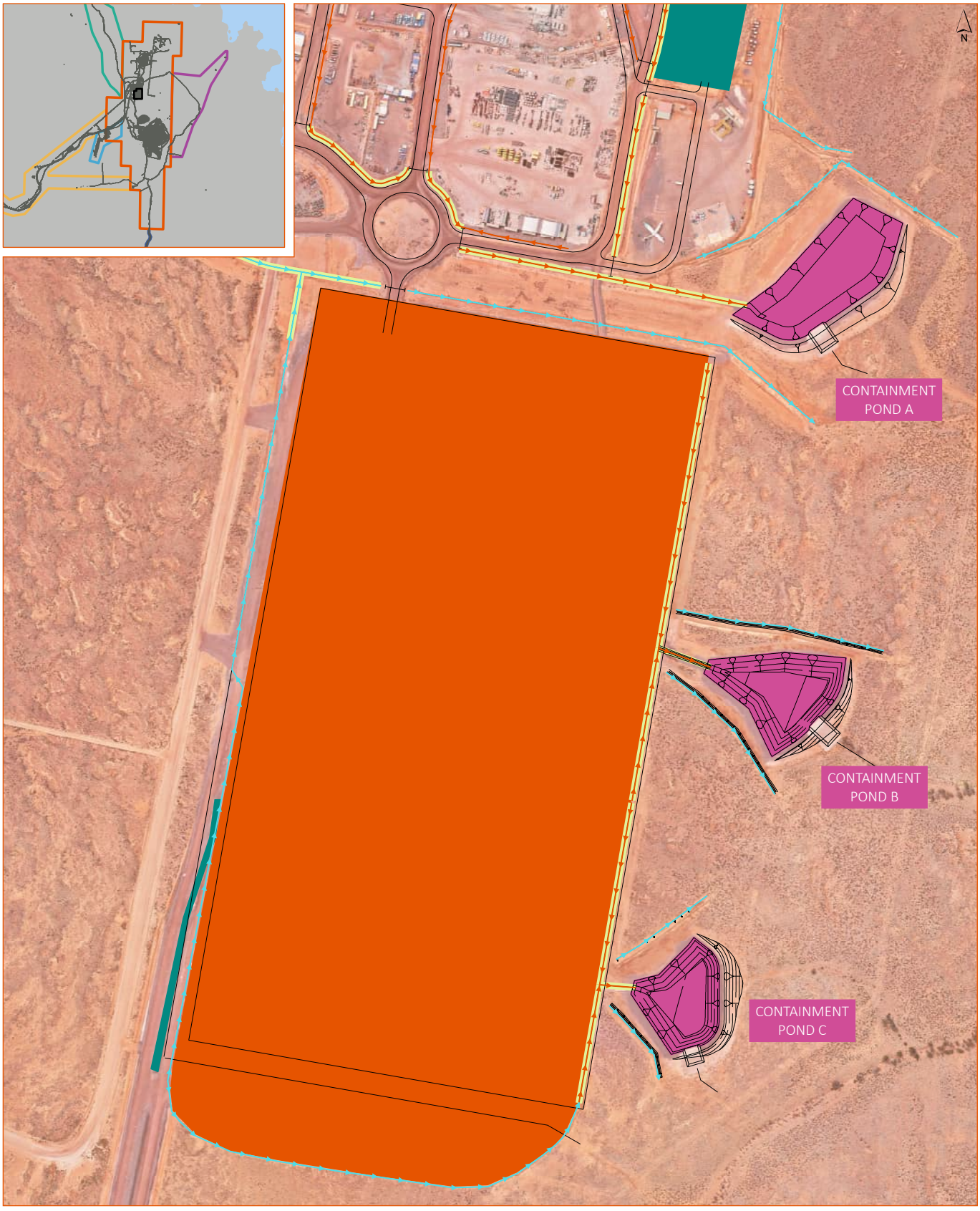


Figure 4.35 | Production stockpile and surface water management features



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- Processing Plant Layout
- Disturbed Area Drain / Diversion Bund
- Undisturbed Area Drain / Diversion Bund
- Key Surface Water Management Infrastructure
- Sediment Pond
- Topsoil Stockpiles
- Waste Rock Dump

0 125 250 m

GDA 1994 MGA Zone 53

Figure 4.36 | WRD layout and surface water management features

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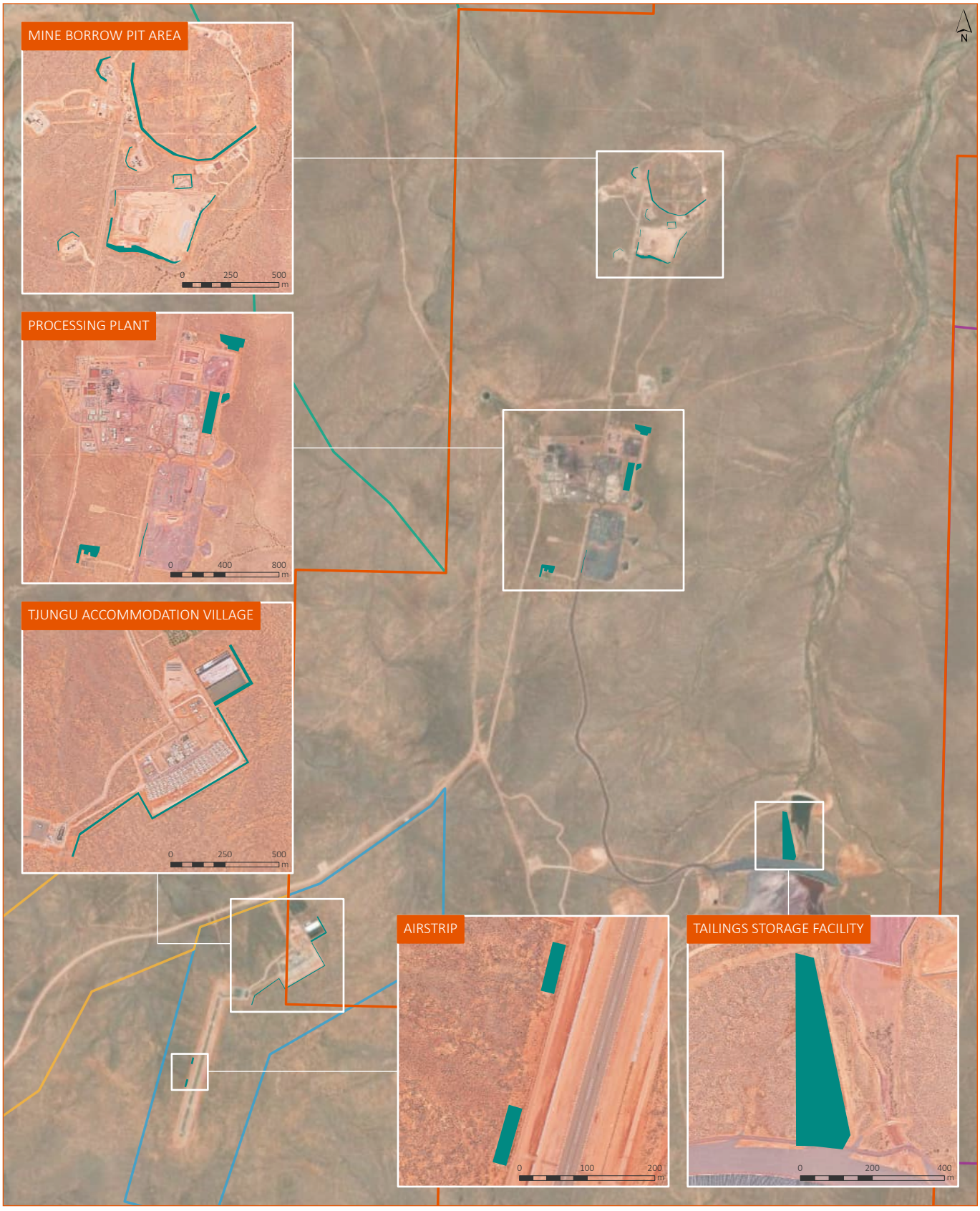


KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- Topsoil Stockpiles (all topsoil stockpiles restricted to 2 m in height, and 50,000 t total capacity)

0 1.5 3 km

GDA 1994 MGA Zone 53

Figure 4.37 | Topsoil stockpile locations, dimensions and capacities

Carrapateena BHP

4.11.5 Borrow pits

Waste rock generated and/or reclaimed from mine development (previous RL 127 and ML 6471-related) activities was insufficient during the initial ML infrastructure construction phase to meet the construction material demand.

To meet the construction material needs, several borrow pits have been established within the tenements, supplemented with imported construction materials from offsite (third-party) quarries. These are summarised in Table 4.49 and described in the following sections.

Table 4.49 | Non-mining construction material sources

Supply	Product	Demand(s)	Mining rate	Mine life (years)	Total resources
Mine area borrow pit	Quartzite gravel sand	Bulk fill, concrete aggregate, road base and sub-base, TSF embankment and decant causeway fill, miscellaneous earthworks	900 ktpa	2.5	2.25 Mt
TSF location borrow pits	Clay soil weathered quartzite	TSF embankment construction	As required	20	260 kt 4.4 Mt
Western Infrastructure Corridors EMLs	Gravels	Western Access Road construction and maintenance	As per EML approvals		

4.11.5.1 Mine area borrow pit

A mine area borrow pit was established outside of the footprint of the subsidence zone for extracting soil and weathered rock for use in ML construction activities (see Figure 4.38). Following completion of ML construction activities and the development of the subsidence zone, quarrying activities within the borrow pit have now ceased, however a description of the operations is provided here in the event that recommencement of operations is required.

The borrow pit is a surface mining operation consisting of drilling, blasting, hauling and crushing quartzite material from the borrow pit reserve. The borrow pit slopes have been designed at a conservative 45-degree angle through the Arcoona Quartzite and 20 degrees through the topsoil and subsoils (see Figure 4.38). The first bench is approximately 4 m deep, excavating the topsoil and subsoils. The following two production benches are 8 m deep. These are both in the competent Arcoona Quartzite and need to be drilled and blasted one at a time. A safety windrow is provided around the borrow pit to stop access by unauthorised personnel. There is a 10 m berm between the edge of the borrow pit and the inside toe of the windrow, and a single 11 m wide ramp to access the borrow pit workings.

To minimise the requirement for blasting, the area of the borrow pit was designed with consideration to allowing the stripping of material across a wider area to a shallower depth. Blasting of the production benches, where required, would be fired at the end of dayshift, with each blast generating approximately 21,000 t of material. AN Emulsion is preferentially used as an explosive. Standard initiating explosives such as NONEL and surface Connectadets™ are also used. An explosive storage magazine has been constructed within the borrow pit reserve for the storage of up to 150 t of AN Emulsion. Blasted material is transported to a temporary stockpile and subsequently reclaimed to a mobile crusher that operates at up to 3,000 tonnes per day (tpd). The crushed material is stockpiled pending use in construction activities.

The number and size of the individual stockpiles is determined by the product requirement for construction, with each of the stockpiles fluctuating in size to match production requirements. The as-blasted rock material in the stockpile is dumped by haul trucks and then shaped by the loader. The crushed material stockpile is also shaped by the loader to ensure efficient use of stockpiling space.

Mobile and fixed plant that is independent of that used in the underground mining operations is used in the borrow pit operations. The mobile and fixed plant associated with the mine area borrow pit are detailed in Table 4.50.

Table 4.50 | Mine area borrow pit fixed and mobile plant and equipment

Equipment	Model	Capacity	Number
Articulated dump truck	AD40 (or equivalent)	40 t	3
67 t excavator	ZAXIS 670 (or equivalent)	67 t	1
30 t excavator	ZX 350 (or equivalent)	30 t	2
Grader	14M (or equivalent)	-	1
Loader	950H (or equivalent)	12 t	1
Service truck	6TIJ (or equivalent)	-	1
Scraper watercart	631E (or equivalent)	-	1
Smooth drum roller	BW213DH (or equivalent)	-	1
Mobile crusher	UJ440i (or equivalent)	-	1
Dozer	D10 (or equivalent)	-	1
Mobile rock breaker	TM12 (or equivalent)	-	1

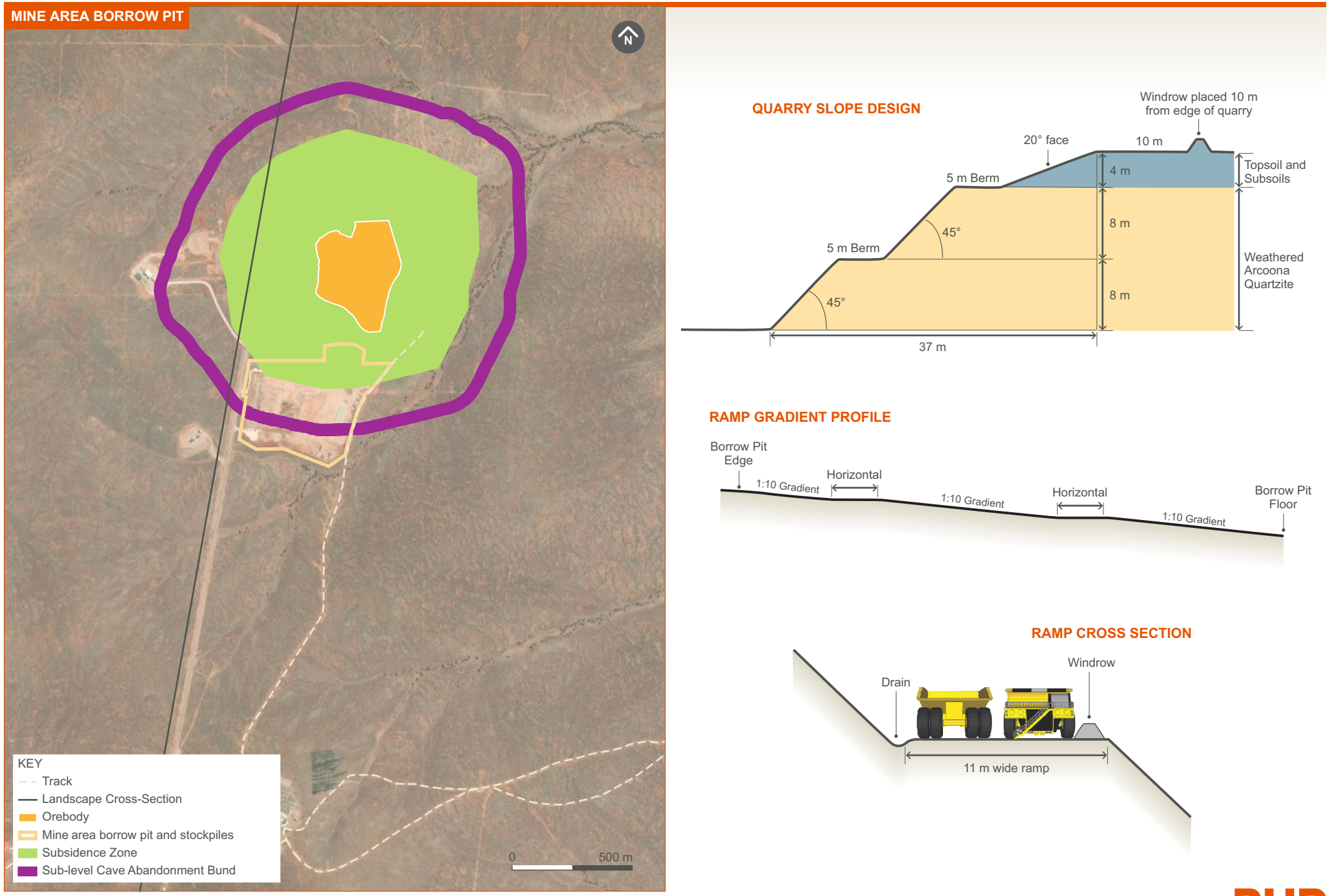


Figure 4.38 | Mine area borrow pit layout and cross-section

4.11.5.2 TSF construction borrow pits

The TSF construction requires clay soil (for use as compacted clay) and weathered rock (for use as compacted weathered rock) as embankment fill materials. This material is excavated from borrow pits adjacent to the TSF, supplemented, as necessary, through reclaimed waste rock from the surface WRD. The borrow pits are located outside the starter TSF and Decant Dam impoundment footprints and outside the footprint of future embankment raises.

Borrow pit locations and other areas that may have potential for harvesting embankment fill material based on the outcomes of site geotechnical investigations are shown in Figure 4.39. The borrow pits are operated intermittently to recover material for direct use in each embankment lift construction. Extraction of clay soil and weathered rock occurs in 1 m thick benches up to total depth of 3 m, or 8 m in the case of Borrow Pit (BP) BP2. Borrow pit cross-sections are shown in Figure 4.39.

The borrow pits are surface mining operations consisting of dozer ripping then loader/excavator retrieval of free-dig material. The borrow pits are inactive in the periods between embankment raise campaigns. Limited drill and blast activities are employed if necessary, subject to geotechnical conditions, and crushing and screening of some of the borrow pit product is undertaken, subject to material needs. Material is loaded into TSF construction haulage trucks with an excavator, for direct transportation to the embankment. A provision for that temporary stockpiling of some material, including surface cobbles, has been established. These stockpile areas will only be constructed as necessary.

Figure 4.39 | Tailings Storage Facility borrow pit locations and typical cross-section

4.11.5.3 Western infrastructure corridor borrow pits

Nine borrow pits within the Western Infrastructure Corridor MPL 152 were approved to support the development and ongoing maintenance of the Western Access Road. The borrow pits are approved separately from the Carrapateena mining tenements under EML 6480, 6481, 6482, 6483, 6484, 6485, 6486, 6487 and 6488. To date, only the Midway borrow pit (EML 6488) has been utilised.

The land disturbance footprint presented in Section 4.5.2 includes an allocation for land disturbance associated with the construction of vehicle tracks to access the Midway EML, however the EMLs are otherwise not discussed further in this PEPR.

4.11.5.4 Off-lease construction materials supply

BHP consulted with local landowners and the Kokatha People to identify other potential source of quarry material. Through these discussions two alternate sources were identified:

- Boral quarry at Whyalla (currently has a LOM of 20 years)
- Holcim quarry at Pernatty (currently mothballed, with approximate supply 2 Mt of material).

Both are hard rock quarries capable of supplying DIT-specification materials, however due to its proximity, extraction of material from the Holcim quarry at Pernatty would be preferred should this material be required.

The Holcim quarry at Pernatty is currently licensed under a Mining and Rehabilitation Program (MARP) to produce between 20,000 and 50,000 tpa of quarry material. This production range is indicative and could be expanded to approximately 65,000 tpa for a limited period. There are no restrictions on stockpiling materials at the quarry. The current licence provides for the extraction of the remaining resource.

4.12 Water management

This section outlines the water demand and supply for Carrapateena, including details with respect to groundwater abstraction, water treatment, wastewater management and associated infrastructure, together with description of the management of surface waters and rainfall runoff.

4.12.1 Key elements

A description of the key elements of water management at Carrapateena is provided in Table 4.51. Water management elements have been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 4.52 and Table 4.53 provide a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators for the water exploration activities and operational activities respectively, as provided in Chapter 7.

Table 4.51 | Water management key project elements

Key element	Summary
Water demand	Calculated operations water demand of up to 12.9 ML/d from a combination of the Radial Wellfield and Northern Wellfield
Approved groundwater abstraction rate	Approved abstraction of up to an annual average of 14.5 ML/d (consisting of 7.5 ML/d from the Radial Wellfield and 7.0 ML/d from the Northern Wellfield)
Groundwater supply	Groundwater abstraction across the following wellfields and tenements: Radial Wellfield: • ML 6471 (Production wells RP-1, RP-2) • MPL 153 (Production wells RP-3) • MPL 154 (Production wells RP-5, RP-6, RP-4, RP-7) Infrastructure Wellfield: • MPL 152 (Production wells WAT-3, WAT-17, WAT-49) Northern Wellfield: • MPL 156 (Production wells NT-1, NT-2P, NT-4P(T), NT-4P(P), NT-5P, NT-8P, NT-10P, NT-11, NT-12, NT-13, NT-17P, NT-20, NT-24, NT-38, NT-40, NO-1)
Supplementary water supplies	Water demand from the groundwater wellfields is minimised through the opportunistic recovery of mine water inflows and TSF decant return water (including surface water capture in the TSF catchment)

Table 4.52 | Water exploration drilling Impact IDs, design and management controls and uncertainty

Water management
Northern Wellfield Impact IDs[1]
The impact and risk assessment associated to on MPL exploration activities at the surface include Impact IDs L01*, L02*, L04, L10*, L11*, L12*, L13, L14, L15, L16, L21*, L22* and L23*
Design controls
• Avoidance of sites of cultural heritage significance as determined in consultation with the Kokatha People • Avoidance of critical habitat during site selection • Exploration sites chosen with buffers applied to minimise impacts to native vegetation, topsoil and changes to natural drainage patterns • 25 m buffer distance of drill pads from drainage lines • Land disturbance approval process prior to any ground disturbing works
Management controls
• Exploration reports, data and samples in accordance with the requirements of Ministerial Regulations MG13 Mineral Exploration Reporting Guidelines for South Australia • Construction of surface drill sites is undertaken in accordance with information sheets ‘M21 Mineral Exploration Drillholes – General Specifications for construction and backfilling’ (DSD 2012) and ‘M33 Statement of Environmental Objectives and Environmental Guidelines for Mineral Exploration Activities in South Australia’ (DSD 2004) • Drilling to be undertaken in compliance with Government of South Australia’s Department for Environment and Water (DEW) permits and by licensed drillers and with qualified hydrogeologist supervision • Consultation/liaison with landholders undertaken in accordance with Government of South Australia, Department of the Premier and Cabinet (DPC) guidelines, Mining Act and Regulations • Complaints management process • Land Disturbance Register and Cultural Heritage Obligations Register and supporting GIS information (shapefiles) to record/identify clearance areas and status • Monthly (construction) or annual (operations) land disturbance reconciliation • Area-specific and site inductions and training including cultural respect training

Water management
• Employment of suitably qualified people • Cultural Heritage Management Plan, including identification and fencing of sites of cultural heritage significance and new discovery reporting procedures • Vehicle wash down, maintenance and cleaning procedures • Regular monitoring and identification of areas susceptible to weeds • Appropriate signage and flagging in place to protect employee and public safety • Fire prevention measures and firefighting equipment in place • Fauna entrapment and rescue measures in place • Speed limit restrictions in place and use of existing tracks where possible • Fuel stored in accordance with EPA requirements • Turkeys nests appropriately constructed and sized in accordance with Safe Work Instruction – Drill Pad Construction and Rehabilitation and monitored in accordance with Safe Work Instruction for Aquifer Testing • Waste securely stored before disposal in accordance with relevant legislation • Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation) • Rehabilitation undertaken in accordance with information sheet 'M21 Mineral Exploration Drillholes' (DSD 2012) and bore completion, headworks and site restoration in accordance with 'Minimum Construction Requirements for Water Bores in Australia' (NUDLC 2020).

*Non-Outcome or Outcome-Based Lease Condition Proposed

Table 4.53 | Operational water management Impact IDs, design and management controls and uncertainty

Water management		
Carrapateena Impact IDs[1]	Airstrip and Workers' Accommodation Village Impact IDs[2]	Northern Wellfield Impact IDs[3]
SW01, SW02, SW03, SW04, SW05, SW06, SW07*, SW08*, SW09*, SW10*, SW46, SW47 GW01, GW02, GW05, GW06, GW09*, GW11, GW13, GW15, GW17, GW18, GW19, GW20, GW27*	ID036, ID037, ID038, ID044*, ID045, ID046*, ID047*	SW01, SW02, SW03, SW04, SW05, SW06, SW07*, SW08*, SW09*, SW10* GW01, GW02, GW03, GW04, GW05*, GW06, GW07, GW08, GW09, GW10, GW11, GW12, GW13*
Design controls		
• Separation of overland surface water flows originating from undisturbed areas of the Project Area from the surface water runoff that has interacted with stockpiles, MPP and mining infrastructure • Provision of sediment basins/ponds and appropriate drainage on roadways adjacent to surface water bodies or catchments for the collection of sediments in surface water transported along the roadway (longitudinal flows) • TSF embankment and decant collection dam and ponds • Design and install fords, culverts, diversion drains, bunding and sedimentation/event basins in accordance with a Best Practice Operating Procedures endorsed by the SA Arid Lands Natural Resources Management Board or a Water Affecting Activity Permit under the *Landscape South Australia Act 2019* (SA) • Progressive rock armoured TSF Embankment • Design hydrocarbon and chemical storage facilities in accordance with relevant Australian Standards • Constructed and operated the landfill in accordance with EPA Guidelines and is appropriately licensed under the EP Act • Bund storages in accordance with EPA Bunding Guidelines and/or relevant Australian Standards • Site Water Balance based on modelling inputs and LOM plan • Abstraction rates designed to sustainable yields • Separation distance between wells designed to limit interference		

Water management
Management controls
• Install temporary sediment and erosion controls (e.g. mobile sediment booms, sediment fencing) • Surface water management infrastructure maintenance and inspection programs • Culvert and ford maintenance and inspection programs • Spill and emergency response procedures • Equipment maintenance to prevent accidental releases • Licenced chemical and waste transporters • Incident reporting procedures • Regular inspection programs where bunding either temporary or permanent is installed to ensure appropriate use, placement of spill kits, clean up procedures and handling procedures • Induction contains process for bringing chemicals and hydrocarbons onsite including requirements for storage, handling and disposal • Contracts contain conditions relevant to design, management of the storage and handling of chemicals and hydrocarbons • Water balance to be updated in conjunction with LOM plans • Telemetric controls and flow/sump meters to monitor abstraction and mine dewatering rates • Develop a program for the ongoing calibration of the groundwater model using data obtained from groundwater monitoring

*Non-Outcome or Outcome-Based Lease Condition Proposed
(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
(2) Appendix B Consolidated Assessment (OZ Minerals 2017b)
(3) Appendix E Consolidated Assessment (OZ Minerals 2018c)

4.12.2 Water exploration

Water exploration drilling works continue across the Northern Wellfield and other tenements as required to provide ongoing water security for Carrapateena. These works build further confidence and reduce uncertainty regarding the water supply operations and potential effects on groundwater resources and impacts on groundwater receptors.

4.12.2.1 Drilling methodology

Pilot production well locations are chosen based on the results of prior drilling in the Northern Wellfield area, regional geophysical data and imagery and lineaments.

Water exploration drilling is undertaken using the conventional downhole hammer rotary air blasting (RAB) technique, using a custom-built air rotary rig equipped with a 650 psi/4,000 cfm booster air compressor, and polycrystalline diamond compact (PDC) bits. Drilling is carried out in accordance with well construction permits issued by DEW, and the NUDLC (2012) requirements for construction of water wells. During drilling, drill cuttings are collected into chip trays and logged at 2 m intervals.

Pilot well drilling and construction typically involves the following:

- drilling at 16 inch using a tri-cone roller bit and installation of DN 350 mm steel surface casing (depths ranging between 6 and 18 m below ground level (mbgl), dependent on ground conditions)
- RAB drilling of pilot holes at 8.5 inch diameter using to the target depth (550 mbgl or shallower), and monitoring of water cuts, drilling penetration rates, airlift yields and water quality (electrical conductivity (EC), pH and temperature) as drilling proceeds.

Where measured airlift yields are greater than 2.5 L/s within the THA, drilling of pilot holes ceases at the top of the competent Woomera Shale and the holes left open for aquifer testing. Following aquifer testing of the THA, the pilot hole is then deepened to the target depth (550 mbgl) or shallower if the water sump reached holding capacity. Where measured airlift yields in the lower section of pilot holes are greater than 2.5 L/s, pilot holes are left open for further aquifer testing. Where measured airlift yields are less than 2.5 L/s, pilot holes are backfilled and abandoned by installing a hydraulic seal within a competent zone of the Woomera Shale hydrostratigraphic units (HSU), comprising:

- a cement basket, gravel, bentonite pellets and a cement/bentonite slurry
- backfilling to the surface
- cutting the steel collar at ground level.

4.12.2.2 Aquifer testing

Pilot wells that report airlift yields above the 2.5 L/s threshold are subject to aquifer testing. The aquifer testing at each pilot production well typically involves:

- Multi-rate tests (MRT) typically consisting of three 100-minute steps at increasing flow rates.
- Following the groundwater level recovery of drawdown (greater than 90%) arising from the MRT, a constant rate test (CRT) is conducted. The CRT duration is typically 72 hours (depending on sump capacity) and involved pumping the pilot well at a consistent flow rate.
- Following the CRT, groundwater level recovery is monitored for 24 hours or until 90% recovery of drawdown occurred. After completion of the 24-hour recovery monitoring period, measurements are taken opportunistically at tested wells.
- Water levels were measured within the pumped well due to no observation wells being present at the testing locations.

4.12.2.3 Rehabilitation activities

Rehabilitation of surface drill sites that are not converted into wells is undertaken in accordance with information sheets ‘M21 Mineral Exploration Drillholes – General Specifications for construction and backfilling’ (DSD 2012) and ‘M33 Statement of Environmental Objectives and Environmental Guidelines for Mineral Exploration Activities in South Australia’ (DSD 2004).

At the conclusion of drilling, casings, including surface casings, are removed from the hole wherever possible. A Van Ruth plug is installed at least 20 m below the bottom of the Whyalla Sandstone and the hole grouted from here to at least 20 m above the base of the Woomera Shale. Approximately 2 m of PVC casing is pushed into the hole to below ground surface, and a PVC cap placed until such time as it is determined that the hole will not be re-entered. In instances where two aquifers are present, the Van Ruth plug is installed 20 m below the top of the basement rock units and grouted to 20 m above the base of the Woomera Shale. A second Van Ruth plug is installed 20 m below the top of the Woomera Shale and grouted from here, through the Corraberra Sandstone, to 20 m into the base of the Arcoona Quartzite.

Once it has been determined that an exploration drillhole will not be re-entered, the drillholes are backfilled with cuttings and capped. Prior to final site completion, all rubbish is removed from the area, new access tracks are scarified and the stones/gibbers re-spread, flagging and non-permanent stakes are removed, all sumps are backfilled, and the areas levelled to match the surrounding topography.

4.12.3 Construction water

A construction water supply was established early in the development of Carrapateena and has subsequently evolved into the operational water supply. Ongoing supply of water for occasional construction activities is now sourced via the operational water supply described in the following sections.

4.12.4 Operations water

The operations phase of Carrapateena requires water for mineral processing operations, with minor quantities for associated infrastructure. Water demand is achieved through continued abstraction of water from the Radial Wellfield, supplemented by water from the Northern Wellfield.

4.12.4.1 Demand

The primary water demand at Carrapateena is the MPP. Based on the current operation of Carrapateena, the MPP has the following water demands:

- 0.65 kL fresh water per tonne of concentrate
- 0.57 kL raw water per tonne of ore processed.

Other water demands include construction water for TSF lifts and access roads, gland water for cooling pumps, underground water use, stockpile sprays, dust suppression, RO plants, and other uses described in Table 4.54.

Total annual average water demand is approximately 10.5 ML/d of all qualities from all sources, with additional water required to facilitate occasional construction activities, and varying seasonally in response to changes in evaporation rates.

Table 4.54 | Carrapateena annual average water demand

Water demand	Water source	Demand	Units
Potable			
Facilities	Process RO plant	0.012	ML/d
Freshwater			
Underground fire water demand	Process RO plant	0.000	ML/d
Vehicle wash	Process RO plant	0.012	ML/d
Concrete batching	Process RO plant	0.040	ML/d
Workshop	Process RO plant	0.050	ML/d
Concentrate	Process RO plant	0.65	kL/tonne of concentrate
Raw water			
MPP make up water	Process water pond	0.57	kL/tonne of ore
Mine area dust suppression	Mine clean water pond	0.221	ML/d
Access road maintenance	South Pernatty balance tanks	0.750	ML/d
Tjungu Village RO plant	South Pernatty balance tanks	0.090	ML/d
Access road construction	South Pernatty Balance Tanks	NA	ML/d

Water demand	Water source	Demand	Units
TSF embankment construction	South Pernatty Balance Tanks	NA	ML/d
Standpipe	MPP event pond	0.000	ML/d
Gland water	Raw water pond	0.460	ML/d
Stockpile dust suppression	Raw water pond	0.151	ML/d
Underground raw water	Raw water tanks (underground)	NA	ML/d

4.12.4.2 Supply

Rainfall and runoff

Surface water runoff that drains into the water management storages is stored for use onsite. The volume of inflows to each storage is dependent on the direct rainfall onto the storage water surface and the runoff generated from the contributing catchment.

Mine groundwater inflows

Groundwater inflows to the underground workings may be dewatered to the surface for reuse withing the water management system. Measured mine water inflows of 2.1 ML/d are currently experienced, and groundwater models suggest that recent observed dewatering rates are not likely to significantly increase, with a modelled maximum inflow of 2.4 ML/d occurring in 2024, gradually decreasing to 1.5 ML/d in 2038.

Wellfield supply

The majority of Carrapateena water supply is sourced from the Northern Wellfield and Radial Wellfield. The Northern Wellfield is currently comprised of seven production wells, while the Radial Wellfield is comprised of five operational production wells (see Table 4.55 and Figure 4.40). The total available capacity of each wellfield is given by the sum of the individual well capacities.

The wellfields supply water to the operation on an as-needs basis with extraction only occurring to satisfy water demands. The Northern Wellfield supplies water into the water management system via the raw water pond. The Radial Wellfield supplies water via the South Pernatty balance tanks, other than RP-7 which supplies water directly to the Southern Access Road as required. Annual average wellfield water supply is limited by existing approvals as described in Table 4.55.

Additional local water supply is obtained as needed from three production wells within MPL 152, specifically WAT-3, WAT-17 and WAT-49, with WAT-17 and WAT-49 also capable of supplementing the raw water supply to the MPP on ML 6571.

Table 4.55 | Northern Wellfield and Radial Wellfield capacity

Well ID	Well capacity (ML/d)
Northern Wellfield (approved annual average supply of up to 7.0 ML/d)	
NT-2P	0.43
NT-4P(T)	0.43
NT-4P(P)	1.30

Well ID	Well capacity (ML/d)
NT-5P	0.52
NT-8P	0.69
NT-10P	1.73
NT-11P	0.52
NT-12P	0.78
NT-13P	0.26
NT-17P	1.30
NT-20	1.73
NT-24	0.35
NT-38*	~7.5
NO-1P	0.86
Total	**10.9**
Radial Wellfield (approved annual average supply of up to 7.5 ML/d)	
RP-1	0.00
RP-2	0.36
RP-3	1.04
RP-4	0.35
RP-5	0.35
RP-6	1.73
RP-7	0.32
Total	**4.15**

* Well capacity to be confirmed

4.12.5 Water distribution and infrastructure

4.12.5.1 Water supply infrastructure

Produced groundwater is of variable quality with respect to TDS. The quality of the groundwater is determined by the aquifer in which water is produced (e.g. THA regional water quality is approximately 35,000 mg/L TDS, while Whyalla Sandstone aquifer regional water quality is approximately 100,000 mg/L TDS), and the location (e.g. THA water quality within the vicinity of Lake Torrens can reach 250,000 mg/L TDS). Produced water is blended and/or treated as necessary to ensure a consistent raw water quality for the Project whilst meeting the water quality requirements and volume demands outlined earlier in this PEPR. Alternatively, production lines may be separated in future based on operational use (e.g. saline for treatment and/or construction uses, and hypersaline for salt tolerant construction operations). The layout of the water supply infrastructure is shown on Figure 4.40 and consists of:

- Production wells drilled to depths approximately between 120 m (THA installations) and in excess of 450 m (Whyalla Sandstone) are expected to deliver groundwater into a header pipe that would terminate at a raw water break tank.

- Each raw water break tank is equipped with a pair of transfer pumps (duty and standby). The pumps deliver into a transfer pipeline.
- Wherever possible, the transfer pipelines have been installed parallel to existing pastoral tracks to minimise land disturbance.
- The wells are powered by self-bunded diesel electricity-generating sets.
- All pumps are controlled through a telemetry system from the MPP.
- Water flow monitoring of each input to the groundwater pipeline is incorporated to enable real-time monitoring of the water flows.
- All wells are fitted with stainless steel submersible pumps, impellers and motors, or an equivalent alternative pumping technology. Shrouds are attached to submersible pumps to assist with cooling of the motor when required.

The groundwater production wells are equipped with submersible pumps, flow meters, telemetric controls, pole-mounted transformer, contactors and a motor starting panel. Produced water from the production wells is transferred via buried and/or aboveground branch lines within the wellfields to wellfield staging complexes that provide central balancing storage before the water is transferred from each wellfield to the raw water pond. The total capacity of each staging complex is approximately 2 ML, made up of a series of tanks, an emergency outflow reservoir and a series of pumps. The approximate footprint of each staging complex is approximately 200 m by 200 m. Water abstracted from the wells is transferred to site via a nominal 375 mm diameter HDPE pipeline, or parallel smaller diameter pipelines for redundancy.

A generator is established at each water production well to produce the required electricity, with associated bunded fuel storage facilities located alongside. Access to the wells is via an unsealed service road, for the most part passing along existing pastoral tracks. Sections of the existing tracks have been straightened, repaired and maintained (graded) as required. Where routes cross drainage lines, appropriate crossings (such as flood crossings and/or culverts) are installed.

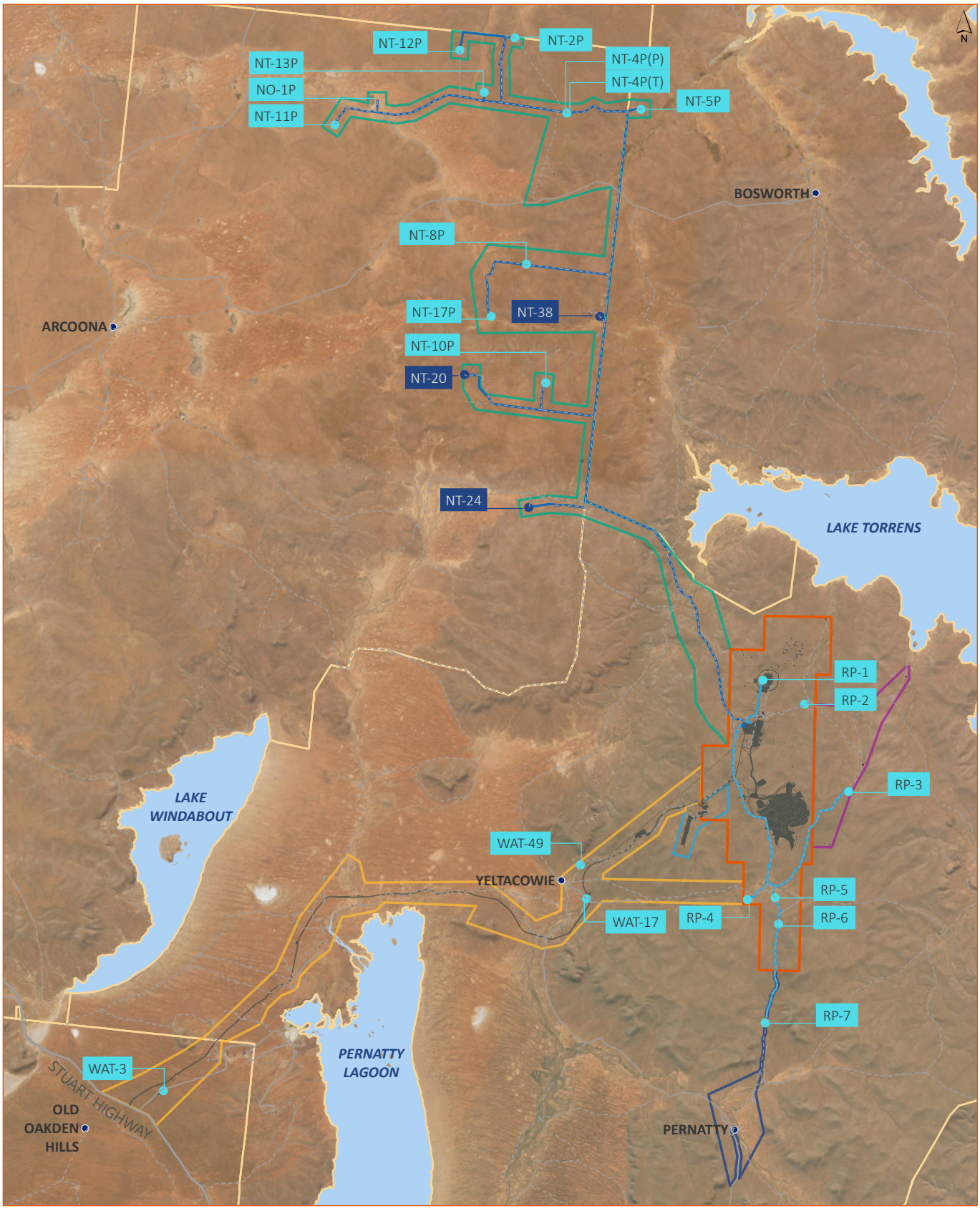
4.12.5.2 Scour and pigging pits

To support maintenance activities during operation of the Northern Wellfield, a series of approximately 30 scour and pigging pits have been established along the pipeline corridor. The scour pits are between 15 m x 15 m and 31 m x 31 m in area, about 0.7 m deep and between 55 m^3 and 687 m^3 in volume, with larger pits installed at the staging complexes to provide sufficient storage capacity for pipeline flushing activities. The pits are HDPE-lined to prevent the infiltration of pipeline scale and biological growth into the soil prior to emptying the pits.

Material generated during excavation of the pits was shaped to form a turkeys' nest-style embankment around the pits, and waste materials collected during pipeline maintenance operations is collected from the pits via vacuum trucks and disposed of in either the approved Carrapateena TSF or waste management facilities, depending on the nature of the material.

4.12.5.3 Water distribution network

The Carrapateena water distribution network is illustrated in Figure 4.41.



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- Pastoral station
- TSF Stage 3 PEPR footprint
- Northern Wellfield water supply pipeline and access track
- Radial Wellfield water supply pipeline and access track
- Production well
- Potential / alternate production well
- Homestead

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 4.40 | Raw water supply wells and wellfields

Carrapateena BHP

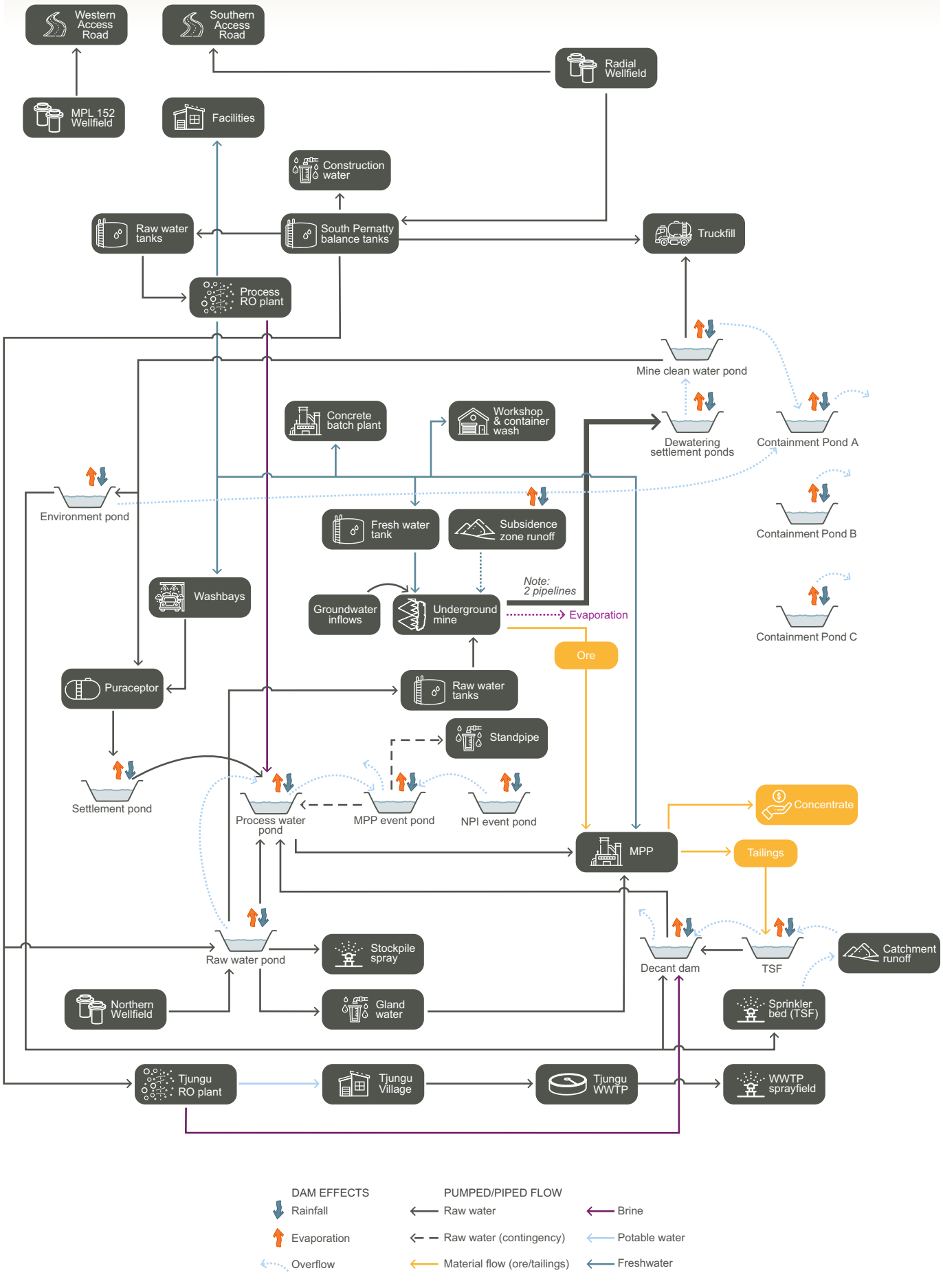


Figure 4.41 | Carrapateena water distribution network

4.12.5.4 Water holding

Water management storages are used to capture and contain rainfall and runoff from mine catchments, manage groundwater inflows to the underground workings, and store water sourced from production wells. Water can be extracted directly from storages to satisfy mine water demands or transferred between storages for broader use across the operation. Water holding structures and associated water quality are detailed in Table 4.56.

Water storages are typically constructed as engineered turkey's nest dams and are HDPE-lined to prevent water loss via seepage. All storages are operated to maintain at least 300 mm freeboard to prevent overtopping.

Table 4.56 | Water holding storage summary

Storage name	Description	Catchment area (ha)	Storage capacity (ML)	Water quality	Overflows to
Containment Pond A	Inflows to Containment Pond A include rainfall and runoff from the adjoining catchment along with overflows from the environment pond and mine clean water pond. Outflows from Containment Pond A occur due to evaporation from the storage water surface and as overflows if the storage capacity is exceeded. Overflows from Containment Pond A discharge offsite.	27.6	22.7	Generally, would contain surface water runoff (i.e. consistent with background surface water quality) but may contain overflow from the process water pond	Offsite
Containment Pond B	Inflows to Containment Pond B only occur due to rainfall and runoff from the adjoining catchment. Outflows occur due to evaporation from the storage water surface and as overflows if the storage capacity is exceeded. Overflows from Containment Pond B discharge offsite.	16.7	17.2		Offsite
Containment Pond C	Inflows to Containment Pond C only occur due to rainfall and runoff from the adjoining catchment. Outflows occur due to evaporation from the storage water surface and as overflows if the storage capacity is exceeded. Overflows from Containment Pond C discharge offsite.	11.5	13.6		Offsite
Decant dam	See Section 4.10.4.5.	111.9	500.0	See Section 4.10.3	Offsite (Eliza Creek)
Dewatering settlement ponds	Inflows to the dewatering settlement ponds include rainfall and runoff from the adjoining catchment along with dewatering water from the underground mine. The function of the dewatering settlement ponds is to allow sediment in the dewatered volumes to settle out prior to reuse in the water management system. Outflows from dewatering settlement ponds occur due to evaporation from the storage water surface and as overflows when the storage capacity is exceeded. Overflows from dewatering settlement ponds discharge directly into the mine clean water pond, as part of standard operation of the ponds.	1.0	9.8	Mine dewatering water of pH 6 – 8 and a TDS of 60,000 – 80,000 mg/L (equivalent to raw THA water)	Mine clean water pond
Environment pond	Inflows to the environment pond include rainfall and runoff from the adjoining catchment along with transfers from the mine clean water pond. Transfers from the mine clean water pond occur when there is excess underground dewatering water after truck fill and puraceptor demands have been met. Transfers only occur if there is available storage capacity within the environment pond. Outflows from the environment pond occur due to evaporation from the storage water surface along with transfers to the decant dam for storage and reuse within the MPP.	7.4	18.5	Generally, would contain surface water runoff (i.e. consistent with background surface water quality) but may contain metalliferous or acid mine drainage from the storage of PAF materials on the Production Stockpile.	Containment Pond A
Freshwater tanks	The freshwater tanks receive inflows from the process RO plant. The freshwater tanks are used to store freshwater for underground firefighting purposes.	NA	1.0	Potable water	NA
Mine clean water pond	Inflows to the mine clean water pond include rainfall and runoff from the adjoining catchment along with overflows (due to underground dewatering) from the dewatering settlement ponds. Outflows from the mine clean water pond occur due to evaporation from the storage water surface along with transfers to meet mine water demands.	0.4	4.0	Mine dewatering water of pH 6 – 8 and a TDS of 60,000 – 80,000 mg/L (equivalent to raw THA water)	Containment Pond A
Raw water tanks (underground)	The raw water tanks receive inflows via transfers from the raw water pond. Water is extracted from the raw water tanks (underground) to supply underground mine raw water demands.	N/A	2.0	Raw wellfield water (TDS of up to 110,000 mg/L)	NA
MPP event pond	Inflows to MPP event pond include rainfall and runoff from the adjoining catchment along with overflows from the non-process infrastructure (NPI) event pond and process water pond. Outflows from the MPP event pond occur due to evaporation from the storage water surface along with transfers to meet mine water demands.	19.7	11.5	Generally, would contain surface water runoff (i.e. consistent with background surface water quality) but may contain overflow from the process water pond	Offsite
NPI event pond	Inflows to the NPI event pond only occur due to rainfall and runoff from the adjoining catchment. Outflows occur due to evaporation from the storage water surface and as overflows if the storage capacity is exceeded. Overflows from the NPI event pond flow into the MPP event pond.	10.1	11.0	Generally, would contain surface water runoff (i.e. consistent with background surface water quality) but may contain overflow from the process water pond	MPP Event Pond
Process water pond	The process water pond is the primary source of water for the MPP. In addition to rainfall and runoff from the adjoining catchment, the process water pond also receives inflows via: • return transfers from the decant dam • transfers from the MPP event pond • transfers from the raw water pond • overflows from the raw water pond • overflows from the settlement pond • brine stream from the process RO plant • return transfers from the MPP. Outflows from the process water pond occur due to evaporation from the storage water surface along with transfers to the MPP.	0.4	8.7	A blend of raw water, tailings thickener overflow water, TSF decant return water and captured surface water runoff. Would have slightly higher metals concentrations than raw water, with traces of reagents (for example collectors, promoters, flocculants) that have been added during the flotation process	MPP event pond
Raw water pond	Inflows to the raw water pond occur due to rainfall and runoff from the adjoining catchment. Inflows are also sourced from the Northern Wellfield and South Pernatty balance tanks on an as needs basis. Outflows from the raw water pond occur due to evaporation from the storage water surface along with transfers to meet mine water demands	0.3	4.5	Raw wellfield water (TDS of up to 110,000 mg/L)	Process water pond

Storage name	Description	Catchment area (ha)	Storage capacity (ML)	Water quality	Overflows to
Raw water tanks (process RO plant)	The raw water tanks (process RO plant) receive inflows from the South Pernatty balance tanks. Water is extracted from the raw water tanks (process RO plant) to supply the process RO plant water demands.	NA	2.0	Raw wellfield water (TDS of up to 110,000 mg/L)	NA
Settlement pond	Inflows to settlement pond include rainfall and runoff from the adjoining catchment along with transfers from the puraceptor following treatment. Outflows from the settlement pond occur due to evaporation from the storage water surface and as overflows if the storage capacity is exceeded	0.2	3.7	Like that within the process water pond, with a greater concentration of sediments	Process water pond
South Pernatty balance tanks	Inflows to the South Pernatty balance tanks are sourced from Radial Wellfield production wells on an as needs basis. Outflows from the South Pernatty balance tank feed the Tjungu Village RO plant and top up the site raw water tanks.	NA	1.0	Raw wellfield water (TDS of up to 110,000 mg/L)	NA
Underground sump	The underground sump comprises several storage tanks located on various levels of the underground mine. The underground sump also includes storage associated with the mine void which can be used to temporarily store water during large rainfall events where a substantial volume of water is expected percolate into the underground workings. Water that drains into, or is supplied to, the underground mine is returned to the surface.	NA	60.0	Mine dewatering water of pH 6 – 8 and a TDS of 60,000 – 80,000 mg/L (equivalent to raw THA water)	NA

4.12.5.5 Water treatment

Operations require water of differing qualities to supplement the main processing operations, which are capable of using untreated (or blended) raw water. These uses include:

- human consumption (e.g. at the village, office/administration buildings, underground workers)
- safety shower circuits, chilled water circuits, ice machines, ablutions, showers and change-rooms
- MPP
- wash-down bays/wheel wash for vehicles (low TDS water needed)
- concrete and fibrecrete production (low TDS water needed)
- topsoil spreading (if required) on mine closure (low TDS water needed).

The treatment of raw water and the management of wastewater is described in the following sections.

Potable water treatment

Potable water is generated via two RO plants.

Freshwater is required for several mine water demands. Freshwater demands are supplied via the process RO plant. The volume of water that is treated by the process RO plant is based on the total freshwater demand (i.e. concentrate production rate), the capacity of the Radial Wellfield which supplies water to the process RO plant via the South Pernatty balance tanks and raw water tanks (process RO plant), the process RO plant maximum treatment rate. The process RO plant has a maximum treatment rate of 2.22 ML/d raw water, producing 1.31 ML/d permeate and 0.91 ML/d brine, a recovery rate of 59%. The brine stream is directed to the process water pond for reuse in the MPP.

The Tjungu Village RO plant is used to supply potable water to the Tjungu Village. Inflows to the Tjungu Village RO plant are sourced from the South Pernatty balance tanks and are based on the potable water demand, the capacity of the Radial Wellfield which supplies water to the Tjungu Village RO plant via the South Pernatty balance tanks and the Tjungu Village RO plant maximum treatment rate. The Tjungu Village RO plant has a maximum permeate treatment rate of 0.14 ML/d and plant recovery rate of 35%, resulting in a maximum raw water throughput of 0.4 ML/d. The difference between the raw water throughput and permeate generated (0.26 ML/d) forms a brine stream which is directed to the decant dam.

During early phase operations, RO brine was managed via installation of a second sprinkler bed system within the footprint of the TSF and associated pipeline infrastructure to enable surface irrigation and evaporation of excess brine water stream from the Tjungu Village RO plant. The TSF sprinkler bed has been decommissioned.

As a contingency option, BHP also obtained approval to establish injection wells to manage RO brine from the Exploration Village. Details of the injection wells are presented in Table 4.57.

Table 4.57 | Radial Wellfield water disposal wells

Screened aquifer	Well ID	Disposal rate (ML/d)
THA	IS1	0.3
	IS2	0.1
	IS3	0.03
	RP2	0.3
Total	**-**	**0.7**

The injection wells have not been commissioned at this time.

Wastewater treatment

The various elements contributing flows to the wastewater stream are:

- workers' accommodation rooms
- common facilities, including kitchen, dining, mess, laundries, amenities, gym and associated service buildings located onsite
- airstrip terminal amenities
- wastewater from the mining, process and administration area within ML 6471.

As part of the approvals process and construction of the Tjungu Village, a WWTP was installed to accommodate the peak construction and operational workforce, as approved under MPL 149. The Tjungu Village WWTP was later upgraded with nameplate hydraulic capacity of 126.5 kL/d to accommodate the expansion of Tjungu Village to 550 people, with a design allowance of 230 L/person/day under SA Health Approval WWI-10185.

An expansion of the WWTP to a nameplate hydraulic capacity of 212.5 kL/d (allowing for up to 788 people with an allowance of 250 L/person/day is being undertaken by way of installation of a membrane bio-reactor (MBR), with treated wastewater of a quality suitable for reuse within mining processes, else disposed of via spray irrigation.

Wastewater is directed to the WWTP from the mining, processing and administration areas of the MPP via a transfer pump station located at the MPP site, and consists of a pump and sump arrangement directing flows via a HDPE pipeline to the Tjungu Village sewer pump station. Wastewater from the Tjungu Village is also directed to the accommodation village sewer pump station, consisting of pumps, sumps and tanks which direct wastewater to the WWTP.

The MBR treatment process is based on a modified Ludzac-Ettinger (MLE) MBR process for nitrogen removal utilising proprietary Toray submerged flat sheet membranes. The MLE process allows for a pre-anoxic zone, aerobic zone with internal recycle, an aerobic MBR zone with activated sludge return to provide a high level of nitrate removal.

The MBR treatment plant consists of the following main process items:

- balance tanks
- inlet screen
- anoxic tank
- aeration tank

- MBR tank with flat sheet membranes
- biological and membrane blowers
- return activated sludge pump
- permeate pumps
- poly-aluminium-chloride dosing system
- sodium hypochlorite dosing system
- recycled water reuse tanks
- sludge dewatering screw press and return sump.

Wastewater recycling

A key driver for upgrade of the Tjungu Village WWTP is reusing recycled water as a part of the mining processes, rather than disposing to the sprayfield irrigation area. Such uses may include utilising recycled water in the concentrate filter, the final step in the coarse flotation process prior to the mined concentrate being stockpiled and carted to market. Recycled water is supplied to the concentrate filter wash tank and will replace a small portion of the freshwater requirements in the process, and will be completely isolated from operator contact, minimising the human health risk posed by reuse. The nominal treated wastewater quality is described in Table 4.58.

Treated wastewater that is unable to be used will be directed to the sprayfield irrigation area, covering 28,900 m^2 and located north of Tjungu Village. The spray nozzles utilised in the sprayfield are aerial type, and the site is fenced from unauthorised access.

Table 4.58 | Wastewater specification for reuse

Description	Value	Units
Expected peak daily flow	212.5	kL/d
Biological oxygen demand (BOD)	<10	mg/L
Total suspended solids (TSS)	<5	mg/L
Total nitrogen (TN)	<15	mg/L
Total phosphorus	<5	mg/L
pH	6.5 – 8.5	
Escherichia coli (E. coli)	<1	cfu/100 mL
Chlorine (Cl_2)	0.2 – 2.0	mg/L
Turbidity	<2 (95th percentile)	NTU
	<5 (maximum)	NTU

4.12.6 Surface water management

4.12.6.1 Management approach

The management of surface water is based on the separation of overland and ephemeral surface water flows originating from undisturbed areas of the ML. Management targets surface water runoff that has interacted with disturbed land (i.e. the mining and processing infrastructure). The basis of the system design is as follows:

- Water that contacts disturbed land (e.g. runoff from the MPP) needs to be collected/contained and managed prior to release (if captured water stores are at capacity or the water is unable to be reused within the operation).
- Water that contacts undisturbed land is diverted around areas of disturbance to limit the volumes of water requiring management and to minimise effects to pre-mine watercourses. Diversions preferentially keep surface water flow within its originating catchment.
- Water is diverted around the SLC subsidence zone to minimise water inflows to the underground workings and avoid degradation of the abandonment bund.

The MPP area surface water management system is illustrated in Figure 4.42. Mine area surface water management was previously discussed in Section 4.8.5.4 and illustrated in Figure 4.22.

4.12.6.2 Interaction with on-lease infrastructure

A network of containment and diversion drains consisting of unlined excavations and bunding is established within the ML. Drains are typically 4.0 m wide by 0.5 m deep, with a wall angle of approximately 30 degrees for a total flow area of approximately 2.3 m^2. Bunding is sized based on the material excavated during drainage installation work.

The drains and bunds re-direct surface water flows around the MPP area (including the mine portal and WRD) into the existing surface water catchments and capture runoff from the disturbed areas around the WRD, stockpiles, MPP and mine portal. The captured runoff is directed to the site event pond. From the Event Pond, stormwater is directed to a settling pond and subsequently to the Process Water Pond for re-use in the metallurgical process. Should the process water pond reach capacity (e.g. for higher rainfall events), overflow is directed to the MPP event pond. Overflow from the MPP event pond directs water into a drainage channel for re-introduction into the local surface water catchment. Site ponds are constructed as balanced cut to fill with excavated material forming compacted walls and are lined with HDPE.

Similar surface water diversion infrastructure and bunding is established around the mine infrastructure associated with the SLC operations (i.e. ventilation fans, refrigeration plants, access roads and the SLC zone of influence). In this instance, flows are directed to detention ponds that are sized to capture all waters for infiltration and evaporation up to approximately a 1-in-50-year rainfall event. Beyond a 1-in-50-year rainfall event, flows are slowed to remove sediment prior to discharge of waters into existing watercourses or engineered diversions, thus minimising the flow of water into the underground workings.

Figure 4.43 describes the surface water management system for the Carrapateena airstrip.

4.12.6.3 Interaction with off-lease infrastructure

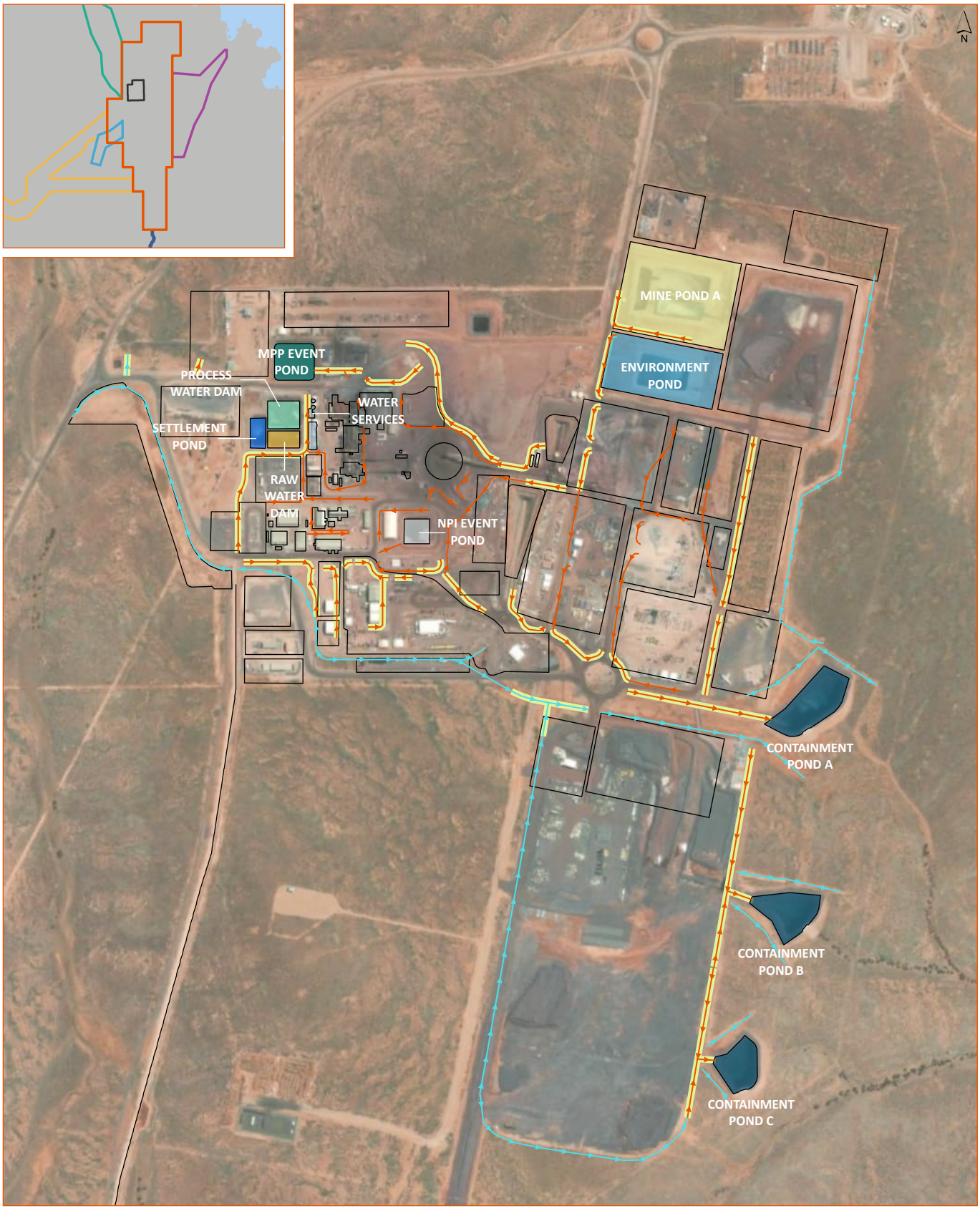
Access roads to and from the ML and to activities associated with the Radial Wellfield MPL 153 and Western Infrastructure Corridor MPL152 involve the crossing of Elizabeth Creek, Yeltacowie Creek and other minor tributaries to the catchments detailed in Chapter 6. Culverts or concrete-lined fords have or will be installed as required for road crossovers and stormwater drainage. They have been located and orientated to minimise disruption to existing drainage paths. Scour protection is provided to limit erosion under the design flow conditions.

For shallower crossings, concrete-lined fords are located in a straight stretch of the stream or at the crossover point of a meander where flow is directed through the centre of the channel. The streambed is concrete lined so that the natural cross-sectional area and shape of the channel is preserved as much as possible. The fords are kept as low as possible (less than 300 mm where practicable) to reduce the risk of head cut processes undermining the crossing. The concrete extends across the stream to above the highest flood level to avoid the possibility of floods scouring a bypass around the crossing.

For deeper crossings, culverts are established. Culvert inlet design ensures that the potential for displacement of the culvert structure during large flood events is minimised. Drainage channel outfalls would have scour protection (stone pitching or lining) as required. Culvert materials options for use for stormwater drainage and road crossovers include reinforced concrete pipes, corrugated steel culverts and PVC.

The wall thickness of culverts is designed to accommodate the embankment height above each culvert and superimposed wheel loads, including construction vehicles as applicable in accordance with the relevant Australian Standards. Culverts are also designed to accommodate fluid pressures if applicable as determined by the hydraulic computations in accordance with the relevant Australian Standards.

Typical culvert design is presented in Figure 4.44, and typical ford design is presented in Figure 4.45.



KEY

- Disturbed Area Drain / Diversion Bund
- Undisturbed Area Drain / Diversion Bund
- Processing plant layout
- Key Surface Water Management Infrastructure
- Environment Pond
- MPP Event Pond
- Mine Pond A
- NPI Event Pond
- Process Water Dam
- Raw Water Dam
- Settlement Pond
- Water Services
- Sediment Pond
- Tailings Disposal Pipeline

0 200 400 m

GDA 1994 MGA Zone 53

Figure 4.42 | MPP surface water management system

Carrapateena BHP

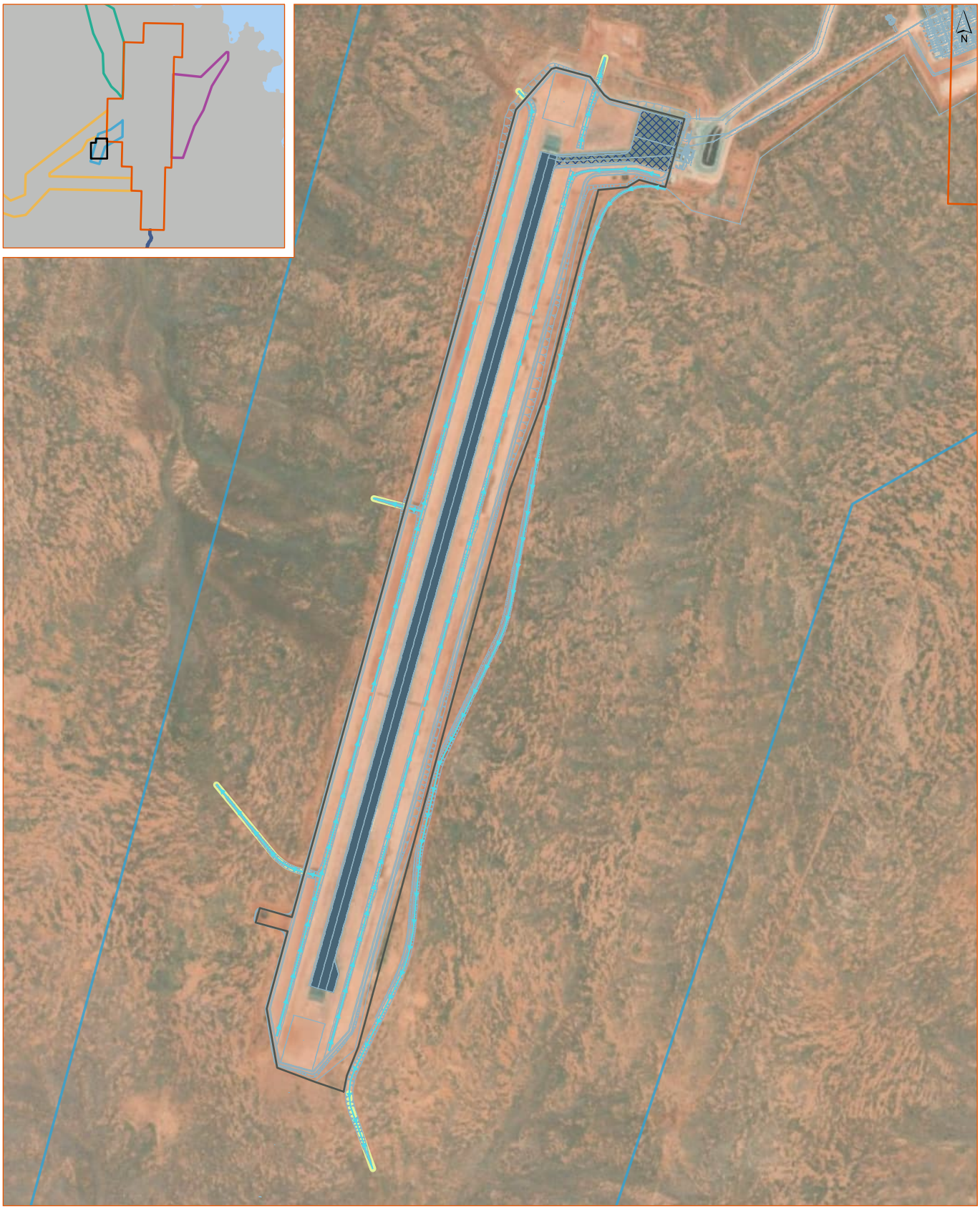
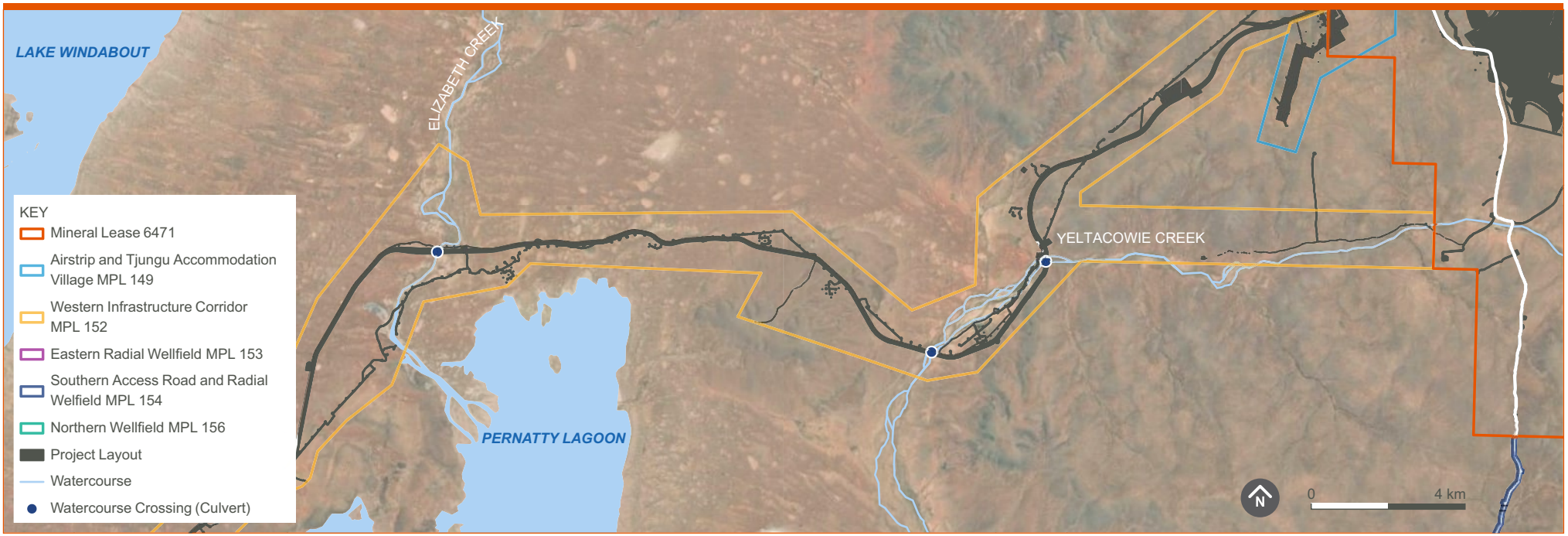


Figure 4.43 | Carrapateena airstrip surface water management infrastructure

Carrapateena BHP



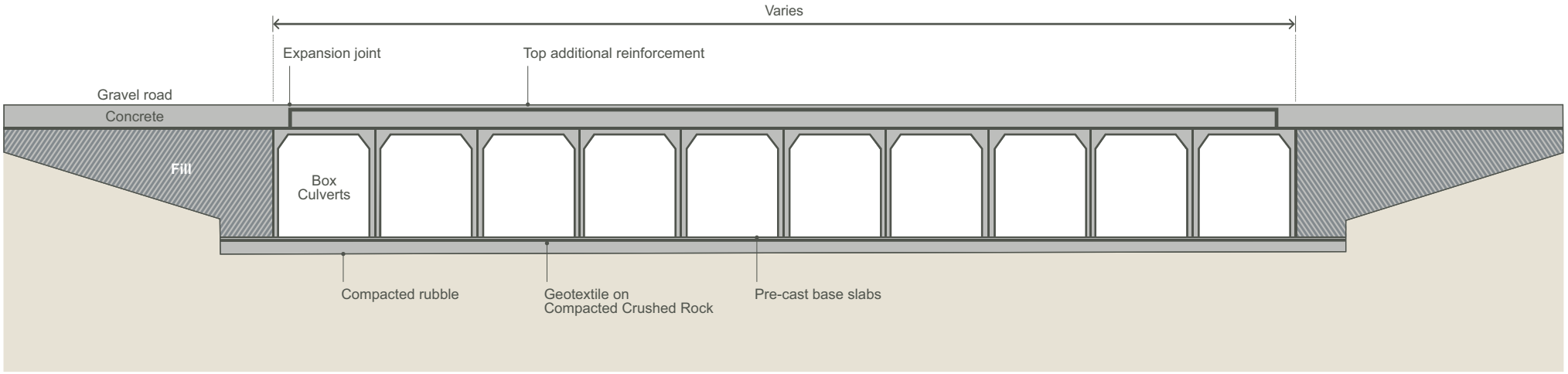
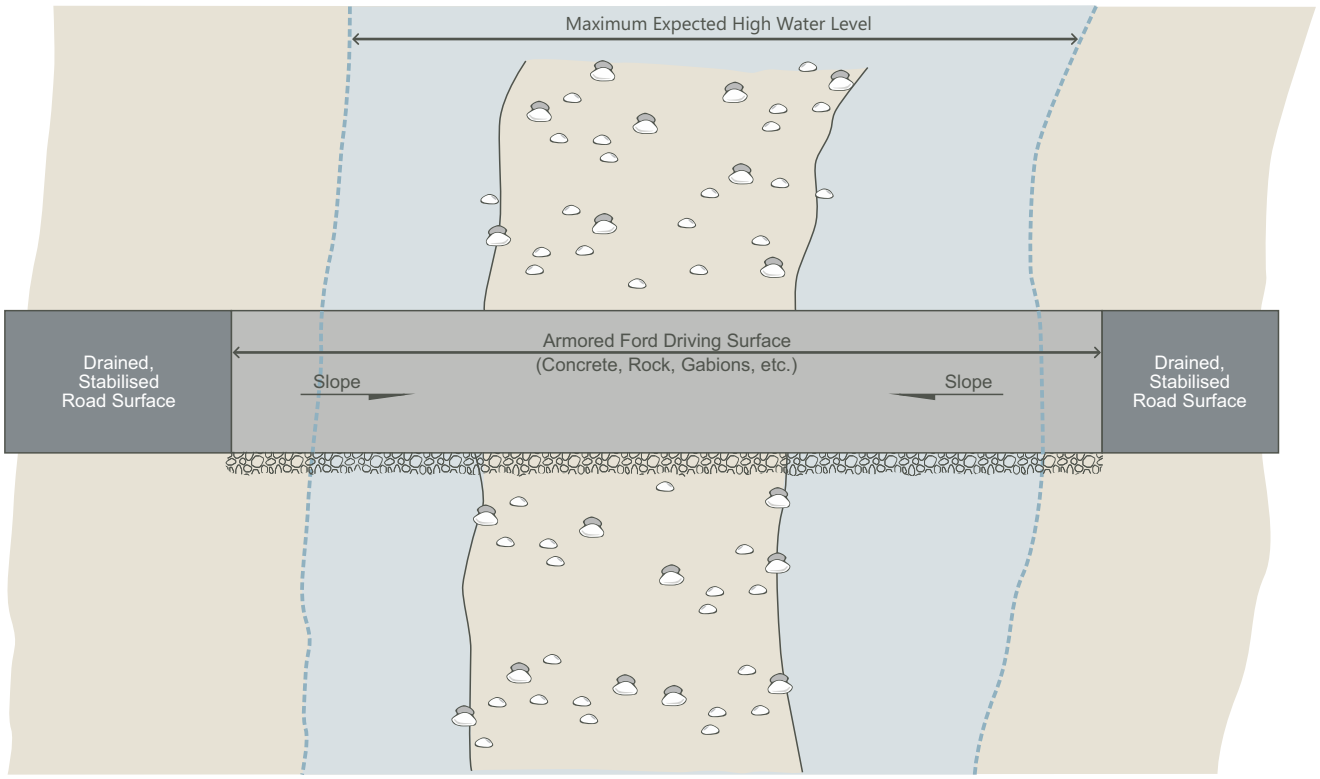


Figure 4.44 | Typical culvert cross-section



PLAN VIEW

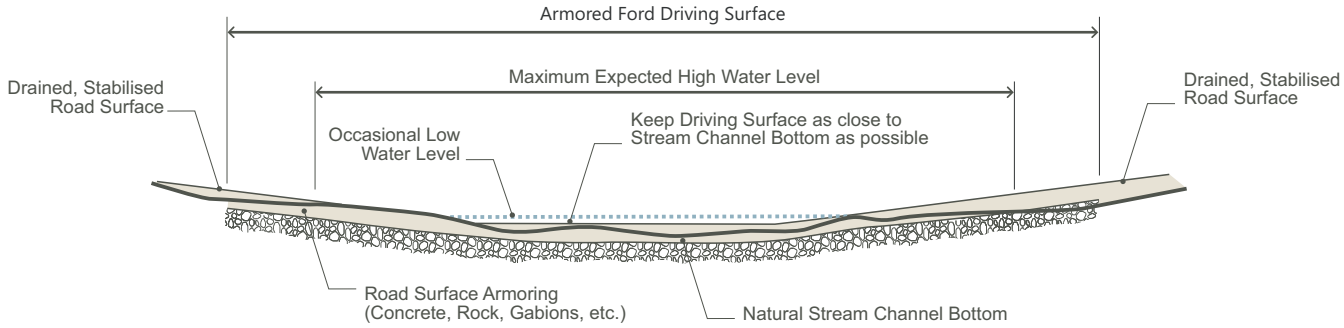


Figure 4.45 | Typical ford crossing detail

4.12.6.4 Sediment and stockpile runoff containment ponds

The Sediment Basin Design, Construction and Maintenance Guidelines (Brisbane City 2001) describe two philosophies for sedimentation basin design. When 70% of soil particles are expected to be greater than 0.02 mm in diameter, it is expected that sediment would drop relatively quickly through the water column, and a basin that treats a design peak flow rate is recommended. In this case, stormwater flows into the basin where it is slowed. During its time in the basin, the soil drops to the bottom, and clean water exits via a spillway. When more than 30% of soil particles are expected to be smaller than 0.02 mm, it is expected that it would take a long time for sediment to settle. Rather than treating water and then releasing it during the storm event, water is captured, and sediment is allowed to settle over a period of days following the rain event.

The majority of rainfall events are smaller than a 1-in-1 year ARI event, and the majority of sediment is transported in common, every-day-type rainfall events. Larger rainfall events may cause significant landscape erosion due to faster runoff velocities, however sedimentation basins are designed to capture and treat runoff from the multitude of small rainfall runoff events rather than large, infrequent events. The Sediment Basin Design, Construction and Maintenance Guidelines recommend that the peak flow for design purposes should be one quarter of the 1-in-1 year ARI flow, or, in effect, the peak flow that could be expected to occur several times per year.

Once the sedimentation ponds reach capacity, they will be drained to allow access and accumulated sediment and other debris cleaned out. The wet sediment will be placed nearby to dry and may be mixed with dry soil from subsoil stockpiles. Once dry the material will be analysed to assess its suitable as fill material before being disposed of to the WRD.

As part of the site surface water management infrastructure maintenance and inspection program, the sedimentation ponds will be inspected annually (prior to summer) and after rainfall events that create surface water flows. These inspections will monitor the performance of the sediment ponds and highlight the need for maintenance or repair activities outside of the regular program. A typical sedimentation basin design for the site ponds is shown in Figure 4.46.

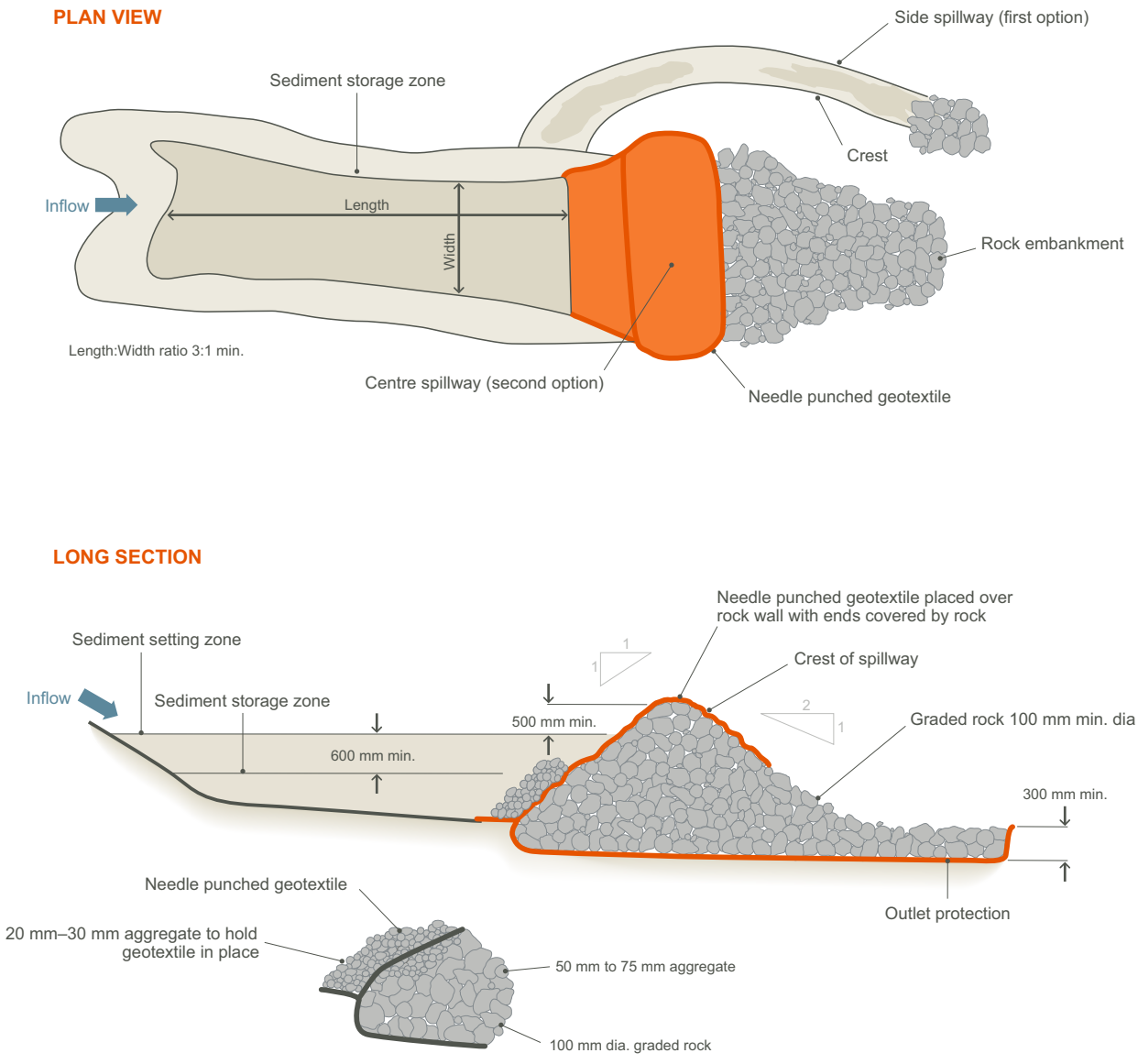
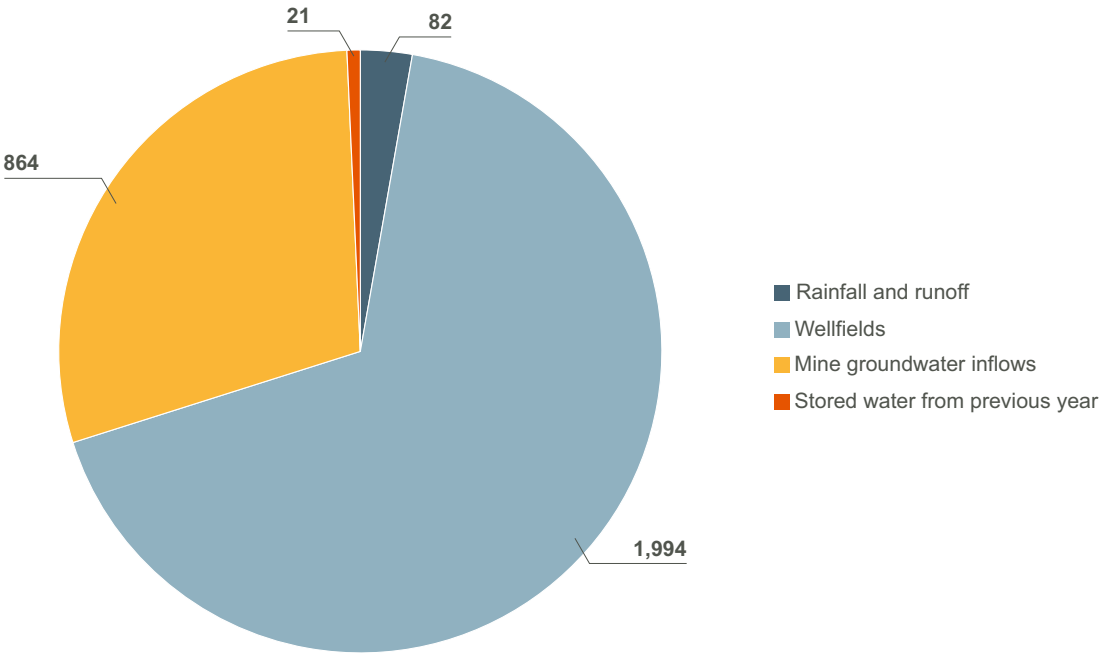


Figure 4.46 | Typical sediment pond design

4.12.7 Water balance

The water demand and supply for Carrapateena was presented in Section 4.12.4.1 and Section 4.12.4.2 respectively, with the site water distribution network described in Section 4.12.5.3. The site water balance is illustrated in Figure 4.47.

WATER SUPPLY (2021), TOTAL 2,961 ML/YEAR FOR 4.3 MTPA



WATER DEMANDS (2021), TOTAL 2,961 ML/YEAR FOR 4.3 MTPA

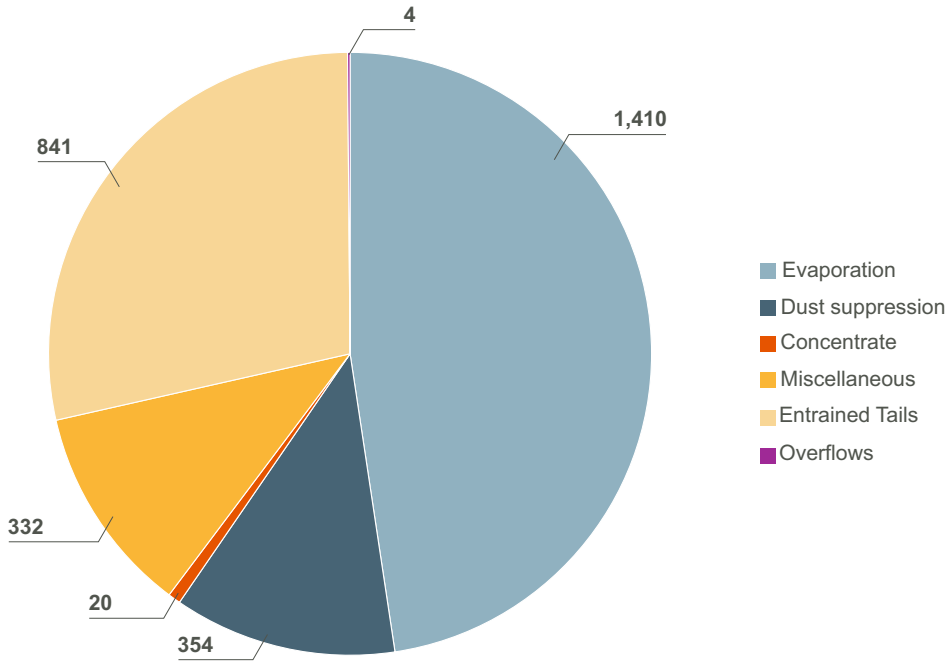


Figure 4.47 | Carrapateena operational water balance

4.13 Energy management

This section outlines the energy demand and supply for Carrapateena, including details with respect to diesel consumption, electricity demand and transmission infrastructure and estimates of greenhouse gas emissions.

4.13.1 Key elements

A description of the key elements of energy management at Carrapateena is provided in Table 4.59. Energy management elements have been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 4.60 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators for the energy-related infrastructure and activities, as provided in Chapter 7.

Table 4.59 | Energy management key project elements

Key element	Summary
Diesel demand	Average of approximately 12,500 kL per annum consumption associated with mobile fleet and electricity generation for remote infrastructure, with a peak of up to 13,760 kL per annum
Diesel supply	Diesel supply from offsite providers. Approximately 500 kL total diesel storage capacity within the ML, with additional 20 kL storages at remote infrastructure sites
Electricity demand	Up to 410 GWh per annum demand, the major components of which are electricity usage associated with underground mining (crushing and ventilation) loads and surface ore grinding. Current average annual electricity consumption of approximately 300 GWh per annum
Electricity supply	Connection to the National Electricity Market (NEM) via a 132 kV overhead transmission line (OHTL) from Mount Gunson South Substation to Pernatty Substation (located on the ML)
Greenhouse gas emissions	Current annual NGERS-reportable greenhouse gas emissions of approximately 110,000 t of carbon dioxide equivalent (CO_2-e) per annum, consisting of 34,000 t CO_2-e of Scope 1 emissions and 76,000 t CO_2-e of Scope 2 emissions

Table 4.60 | Energy management Impact IDs, design and management controls and uncertainty

Energy management	
Carrapateena Project Impact IDs[1]	Northern Wellfield Impact IDs[1]
L31*, L32*, L33*, L35 AQ31, AQ32, AQ33, AQ34, AQ51 SE19	L39 AQ09, AQ10, AQ11, AQ12
Design controls	
• Transmission line spacing between phase and ground conductors will be greater than 150 cm • Use of emissions control equipment on fixed and mobile plant and equipment	
Management controls	
• Insulation of phase and/or grounds where necessary • Use of perch discouragers where necessary • Wherever possible, open excavations and drillholes will be covered as soon as practicable or managed to ensure no entrapment can occur through the use of ramps. • Induction contains process for bringing chemicals and hydrocarbons onsite including requirements for storage, handling and disposal • Establishment of Chemical Database including copies of MSDS and storage, handling and disposal requirements • Fuel storages to designed in accordance with relevant Australian Standards and EPA Bunding Guidelines • All equipment fitted with appropriate firefighting equipment • Site based Emergency Response Team (ERT)	

*Non-Outcome or Outcome-Based Lease Condition Proposed
(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
(2) Appendix E Consolidated Assessment (OZ Minerals 2018c)

4.13.2 Diesel

4.13.2.1 Demand

Carrapateena diesel uses include exploration, construction, mining, environmental and site services (see mobile and fixed plant descriptions for mining and processing in Section 4.8.2.7 and Section 4.9.4.2, respectively). Site diesel consumptions are summarised in Table 4.61.

Table 4.61 | Carrapateena peak diesel consumption

Demand source	Annual consumption (kL)
Underground mining mobile fleet	5,200
Surface mobile fleet	1,100
Wellfield infrastructure	4,460
Underground explosives manufacture	100
Onsite electricity generation (total)	2,900
Total	**13,760**

4.13.2.2 Supply

A single bulk diesel storage facility is established in the MPP area to meet surface and underground demands. The facilities consist of a series of self-bunded tanks, concrete slabs, bowser/discharge hosing, lighting and pumps. The tanks are between 50,000 L and 110,000 L with a combined storage capacity of approximately 500,000 L.

Bunded diesel storages of nominally 20,000 L capacity are provided at each of the water production wells for the refuelling of onsite diesel generators.

4.13.3 Electricity

4.13.3.1 Demand

The Carrapateena operations have an average power load ranging between 40 and 50 MW and may consume approximately 410 GWh per annum of electricity. Current average electricity consumption is 300 GWh/annum. The major site electricity users are summarised in Table 4.62 and include:

- underground mine ventilation systems
- primary crushers
- grinding mills.

Table 4.62 | Carrapateena electricity consumption

Demand source	Electricity load (kW)
Mining	22,569
Decline conveyor	3,199
Crushing and grinding circuits	19,101
MPP	4,311
Tjungu Village	500
Offices/administration	320
Total	**50,000**

4.13.3.2 Supply

The operational power supply for Carrapateena is via a 132 kV OHTL connecting into the existing South Australian electricity network at Mount Gunson South Substation with transmission to the Pernatty Substation located adjacent to the Carrapateena MPP.

The Mount Gunson South Substation was subject to (third-party) approvals under the *Development Act 1993* (SA) and includes the following equipment:

- additional 132 kV circuit breaker and bay assembly
- metering equipment to the national grid metering standards
- Supervisory Control and Data Acquisition (SCADA) for monitoring and control of the circuit breaker and metering equipment

- communications equipment for remote control and monitoring
- connection of the circuit breaker to the overhead power line.

BHP has entered into a Transmission Connection Agreement (TCA) with ElectraNet that guarantees a 55 MW power allocation for a 20-year period. The supply of the power requires a two-part process covering regulated assets and unregulated assets. Energisation and commissioning of the line occurred in mid-2019.

The OHTL alignment is located within the Western Infrastructure Corridor (MPL 152, see Figure 4.48). This 132 kV overhead transmission line connects to site via a high voltage substation where the 132 kV supply is stepped down to 22 kV or 33 kV and further reticulated to other users such as mining, surface operations facilities and accommodation facilities via overhead transmission lines. Additional fit-for-purpose site electrical infrastructure, substations and reticulation are installed across the site.

4.13.3.3 Transmission

Design criteria and basis

The transmission line design is consistent with relevant Australian Standards and ensures that:

- electrical, road and ground clearances meet Australian Standards
- specific soil conditions are accounted for in foundation design
- environmental management measures are appropriately considered in the Operations and Maintenance Plan
- materials are suited to ambient temperatures and anticipated conditions for the design life of the transmission line.

The transmission line design is based on the use of monopoles ranging in height from 17 m to 30 m. They are spaced approximately 250 m apart, depending on topography. The conductor is sized for a thermal rating of 80 MVA based on a design temperature of 80ºC and the anticipated maximum ambient temperature condition for the region.

The key design criteria and characteristics for the transmission line are presented in Table 4.63.

Table 4.63 | Carrapateena electricity transmission line design criteria

Aspect	Description
Transmission line	Single circuit transmission line between the new Mount Gunson South Substation and Pernatty Substation (located adjacent to the MPP)
Transmission voltage	132 kV
Tenement type	MPL
Transmission line length	55 km
Operating hours	24 hours
Tower type	Monopoles and olive conductor
Number of towers	206 monopoles
Height of tower	17 m – 30 m
Footings	Bored pier *in-situ* concrete footings with holding-down bolt assemblies
Power source	Connection to the South Australian electricity network at Mount Gunson

Alignment

The transmission line route is contained within the boundary of the Western Infrastructure Corridor on MPL 152; which also contains the Western Access Road. The alignment of the transmission line is shown in Figure 4.48 and includes an undercrossing of the Olympic Dam 275 kV transmission line near Mount Gunson.

Network interaction

The power load for Carrapateena is between 40 MW and 50 MW, supplied via a network connection to the dedicated BHP Hill-to-Hill (H2H) 275 kV transmission line. The H2H transmission line consists of:

- a 275 kV section extending approximately 130 km from Davenport Substation to the Mount Gunson South Substation
- a 132 kV section extending approximately 128 km from the Mount Gunson South Substation to the existing Prominent Hill 132 kV transmission line, connecting to the west of Olympic Dam.

Approval for the H2H transmission line was granted in late 2018 under the *Planning, Development and Infrastructure Act 2016* (SA).

The availability of 55 MW of power at Carrapateena is confirmed at a thermal loading of 91%. In order to ensure the stable supply of electricity to the site and minimise the potential for the introduction of instability into the SA electricity network, reactive power compensation infrastructure has been installed.

4.13.3.4 Distribution

Power is distributed throughout the surface areas of the site via an 11 kV distribution system, originating at the Pernatty 132/11 kV substation located adjacent to the MPP. Power distribution is to the following load centres:

- Tjungu Village: fed via an 11 kV (3.8 MVA) overhead transmission line to three kiosk substations located at the village. That powerline incorporates a fibre to support the site communications network in its earth wire. The substation at the Tjungu Village is ground mounted and incorporates 11 kV switchgear and is configured to accept the connection of backup generation.
- SLC Mine: supplied from the Site Main 132/11 kV substation with substations established at the portal/vent rise locations. Each substation incorporates 11 kV bus and switchgear to feed the surface infrastructure and mine underground feeders. The power supply to the mine network is by cable from the site main high voltage substation to the box cut area and then by 11 kV overhead power line (25 MVA) to the vent raise substation locations. The mining area electricity transmission line incorporates a fibre to support the site communications network in its earth wire.
- Site offices and heavy vehicle workshop areas: kiosk substations are ground mounted, incorporating 11 kV switchgear, transformers and distribution boards and are fed by underground cable from the site high voltage substation. The kiosk substation at the heavy vehicle workshop includes a 1,000 V supply for the specialist equipment workshop for testing of 1,000 V underground electrical equipment.

4.13.3.5 Emergency generation

Table 4.64 details emergency power generation capacity in the event of a network power outage.

Table 4.64 | Carrapateena emergency electricity generation

Facility	Capacity (MW)	Emergency generation
Village	2.4	4 x 600 kVA diesel generators
MPP	4.95	3 x 1,675 kVA diesel generators

4.13.4 Greenhouse gas emissions

The *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act) introduced a national framework for the reporting and dissemination of information related to greenhouse gas emissions, energy production and energy use. BHP reports Scope 1 and Scope 2 emissions under the NGER Act for Carrapateena:

- Scope 1 emissions, as determined in accordance with the National Greenhouse and Energy Reporting (NGERs) framework, for the current reporting year were 34,033 t of CO_2-e.
- Scope 2 emissions, from annual electricity consumption, were 75,009 t CO_2-e for the current reporting year.

Greenhouse gas emissions by source are described in Table 4.65.

Table 4.65 | Carrapateena greenhouse gas emissions

Demand source	Annual consumption (kL)	Greenhouse gas emission (t CO_2-e)
Scope 1 emissions		
Non-lubricant fluid oils	220	NA
Diesel (non-transport)	10,847	29,393
LPG (non-transport)	19	29
Grease	24	3
Lubricating oil	317	171
Diesel (transport)	1,630	4,431
Sulphur hexafluoride (SF_6)	Total stock of 591 (t CO_2-e)	5
Total		**34,033**
Scope 2 emissions		
Purchased electricity	300,034 MWh	75,009
Total		**75,009**
Greenhouse gas emissions		
Total		**109,042**

4.13.5 Energy efficiency and offsets

Carrapateena aims to operate as efficiently as possible with respect to energy usage, acknowledging that the purchase of imported electricity represents a significant cost to business. Optimisation of elements such as ore throughput, grind size, mine ventilation requirements all contribute to a reduction in energy demand. Coupled to that, the proposed changes to approved operations described in this PEPR aim to further reduce energy consumption.

Local (small scale) renewable installations are provided for the accommodation village and some remote plant and equipment; however the large-scale use of renewable electricity remains an opportunity under investigation.

Carrapateena does not currently purchase carbon offsets for its residual greenhouse gas emissions, however BHP has a medium-term target to reduce operational greenhouse gas emissions by at least 30% from FY2020 levels by FY2030, with a long-term goal to achieve net zero operational greenhouse gas emissions by 2050. The use of carbon offsets for Carrapateena's residual greenhouse gas emissions may form a component of progress towards these targets.

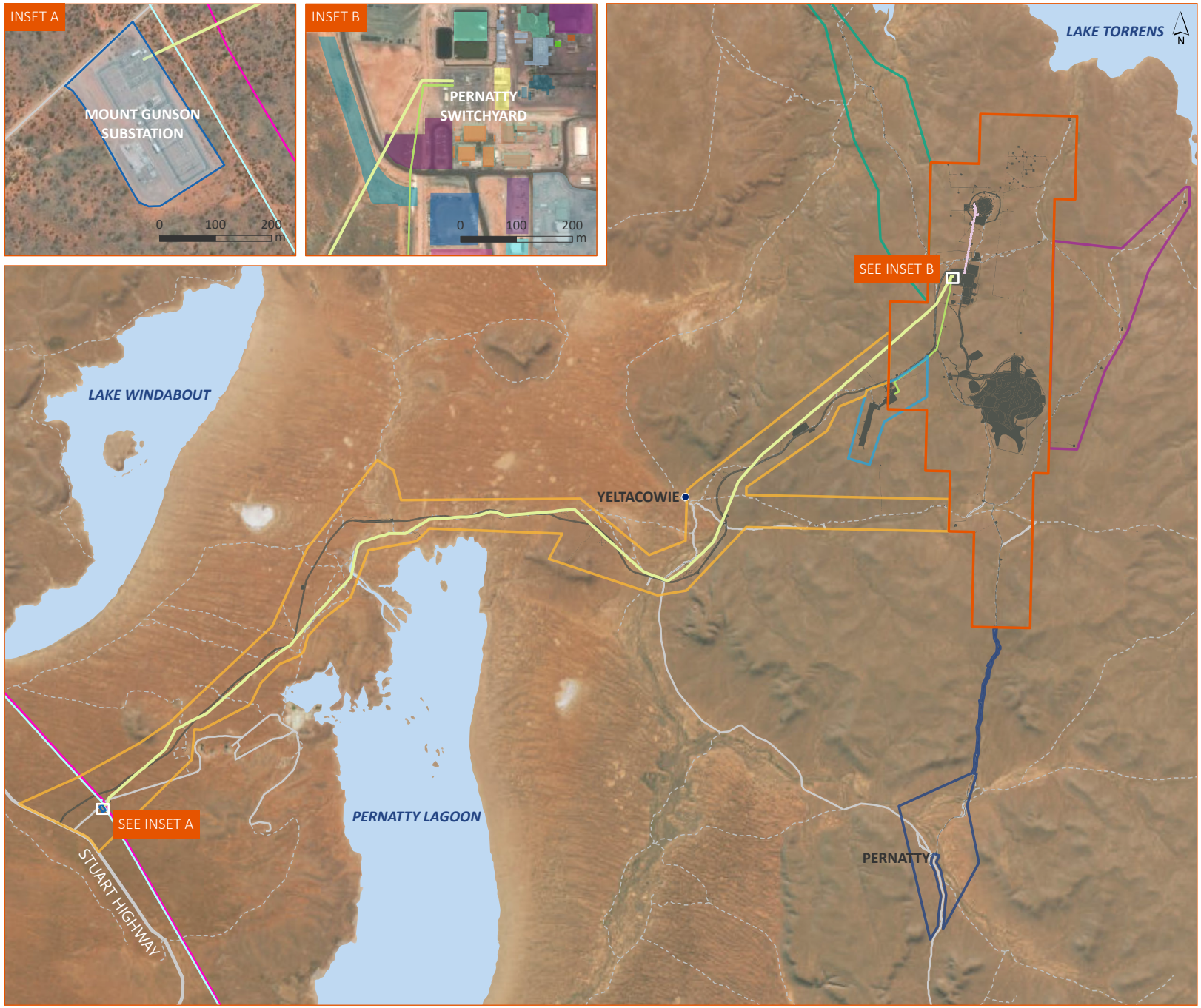


Figure 4.48 | Electricity supply infrastructure and transmission line alignment

Carrapateena BHP

4.14 Logistics and site access

4.14.1 Key elements

A description of the key elements related to logistics and site access at Carrapateena is provided in Table 4.66. Logistics management elements have been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 4.67 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators for the logistics-related infrastructure and activities, as provided in Chapter 7.

Table 4.66 | Logistics and site access key project elements

Key element	Summary
Primary site access	An all-weather primary site access road (the Western Access Road) has been established to the west of ML 6471, within the Western Infrastructure Corridor on MPL 152 tenement, intercepting the Stuart Highway near Mount Gunson, approximately 52 km south-east of Pimba by road
Secondary site access	Secondary site access is via a dedicated access road to the south of ML 6471, joining the gazetted road at Pernatty Station, and passing through South Gap Station prior to joining the Stuart Highway approximately 80 km (by road) north-west of Port Augusta (the Southern Access Road)
Northern Wellfield access	Access to the wells is via an unsealed service road connecting ML 6471 to MPL 156, for the most part passing along existing pastoral tracks. Sections of the tracks are repaired and maintained (graded) as required
Site security	A permanent site access gatehouse has been constructed on the Western Access Road on MPL 152, located prior to the turnoff to the Tjungu Village
Airstrip	Sealed 1,600 m x 30 m airstrip suitable for use by Avro RJ100 (or similar) aircraft capable of carrying up to 100 passengers
Workforce	Current workforce is approximately 656 personnel, consisting of 208 employees and 448 contractors. Estimated peak workforce over the Carrapateena LOM would be up to 740 personnel (nominally 215 employees and 535 contractors)

Table 4.67 | Logistics and site access Impact IDs, design and management controls and uncertainty

Logistics and site access	
Carrapateena Project Impact IDs[1]	Northern Wellfield Impact IDs[1]
L07*, L08*, L09*, L23*, L24*, L25*, L26*, L27*, L31*, L32*, L33*, L34* AQ41*, AQ42, AQ43*, AQ44, AQ50 SW48, SW49, SE01, SE02, SE03*, SE04, SE05, SE13, SE14, SE15*, SE16 and SE17	L07, L08, L09*, L27*, L28*, L29*, L30*, L31*, L35*, L36*, L37*, L38* AQ14, AQ15, AQ16 SE01, SE02, SE03*, SE04, SE12, SE13
Design controls	
• Intersections with the Stuart Highway constructed in accordance with appropriate standards and other requirements established in consultation with DPTI • Pernatty Station Homestead bypass road on the Southern Access Road (if required)	

Logistics and site access
• 1.2 – 1.5 m high wildlife and stock control fence surrounding the airstrip

Management controls
• Traffic Management Plans and speed limits • Area-specific and site inductions and training • Incident reporting procedures • Vehicle inspections and wash-down procedures • Maintenance of unsealed roads • Dust suppression on unsealed roads* • Speed limit restrictions at homestead* • Local Area Agreement – Operating Protocols • Regular meetings with pastoral land managers • Waivers in place for any water point infrastructure in close proximity to Project activities • Heavy vehicle transport movements adjacent to the Pernatty Homestead limited to hours between 7 am and 7 pm without prior agreement • Access area gatehouse and signage at site access points • Exclusion fencing and a security gatehouse would be established at the entry to the Mineral Lease area • Destocking infrastructure locations • Signage to the airport at access points • Airstrip clearance and foreign object inspections • Airstrip operating procedures • Wildlife and stock fence maintenance program.

*Non-Outcome or Outcome-Based Lease Condition Proposed
(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
(2) Appendix E Consolidated Assessment (OZ Minerals 2018c)

4.14.2 Logistics

The Carrapateena logistics task includes the movement of personnel, materials and concentrate to and from Carrapateena as described in Table 4.68. Planned shutdown periods may require a temporary increase in traffic volumes, and there are light vehicle movements between the site and offsite infrastructure associated with on-going maintenance activities.

Total (one-way) vehicle movements along the Western Access Road average approximately 1,500 per month, consisting of approximately 415 light vehicle movements and 1,085 heavy vehicle movements per month.

Table 4.68 | Carrapateena logistics task

Logistics task	Volume	Origin	Destination	Travel mode
Inbound personnel	100 movements/week	Adelaide Port Augusta	Carrapateena	Air
Outbound personnel	100 movements/week	Carrapateena	Adelaide Port Augusta	Air
Diesel import	100 kL/week	Adelaide	Carrapateena	Road
Process reagents and media	80 t/week	Adelaide Whyalla	Carrapateena	Road
General inbound freight	20 t/week	Adelaide	Carrapateena	Road

Logistics task	Volume	Origin	Destination	Travel mode
Concentrate	4,450 t/week (52 movements/week)	Carrapateena	Whyalla	Road
Concentrate (export to market)	4,450 t/week	Whyalla	Various	Sea
Waste materials	20 t/week	Carrapateena	Port Augusta	Road

4.14.3 Airstrip

An airstrip supporting the ML and associated MPL activities was approved under MPL 149.

The airstrip provides all-weather access and can accommodate occasional unscheduled or emergency night landings. Minor changes to the components of the airstrip have been made since the lodgement of the MPL Management Plan (OZ Minerals 2017). The most significant changes include a minor (6 degree) realignment of the airstrip and widening and lengthening of the apron. The design for the airstrip is provided in Figure 4.49.

The number of scheduled aircraft movements servicing the Carrapateena operations are approximately 10 inbound flights and 10 outbound flights per week, consisting of nominally eight inbound and outbound flights between Carrapateena and Adelaide and two inbound and outbound flights between Carrapateena and Port Augusta. The current air services provider operates two aircraft, 30-seat Dash-8 class aircraft and 78-seat BAe 146 class aircraft. The current Civil Aviation Safety Authority (CASA)-approved approach charts for the airstrip are available via Airservices Australia.

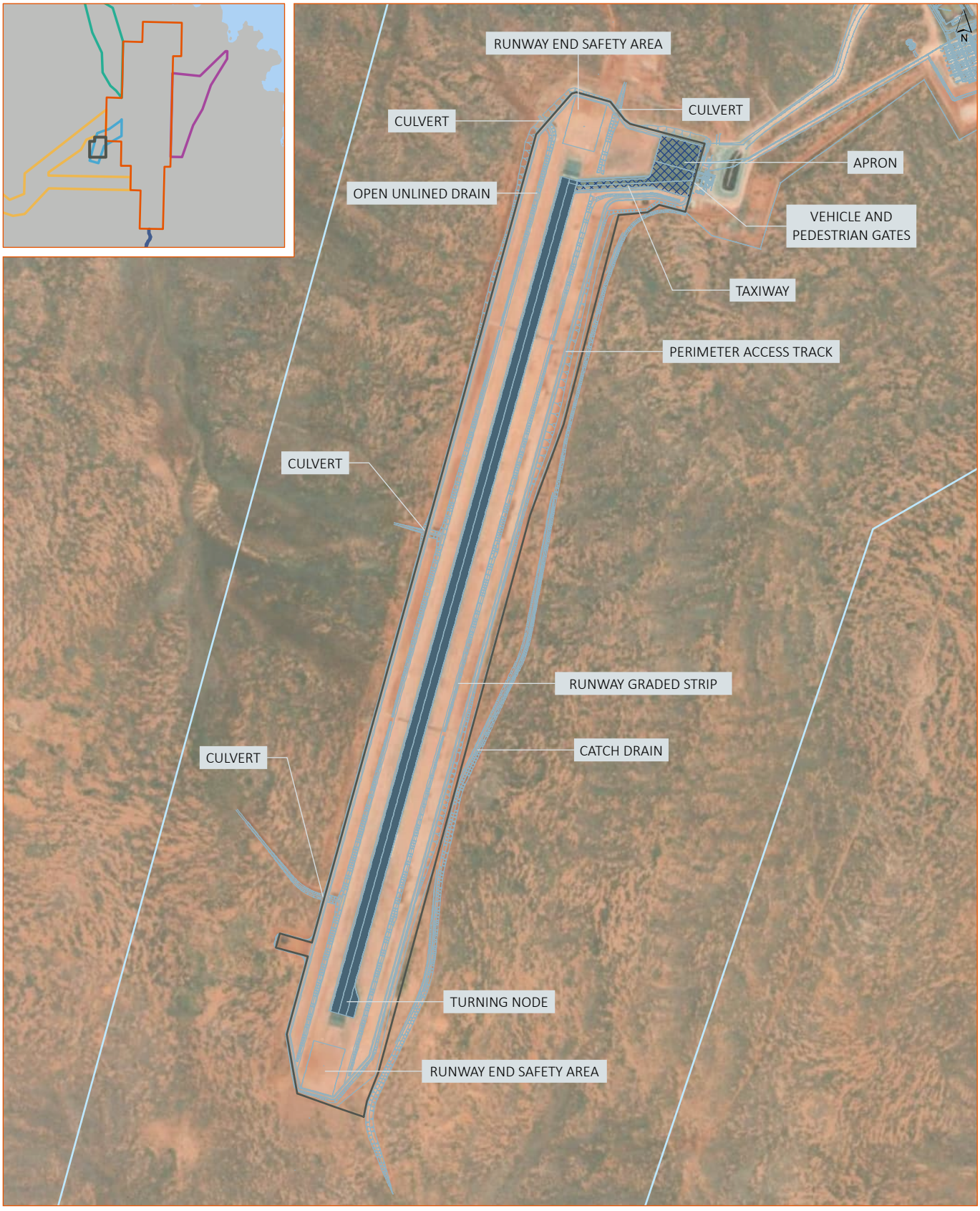
Movements are scheduled with consideration to the curfew times in place at Adelaide Airport and are scheduled between 6 am and 8 pm on weekdays. Emergency flights (for example, medical evacuations) could occur at any time of the day or night, and on any day of the week, as required.

The approach path for the airstrip is 4.2 km from Pernatty, and 6.9 km from Yeltacowie. The lowest safe altitude for aircraft during the initial approach varies between 1,500 – 1,900 ft, however the majority of the flights will occur at altitudes above 20,000 ft.

The airstrip has the following key features:

- sealed 1,600 m x 30 m airstrip suitable for use by Avro RJ100 (or similar) aircraft capable of carrying up to 100 passengers
- geometric design conforming to the CASA Manual of Standards 139 (MOS139) for compliance as a Code 2C aerodrome
- runway running surface 30 m wide contained within a 90 m wide cleared and graded strip area
- Runway End Safety Area (RESA) of 90 m at either end of the strip
- a 60 m clearway at either end of the airstrip (in addition to the RESA)
- turning node at one end
- a 15 m wide by 30 m long taxiway with a 110 m by 100 m apron (suitable to accommodate two aircraft)
- taxiway strip 40 m wide
- runway markers, a windsock and other mandatory items appropriate for the airstrip category

- airstrip constructed with imported locally borrowed gravelly materials and/or RL 127 waste rock material placed and compacted as classified fill with a nominal layer of wearing course material
- drainage infrastructure
- a 1.2 to 1.5 m high wildlife and stock control fence and service road surrounding the airstrip
- a transportable terminal building complete with ablutions facility and air conditioning and shaded area for baggage check-in
- power supply provided by diesel generators for the airstrip, and later permanent power from the accommodation village
- a refuelling facility with a capacity of approximately 100,000 L of JET A1 fuel established adjacent to the airstrip in a bunded area if considered necessary
- storage and handling of small volumes of hydrocarbons and chemicals
- operational access provided by the existing Yeltacowie access road, the northern proportion of which has been upgraded.



KEY

- Airstrip and Tjungu Accommodation Village MPL 149
- Airstrip and Tjungu Accommodation Village Infrastructure
- Airstrip Fenceline
- Runway Pavement
- Taxiway and Apron Pavement

0 250 500 m

GDA 1994 MGA Zone 53

Figure 4.49 | Location and layout of the Carrapateena airstrip

Carrapateena BHP

4.14.4 Vehicle access

4.14.4.1 Western access road

The Western Access Road is an all-weather primary site access road established to the west of ML 6471, within the Western Infrastructure Corridor on MPL 152 tenement, intercepting the Stuart Highway near Mount Gunson, approximately 52 km south-east of Pimba by road (see Figure 4.48).

The road is similar in principle and construction to the upgraded Southern Access Road (see Section 4.14.4.2) and is constructed of formed, graded and compacted imported crushed material, with either a cross-fall or crown. A hydrological analysis of the catchment was undertaken to inform design requirements. In addition, the road was modelled in a three-dimensional (3D) design environment to identify opportunities to minimise earthwork requirements by optimising cut to fill ratios through revised grades and road curvature.

In general, geotechnical testing of the in-situ borrow material in the vicinity of the Western Access Road alignment demonstrated that *in-situ* soils along the Western Access Road are of low quality and were not suitable or economical for road construction. Due to its low specification, a thick sub-base layer of up to 600 mm was needed to meet the required structural integrity of the road. Furthermore, use of local borrow for the 150 mm wearing course (above sub-base) results in 40% of wearing course needing to be replaced annually. To avoid this, the construction methodology for the Western Access Road was optimised and the import of high-quality construction material sourced from Pernatty Quarry progressed, thereby significantly reducing the required thickness of sub-base and improving durability of the wearing course.

A temporary construction accommodation camp was established on MPL 152 to facilitate construction of the Western Access Road, which was subsequently decommissioned and removed upon completion and commissioning of the access road.

A summary of the main features of the Western Access Road is presented in Table 4.69.

Table 4.69 | Key features of the Western Access Road

Key element	Summary
Length	52.5 km
Width	9.5 m
Finish	Unsealed all weather access
Causeway crossings	None
Floodway crossings	Elizabeth Creek, Yeltacowie Creek
Major intersection	Stuart Highway
Hydrological design criteria	1:5
Length of road with culverts	17 km
Source of majority of borrow material	Pernatty Quarry (average 35 km)
Sub-base thickness	200 – 600 mm
Sub-base specification	DIT standard
Design speed	80 km/hr
Signposted speed	70 km/hr

4.14.4.2 Southern Access Road

The Southern Access Road was used for site access and concentrate export until construction of the Western Access Road is completed. The Southern Access Road is a dedicated access road to the south of ML 6471, joining the gazetted road at Pernatty Station, and passing through South Gap Station prior to joining the Stuart Highway approximately 80 km (by road) north-west of Port Augusta.

This road was upgraded during the initial ML construction phase including:

- road surface was built up with gravel imported to site and/or from local borrow pits where suitable materials were identified/available
- an 8 m wide carriageway and 1 m wide shoulders to allow for two-way traffic
- road suitable for heavy vehicular traffic including fully loaded semi-trailers and road trains
- road developed as 'fit for purpose' and is not expected to withstand major flood events, but is expected to withstand rain and traffic with ongoing maintenance during the construction and operations phases
- installation of information and warning signage and guideposts
- installation of drainage design including roadside parallel drains with levees to disperse water from the roadside drains, with culverts included at the lowest levels along the road formation
- upgrades to the Southern Access Road considering public safety at the turn off to the Stuart Highway with appropriate measures agreed with DIT.

The Southern Access Road is maintained as a secondary site access in the event that the Western Access Road is unavailable.

4.14.4.3 Vehicle wash-down

Both heavy vehicle and light vehicle wash-down facilities are established in ML 6471. The facilities consist of high-pressure hoses, water cannons and self-bunded concrete platforms. Water used in the facilities would be captured and transferred though oil-water separators, with clean water reporting to the process water pond. Collected waste will be transferred offsite to an EPA-licensed facility by licensed waste transport contractors.

4.14.5 Site security

The Project Area and site access roads are fenced where necessary (e.g. at vehicle access points and fence line intersections) to discourage stock access. The following precincts are fenced to stock fencing standards:

- TSF impoundment
- active mining areas – including ventilation infrastructure and the subsidence zone
- MPP area.

Security gates and stock grids are constructed to control access to and from the ML area, including the Northern Wellfield MPL. A temporary gatehouse was initially constructed at the entrance to the Tjungu Village (on MPL 149) to regulate access to the airstrip and village. A permanent site access gatehouse has been constructed on the Southern Access Road on MPL 154, with a second constructed on the

Western Access Road on MPL 152, located prior to the turnoff to the accommodation village. These provide site security for all traffic and personnel entering and exiting ML 6471 and all MPLs. The gatehouse consists of a small modular building with an office, amenities and boom gates, and accommodates one to two people 24 hours a day, seven days per week.

All access points to site are appropriately signposted to prevent inadvertent access by the public. The site is not visible from public land or any residences and as such no visual screening, vegetation or otherwise has been undertaken.

4.14.6 Accommodation (Tjungu Village)

MPL 149 was granted in mid-2017 for an airport and workers' accommodation village (Tjungu Village), located west of ML 6471. The Tjungu Village provides accommodation for peak workforce requirements for Carrapateena. The layout for the Tjungu Village is provided in Figure 4.50. The Tjungu Village comprises a 714 bed (plus anticipated expansion of a further 64 rooms) permanent accommodation village, including associate infrastructure, to house personnel for the duration of mine construction activities and for the life of Carrapateena, and includes:

- up to 180 x 4 single person quarters with ensuite facilities
- wet mess facility
- kitchen and dry mess
- up to 42 x 4 temporary single person quarters with ensuite facilities for peak construction periods
- option for single and dual storey accommodation modules
- nine laundries
- recreational areas, including gym, perimeter recreation loop (also fire access path) and multipurpose sports courts
- private access road with designated parking zones, bus pick-up areas and service access
- pedestrian pathway network and landscape setting
- communications tower
- wastewater treatment plant and land application area (evaporative ponds or irrigation field) approved by SA Health
- RO plant and brine disposal
- potable drinking water supply approved by SA Health
- electricity is sourced from a medium voltage (MV) supply (22 kV/33 kV) from the main switchyard, and may be supplemented by renewables in future
- environmental monitoring station.

The design of the Tjungu Village considers sustainable design principles wherever practical, including waste reduction, energy use and water consumption.

The firewater system for the village is fed from firewater storage tanks with hose reels installed to ensure firewater coverage throughout Tjungu Village. Fire extinguishers are mounted throughout in accordance with the relevant Australian Standards.

Figure 4.50 | Tjungu Village layout

4.14.7 Offices, workshops and laboratories

The construction and operational administration areas are located adjacent to the MPP (see Figure 4.24) and comprise:

- main office
- mine office
- MPP office
- MPP workshop and store
- mine and heavy vehicle workshops
- emergency services building
- warehouse and other ancillary buildings.

All buildings are steel clad, steel framed modular transportable buildings, complete with timber laminate wooden floors and vinyl floor covering. All buildings other than the ablutions facility are air-conditioned and the administration building has a verandah.

An MPP workshop and warehouse is contained within a single steel-framed building. The building includes a dividing wall separating the two sections. Each section of the building includes two roller doors, front and rear, for vehicle access. The floors are concrete, and each doorway includes a concrete apron. High bay lighting is included with roof and wall vents. Racking and shelving for the store is provided also. A fenced compound is installed at the rear of the warehouse to enable secure storage of large bulk items.

The emergency services building contains a fully equipped first aid facility staffed by a nurse/paramedic and supplied with an emergency services vehicle.

The mobile equipment fleet required for mining works is supported by a workshop facility adjacent to the MPP. Facilities include office and workshop buildings, washdown bay, tyre-change facility and warehouse storage for parts, supplies, tyres and general consumable items. Fuel and lubricant storage and delivery services are located adjacent to the workshops.

The laboratory provides support for mining and processing operations by routine analyses for mine grade control, MPP metallurgical control and accounting and onsite metallurgical test work. The concrete slab and footings for the laboratory, along with water supply, air supply, power supply and connection to the wastewater treatment, are installed as part of the MPP installation.

4.14.8 Communication, technology and information systems

Communications for voice and data for site are connected to a National Network Carrier at the Mount Gunson Substation via a 48-fibre overhead optical ground wire cable. The following areas of the site are connected to the fibre network:

- administration building
- mine administration building
- site operation control centre
- stores and workshop offices
- plant control room

- airport
- accommodation village.

A mobile network tower, antennas and system (4G) is installed on ML 6471 to provide mobile phone communication in the MPP, accommodation village and surrounding areas. A radio communications system, including antennae tower, is installed near the Tjungu Village and other areas requiring coverage across the lease.

Technology and information systems provide robust foundational elements, to enable current and future capability requirements of Carrapateena. Standard control systems with integrated site operations, digital voice radio and closed-circuit television (CCTV) coverage support the operational philosophy to enable future automation and remote control of the plant and process. A single control room is established onsite to accommodate and drive collaboration along the mine/processing value chain.

Proven and established technology and information systems are used to provide solutions over the life of the mine. Wherever possible, systems are hosted offsite using BHP's current cloud technologies. Enterprise systems (including SAP, Microsoft Office 365) are extended to ensure standardised core business processes and business-wide collaboration. This enables effective use of data for control, monitoring and visibility of operations from day one, supporting real-time data-driven decision making and predictive analytics into the future. Key features of the communications system are described in Table 4.70.

Table 4.70 | Key features of the site communications systems

Key element	Summary
Wide-area network (WAN)	Temporary satellite (construction), Permanent Fibre
Local-area network (LAN)	Site-wide fibre optic backbone for corporate, optic transmitters (OT), plastic-clad silica (PCS), Wi-Fi
Digital voice radio	Tetra ultra-high frequency (UHF)
Data centre and platforms	Redundant data centres
CCTV, security and access	• provision for CCTV at gatehouse, MPP, NPI, underground, village and airstrip • electronic site access, entry turnstiles • personnel tracking
PCS	Rockwell PlantPAx system, site-wide standards, hardware and templates
Mining systems	ABB suite of products
Manufacturing execution systems	ABB suite of products
Operational support systems	Workforce management, flights and accommodation, tenement management
Village entertainment system	Village entertainment solutions incorporating pay television, internet access to rooms, potential for other online services to rooms
Enterprise systems	Interface to SAP/Hyperion
Analytics and visualisation systems	Provision in ABB suite of products
ICT peripherals and end user computing	Site information and communication technologies (ICT) hardware, computers, printers, whiteboards, etc
Project support systems	Document control and transmittals

4.14.9 Workforce

Current workforce is approximately 656 personnel, consisting of 208 employees and 448 contractors. Estimated peak workforce over the Carrapateena LOM may be up to 740 personnel (nominally 215 employees and 535 contractors). Approximately 13% of the workforce originates from the Upper Spencer Gulf (USG) region, with 69% from elsewhere in South Australia and 18% originating from interstate. Breakdown of roles by job type for BHP employees is presented in Table 4.71.

Personnel numbers onsite vary due to the overlap as construction and/or shut-down activities are undertaken during operations and have historically peaked at around 750 to 1,100 personnel. The average number of operational personnel onsite in 2023 was approximately 700 people.

The workforce generally operates on 12-hour shifts, on an eight-days-on, six-days-off roster; although some positions have alternative shift arrangements. Workers nominally commence work at 6 am and finish at 6 pm. Different arrangements may be undertaken during construction or shutdown activities.

The current and projected workforce profile is illustrated in Figure 4.51.

Table 4.71 | Employee breakdown by job type

Employee role	Proportion of employees (%)
Commercial	12%
Management	3%
Processing	14%
Maintenance and engineering	22%
Integrated planning	24%
Mining	5%
People, environment and governance	5%
Health and safety	5%
Project management operations	3%
Expansion and growth	7%

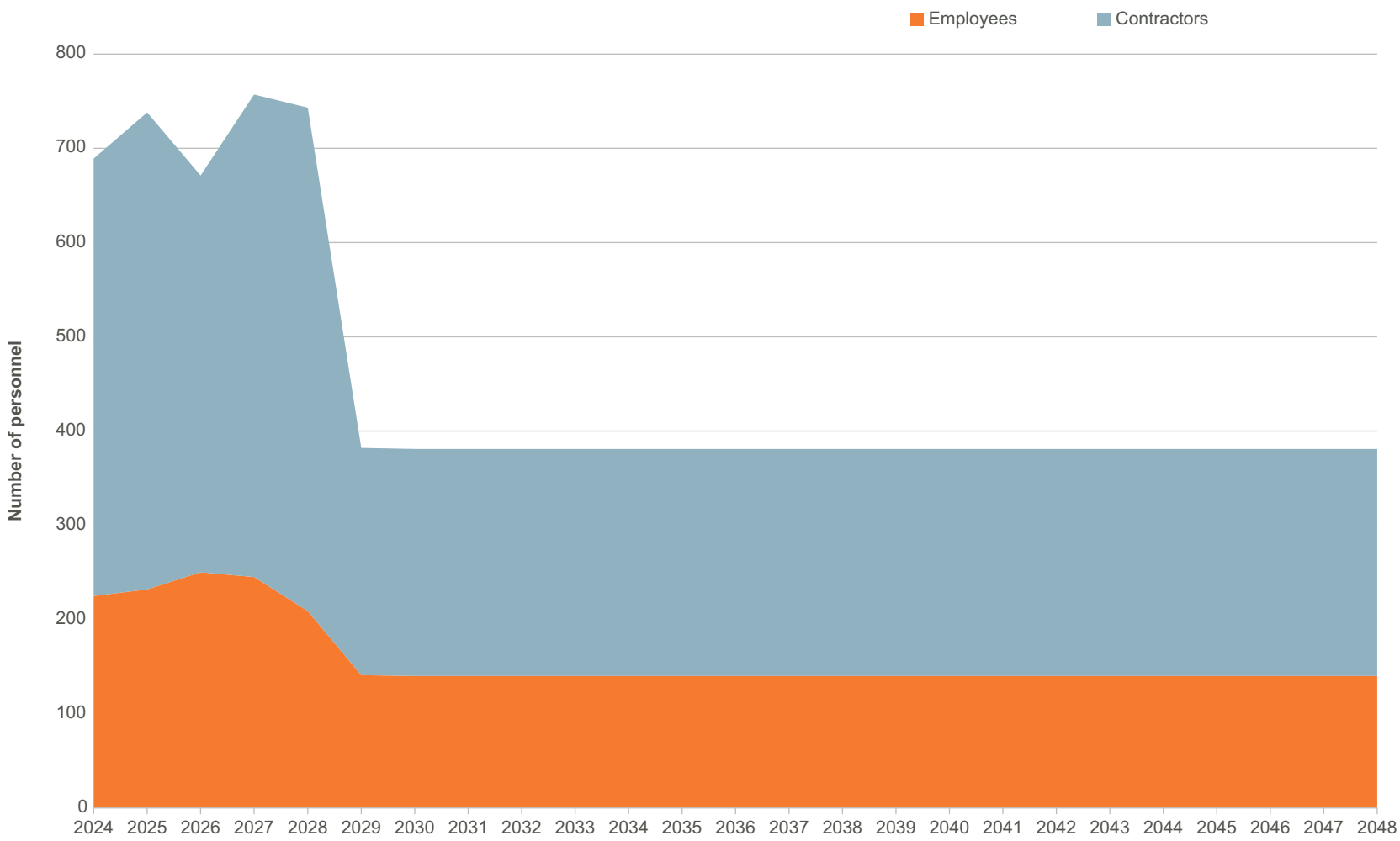


Figure 4.51 | Projected Carrapateena workforce profile

4.15 Waste management

Wastes are managed in accordance with the EPA Waste Hierarchy outlined in the Environmental Protection (Waste to Resources) Policy 2010 (SA). The Project generates the following categories of waste:

- domestic waste from accommodation and office facilities in the accommodation village and offsite
- tyres, industrial and construction waste
- hazardous materials and dangerous goods from workshop activities, water treatment and clean-up of spills
- medical waste
- waste material that has been exposed to the orebody (i.e. potentially radioactive wastes).

Individual waste streams are assessed using the waste hierarchy to establish a suitable disposal method. Collection infrastructure is labelled and/or identified by a colour code (recyclables – yellow; paper and cardboard – blue; non-hazardous non-recyclable (residual) – red), to show the type of waste that can be put in each bin.

Currently all hazardous and non-hazardous waste is transferred offsite to an EPA licensed facility by licensed waste transport contractors. An onsite landfill may be established should this be determined to be viable or desirable in future.

Carrapateena is supported by a Resource Recovery Centre (RRC) to meet general resource recovery activities and store recyclable material prior to transport. The RRC is a purpose-built work area designed to house a baling press (for cans, cardboard, paper and polyethylene terephthalate (PET) plastics), sorting tables and bin handling equipment.

4.15.1 Key elements

A description of the key elements related to waste management at Carrapateena is provided in Table 4.72. Waste management elements have been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 4.73 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMC and Leading Indicators for the waste management infrastructure and activities, as provided in Chapter 7.

Table 4.72 | Waste management key project elements

Key element	Summary
At-source waste sorting	Collection infrastructure is labelled and/or identified by a colour code: • recyclables – yellow • paper and cardboard – blue • non-hazardous and non-recyclable (residual) – red
Waste sorting and storage	RRC to segregate recyclable material such as steel, cardboard, timber, batteries, aerosols and lighting, and store recyclable material prior to transport offsite
Bioremediation	A BioPad allows for the bioremediation of contaminated soil and storage of waste hydrocarbons and other hazardous/listed wastes that require containment

Key element	Summary
Waste disposal	Collected waste is disposed of offsite by an appropriately licensed waste contractor at an appropriately licensed facility
Landfill	Approved under both MPL 149 and ML 6471, however not constructed to date

Table 4.73 | Waste management Impact IDs, design and management controls and uncertainty

Waste management	
Carrapateena Project Impact IDs[1]	Northern Wellfield Impact IDs[1]
L20*, L21*, L22*, L28*, L29*, L30*, L39*, L40*, AQ47, SW11, SW12, SW13, SW14* and SW15	L24*, L25*, L26*, L28*, L29*, L30*, L31*, L32*, L33*, L34*, L40*, GW14*
Design controls	
• Landfill is constructed and operated in accordance with EPA Guidelines and is appropriately licensed under the EP Act. • Hydrocarbon and chemical storage facilities will be designed in accordance with Australian Standards. Storages bunded in accordance with EPA Bunding Guidelines and/or relevant Australian Standards.	
Management controls	
• All commercial or industrial waste is disposed of in an EPA licensed facility, which is closed in accordance with relevant EPA Guidelines* • Licenced chemical and waste transporters* • Establishment of Chemical Database including copies of MSDS and storage, handling and disposal requirements • Contaminated land register • Contracts contain conditions relevant to the bringing of chemicals and hydrocarbons onto site • Induction contains process for bringing chemicals and hydrocarbons onsite including requirements for storage, handling and disposal • Contracts contain conditions relevant to design, management of the storage and handling of chemicals and hydrocarbons • Spill and emergency response procedures • Equipment maintenance to prevent spills • Incident reporting procedures • Regular inspection programs where bunding either temporary or permanent is installed to ensure appropriate use, placement of spill kits, clean up procedures and handling procedure • Landfill Environmental Management Plan • Waste Management Plan and practices, including daily covering of the landfill face	

*Non-Outcome or Outcome-Based Lease Condition Proposed
(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
(2) Appendix E Consolidated Assessment (OZ Minerals 2018c)

4.15.2 Waste characterisation

Waste streams at Carrapateena are classified into the following four categories:

- Non-hazardous waste – largely comprises general/residual waste, including all organic food waste and recyclables.
- Hazardous waste – defined by the EPA guideline ‘EPA 842/19 Waste definitions’ (EPA 2019a) as a listed waste having a characteristic described in Schedule A List 2 of the National Environment Protection (Movement of controlled waste between States and Territories) Measure (Cth). It

includes any unwanted or discarded material (excluding radioactive material) that can cause a significant hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. BHP also includes in its definition of hazardous waste any waste listed under Schedule 1, Part B of the EP Act.

- Wastewater – generated by a mixture of domestic wastewater from workers' accommodation rooms, common facilities such as kitchens, dining areas, laundries, and amenities, as well as industrial wastewater from mining processing and administration areas. Domestic wastewater typically contains a variety of organic and inorganic substances. These substances can contribute to high levels of nutrients, such as nitrogen and phosphorus, as well as organic matter, which can negatively impact water quality if not properly treated. Industrial wastewater can contain chemicals and substances that can be harmful to human health and the environment if not properly treated (see Section 4.12.5.5).
- Contaminated waste – have surfaces contaminated with radioactive materials at concentrations that, averaged over the surface area and mass of the waste, are greater than the regulated concentration (i.e. 1 Bq/g). This material includes contaminated plant and equipment and wastes from operational areas, including equipment, steel, discarded conveyor belts, rubber lining material, pipes, filter media and used protective equipment.

4.15.2.1 Non-hazardous wastes

Non-hazardous waste management practices are described in Table 4.74.

4.15.2.2 Hazardous wastes

Hazardous waste management practices are described in Table 4.75.

4.15.2.3 Contaminated wastes

BHP implements a contaminated waste program at Carrapateena that aims to minimise the volume of contaminated wastes to be disposed of. Where practical, potentially contaminated waste is decontaminated and disposed of via normal waste disposal methods. Where this is not possible and depending on the nature of the waste, several disposal options may be implemented. These include:

- disposal to the TSF
- temporary storage in a dedicated area followed by disposal into the underground mine workings at the end of operations
- disposal in an approved onsite landfill.

The landfill, if constructed, would be constructed and operated in accordance with International Atomic Energy Agency (IAEA) Safety Standard Series No. SSR-5 Disposal of Radioactive Waste (IAEA 2011) (as referred to by Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) as a 'Trusted International Standard') and would meet the requirements of the EPA Guideline: Environmental management of landfill facilities – solid waste disposal (EPA 2019b). A system that retains records of the disposal, including type of material, quantities and locations would be maintained.

Table 4.74 | Carrapateena non-hazardous waste management

Material	Description	Current management pathway	Preferred future management pathway
10c bottles and cans	Recyclable bottles and cans that are listed under South Australia's container deposit legislation (CDL), e.g. soft drink containers. This includes aluminium, plastic and glass containers.	Recyclables and CDL mobile garbage bins are to be collected by waste services contractor or village services contractor and contents disposed to an appropriate site location. Village services contractor to relocate from inside collection points to designated storage area for waste services contractor to collect. All CDL products are sorted, baled and stored at the RRC for transport to a licensed recycler.	User disposal. Accommodation and back-of-house (BOH) kitchens: Bins located in accommodation bin stations. All other locations: Collected in appropriate containers (e.g. milk crates, plastic bags) and taken to RRCs by staff when required.
Cardboard and clean paper	Cardboard, newspapers, office paper, magazines etc.	Paper and cardboard mobile garbage bins to be collected by waste services contractor or village services contractor and contents disposed to an appropriate site location. Village services contractor to relocate from inside collection points to designated storage area for waste services contractor to collect. Paper and cardboard, baled and stored at the RRC prior to transport to offsite recycling processor.	User disposal. Accommodation: Bins located at accommodation bin stations. BOH kitchens: Collected in appropriate stillages (e.g. caged trolley) and taken to baler as required. All other locations: Collected in appropriate stillages (e.g. in a caged trailer) and taken to a baler when full.
Construction and demolition (C&D)	Concrete and similar inert construction and demolition wastes. Can include concrete and non-contaminated aggregate, sand and topsoil.	C&D wastes are stockpiled in separate piles for future use. Disposal of excess concrete to landfill.	C&D materials are processed (crushed, sifted etc.) and reused onsite (e.g. for road base or land rehabilitation).
Cooking oil and grease trap waste	Used cooking oil and grease trap waste from village kitchens.	Waste services contractor to collect and store on Bioremediation Pad for periodic transport offsite by external licensed waste contractor.	Continue with current practice.
General waste/residual waste	General waste (refuse, putrescible and rubbish) and other materials not able to be viably recovered or recycled at the Carrapateena site. At the present time, this includes all organic food wastes, as it is not currently considered practicable nor feasible to process this stream onsite.	Residual waste mobile garbage bins to be collected by the waste services contractor or village services contractor and contents disposed to an appropriate site location. Village services contractor to deposit to designated storage area at RRC for waste services contractor to process and collect prior to transportation.	User disposal. Accommodation and offices: have general waste bins in bin stations. BOH kitchens and all other locations: Disposal into the bulk front lift general waste bins. Consolidation and collection. Village services contractor to conciliated accommodation bin waste into the bulk bins. Bulk bins are collected by the waste and recycling collection contractor when required (e.g. Veolia) current practice.
Glass	Glass products no longer suitable for use. Includes jars, wine bottles, large juice bottles, windows, etc.	Recyclables to be collected by waste services contractor or village services contractor and contents disposed to an appropriate site location. Village services contractor to relocate from inside collection points to designated storage area for waste services contractor to collect. During sorting, all non-CDL glass is segregated and disposed of to landfill.	Continue with current practice.
Intermediate bulk containers (IBC)	An IBC is a pallet mounted, industrial grade reusable container that is used for storing and transporting bulk liquids and powders.	IBCs are currently stockpiled on site. Some IBCs are modified for storage and transport of hazardous wastes (e.g. oily rags).	Priority is for suppliers to avoided delivering goods in IBCs or for suppliers to take back IBCs once emptied for reuse. Otherwise, IBCs are to be sent to or collect by a container/IBC recycler. If the above options are not viable, IBCs are to be deconstructed into their metal and plastic components, and the metal to be recycled and plastic to be disposed of in the general waste bins.
Milk bottles and other HDPE containers	Milk jugs and other HDPE e.g. frosted plastic juice containers with the recyclable symbol.	Currently disposed of in general waste bins.	User disposal BOH kitchens: Collected in larger bags (e.g. using bale frame). Consolidation and collection Village Services Contractor to bale bagged containers. Transported to or collected by a soft plastics recycling contractor (e.g. Veolia, ORORA).
Pallets (reusable)	Pallets are generally timber portable platforms for handling, storing, or moving materials and packages.	Currently stockpiled in the ERT burn pit and burnt.	Priority is for suppliers to take back pallets after deliver of goods. Otherwise, pallets are to be stockpiled in appropriate locations to be sent to or collect by a pallet recycling company or mulched. Small amounts (where permission has been sought) to be burnt in the ERT burn pit.
Pallets (broken and other wood waste)	Non-treated pallets, packaging, furniture and any other wood-based items not suitable for reuse.	Disposed of and burnt in the ERT burn pit. No treated wood products (i.e. CCA) are to be burnt onsite.	Majority of non-treated wood wastes to be stockpiled to be transported to or collected by a timber recycling contractor. Small amounts (where permission has been sought) to be burnt in the ERT burn pit.
Plastics (polypipe)	Polypipe not required and not suitable to retain for future use.	Poly pipe is disposed of into a designated poly pipe bin. Waste services contractor to consolidate for periodic transport to offsite recycling processor or disposed of to landfill.	Continue with current practice.
Plastics (soft plastics)	Soft plastics from goods delivery and packaging (e.g. plastic wrapping, plastic bags, bread bags, cling wrap).	Currently disposed of in the general waste bins.	User disposal. BOH kitchens: Collected in larger bags (e.g. using bale frame). Consolidation and collection. Village Services Contractor to bale bagged soft plastics from accommodation and BOH areas. Transported to or collected by a soft plastics recycling contractor (e.g. Veolia, ORORA).

Material	Description	Current management pathway	Preferred future management pathway
Rubber	Conveyor belt no longer required or changed out and general rubber items or off-cuts.	Small amounts collected with general waste and disposed of to landfill.	Large amounts: Stockpiled and transported off site for recycling when full loads are available by rubber recycling contractor.
Scrap metal (large)	Large metal items such as light vehicle bodies and haul truck trays.	Scrap vehicle bodies are stockpiled in ERT training area for training purposes. Other large metal items are stockpiled in a steerable location (e.g. waste transfer compound). A metal recycling contractor will transport large scrap metal items off site for recycling, when full loads are stockpiled. Where this is logistically difficult (e.g. oversized loads necessitating road closures) or is not justified on a life-cycle basis, these materials may be suitably buried.	Continue with current practice.
Scrap metal (small/mixed)	Metal items, scrap or off-cuts not suitable for further use onsite, including steel rigid packaging and aerosol cans, unrepairable whitegoods.	Small scrap metal items are to be separated into: • scrap metal (mixed)/majority ferrous material • aluminium • copper piping and wire (separated by grade) • armoured cable. Waste services contractor to consolidate for periodic transport to offsite recycling processor. Aerosol cans are stockpiled prior to transportation offsite to a recycling processor.	Continue with current practice.

Table 4.75 | Carrapateena hazardous waste management

Material	Description	Current management pathway	Preferred future management pathway
Batteries (small and large)	Waste batteries leftover from equipment and vehicles. Lead acid batteries and other larger battery types.	Waste services contractor to consolidate for periodic transport to offsite recycling processor.	Large batteries: Continue to collect in converted IBCs. Small batteries: Collected in suitable containers in offices and equipment stores and consolidated drums with plastic liners at camp RRCs. Contractors to management their own batteries
Copper chrome arsenate (CCA) timber	CCA treated timber.	Where encountered, EPA advice for disposal to be sought.	Continue with current practice.
Hazardous chemicals	Waste hazardous chemicals produced/leftover from site processes.	Appropriately disposed of as per MSDS.	Continue with current practice.
Lead cupels (listed waste)	Lead cupels leftover from site processes.	Collected, sealed and stored at the onsite laboratory and processed through the MPP.	Continue with current practice.
Medical waste – listed waste	Medical wastes, including sharps.	Disposed of to a licensed medical waste disposal facility.	Continue with current practice.
Oil filters – listed waste	Left over oil filters from site processes.	Collected by converted IBCs for periodic transport offsite by licensed contractor and recycled of offsite.	Installation of an oil filter crusher to puncture and crush oil filters to reducing volume and recovering oil for separate disposal. Recovered oil to then be disposed of into the bulk waste oil storage for periodic transport offsite by licensed contractor and disposed of/recycled of offsite. Crushed oil containers to be stockpiled in appropriate containers for periodic transport offsite by licensed contractor and recycled of offsite.
Oil rags – listed waste	Left over oil rags from site processes.	Collected in appropriate stillages or converted IBCs for periodic transport offsite by licensed contractor and disposed of offsite.	Continue with current practice.
Paints and resins	Paints, resins and other non-oil-based solvents.	Minimise waste by producing/procuring only the amount required. Offsite painting where possible. Collection onsite and storage in a segregated area. Transportation offsite by licensed regulated waste transporter, and disposal at a licensed facility.	Continue with current practice.
Tyres (incidental) – listed waste	Light vehicle tyres from BHP vehicles only, and no longer suitable for use. Heavy vehicle tyres from BHP vehicles only, and no longer suitable for use.	Heavy vehicle tyres are returned to supplier or to a recycler as they are generated. Light vehicle tyres (from incidents such as blown tyres) are consolidated for periodic transport to offsite recycling processor.	Continue with current practice.
Waste oil/hydrocarbons	Left over oils and fuels from site processes.	Collected by licensed contractor and disposed of/recycled offsite. May be stored on known various appropriately bunded areas around site or on the Bioremediation Pad.	Continue with current practice.
Xanthate	Waste xanthate packaging (residual xanthate reports to the TSF).	Collected and buried separately at site landfill in accordance with MSDS.	Continue with current practice.

4.15.3 Waste management

4.15.3.1 Waste avoidance

Product stewardship is the principle that everyone involved in a product supply chain, including raw material and component suppliers, product and packaging manufacturers, brand owners, recyclers, governments and consumers; share responsibility for minimising environmental impacts over the life cycle of a product, including any packaging. At Carrapateena, product stewardship activities that are to be carried out by all employees of BHP, contractors and suppliers include:

- Minimise the amount of packaging used to store and transport goods without compromising the safety and security of the goods delivered. This includes supplying materials and goods in bulk when able to.
- Where packaging is unavoidable, it is designed for maximum reusability and is returned to the supplier for reuse.
- Where packaging is unavoidable and cannot be returned to the supplier, it can be recycled using the recycling services provided at the site, with minimal preparation or intervention from staff.

These activities have numerous benefits for the Carrapateena operations including:

- Avoids waste materials, saving on waste disposal fees and associated activities for staff.
- Reduces costs of delivering materials to the site, as packaging is reused many times rather than disposal.
- Maximises the use of backloading opportunities.
- Minimises environmental, health, safety and management issues from over-stockpiling packaging (e.g. IBCs).
- Minimises potential litter streams (e.g. soft plastic packaging).

4.15.3.2 Source separation

Source-separated recycling is separating and/or treating wastes into their prescribed waste and recycling streams so they can be recycled or disposed of correctly. Separation of waste has many benefits, including:

- Enables compaction and baling of some streams (e.g. cardboard, soft plastics), reducing the volume of material required to be stored onsite and transported for disposal/processing.
- Ensures potentially hazardous waste materials and not mixed with other waste streams and are correctly and safely handled, transported, and disposed of.
- Helps to avoid contamination of recycling streams, reducing disposal fees.
- Assists in minimising litter at the site by reducing volumes of litter-prone material in the general waste bins.
- Separates domestic and industrial wastewater streams at the onsite WWTP to prevent contamination and ensure that each stream is treated appropriately. Also, the WWTP separates solid waste and sludge generated during the treatment process for appropriate disposal.

At Carrapateena, all employees of BHP, contractors and suppliers will separate waste streams at the generation source.

4.15.4 Waste management facilities and infrastructure

4.15.4.1 Waste transfer station and Resource Recovery Centre

The RRC and recycling yard consist of a purpose-built work area under the management and operation of the waste services contractor. The purpose of this yard is to provide a central location for contractors/site staff to segregate recyclable material such as steel, cardboard, timber, batteries, aerosols and lighting, and store recyclable material prior to transport offsite. The RRC houses a baling press (for cans, cardboard, paper and polyethylene terephthalate plastics), sorting tables and bin handling equipment.

4.15.4.2 Bioremediation pad

A bioremediation area (or BioPad) was established, consisting of a contained area purpose built for the bioremediation of contaminated soil and storage of waste hydrocarbons and other hazardous/listed wastes that require containment. These are stored in IBCs or 205 L drums.

The BioPad is approximately 20 m wide and 20 m long and has a blind sump with a manual bilge pump to allow transfer of water to a storage tank on the BioPad. Contaminated soil is either collected and disposed of offsite by a licensed waste contractor at a licensed facility, or bio-remediated and validated prior to onsite use as landfill face covering material or other suitable purposes.

4.15.4.3 Landfill

Landfill size and classification

Up to 750 – 1,000 people may be onsite at any one time during peak construction and shutdown periods, with an average number of people onsite being around 350 personnel. Australian Bureau of Statistics (ABS) data (ABS 2010) indicates that the average Australian person produces around 2,080 kg of waste per year, with approximately 52% of that diverted from landfill into recycling and/or reuse programs. The landfill has been designed to store the waste from 350 people accommodated onsite for 20 years, plus an allocation associated with ongoing closure activities. The volume of workforce-related waste that would be directed to the onsite landfill over the life of the mine is around 9,500 tonnes, or around 19,000 m^3 using the standard EPA waste consolidation factor.

In addition, the following industrial and commercial wastes materials may also be disposed of to landfill (if not able to be viably recycled):

- miscellaneous construction and demolition wastes
- HDPE pipe and plastics
- rubber including conveyor belt materials.

Annual generation of these materials are around 500 t per annum on average (noting that the majority of construction wastes are generated in the early years of Carrapateena, and operational wastes in the later years). Total industrial waste generated over the LOM will be around 13,500 t. The total landfill size is 22,500 t (45,000 m^3).

The landfill class was determined in accordance with the EPA Guideline 'Environmental management of landfall facilities – solid waste disposal' (EPA 2019b). The landfill class was determined to be Small based on the following:

- less than 5,000 tpa filling rate
- less than 10 m total depth
- in a geotechnically suitable area
- greater than 2 m separation from the landfill base to groundwater
- groundwater quality greater than 13,000 mg/L TDS
- construction, operation and closure methodologies consistent with the 'Small' categorisation within the guideline.

There is a low risk of surface water flow into the landfill facility and the climatic conditions (arid) mean that the risk of leachate generation is considered sporadic.

Location

The landfill and associated RRC would be located within ML 6471 or MPL 149, with the final location to be determined with consideration to the following buffer distances nominated within the Guidelines:

- 500 m to residences, townships, highways or arterial road networks
- 3,000 m to an airport that utilises turbine aircraft (1,500 m to an airport utilised by piston aircraft) and a landfill that attracts birds (due to food or other wastes))
- 500 m between the landfill and the nearest surface water (whether permanent or intermittent)
- landfills must not be located in areas that are susceptible to ground movements that may adversely impact on the integrity of the landfill and engineering systems such as the liners, leachate collection system, landfill gas collection system and final cover.

Design

The design for the landfill is described below and illustrated in Figure 4.52. The landfill facility consists of:

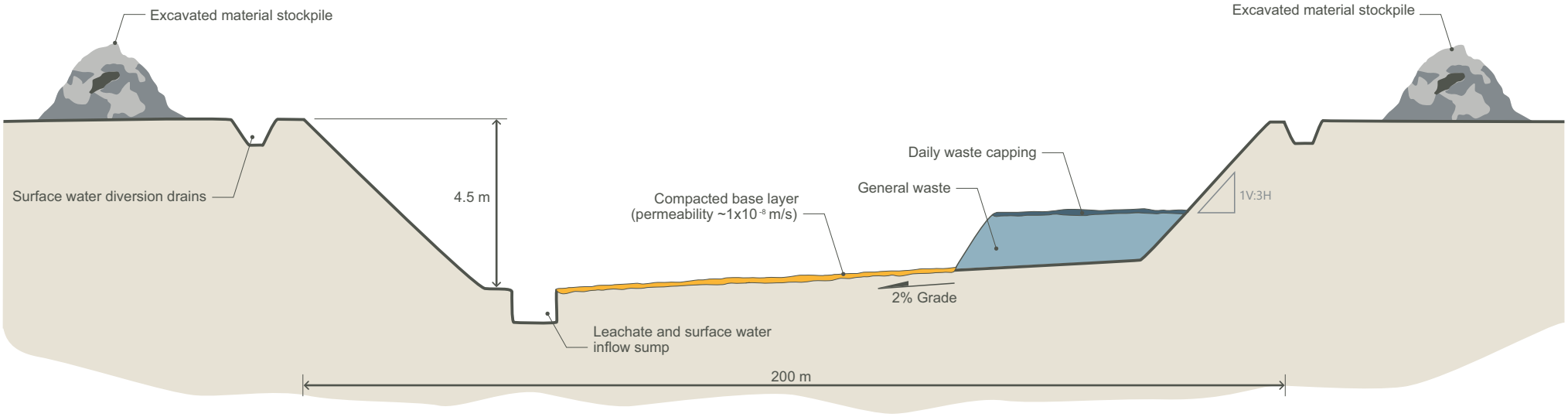
- A hardstand laydown area (the RRC) provided in proximity to the landfill facility for the segregation of recyclable and/or reusable materials and those requiring disposal to landfill. Suitable storage is provided for recyclable materials pending collection and transfer to offsite recycling depots.
- The landfill consists of an excavation of approximately 200 m x 200 m to a depth of around 4.5 m. The size of the facility is sufficient to store approximately 45,000 m^3 of waste over the life of the facility, with additional allowances for daily waste capping material, and maintaining waste at a maximum height of at least 500 mm below ground level.
- The landfill walls are excavated to a slope of around 1V:3H to ensure adequate stability during the life of the landfill, and the excavation will maintain sufficient capacity to store a 1-in-100-year rainfall event without over-topping.

- The floor consists of a 150 mm compacted sand-clay layer with a permeability of around 1 x 10-8 m/s, compacted to a minimum dry density ratio of 95% relative to standard compaction in accordance with AS 1289.5.1.1. This is proof-rolled smooth to prevent ponding and to determine whether there are areas of the base layer that require subgrade improvement.
- The floor is graded to at least 2% to a leachate and stormwater collection sump, also constructed of compacted clay. The leachate and stormwater collection sump is sized to allow for stormwater generated from rainfall collected within the facility to be stored and either removed to the Carrapateena TSF or left in-situ for removal via evaporation, depending on the volume of collected.
- The landfill is surrounded by a surface water diversion drain and bunding to direct surface water flows around the facility in the event of an overland flow rainfall event.
- A 1.8 m high wire mesh fence is constructed around the perimeter of the landfill facility with lockable gates allowing vehicle access. The gate is closed at all times the landfill is inactive, thus preventing fauna access to the landfill and preventing unauthorised dumping of waste to the landfill. Additionally, baiting is undertaken from time-to-time as necessary to eradicate pests from the facility. The fence has a secondary function, limiting the spread of litter from the facility, although the primary control mechanism for the management of litter is the regular capping and compaction of the waste mass.

At closure, all landfill surface infrastructure, including fences, gates and unused stockpiles will be removed. The final filling height is a minimum of 500 mm below ground level, after which 300 mm of interim fill cover is established prior to the placement of an engineered cap of at least 600 mm of Quaternary clays. This is placed above the deposited and compacted waste materials, and blended into the surrounding land to ensure physical, geochemical and ecological stability. This layer is compacted and provides a layer designed to shed any rainfall/surface water, minimising infiltration and avoiding the build-up of leachate within the facility.

This is topped with at least 100 mm of topsoil to allow for revegetation using endemic native species (shrubs) with a rooting depth sufficiently shallow to avoid roots penetrating the cap, negatively influencing its ability to mitigate rainfall infiltration. The landfill cap is designed to be proud of the natural land surface and be mildly sloped to promote the runoff of surface water. Initially, temporary sediment control measures such as mulch or hale bales are used to mitigate the potential for erosion prior to the establishment of vegetation. With time, it is expected that the landfill mass will compact with the decomposition and compression of the putrescible waste, ultimately leaving a vegetated landfill cap that approximates the local topography and is suitable for the resumption of pastoral activities.

OPERATIONS



CLOSURE

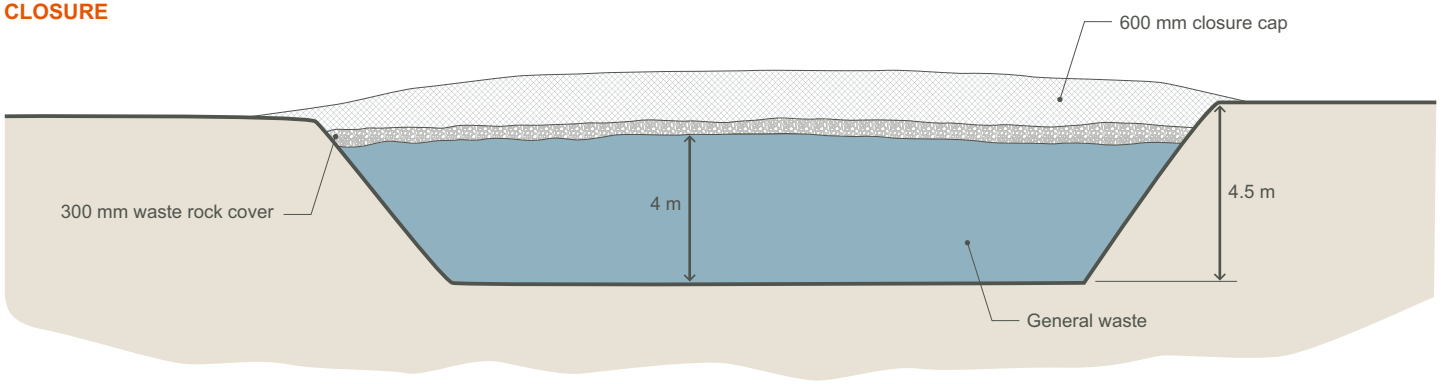
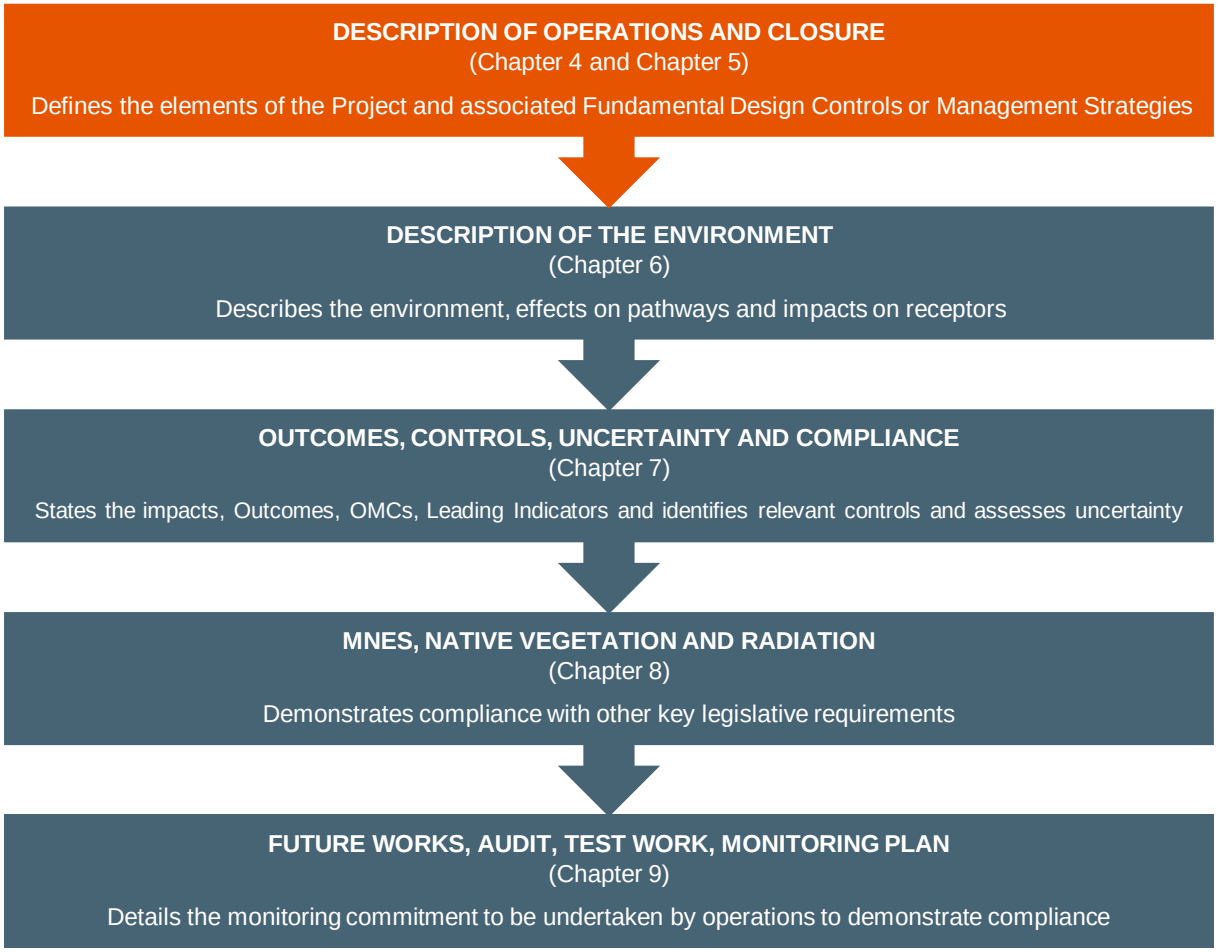


Figure 4.52 | Conceptual landfill design

5. Closure



5.1 Mine closure planning

5.1.1 Planned mine closure

Planned closure management has been incorporated throughout this document, reflecting the integrated approach to closure management for Carrapateena. The aim of the PEPR is to also be a comprehensive Decommissioning and Rehabilitation Plan (DRP) for the planned closure of Carrapateena that defines proposed post-operation land use, monitoring and closure management to guide the operation to lease surrender in an effective and timely manner.

In accordance with the Guidelines for Preparing Mine Closure Plans (DMP and EPA 2015), the closure methodologies described throughput this PEPR are Outcome-based. These methodologies are based on the proposed post-mining land use and are as specific as possible to provide a clear indication to government and the community on what BHP commits to achieve at closure.

In developing the closure strategy for the operation, the requirements of the Minerals Regulatory Guideline MG2b (DEM 2023b) were considered. These outline the minimum general standards to be met before surrender of the tenements.

Carrapateena will maintain, via this PEPR and subsequent revisions, a fit-for-purpose DRP which includes:

- rehabilitation and closure objectives and criteria
- methods used for rehabilitation and closure of various aspects of the assets
- as-built surveys for structures
- asset liquidation
- actual versus estimated costs.

The closure management process includes an annual workshop with relevant operational personnel to review the closure methodology and assumptions, the status of progressive rehabilitation activities and changes to operations (past and/or budgeted) that may have relevance to closure. The outcomes of these reviews, including actions designed to reduce uncertainty associated with closure activities, will be reported in the annual compliance reporting. Detailed closure actions for each domain are discussed in Section 5.4 with Outcomes and OMCs related to closure detailed in Section 7.3. Where uncertainty relating to closure exists, OMC has been applied to undertake further works at critical points in the operation to reduce uncertainty.

5.1.2 Unplanned mine closure

5.1.2.1 Unplanned closure management

Closure-related activities may commence once a milestone has been met, or may be the result of unplanned events that interrupt mining and/or processing operations, including:

- economic risk events
- business interruption occasioned by extreme weather
- business interruption arising from transport or logistics issues
- business interruption arising from industrial disputes
- technical issues affecting mining and/or processing (e.g. geotechnical conditions or plant failures)
- business interruption arising from health, safety or environmental issues
- policy or regulatory issues
- social or community pressures (e.g. non-government organisations (NGOs)).

BHP will provide notification to DEM in the event that operations are likely to be interrupted for a period of greater than seven days.

The consequence of these events can be categorised as:

- events resulting in the cessation of operations and Carrapateena entering care and maintenance (i.e. maintenance of plant/equipment in a manner to be determined) until such time as operations resume (temporary closure), or
- events resulting in the closure of operations prematurely (unplanned closure).

Should an event occur that results in the interruption of operations, the decision as to whether the asset enters temporary closure or progresses to unplanned closure would be dependent on several factors, including:

- mine-life related factors (e.g. the value of remaining ore stockpiles, Ore Reserves, the likelihood of identified Mineral Resources being converted to Ore Reserves, and the costs of conversion of Ore Reserves to saleable product)
- asset-sale related factors (e.g. the likelihood of the sale of the asset as a ongoing concern to another entity with the (generally financial) resources to restart/continue operations)
- economic factors (e.g. the likely duration and nature of the care and maintenance period, if undertaken, which may influence the costs of re-commencing operations, the ability of BHP to restructure and/or refinance operations)
- policy or regulation-related factors (e.g. the operation may be committed to entering one or other of the closure Environmental Outcomes via Government intervention and/or internal policies).

It is considered almost certain that any interruption to business, for whatever reason, which results in the unplanned cessation of operations, would result in Carrapateena initially entering care and maintenance whilst forward/corrective actions are developed and implemented.

5.1.2.2 Care and Maintenance Plan

In the event that Carrapateena enters temporary closure, BHP would develop a detailed Care and Maintenance Plan, which would cover, at a minimum, the following aspects:

- care and maintenance of plant and equipment
- demonstration that relevant Environmental Outcomes nominated in this PEPR will be met (including environmental monitoring as required)
- statutory and documented commitments
- resource scheduling.

In the event that activities have substantially ceased for two years or more, BHP would develop a DRP reflecting the current state of the Project, that sets out the activities and scheduling required for carrying out rehabilitation of the tenements.

Some of the key care and maintenance considerations that will need to be managed at the time of placing the operation on care and maintenance, are outlined in Table 5.1.

Table 5.1 | Care and maintenance considerations

Carrapateena element	Care and maintenance consideration
SLC Zone of Influence	The abandonment bund is proposed to be constructed early in the development of the SLC. However, if appropriate abandonment bunding is not in place at the time of placing the operation on care and maintenance, such a structure or alternative may be constructed to restrict access.
Underground	Underground mine dewatering systems would continue to operate while in care and maintenance in order to facilitate the recommencement of mining operations. This would lead to the need to maintain surface water storages. Other mine infrastructure, including the mine ventilation systems would be operated and maintained on a modified schedule.
MPL infrastructure (accommodation village, access road, wellfields, electricity transmission lines)	MPL infrastructure may require on-going maintenance, especially where disrepair may lead to adverse safety and environmental outcomes (such as the case with overpasses and culverts).
MPP including ROM Stockpile, COS and Marginal Ore Stockpiles	At the time of shut down, treatment plants may contain significant volumes of process-related materials and chemicals. These materials may require storage and/or disposal to prevent dispersion outside the plant area. No PAF material would be left on the surface during care and maintenance. If ore (including marginal ore) cannot be processed through the plant prior to care and maintenance, any remaining stocks would be placed into underground voids as part of planned care and maintenance activities.
Chemical and hydrocarbon storages	Chemicals, fuels, oils and greases including used chemicals, oils and greases would be stored in appropriate containers or disposed of correctly to prevent unplanned release to the environment (surface water, groundwater or land).
TSF	Assessment undertaken by a suitably qualified and experienced expert demonstrates that the following can be achieved during care and maintenance: • Demonstrate that sufficient freeboard has been achieved to ensure flood storage capacity for a 1-in-100 AEP rainfall event including wave freeboards (1-in-10 AEP winds) and contingency freeboard of 0.5 m. • Demonstrate emergency spillways for each stage of the operation have the capacity for flow resulting from a 1-in-1,000 AEP critical duration event including wave freeboard. The Operations, Maintenance and Surveillance (OMS) Manual would be updated and continued to be implemented during care and maintenance.
Waste management	The ongoing disposal of wastes (including wastewaters) would require consideration during the care and maintenance phase.
Emergency response and site security	An emergency response action plan would be developed and in place with clear lines of communication. Any adverse findings during inspections or monitoring that may lead to serious environmental harm would be dealt with in a timely manner.
Disturbed land	Any disturbed land that is no longer utilised and has not been subject to progressive rehabilitation shall be rehabilitated to achieve physical stability and form part of any rehabilitation trials if still ongoing.

5.2 Closure strategy

When considering the activities undertaken for mining, efforts have been focussed to ensure the activity is planned to completion in the context of progressive rehabilitation activities and longer-term closure strategies. The overarching goal of the closure strategy is to identify and evaluate an integrated asset closure solution that creates a safe, stable, resilient and achievable closure outcome, acceptable to key stakeholders. The strategy seeks to deliver post-completion conditions that would support the pre-mining land uses and landscape functions. Mine closure considerations have been integrated into the design of the site and addressed in each of the closure domains. Opportunities to commence closure activities ahead of schedule are actively sought and actioned during operations.

Minimising post-completion landforms was a key priority during the design phase of Carrapateena. For example, reuse of waste rock in construction and preferentially disposing of PAF waste rock underground and/or processing PAF waste material as ore instead of bringing it to surface and encapsulating it in a landform. The vast majority of the site will be returned to pre-mining land use (see Figure 5.1) with the permanent post-closure landforms including the SLC subsidence zone, abandonment bund, and the TSF, as illustrated in Figure 5.2 and Figure 5.3. A comparison of the pre- and post-mining landscape sections is presented in Figure 5.4.

The construction and operations schedule for Carrapateena has prioritised reduction of final (end of life) surface closure activities, by completing items at the earliest possible stage. Progressive rehabilitation was a key focus during planning and design of the Project and is incorporated into the Project's scheduling as summarised in Section 4.4 and illustrated in Figure 4.10.

The activities onsite are separated into representative closure domains. Viable closure alternative strategies were evaluated at a high level, and considered the project context, design constraints, availability of materials/resources and likely success rate of the proposed strategy. The options assessed formed the basis of the closure specifics detailed in MLP Appendix A7 Closure Strategy (OZ Minerals 2017a) associated with each complex primary domain.

Closure has been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c). Table 5.2 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMCs and Leading Indicators as detailed in Section 7.3. A list of further works to be undertaken to reduce uncertainty have also been provided and these have been addressed through the application of OMC.

Table 5.2 | Closure Impact IDs, design and management controls and uncertainty

Closure	
Carrapateena Impact IDs[1]	Northern Wellfield Impact IDs[2]
L08*, L13*, L14*, L15*, AQ09, AQ10, AQ11*, AQ12, AQ13, AQ14*, AQ15*, AQ16, AQ24, AQ25, AQ26*, AQ27*, AQ28*, AQ29*, AQ30 SW02, SW04, SW06, SW08*, SW10*, SW21, SW22, SW23, SW24*, SW25, SW32, SW33, SW34, SW35, SW36, SW37 GW03, GW04, GW07, GW08, GW10*, GW12, GW14, GW16, GW17, GW18, GW19, GW20 and GW27*	L08, L17*, L18*, L19*, L40* SW02, SW04, SW06, SW08*, SW10* GW01 to GW14*
Design controls	
• Design measures to minimise risks at closure (e.g. SLC abandonment bund, decline portal plug, box cut backfilled, ventilation raises capped, wells closed in accordance with relevant standards) • Rock armouring of final landforms external slopes (rock armouring of the TSF embankment and SLC abandonment bund) • Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation) • No-cover capping for TSF surface • All disturbed areas rehabilitated except for TSF top surface and subsidence zone crater • Field trials to confirm outputs of the post closure air quality modelling outputs • Rehabilitation of land to achieve a landscape function equivalent to the surrounding landscape • Final detailed design to be provided in accordance with ANCOLD design criteria • Spillway designed for the PMP, critical duration event, in accordance with ANCOLD	
Management controls	
• Decommissioning and Rehabilitation Plan • Removal of infrastructure • Temporary sediment and erosion controls (e.g. mobile sediment booms, sediment fencing) • Rehabilitation procedures and inspection program • Abandonment bund construction quality assurance procedures • Field trials to confirm outputs of the landform evolution modelling • All commercial or industrial waste is disposed of in an EPA licensed facility • Establishment of a landscape function criteria and rehabilitation methodology • Rehabilitation trials • Stockpile management procedures to ensure quality and quantity is maintained	
Uncertainty assessment	
• Calibration of air quality model, landform evolution model to support the no cap on the TSF closure methodology • Validation of landform evolution model and air quality modelling inputs	

* Non-Outcome or Outcome-based lease condition proposed

(1) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

(2) Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

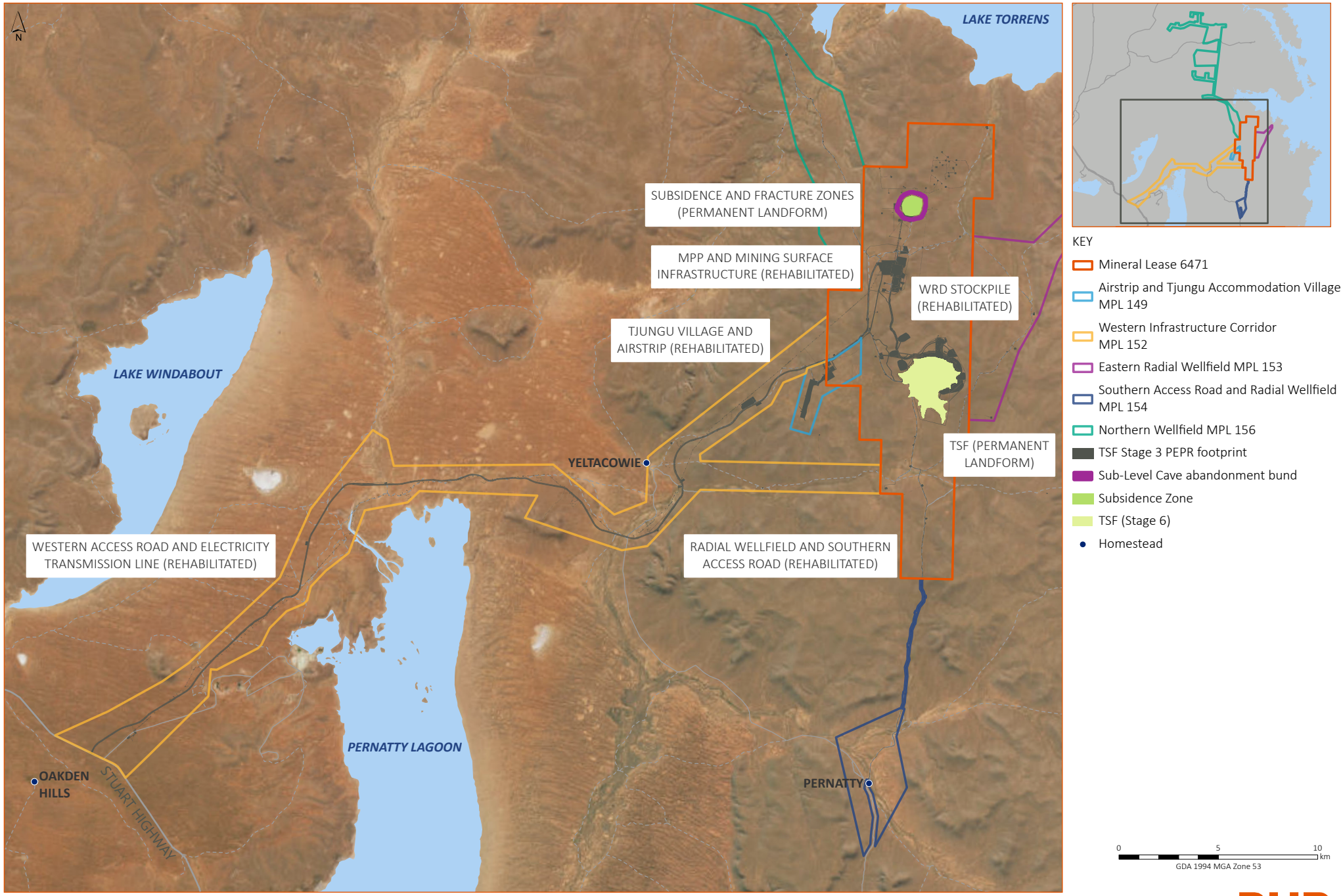


Figure 5.1 | Carrapateena area following closure

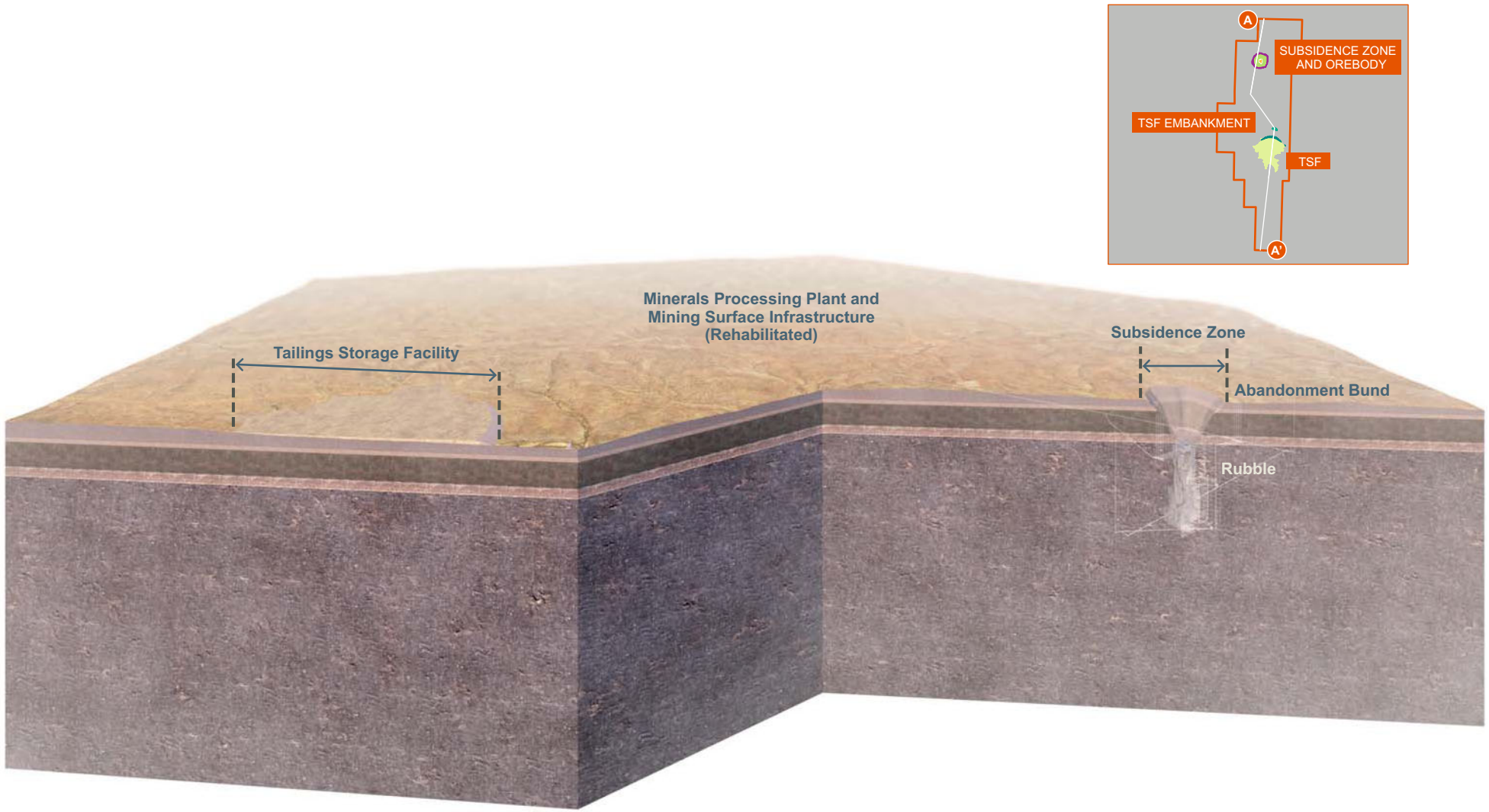
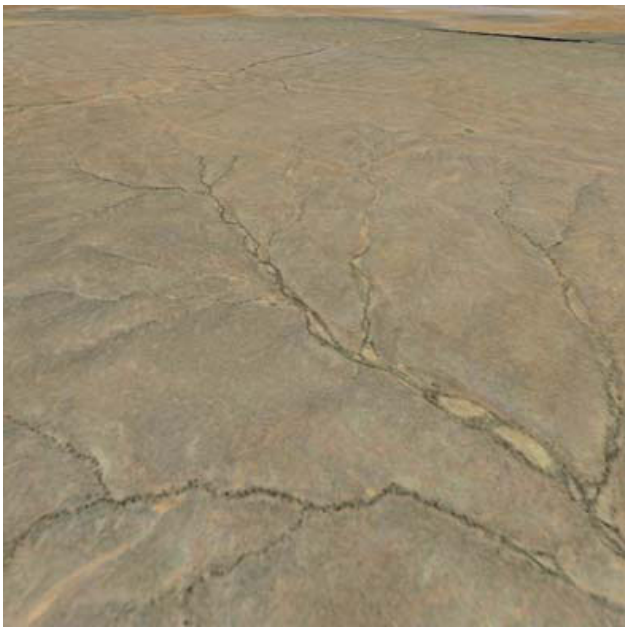


Figure 5.2 | Indicative post-completion landscape

SUBSIDENCE ZONE: PRE-MINING

TAILINGS STORAGE FACILITY: PRE-MINING



SUBSIDENCE ZONE: POST-MINING

TAILINGS STORAGE FACILITY: POST-MINING

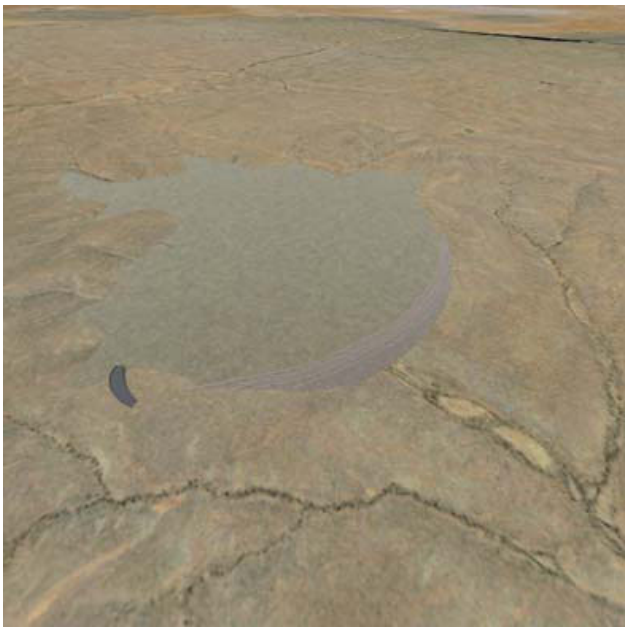


Figure 5.3 | SLC and TSF pre- and post-completion landforms

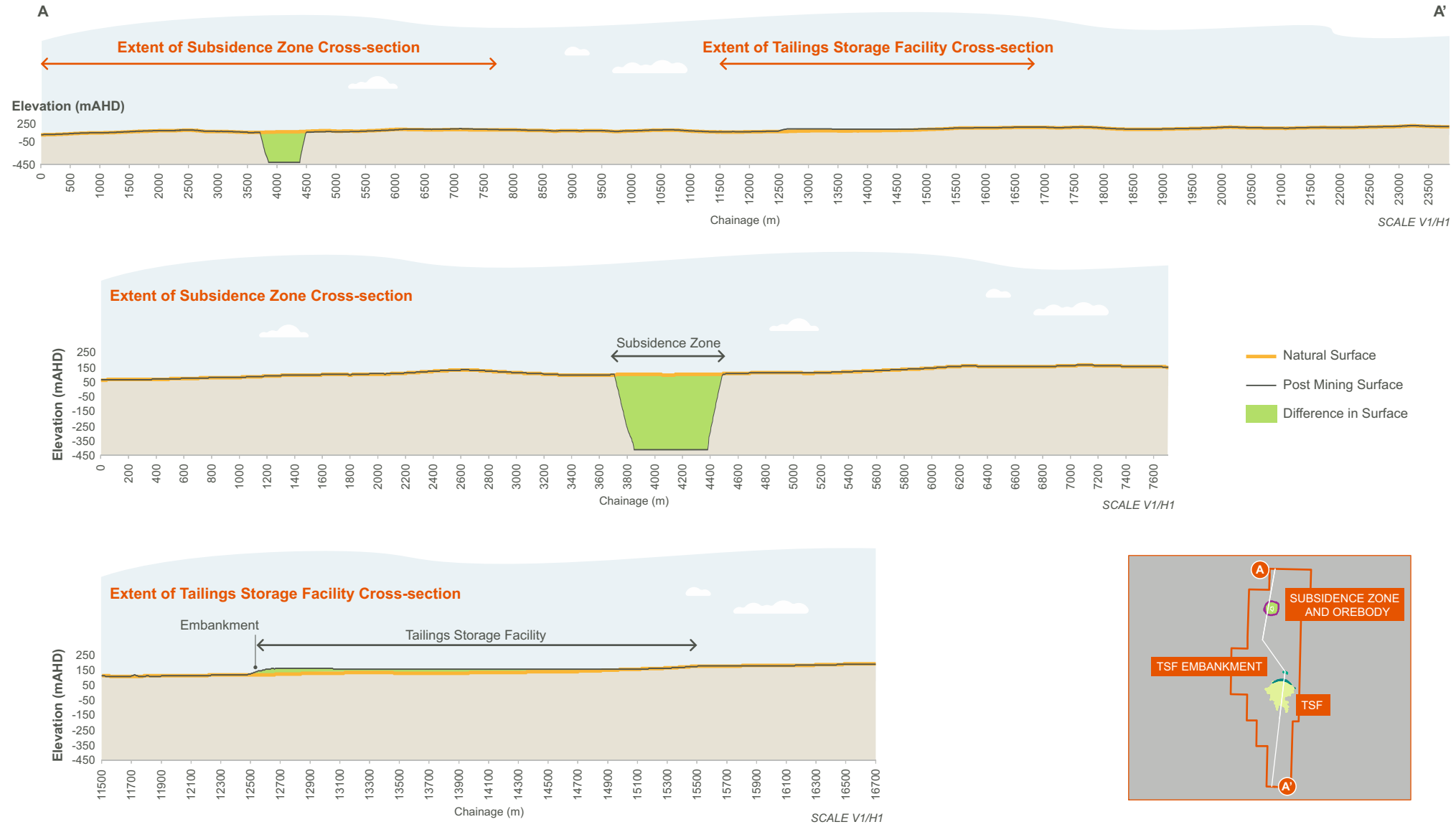


Figure 5.4 | Pre- and post-mining cross-sections

5.3 Post-operations land use

Two categories of post-closure land use are envisaged:

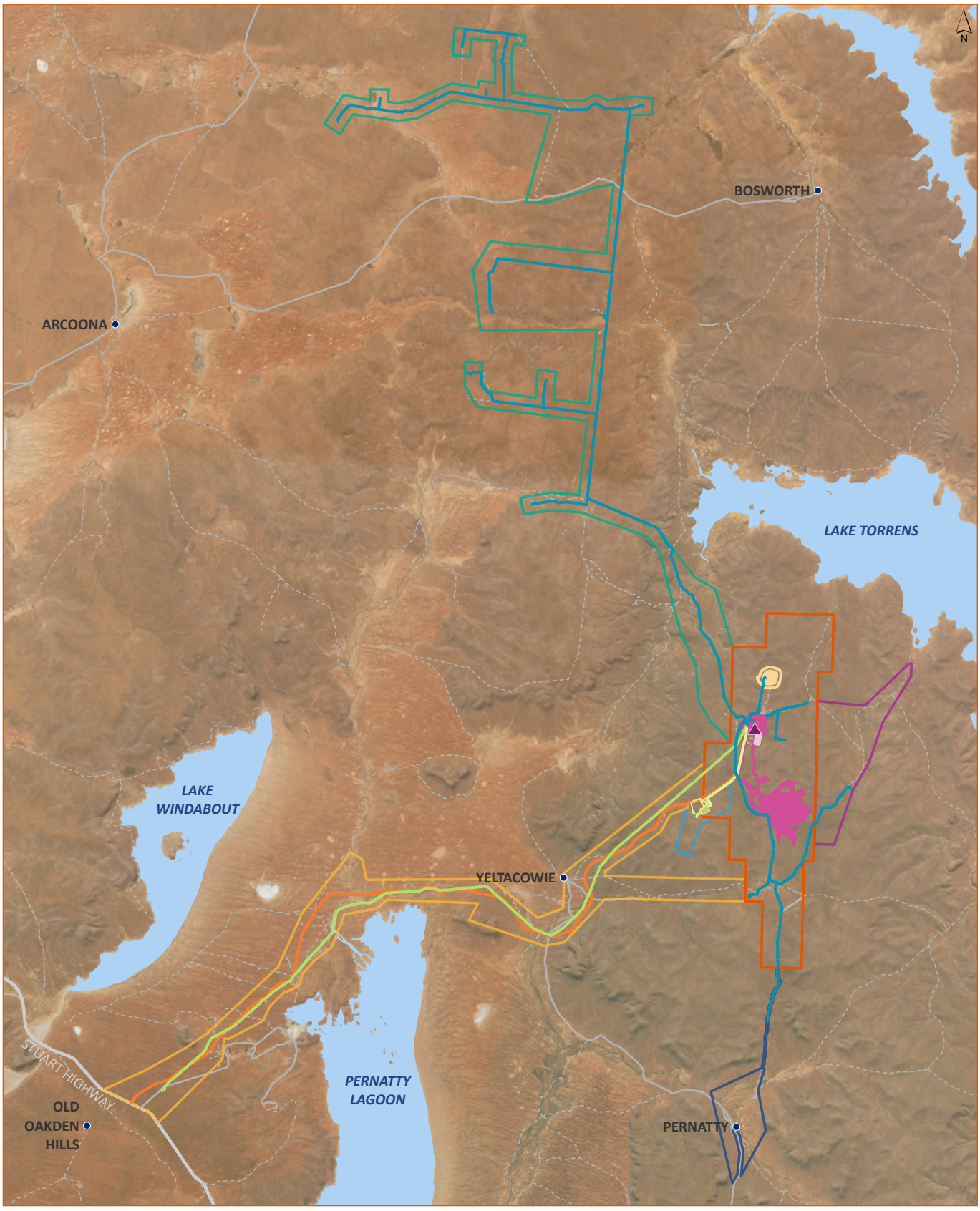
- Land disturbance within the ML (e.g. MPP infrastructure footprints) and within the associated MPLs (e.g. access roads, electricity transmission line and water supply wellfield footprints), except land occupied by the mine subsidence zone and the TSF, will generally be returned to a condition that is compatible with pre-mining land uses (productive pastoral use and/or ecosystem functions). If requested by stakeholders and authorised by relevant authorities, some assets may be retained for use by others (i.e. particular groundwater wells and/or access tracks).
- The tailings-filled valley and the subsidence zone will remain as permanent structures after closure. These project elements have physical and chemical characteristics that will constrain future use and/or access. None of these features are likely to revegetate sufficiently to achieve a landscape function equivalent to the pre-mining landscape in the short term, although alternative landscape functions may develop over the longer term.

5.4 Closure activities

This section summarises the activities for each closure domain. The closure domains are listed in Table 5.3 and shown in Figure 5.5. Table 5.3 includes a cross reference to the proposed tenements and the related document section. An options analysis for each domain was undertaken to develop the closure strategy for each domain summarised in the following sections.

Table 5.3 | Closure domains

Domain	Description	Tenement	PEPR Location
1	Pit voids	ML 6471	Section 4.8.3 Section 4.11.5
2	Underground workings	ML 6471	Section 4.8.2
3	Infrastructure	ML 6471 MPL 149 MPL 152	Section 4.8.4 Section 4.8.6 Section 4.9.4 Section 4.12.7 Section 4.11 Section 4.14 Section 4.15
4	Hardstand areas and stockpiles	All	Section 4.11
5	Roads and corridors	All	Section 4.14
6	Water management infrastructure	All	Section 4.12
7	Exploration	All	Section 4.7
8	Specific features (MPP, TSF)	ML 6471	Section 4.9 Section 4.10



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156

Closure Domains

- 1. Pit voids
- 2. Underground workings
- 3. Infrastructure
- 4. Hardstand areas and stockpiles
- 5. Roads and corridors
- 6. Water management infrastructure
- 7. Exploration (specific activities not shown)
- 8. Specific features (MPP, TSF)

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 5.5 | Closure domains

Carrapateena BHP

5.4.1 Domain one – pit voids

5.4.1.1 Sub-level cave

Upon the cessation of underground mining, mine-dewatering activities will cease and water from the THA and WSA will flow into the underground workings and into the subsidence zone. Over long periods of time, a permanent, hypersaline pit lake is likely to form in the subsidence zone above the main orebody. Modelling of the likely post-closure subsidence zone pit lake (OZ Minerals 2017a; MLP Appendix C3 Groundwater Modelling and Assessment of Effects) indicates that the area of the pit lake may be between 7 and 28 ha, depending on the actual rate of evaporation but would remain below the pre-mining water table and thus be a perpetual groundwater sink.

The subsidence zone will remain as an area of potential geotechnical instability and access to it will be controlled to prevent access by member of the public post-closure through construction of an abandonment bund. This is distinct from the safety bund, which will be established early in the mine life around the entire perimeter of the subsidence zone to avoid inadvertent access during operations.

Initial construction of the abandonment bund leaves road width openings at a number of locations to enable access to monitoring points during mining. These openings are gated to restrict access during mining and post-closure monitoring.

The final closure abandonment bund will be constructed in accordance with the Guideline ‘Safety Bund Walls Around Abandoned Open Pit Mines’ (Department of Industry and Resources 1997), which states the bund should be a minimum two metres in height with a base width of five metres, and wherever possible, should be constructed from unweathered, freely draining, end-dumped rockfill. The abandonment bund is approximately 2 m high and shaped so it is not possible to drive over. Once post-closure monitoring ceases, the openings are permanently closed with rock bunds and signage erected to warn of the hazardous conditions inside the bunded area. Post closure, an audit to ensure the abandonment bund design and integrity is to be undertaken.

The area inside the bund is permanently unsuitable for establishment of buildings and for most commercial land uses, including pastoral use. No revegetation will be undertaken in this area.

5.4.1.2 Mine area borrow pit

A borrow pit operation has been established outside of the SLC subsidence zone, to provide construction materials (weathered and fresh Arcoona Quartzite). At closure, the quarry will be modified to be physically stable, which may involve the backfilling of remaining mine waste from the site WRD and the battering of borrow pit walls.

During mining operations, borrow pit material excavated from within the subsidence zone is temporarily stored in stockpiles on the land surface for use during construction. At completion, the disturbed land surface outside of the subsidence zone is rehabilitated to a landscape function equivalent to the surrounding analogue landscapes (pastoral use and/or ecosystem support functions). Rehabilitation trials are proposed to develop the most appropriate methodology for revegetating disturbed areas. If required, the area would be ripped or scarified to encourage natural vegetation recruitment. Should any borrow pit material remain at completion, it would be used for armouring of the TSF or construction of the subsidence zone abandonment bund. Should there be excess borrow pit material remaining post closure, it would be backfilled to the pit.

5.4.2 Domain two – underground workings

Several openings exist into the underground mine for access and ventilation. While these openings constitute minimal surface disturbance, they provide a post-completion safety hazard for members of the public and fauna. At the cessation of underground works, measures to restrict access to the ventilation shafts and access decline portals will be put in place. The Tjati Decline, conveyor decline and the ventilation raises will not be backfilled at closure, however access would be closed through cemented rockfill plugs and concrete/steel capping structures. This will enable access for future mining operations should this be determined to be economically viable.

The first 50 m of each decline would be backfilled with competent rock, then cemented with concrete and stabilised sand. Demolition rubble would be deposited within the box cut, before backfilling of the remaining box cut void with waste rock and topsoil. The former portal area will be covered with a shallow 1 m high mound of waste rock to allow for settlement. The ventilation raises will be capped with a purpose-build steel and concrete cap structure that would prevent access and eliminate the potential for fretting. The caps will be established by constructing a concrete sill anchored to the raise walls, between 3 and 5 m below ground. The volume above the sill would then be filled to ground level with cemented sand or concrete fill. The raise collar area will be covered with a 1 m high mound of waste rock to allow for settlement of the fill material.

5.4.3 Domain three – infrastructure

5.4.3.1 Mine surface infrastructure

Surface infrastructure associated with mine ventilation, refrigeration and water management systems would be decommissioned and removed at the same time that the MPP is decommissioned. The conveyor and steel work outside the mine portal, and from the first 50 m of the conveyor decline, will be removed from site. At closure, all aboveground steelwork and associated ventilation infrastructure will be removed.

At cessation of operations, the mine surface infrastructure elements require minimal surface rehabilitation (other than that required to prevent access to underground openings). The reshaped land will be ripped and/or contoured to encourage natural recruitment of the prevailing chenopod shrubland vegetation.

5.4.3.2 Electricity infrastructure

Electricity infrastructure (transmission lines, conductors, towers and access roads) will be removed and rehabilitated to a landscape function equivalent to the pre-mining landscape function (pastoral use and/or ecosystem support functions). If requested by stakeholders (e.g. pastoralists and/or other mining companies), and subject to regulatory authorisation, infrastructure may be retained and management of the asset transferred to another entity.

5.4.3.3 Accommodation village and airstrip

At completion, the two accommodation villages and the airstrip would be removed and rehabilitated to a landscape function equivalent to the pre-mining landscape function (pastoral use and/or ecosystem support functions). Buried services below a depth of 1 m would be abandoned in situ, otherwise would be exposed and disposed of within a designated landfill or at an appropriate offsite location.

Access roads would be rehabilitated to a landscape function equivalent to the pre-mining landscape function (pastoral use and/or landscape functions) equivalent to the surrounding landscape.

Unpaved sections of the access roads would be reshaped (if required) and ripped or scarified to encourage natural vegetation recruitment. Re-establishment of the landscape function would be monitored in the post-closure period to ensure that rehabilitation is showing a satisfactory trend towards a condition similar to the landscape function measured at nearby analogue monitoring sites.

At completion, all surface infrastructure associated with the water supply system (wells, pipelines, staging tanks) would be removed. Below-ground infrastructure would be retained (abandoned in situ). The disturbed land surface would be scarified and rehabilitated as required to achieve a landscape function equivalent to the landscape function at nearby (undisturbed) analogue sites.

At completion of activities, all surface water management infrastructure, including sedimentation ponds, would be decommissioned and rehabilitated in keeping with the surrounding landscape. Creek lines would be restored to ensure smooth flow through the existing creek lines and to ensure physical stability to prevent erosion and sedimentation.

If requested by stakeholders (e.g. pastoralists and/or other mining companies), and subject to regulatory authorisation, infrastructure may be retained and management of the asset transferred to another entity.

5.4.3.4 Landfill

At closure, all constructed landfill surface infrastructure, including fences, gates and unused stockpiles would be removed. The final filling height would be a minimum of 500 mm below ground level, after which 300 mm of interim fill cover would be established prior to the placement of an engineered cap of at least 600 mm of Quaternary clays, to be placed above the deposited and compacted waste materials, and blended into the surrounding land to ensure physical, geochemical and ecological stability. This layer would be compacted and would provide a layer designed to shed any rainfall and surface water, minimising infiltration and avoiding the build-up of leachate within the facility. This would be topped with at least 100 mm of topsoil to allow for revegetation using endemic native species (shrubs) with a rooting depth sufficiently shallow to avoid roots penetrating the cap, negatively influencing its ability to mitigate rainfall infiltration.

The landfill cap would be proud of the natural land surface and be mildly sloped to promote the runoff of surface water. Initially, temporary sediment control measures such as mulch or hay bales may be used to mitigate the potential for erosion prior to the establishment of vegetation. With time, it is expected that the landfill mass will compact with the decomposition and compression of the putrescible waste, ultimately leaving a vegetated landfill cap that approximates the local topography and is suitable for the resumption of pastoral activities.

5.4.4 Domain four – hardstand areas and stockpiles

5.4.4.1 Hardstand areas

Hardstand areas such as laydowns and other cleared areas will be reshaped and ripped to promote natural recruitment of chenopod shrubland vegetation.

5.4.4.2 Stockpiles

During mining operations, a range of materials would be temporarily stored in stockpiles on the land surface, pending processing. At completion, some mineralised materials will remain at surface. If the material is uneconomic to process, it will either be returned to the mine for backfilling of voids, including closed ventilation raises or stored in the WRD.

At closure, the surface of the COS pad (potentially containing residual PAF material) is removed and processed. Any non-mineralised waste rock (e.g. remaining on the WRD) is used in site closure activities, including stabilisation of the TSF embankment (if required), quarry and borrow pit back-filling and/or ventilation shaft and box cut backfilling and mine access closure. The area formerly occupied by the stockpiles will be reshaped and ripped to promote natural recruitment of chenopod shrubland vegetation.

5.4.5 Domain five – roads and corridors

Access roads (Southern Access Road, Western Access Road and infrastructure access tracks) will be rehabilitated to a landscape function equivalent to the pre-mining landscape function (pastoral use and/or landscape functions equivalent to the surrounding landscape.

Unpaved sections of the access roads will be reshaped (if required, should surface water overland flow be significantly altered) and ripped or scarified to encourage natural vegetation recruitment. Re-establishment of the landscape function is monitored in the post-closure period to ensure that rehabilitation is showing a satisfactory trend towards a condition similar to the landscape function measured at nearby analogue monitoring sites.

Paved sections of the road formation are removed, along with drainage culverts or other drainage elements. The formation will be ripped to reduce compaction and the ground re-contoured to reinstate (to the extent practicable) pre-development drainage paths. The prepared surface will be scarified and the topsoil or vegetation that was stockpiled during initial development works respread to encourage natural recruitment of vegetation. Barriers are installed at suitable locations to prevent access by vehicles to the closed access road alignment.

If requested by stakeholders (e.g. pastoralists and/or other mining companies), and subject to regulatory authorisation, the access roads (in particular the airstrip access road) may be retained and management of the asset transferred to another entity.

5.4.6 Domain six – water management infrastructure

At completion, all surface infrastructure associated with the water supply system (wells, pipelines, staging tanks, turkey's nests) will be removed, unless otherwise requested by stakeholders. If requested by stakeholders (e.g. pastoralists and/or other mining companies), and subject to regulatory authorisation, infrastructure may be retained and management of the asset transferred to another entity.

All wells are decommissioned in accordance with National and DEW guidance on decommissioning wells, unless otherwise requested by a third party. Below ground infrastructure will be retained (abandoned in situ). Where required, wells are capped below ground level, and a permanent concrete marker installed to allow re-establishment of the well in the future if required.

The disturbed land surface will be scarified and rehabilitated as required to achieve a landscape function the equivalent of the landscape function at nearby (undisturbed) analogue sites.

5.4.7 Domain seven – exploration

At completion, all exploration disturbances areas and surface drill sites will be rehabilitated in accordance with information sheets 'M21 Mineral Exploration Drillholes – General Specifications for construction and backfilling' (DSD 2012) and 'M33 Statement of Environmental Objectives and Environmental Guidelines for Mineral Exploration Activities in South Australia' (DSD 2004). Van Ruth plugs will be installed within each drillhole, as described in Section 4.7.4.2. The drillholes are back filled with cuttings and capped. Prior to final site completion all rubbish is removed from the area, new access tracks are scarified and the stones/gibbers re-spread, flagging and non-permanent stakes are removed, all sumps are backfilled, and the areas levelled to match the surrounding topography.

5.4.8 Domain eight – specific features

5.4.8.1 Minerals processing plant

In the months leading up to closure, stores inventory (parts, components and reagents) will be reduced; however, some materials will be left at closure, requiring disposal and/or return to the vendor. At the completion of processing operations, the plant site is decommissioned and demolished and/or removed. Some items of equipment/infrastructure will be sold for re-use or scrap value. Items and materials that have no re-sale or scrap value may be disposed of onsite, subject to regulatory approval. No hazardous materials (explosives, radioactive materials, bulk chemicals, asbestos or hydrocarbons) will be left onsite at closure.

Surface water management infrastructure in the plant area will be maintained until cessation of the mining and processing activities. This allows for the management of 'first flush' sediments and runoff from rehabilitated areas before the system is left to naturally revegetate and integrate back into the surrounding post-mining topography when the erosion of the rehabilitated areas has stabilised. No active rehabilitation of this system is proposed. The drainage lines are expected to develop a vegetation community similar to the Acacia woodland communities that occur along minor ephemeral drainage lines in the locality.

Buildings, hardstand, services and other surface facilities will be removed from site. Concrete footings or other buried structures deeper than 1 m will be abandoned in situ. Once the site has been cleared, a contamination assessment would be carried out to confirm there is no residual contamination that could affect future land uses. If contamination is discovered, remediation will be carried out as required.

Following site demolition, clearing and remediation, the plant area will be reshaped and ripped or scarified to reduce compaction and to achieve a landscape function equivalent to that of the function measured at nearby (undisturbed) analogue sites. Rehabilitation trials are proposed to develop the most appropriate methodology for revegetating disturbed areas.

5.4.8.2 TSF and decant dam

Tailings storage facilities are closed at the end of their life to retain the tailings within a stable landform such that they do not constitute a safety risk or impact and pollute the environment. Tailings facilities typically have two components, namely the beach and the embankment. Tailings beaches tend to have flat slopes (Carrapateena slopes average a grade of approximately 0.5% to 1.0%), while embankments are primarily constructed to be geotechnically stable (Carrapateena 1H:2V). For erosional stability, embankments are typically flatter (in the order of 1H:3V).

The Carrapateena TSF will not be capped following cessation of operations. An air quality assessment of effects study and a radiation impact assessment of the uncapped TSF post closure was conducted as part of the MLP (Appendix C1 and Appendix D3 of the MLP, respectively). A number of potential exposure scenarios were developed, based on a Features, Events, Processes (FEP)-style risk assessment. The calculated potential doses for these post closure scenarios showed that the radiological impacts of an uncapped TSF would be low. These scenarios and the assumptions are outlined in detail in Appendix D3 of the MLP (OZ Minerals 2017a).

Whilst the ‘Code for Disposal Facilities for Solid Radioactive Waste’ (ARPANSA 2018) recommends that radioactive wastes be covered, it is worth noting that this document aims to provide advice on bulk naturally occurring radioactive material (NORM) residue disposal and notes that the requirements do not apply to ‘operations subject to the Mining Code’ (ARPANSA 2005a). Additional broad guidance on waste disposal is provided in the ‘Technical Report 141 Scientific Basis for the Near Surface Disposal of Bulk Radioactive Waste’ (ARPANSA 2005b) that provides general guiding principles for the disposal of waste. This guidance is based on a risk assessment of the waste, where the disposal option is optimised based on the assessed risks. BHP has approached the radiological aspects of closure of the TSF from this perspective, where the risks have been assessed and an optimised closure strategy developed. This approach is consistent with the overall IAEA approach to radiation risk management, in that applied radiation controls should be commensurate with risk and supports the uncapped TSF methodology.

Geochemical analysis was undertaken as provided in Appendix G to the MLP Response Document (OZ Minerals 2017c). The potential risk to environmental receptors was assessed by adopting previously modelled dust generation/deposition plots and calculating dust loading (and thus deposition) of chemical substances over a 100-year period (and also a 1,000-year period). Such calculations indicated that this scenario/pathway was not significant with respect to potential harm to the environment (being flora and fauna using the soils adjacent to the TSF) with respect to copper relative to ‘areas of significant ecological value’ (20 mg/kg) over a 1,000-year period. Only cobalt exceeded the health investigation level (HIL) A tier 1 criteria for residential land use, but not the commercial/industrial criterion. As such, there is no exceedance of soil tier 1 criteria for open space land use or commercial and industrial land use, which is considered applicable for the final land use.

Further, landform evolution modelling (LEM) has been undertaken to assess the potential change in landform associated with exposure to surface waters and wind erosion over time. This modelling demonstrates that the TSF structure will remain physically and chemically stable post completion without the addition of a cap or cover. The LEM outputs show that the tailings surface will capture and store sediments transported from upper areas of the TSF catchment, and while it may undergo some erosion

resulting in the formation of minor rills and gullies, the tailings will remain within the TSF without compromising the ability of the TSF to store a PMP rainfall event without overtopping.

Geotechnical modelling of the TSF in the post-closure phase have also shown that the risk of loss of containment by geotechnical failure is low (MLP Response Document OZ Minerals 2017c; Appendix A). Calculated geotechnical stability factors indicate that the proposed embankments have an adequate factor of safety under static loadings and even under a Maximum Credible Event (MCE) scenario.

An emergency spillway would be constructed close to the eastern abutment of the TSF embankment at closure. The emergency spillway would be approximately 30 m wide at the base, 1.5 m deep and have side slopes of 4H:1V (see Section 4.10.4). Water spilling over the emergency spillway would be directed to a drainage line that directs water back to Eliza Creek, approximately 1 km downstream of the TSF embankment.

Prior to completion, the borrow material pits will be regraded and rehabilitated to the pre-mining land use. Should the borrow pits become too deep for regrading, they may be backfilled with waste rock or abandonment bunds (Department of Industry and Resources 1997) will be utilised to restrict access.

This domain has been subject to impact and risk assessments as provided in the Consolidated Assessments (OZ Minerals 2017a; 2018c). Table 4.31 provides a summary of relevant Impact IDs, design controls and management controls that have led to the development of Outcomes, OMCs and Leading Indicators as detailed in Section 7.3. A list of further works to be undertaken to reduce uncertainty have also been provided.

5.5 Rehabilitation liability estimate

5.5.1 Closure resourcing and financial provisioning

In addition to the financial provisioning required to achieve the Outcomes and to facilitate the closure and rehabilitation activities, provisions need to be made for dedicated project management to coordinate the following activities:

- supervision and management of rehabilitation tasks
- establishment of temporary facilities
- mobilisation and demobilisation.

Suitably qualified experts will be required for investigations and activities associated with closure, including undertaking the following works:

- preparation of post-closure annual reports
- preparation of final relinquishment report and final negotiations
- legal advice
- contaminated site assessment
- general closure consultancy services
- vegetation modelling
- preparation of an environmental assessment for the post-operational land use prior to licence surrender.

Additional resources may be required to manage the closure works and maintain land tenure.

A bond has been entered into for the tenements that ensures sufficient funds are available to satisfy:

- any civil or statutory liability likely to be incurred in the course of carrying out mining operations
- the present and future obligations in relation to the rehabilitation of land disturbed by mining operations.

The bond is based on the rehabilitation liability estimate provided in the following section.

5.5.2 Rehabilitation liability estimate

Cost estimates for closure and rehabilitation of ML 6471 and associated MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156 were calculated using rehabilitation liability calculator software made available for use by DEM. This software facilitates calculation of closure costs including consideration of potential liability items discussed in the DEM MG2b guideline (DEM 2023b). The bond is costed on the basis of a third party being contracted to undertake the work and includes a provision for contingencies and risk associated with the rehabilitation activities.

Reflecting the reconciliation of as-built land disturbance (see Table 4.8), the implementation of the changes to Carrapateena reflected in Program Notifications (see Section 1.2.1) and proposed changes to approved operations (see Section 1.2.5), the Carrapateena rehabilitation and liability estimate has been reviewed and updated as described in Table 5.4. These costs exclude costs associated with the closure of approved alternative activities (e.g. CTP, evaporation ponds, onsite renewable generation etc. as described in Table 4.7) resulting in a decrease in the overall rehabilitation liability estimate.

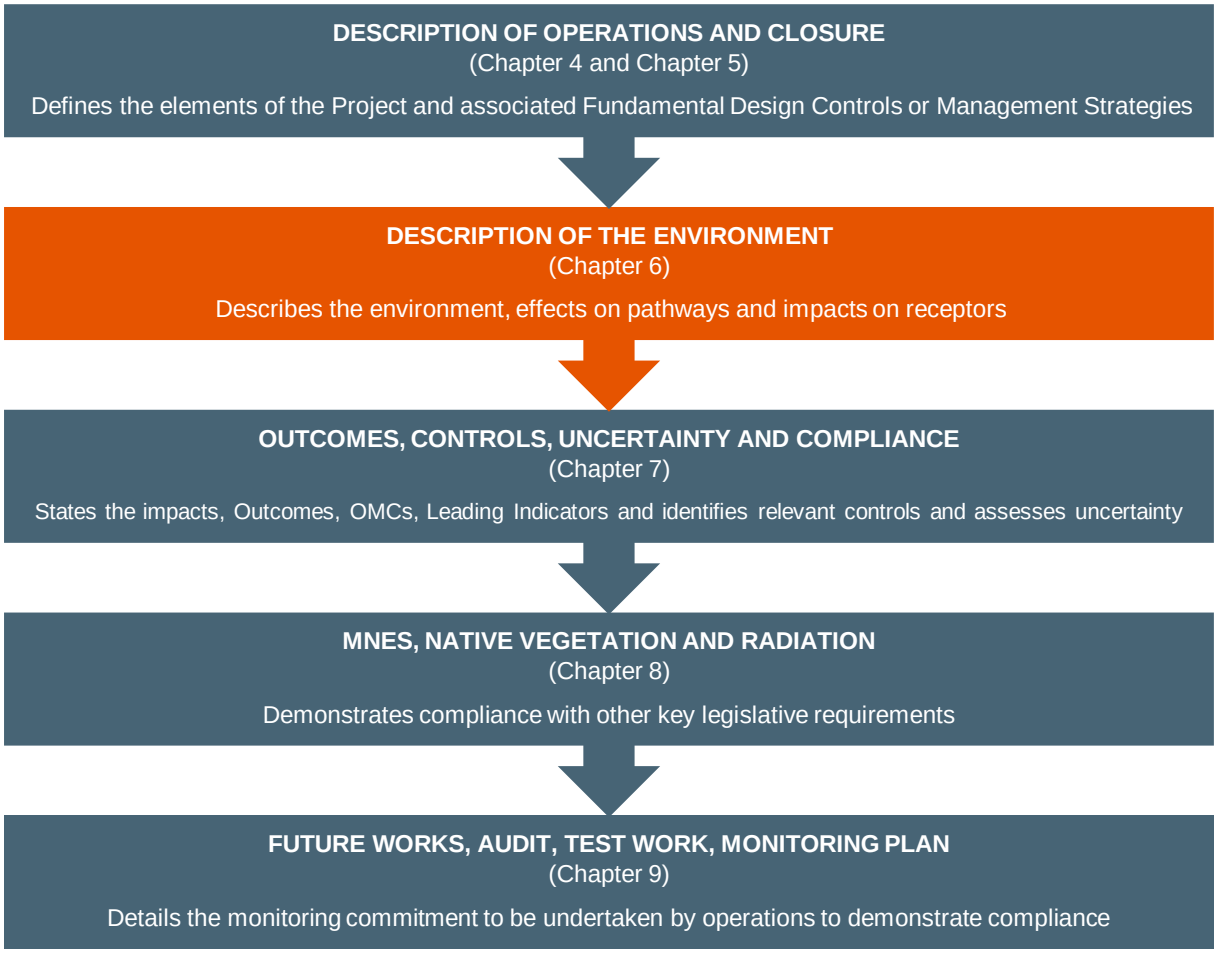
The bond will be reviewed should an approved alternative option be implemented as summarised in Section 4.2, as part of subsequent PEPR reviews and/or as requested by DEM.

Table 5.4 | Carrapateena rehabilitation liability estimate

Cost estimate description	Rehabilitation estimate ($)
Summary of direct costs	
Exploration	172,914
Underground workings	2,700,716
Open cut/extractive pits	390,210
WRD	3,872,983
Processing facilities	9,153,809
TSF	3,470,215
Haul and access roads	1,536,931
Administration and accommodation	6,040,143
Ancillary areas (e.g. workshops, laydown areas)	730,531
Services infrastructure (power and water)	4,424,158
Water management	567,237
Subtotal	**33,059,847**

Cost estimate description	Rehabilitation estimate ($)
Summary of indirect costs	
Monitoring	1,534,000
Maintenance	3,065,410
Government management	2,352,030
Site supervision	3,814,105
Insurances	330,598
Contingencies	9,196,231
Subtotal	**20,292,374**
Total rehabilitation liability	
Total	**53,352,221**

6. Description of the environment and effects



This chapter provides a summary of the existing environment (baseline environment) in the Project Area and surrounds, and describes the effect on the environment, and how the baseline receptor environment is, or will be, impacted by the Project activities described in Chapter 4.

The **Project Area** is comprised of ML 6471, MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156.

High-level descriptions of the pathways and receptors are provided, which were considered in the assessment of impacts that supported the Carrapateena Project's Airstrip and Workers' Accommodation Village MPL MP (OZ Minerals 2016), MLP (OZ Minerals 2017a) and the Northern Wellfield MPL MP (OZ Minerals 2018c) and their respective response documents (OZ Minerals 2017; 2017c; 2018d).

Pathway: The pathway, means or route (with consideration of any natural barriers) by which an identified receptor can be exposed to, or may reasonably be expected to be impacted by, an identified source.

Receptor: A discrete, identifiable attribute or associated entity that can be measurably impacted by an effect to a pathway.

The baseline conditions have been established through a program of data collection activities extending back to 2007. The program includes soil and geotechnical investigations, air quality monitoring (spanning multiple seasons and meteorological conditions), surface water field sampling and modelling, hydrogeological exploration and modelling, seasonal ecological field surveys and ongoing stakeholder consultation activities.

A detailed description of the baseline environment for each element is provided in the Airstrip and Workers' Accommodation Village MPL MP (OZ Minerals 2016), MLP Appendix Set B Description of Environment (OZ Minerals 2017a), and the Northern Wellfield MPL MP (OZ Minerals 2018c). This information is publicly accessible via the DEM website and is also managed by BHP internally.

Changes to our understanding of the baseline environment since the submission of the previous PEPR in June 2024 (BHP 2024a) are described within the following sections. In some instances (e.g. air, surface water and groundwater), a detailed update and review of the baseline environment and the associated effect is under development as of the date of this PEPR. In these cases, a summary of the update to the baseline environment is presented in this chapter of the PEPR, with the full technical studies to be incorporated into future regulatory approvals submissions associated with the assessment of any operational changes, changes to the description of the environment, or modifications to Environmental Outcomes, as required by TOR 005 (DEM 2021) (see Chapter 1).

The additional information presented does not materially change the understanding of the baseline environment and as such, the assessment of environmental impacts and the Environmental Outcomes for the Project remain relevant.

The Carrapateena tenements in a regional context are shown in Figure 4.1. Key infrastructure for each tenement in a local context is shown in Figure 4.2 to Figure 4.7.

6.1 Land

6.1.1 Assessment context

The land baseline description was developed through a land baseline assessment that was undertaken for the MLP (OZ Minerals 2017a; Appendix B1 Land Baseline Assessment). The Land Study Area for the assessment incorporated the Project Area and surrounds. It also draws on information from MLP Appendix B2 Geochemical Rock Classification Baseline Assessment, MLP Appendix B6 Ecological Baseline Assessment (OZ Minerals 2017a) and the Northern Wellfield MPL Appendix B Ecological Baseline Assessment (OZ Minerals 2018c). Baseline characterisation has been established through soil and geotechnical investigations across the Land Study Area, with particular focus on the area of ML 6471.

The land pathway existing environment comprises:

- pre-existing site contamination and previous disturbance
- topography and landscape
- soil
- habitat
- vegetation structure and associations
- geology and geohazards.

The interaction of the Project (Chapter 4) with the baseline land environment may result in changes to:

- how the land looks, e.g. changes in topography and visual amenity
- the environment the land provides, e.g. habitats, vegetation associations and/or pastoral uses
- the heritage of the land, e.g. Aboriginal and/or non-Indigenous
- the nature and condition of the land through the introduction and/or spread of weeds or contamination.

Conservation areas in the vicinity of the Project are the Lake Torrens National Park (proclaimed under the *National Parks and Wildlife Act 1972* (SA) (NPW Act)) and the nearby Pernatty Lagoon and Lake Windabout (Figure 2.1). The next closest National Park is the Flinders Ranges National Park, 95 km to the east of the Project Area.

Numerous sites of Aboriginal cultural heritage significance are known to exist within the region, including both archaeological sites and myth-related sites. Heritage clearances have been undertaken in accordance with the agreed protocol with the Kokatha People.

Based on a review of the SA Heritage Places Database, National Heritage List and the Commonwealth Heritage List no sites of non-Indigenous historical significance have been identified within the Project Area. The closest site being the National Heritage Place Ediacara Fossil Site – Nilpena, located approximately 40 km from the Project Area, north-east of Lake Torrens, and the State registered Dick Clark's residence and Andamooka Historic Precinct at Andamooka, approximately 50 km north of the Northern Wellfield MPL 149.

The Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) describe the magnitude of the change to the land pathway including sensitivities and uncertainties. The effect that is predicted to result in the greatest number of impact events for the land pathway was associated with land access and interaction with Project activities, as shown in Table 6.1.

Table 6.1 | Land pathway effects and impacts

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Land disturbance and rehabilitation	L01*, L02*, L04*, L10*, L11*, L12*, L13*, L14*, L15*, L16*, L17*, L18*, L19*	ID001*, ID002*, ID003, ID004, ID005, ID006, ID007*, ID008, ID009*, ID010, ID011, ID013*, ID015, ID017*, ID018*, ID019, ID020, ID021*, ID022, ID023, ID024*, ID025, ID026, ID027*, ID028, ID029, ID030, ID031, ID032, ID033, ID034, ID035, ID036, ID037, ID038, ID042*, ID043*, ID044*, ID045, ID047*	L01*, L02*, L04, L10*, L11*, L12, L13, L14, L15, L16, L17*, L18*, L19*, L20*, L21*, L22*, L23*, L27*
Visual amenity	L03, L05, L06	ID003, ID005, ID010	L03, L05, L06

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Land access and interaction with Project activities	L07*, L08*, L09*, L20*, L21*, L22*, L23*, L24*, L25*, L26*, L27*, L28*, L29*, L30*, L31*, L32*, L33*, L34*, L35, L39*, L40*	ID011, ID012*, ID014*, ID016*, ID039, ID040*, ID041*, ID046*	L07, L08, L09, L24*, L25*, L26*, L28*, L29*, L30*, L31*, L32*, L33*, L34*, L35*, L36*, L37*, L38*, L39, L40*
Vibration	L36, L37, L38	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix B Consolidated Assessment (OZ Minerals 2017b)

3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The land assessment of effects demonstrated that there are negligible changes to regional vegetation associations, habitat and visual amenity, and that the risks associated with accidental public access to the site post-closure, the introduction of new or spread of existing pest flora and fauna species and the spillage of chemicals or hydrocarbons can be managed with standard environmental management procedures.

6.1.2 Current context

A desktop land baseline review was undertaken for the June 2024 PEPR (BHP 2024a; Appendix C1), with the aim to update the land baseline description by consolidating soils sampling, analysis and geotechnical investigations undertaken since the 2016 land baseline assessment (OZ Minerals 2017a; Appendix B1).

The report summarises the geological setting for the baseline review's Land Study Area as being located within the Stuart Shelf geological province which comprises of thin, flat lying sediments of Neoproterozoic age that mantle the crystalline Archaean-Mesoproterozoic rocks of the Gawler Craton (which is considered geologically stable). The Land Study Area encompasses the Arcoona Plateau, with the deposit hosted within crystalline Mesoproterozoic basement rocks which are unconformably overlain by Neoproterozoic sedimentary sequences. The major faulting system in the region is the Torrens Fault which is an extensive zone of south-north faulting and deformation zone which coincides with Lake Torrens. It forms the eastern boundary of the Gawler Craton overlying the Stuart Shelf sediments. Several lineament features run through the Land Study Area within these sediments likely due to chemical and/or physical weathering of formations. It is thought faulting has also occurred due to the presence of the Pernatty Upwarp (located 40 km west of the Land Study Area).

It is considered that the region comprises of two soil types, being sodosols (heavy red sodic sandy clays) occurring on the Arcoona Plateau where the Tent Hill Formation outcrops and calcarosols occurring in the sand plains in the south-west. A soil analysis was conducted using five topsoil and three subsoil samples with findings concluding:

- all samples were sodosols and classified as alkaline to strongly alkaline
- sulfur was low in topsoil samples but much higher in subsoils
- phosphorus was low across all samples however potassium levels ranged from acceptable to high
- calcium was low in most samples, with magnesium being high and sodium very high

- salts and chlorides were high in most topsoils and all subsoils
- boron levels were very high which indicates poorly drained soils
- there was a trace elements deficiency in all samples
- organic matter was very low and attributed to poor vegetation cover and root growth.

Further sampling at Eliza Creek in 2019 outline that soils are dominated by sodium and chloride levels with elevated calcium and sulfate found at one location. Salt Creek sampling point displays a highly saline environment with elevated sodium, chloride and magnesium levels. It also exhibits elevated calcium and sulfate levels indicating soils are highly enriched in majors ions. Yeltacowie Creek also presents a saline environment, however calcium concentrations are more subdued in comparison to Salt Creek.

When comparing the results to National Environment Protection (Assessment of Site Contamination) Measure (NEPC) guidelines (2013), it was found all sediment samples were naturally below guideline values. Based on the analysis, the soils were considered to likely have the following physical characteristics:

- drainage: imperfectly drained and may remain saturated for several weeks after significant rainfall
- hard-setting: soils are liable to form hard surface crusts after disturbance and wetting which may restrict seed establishment
- aeration: poor if compacted
- physical root limitations: dense clay subsoils will restrict roots
- workability: will be reasonable where surface soil is loose, but poor in hard-setting areas.

Geotechnical properties were derived from core logging assessments for targeted sections within the Land Study Area. This found uniaxial compressive strength results which indicate the Arcoona Quartzite can sustain more stress than other formations. As this is consistent with those presented for the Brazilian tensile strength (indirect tensile strength), it is indicating the Arcoona Quartzite is the most competent rock in the Land Study Area. The Corraberra Sandstone and Whyalla Sandstone contain the highest porosity values in comparison to Arcoona Quartzite and Woomera Shale. The weathering resistance of the units found that the Arcoona Quartzite and Woomera Shale have high durability, the Corraberra Sandstone has very high durability and the Whyalla Sandstone has medium-high durability.

In 2019 sampling for heavy metals (between 0 to 2 cm and 15 to 20 cm or 15 to 30 cm below ground level) and radioactive elements (between 0 to 2 cm and 15 to 20 cm below ground level) were undertaken (Appendix C1). Heavy metals were found to be below the thresholds when compared to the Australian HIL Guidelines for commercial/industrial soil contaminants. Results are provided in Appendix C1 of the June 2024 PEPR (BHP 2024a).

6.1.3 Updates to understanding

There have been no updates to the understanding of the baseline land environment since submission of the June 2024 PEPR (BHP 2024a).

6.2 Air

6.2.1 Assessment context

The air baseline description was developed through an air quality baseline assessment that was undertaken for the MLP (OZ Minerals 2017a; Appendix B3 Air Quality and Meteorology Baseline Assessment). The Air Quality Study Area enabled characterisation of the air environment in the wider region and includes Project Area. Baseline air quality has been established through monitoring within the Carrapateena region since 2012, providing continuous data spanning multiple seasons and meteorological conditions. The air pathway existing environment comprises:

- climate and meteorology
- noise and vibration
- air quality (including gaseous and particulate emissions)
- odour
- light.

The interaction of the Project (Chapter 4) with the baseline air environment may result in changes that cause an effect to travel through the air medium (e.g. airborne emissions, soundwave transmission and light emissions). The Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) describe the magnitude of the change to the air pathway including sensitivities and uncertainties. The effects resulting in the greatest number of impact events for the air pathway were associated with particulate, radon and radionuclide emissions, as shown in Table 6.2. The assessment of effects is supported by the MLP Response Document Appendix G Air Quality and Soil Quality Geochemical Effects Assessment (OZ Minerals 2017c) and the June 2024 PEPR Appendix C2 Air Quality Modelling and Assessment of Effects (BHP 2024a).

Table 6.2 | Air pathway effects and impacts

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Particulate emissions (total suspended particulates (TSP), PM_{10} and $PM_{2.5}$)	AQ01, AQ02, AQ03, AQ04, AQ09, AQ10, AQ11*, AQ12	ID030, ID031, ID032, ID033, ID034, ID035	AQ01, AQ02, AQ03, AQ04
Nuisance dust emissions	AQ05, AQ13	ID006, ID007*	AQ05
Radon and radionuclides emissions	AQ17, AQ18, AQ19*, AQ20*, AQ24, AQ25, AQ26*, AQ27*	NA	NA
Gaseous emissions	AQ31, AQ32, AQ33, AQ34	NA	AQ09, AQ10, AQ11, AQ12
Greenhouse gas emissions	AQ51	NA	AQ17
Saline aerosol emissions	AQ35, AQ36	NA	AQ13
Acid mists emissions	AQ37*, AQ38	NA	NA
Copper concentrate transport particulate emissions	AQ39*, AQ40*	NA	NA
Wheel generated dust	AQ41*, AQ42, AQ50	NA	AQ14

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Noise emissions	AQ43*, AQ44, AQ45, AQ46	ID008, ID009*, ID011	AQ15, AQ16
Odour emissions	AQ47	NA	NA
Light emissions	AQ48, AQ49	NA	NA
Secondary pathway effects	AQ06*, AQ07*, AQ08, AQ14*, AQ15*, AQ16, AQ21*, AQ22, AQ23, AQ28*, AQ29*, AQ30	NA	AQ06, AQ07, AQ08

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The air assessment of effects confirmed that air quality will not change at the nearest homes, with the changes closer to Project activities being of a magnitude that would not reduce the diversity or abundance of vegetation and habitat.

6.2.2 Current context – air quality

Since the initial air quality baseline development in 2016 (BHP 2024a; Appendix C2), activities that may have influenced local air quality have included construction activities at Carrapateena (2016 to 2019) followed by a transition to mining production (2020 to 2022).

Updates to baseline air quality understanding since 2016 include gathering of further local meteorology data, updates to measured air quality data (focussing on incorporation of new measurement of airborne particulate matter and deposited dust) and updates to receptors. The 2016 baseline description of monitoring equipment, Australian Standards, data sources, monitoring locations, and climate change are considered to be relevant and therefore have not been updated.

Updates to the meteorological measurements have been sourced from the Bureau of Meteorology (BoM) measurements for the Woomera Aerodrome (Station ID 016001). While Woomera is located approximately 65 km west of Carrapateena, the wind patterns are broadly similar, including their latitudes and distances from the coastline and their land types. Wind measurements obtained from Woomera Aerodrome (2008 to 2019) and Carrapateena (2014 to 2019) indicate that wind speeds at Woomera are expected to be approximately 1.2 to 1.4 times higher than at Carrapateena for neutral-to-marginally stable atmospheric conditions due to the difference in sensor heights at the two locations. Carrapateena data shows the average wind speed over 2017 to 2019 was 3.9 m/s, with the 99.9th percentile 1-hour wind speed averaging 11.6 m/s over the reporting period. Comparison of wind roses between Woomera Aerodrome and Carrapateena demonstrate the annual wind patterns to be consistent on an annual basis with a dominant southerly wind occurring during the summer.

Annual average rainfall in the region was less than 200 mm over the decade (2010 to 2020). The annual average of Woomera's monthly mean maximum temperature was 26.8°C in 2019, which increased at a rate of approximately 0.28° per annum over the 2010 to 2019 reporting period. Rainfall has been measured at Carrapateena since 2012 using an electronic sensor that detects the impact of individual raindrops. While rainfall is highly variable, it was found these results were comparable with the Woomera

measurements. The highest volume of annual rainfall was recorded during 2016, being approximately 230 mm at Carrapateena and 270 mm at Woomera.

Annual reviews of air quality parameters are undertaken as a component of the Carrapateena Annual Compliance Report (OZ Minerals 2023a). A summary of the outcomes of this review is presented below.

- A high-volume air sampler (HVAS) is installed at Carrapateena, recording PM_{10} from 2012 to 2020 and displaying results for 24-hour average in µg/m^3. The average PM_{10} concentrations over the construction phase of Carrapateena was 22.16 µg/m^3, increasing to an average of 29.0 µg/m^3 during the operations phase to date. Previous estimations of dust emissions from the construction phase indicated the predicted increase in annual average PM_{10} concentrations would be approximately 2 µg/m^3 (minimum) to 7 µg/m^3 (maximum), with the corresponding monitoring results show a measured increase of 10 to 15 µg/m^3. The reason for the discrepancy is likely to be due to actual construction activity near the Carrapateena accommodation village monitoring location being more intensive than modelled in 2016 (BHP 2024a; Appendix C2).
- The average measured PM_{10} concentrations were found to be comparable to the EPA's results for some South Australian regional locations over 2015 to 2017. Baseline PM_{10} concentrations were found to be very low in winter, with limited exposed areas that act as a dust source during shallow covering of flat gibber (stones). A seasonally cyclic PM_{10} baseline model was used to assess the dispersion model results for the 2016 assessment, and data measured to date continues to support this model.
- As $PM_{2.5}$ is not routinely measured at Carrapateena, the $PM_{2.5}$ baseline model was estimated by applying a $PM_{2.5}/PM_{10}$ ratio. The ratios used for updating the model results outlined 40% for baseline particles and 15% for dust emissions from Carrapateena activities.
- Baseline deposited dust values were:
  - total solids 1.6 g/m^2/month
  - insoluble solids 1.2 g/m^2/month
  - soluble solids 1.4 g/m^2/month.
- The insoluble solids component was used as baseline deposited dust and was added to the model results for the mining and closure scenarios for the 2016 assessment (BHP 2024a; Appendix C2). The same dust deposition rate was used to assess monthly averages (1.2 g/m^2/month), and annual averages (14.4 g/m^2/year). Data collected adjacent the Pernatty homestead in the time since the assessment indicated dust deposition rates of around 1.5 g/m^2/month for 2020 and 0.9 g/m^2/month for 2021 to 2022. Measurements of deposited dust at other, non-baseline locations indicated baseline deposited dust is less than 1.0 g/m^2/month.
- Analysis of metals from deposited dust samples acquired over 2015 to 2022 revealed no significant trends in the results between the 2016 measurements and that in 2022. Analysis of metals in airborne dust was undertaken for three samples acquired over sampling period of up to three months over 2021 and 2022. No significant trends with respect to metals in dust concentrations from the samples over the baseline values presented in the MLP were identified from this monitoring campaign except in two cases, where copper in dust values increased slightly over baseline, likely due to operational (ore handling) activities.

Overall, it is considered that the 2016 assessment (BHP 2024a; Appendix C2) remains a satisfactory predictor of operational air quality and no changes to impact assessments are required.

6.2.3 Current context – radiation

An assessment of the radiation-related effects specific to non-human biota and members of the public as a result of the Carrapateena operations is undertaken annually by a suitably qualified third party, in accordance with the approved PEPR monitoring plan (see Section 9.5) and reported as a component of the Carrapateena Annual Compliance Report (OZ Minerals 2023a).

The area surrounding the Project was extensively surveyed in 2007 to determine pre-mining baseline radiological conditions in the immediate area surrounding proposed mining activities. Gamma dose rates were measured in a grid pattern over the entire Radiation Study Area, as well as along transects of interest.

Gamma surveys were conducted in 2007 (RCA 2023), and the average contact dose rate was found to be 0.074 microgray per hour (µGy/h) over all measurements (OZ Minerals 2023a). This dose rate is again low compared to typical environmental levels, with the average in Australia being 0.09 µGy/h (UNSCEAR 2000).

Measurements conducted in 2012 (OZ Minerals 2017a; Appendix B8) were similar. Several locations were monitored over a long-term period, with average dose rate estimated to be 0.06 microsieverts per hour (µSv/h). The same locations were sampled to determine radionuclide concentrations in the soil, and the average concentration of uranium in soil was found to be 13 Bq/kg (0 to 2 cm soil depth), equivalent to approximately 1 ppmU. This concentration is low, but typical of normal soil. For reference, the worldwide average uranium concentration is approximately 3 ppm (UNSCEAR 2000, as cited in OZ Minerals 2023a). The data collected from all locations showed that the radiological conditions are consistent across the wider area. Uranium concentrations in soil are low compared to Australian averages, which are reflected in measured terrestrial dose rates.

Baseline data has been collected for dust over several years, with the most recent baseline radionuclide dust deposition data indicating average deposition rates of 0.017 Bq/m^2/month U^{238}, 0.027 Bq/m^2/month Ra^{226}, 3.04 Bq/m^2/month Pb^{210} and 2.04 Bq/m^2/month Po^{210}. Radon monitoring was conducted as part of the same monitoring, and reported concentrations ranged from less than 15 to 37 Bq/m^3. Groundwater radionuclide concentrations were measured in 2019 prior to TSF activities, with average concentrations of 0.31 Bq/L for gross alpha, 0.69 Bq/L for gross beta (excluding K^{40}), 0.19 Bq/L for Ra^{226} and 0.69 Bq/L for Ra^{228}.

Dust deposition has been monitored since the commencement of mining, at a total of 19 sites surrounding the Carrapateena deposit, mine, MPP, village and access roads, with dust mass per square metre per month calculated for each location. In 2022, these mass values ranged from 0.46 g/m^2/month to 9.0 g/m^2/month with uranium in total dust ranging from less than 0.2 to 7.6 ppm (average of 1.2 ppm). This results in an average nominal deposition of approximately 0.13 Bq/m^2/month for U^{238}, 0.04 Bq/m^2/month Ra^{226}, 1.9 Bq/m^2/month Pb^{210}, and 1.5 Bq/m^2/month Po^{210}. This deposition results in an increase in radionuclide concentrations in soil over background of approximately 0.0001 Bq/g U^{238}, 0.00004 Bq/g Ra^{226} with no change in polonium or lead concentrations.

Groundwater concentrations in two of the four TSF monitoring bores have increased from baseline values determined in 2019. The concentrations for TSFMB1D increased by approximately ten times for gross alpha, and five times for gross beta, while the concentrations for TSFMB3S approximately doubled (shallow bore).

A non-human biota (Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA)) assessment of the monitored radiation activities indicates that all doses to default and user-defined species continue to be orders of magnitude below the screening threshold of 10 µGy/h. The screening threshold is the threshold at which even the most sensitive non-human biota are unlikely to suffer any population effects as a result of chronic exposure to that dose, and therefore there are likely no impacts due to operationally derived radiation doses to non-human biota due to the current operations at Carrapateena.

Doses due to inhalable dust are calculated based on dust concentrations measured by HVAS. The radionuclide concentration in air is estimated to be less than 0.0001 Bq/m^3 for U^{238} and for all associated daughter products, based on the filter concentrations from HVAS filters used to collect dust in 2022. The total dose based on dust for all radionuclides is calculated to be 0.05 mSv, several orders of magnitude below the public dose limit of 1 mSv/year.

Monitoring conducted at all locations since commencement of mining have not detected any radon concentrations above typical background concentrations measured in baseline data with most results below detection limits.

6.2.4 Updates to understanding

There have been no updates to the understanding of the air quality environment since submission of the June 2024 PEPR (BHP 2024a).

Revised estimates of radiation doses to members of the public and non-human biota were presented in the 2023 Annual Radiation Protection Report (RCA 2024), finding:

- Members of the public doses were conservatively estimated to be approximately 0.0612 mSv/year assuming full-time residency adjacent to the ML boundary and assuming a person's annual food intake is derived solely from sources within the ML. The estimated dose to members of the public is significantly below the 1 mSv/annum dose limitation.
- Radiation doses to non-human biota estimated using the ERICA methodology demonstrated that all doses were below the screening threshold of 10 µGy/h, being the threshold at which even the most sensitive non-human biota are unlikely to suffer any population effects as a result of chronic exposure to that dose.

The assessment demonstrates that Carrapateena operations continue to result in no radiological impacts to members of the public and non-human biota.

6.3 Surface water

6.3.1 Assessment context

6.3.1.1 Surface water (pathway)

The surface water baseline description was derived from a baseline assessment that was undertaken for the MLP (OZ Minerals 2017a; Appendix B4 Surface Water Baseline Assessment). The interaction between the surface water and groundwater environment, including water-dependent ecosystems, is presented in Section 6.5.

The surface water pathway of the existing environment comprises:

- surface water features
- quality and quantity of surface water.

Surface water users have been included as a component of the surface water assessment in Section 6.3.1.

The interaction of the Project (Chapter 4) with the baseline surface water environment may result in changes to surface water quality or quantity (e.g. fords, culverts, TSF, chemical and hydrocarbon storage areas and placement of infrastructure in catchment areas). The Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) describe the magnitude of the change to the surface water pathway including sensitivities and uncertainties. The effects resulting in the greatest number of impact events for the surface water pathway were associated with erosion and runoff and acid and metalliferous drainage, as shown in Table 6.3. The assessment of effects is supported by the MLP Response Document Appendix F Surface Water Discharge and Seepage Geochemical Model (OZ Minerals 2017c) and the June 2024 PEPR Appendix C3 Surface Water Modelling and Assessment of Effects (BHP 2024a).

Table 6.3 | Surface water pathway effects and impacts

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Erosion and runoff	SW01, SW02, SW03, SW04, SW05, SW06, SW07*, SW08*, SW09*, SW10*	ID044*, ID047*	SW01, SW02, SW03, SW04, SW05, SW06, SW07*, SW08*, SW09*, SW10*
Uncontrolled release of hydrocarbons or chemicals	NA	ID046*	NA
Transfer and disposal of tailings	SW11, SW12, SW13, SW14*, SW15	NA	NA
Discharge of tailings water	SW16, SW17, SW18, SW19*, SW20	NA	NA
Erosion and runoff from tailings surface	SW21, SW22, SW23, SW24*, SW25	NA	NA
Acid and Metalliferous Drainage	SW26, SW27, SW28, SW29*, SW30, SW32, SW33, SW34, SW35, SW36	NA	NA
Reduced catchment	SW38, SW39, SW40, SW41, SW42*, SW43, SW45*	NA	SW11, SW12, SW13, SW14, SW16*
Reduced flood height	SW44 SW48, SW49	NA	SW15
Cumulative effects	SW46	NA	SW17
Creation of water bodies	SW47	NA	SW18
Altered overland flows	SW50	ID036, ID037, ID038, ID045	SW19, SW20

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Shallow lateral seepage	SW51*, SW52*, SW53*, SW54*	NA	NA
Secondary pathway effects	SW31*, SW37	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix B Consolidated Assessment (OZ Minerals 2017b)

3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The surface water effects assessment demonstrates that there are no significant changes in the surface water environment. Quantity-based effects are limited by the lack of change in catchment areas associated with Project infrastructure and activities, and quality-based effects are prevented through a high reliance on the Fundamental Design Controls relating to the TSF embankment.

6.3.1.2 Surface water users (receptor)

Water supply and quality have been identified as critical issues in the Far North South Australia and are potential constraints to the economic development of the region (RDAFN 2013). Existing water resources have high salinity levels and/or are of limited quantity (in the case of perched aquifers) and are therefore of limited use. Low and irregular rainfall and high evaporation affect the quantity of surface water. Areas that can store surface water for minimal use (if significant rainfall occurs) are usually man-made dams.

Infrastructure that is present within the region and Project catchments include:

- Stuart Highway
- eight homesteads (Pernatty, Yeltacowie, Bosworth, Arcoona, Old Oakden Hills, South Gap, Maslin and Whittata)
- approximately 80 stock watering dams, status (i.e. operating or abandoned) of the identified dams is unknown
- a network of pastoral tracks.

These features are expected to have minor influence on the natural surface water regime due to the size of the equipment used at the existing infrastructure locations.

Effects and impacts at surface water receptors are described in Section 6.6.1.2 (third-party users), and Section 6.8 (terrestrial and aquatic ecology). Existing water supply infrastructure is described in Section 6.6.1.1. Surface water effects at Lake Torrens, Pernatty Lagoon and watercourse springs and a summary of the relevant impacts and outputs from the Consolidated Assessments (OZ Minerals 2017a; 2018c) are shown in Table 6.4.

Table 6.4 | Surface water effects and impacts at Lake Torrens, Pernatty Lagoon and Watercourse Springs (Receptors)

Change in pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Cumulative groundwater and surface water effects	Yes	No	SW46	No	No	SW17
Potential change in surface water quantity	Yes	No	SW38, SW39	No	No	SW11, SW13
	Yes	Yes	SW42*, SW45*	NA	NA	NA
Erosion and sedimentation during all phases	No	No	SW01, SW02, SW03, SW04	No	No	SW01, SW02, SW05, SW06
	No	Yes	SW07*, SW09*, SW10*	NA	NA	NA
Potential changes in surface water quality from tailing transfer and disposal	No	No	SW11, SW12	NA	NA	NA
	No	Yes	SW14*	NA	NA	NA
Emergency release of tailings water in the event the flood storage capacity is exceeded	No	No	SW16, SW17	NA	NA	NA
	No	Yes	SW19*	NA	NA	NA
Erosion and runoff from TSF final landform	No	No	SW21, SW22	NA	NA	NA
	No	Yes	SW08*, SW10*, SW24*	NA	NA	NA
Change is surface water from ARD	No	No	SW26, SW27, SW32, SW33	NA	NA	NA
	No	Yes	SW29*, SW31*	NA	NA	NA
Shallow lateral seepage from upstream of TSF embankment and decant dam	Yes	Yes	SW51*, SW52*, SW53*, SW54*	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The surface water effects assessment undertaken demonstrates that no adverse changes in the surface water environment are predicted, with a high reliance on the Fundamental Design Controls relating to the TSF to prevent an effect on surface water quality.

6.3.2 Current context

A surface water baseline update was undertaken which incorporated knowledge from 2017 to 2023. The baseline updates primarily incorporated data records which have been extended since the MLP (OZ Minerals 2017a; Appendix B4) baseline including water quality records and advanced flood modelling. The remainer of the baseline data, as outlined in the MLP, remains valid. The updated data includes climate data sources from the BoM and Carrapateena, along with calibrated Australian Landscape Water Balance Model using daily climate data. This information fed into a flood modelling update. While stream and runoff sample laboratory analysis were provided to update the site knowledge on surface water quality.

The baseline update outlines that the Surface Water Study Area lies in an arid (low rainfall, high evaporation) area characterised by playa (salt) lakes and sparse vegetation. On average, approximately 2% to 3% of rainfall will runoff the catchment annually. Individual rainfall events typically produce no runoff, though in larger events (around 10% of the time) runoff occurs and may vary between approximately 0% to 13% of rainfall.

Surface water samples were collected using rising stage samplers in the Eliza Creek Catchment and the Salt Creek Catchment. Grab samples were collected following rain events during 2014 and 2018 to 2022 from Eliza Creek, Yeltacowie Creek and Salt Creek. Results were compared against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000) freshwater trigger levels for 95% protection of freshwater species (where available). The analysis showed for the most part, samples were usually within the guideline limits for pH, with some outliers observed. Samples were within guidelines for manganese, and mostly within guideline limits for cobalt, iron, lead, zinc, selenium and arsenic. Samples occasionally exceeded limits for uranium and regularly exceeded limits for aluminium and copper. Water from Euro Spring and Gorge Spring in Salt Creek reported high levels of selenium, strontium and uranium which suggests a local natural source of metals influencing the background quality of spring water. High levels of aluminium and copper in runoff samples is thought to be caused by natural elements in soils and rocks that the catchment is comprised of. Suspended solids are extremely variable throughout the samples, yet it is noted that this is typical of arid land runoff. High suspended solids concentrations are expected following heavy rainfall.

The more recent data (2021 to 2022) show more frequency of exceedance of guideline limits, however it is noted that these samples were analysed for total metal concentrations, whereas analysis up to 2019 were dissolved metal concentrations. Dissolved metal analysis involved filtration of the sample, where total metals does not. Therefore, it includes the fraction associated with suspended particles. Dissolved metal concentration is generally more representative of the bioavailable fraction and is more suitable for comparison to the guideline limit. The difference in analysis may explain the difference in concentrations.

Flood modelling was conducted using TUFLOW software as it incorporates the 2016 edition of Australian Rainfall and Runoff which incorporated long-term surface water flow regime of Eliza Creek and updated climate information. Parameters modelled in the MLP baseline assessment were not altered (BHP 2024a; Appendix C3). The model predicted similar results to those presented in the MLP baseline assessment, being that flow in Eliza Creek would occur on approximately 2% of days, 0 to 10 mm of runoff in 90% of years, and that 93% of rainfall events generate little to no runoff. Further, the updated model predicted an average yearly runoff of 4.9 mm which is 3.4% of rainfall (being slightly higher than, but consistent with, the analysis using regional Flinders Ranges streamflow gauge data). The flow regime of Yeltacowie Creek is expected to be similar to that of Eliza Creek given the proximity and similarities of catchment characteristics. Flow in Yeltacowie Creek on approximately 2% of days and 93% of rainfall events generate little to no runoff.

The decrease in total streamflow due to construction of the site outlines that at the toe of the TSF, streamflow will be reduced to 0%, but effects will decrease downstream as contributing catchment increases, with 85% of natural streamflow reaching Lake Torrens. This is an update from the MLP modelling which reported Lake Torrens would continue to receive 99.99% of the current average surface water inflow after mine development due to the number and size of unaffected catchments which drain into the lake. The change in flow duration and streamflow number of days with flow in Eliza Creek is expected to be negligible downstream (north) of the confluence of the two arms of Eliza Creek. The flow regime will not be affected in the eastern arm of Eliza Creek, while the western arm is currently affected by approved mine infrastructure as described above.

The updated flood modelling also found peak flood depth result for 1% AEP storm (i.e. 1 in 100-year storm) for a period of approximately 9 hours within Eliza Creek channel expected to become inundated to a depth of approximately 1.5 m. Flood waters contained in a defined channel approximately 200 m across near the centre of the catchment, and 500 m across near Lake Torrens. The catchment area impounded by the TSF and decant dam walls will remain the same size and the subsidence zone is expected to develop to approximately the same diameter. Due to this, flooding effects are expected to be essentially remain the same.

6.3.3 Updates to understanding

There have been no updates to the understanding of the baseline surface water environment since submission of the June 2024 PEPR (BHP 2024a).

6.4 Groundwater

6.4.1 Assessment context

6.4.1.1 Groundwater (pathway)

The groundwater baseline description was derived from a baseline assessment that was undertaken for the MLP (OZ Minerals 2017a; Appendix B5 Groundwater Baseline Assessment). Groundwater modelling and an assessment of effects was undertaken for the MLP (OZ Minerals 2017a; Appendix C3), of which the numerical groundwater model was updated for the MLP Response Document (OZ Minerals 2017c; Appendix H). A groundwater numerical model and assessment of effects was subsequently developed for the Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix B).

The interaction between the surface water and groundwater environment, including water-dependent ecosystems, is presented in Section 6.5.

The groundwater pathway of the existing environment comprises:

- hydrostratigraphy and conceptual model of local and regional hydrogeology
- groundwater quality and quantity
- interaction with Lake Torrens.

Groundwater users have also been included as a component of the groundwater assessment in Section 6.4.1.

The interaction of the Project (Chapter 4) with the baseline groundwater environment may result in changes to groundwater quality or quantity. The Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) describe the magnitude of the change to the groundwater pathway including sensitivities and uncertainties. The pathway changes identified through the assessment of effects are shown in Table 6.5. The assessment of effects is supported by the June 2024 PEPR (BHP 2024a) Appendix C4 Groundwater Modelling and Assessment of Effects and Appendix C5 Ecological Baseline; regarding water-dependent ecosystems.

Table 6.5 | Groundwater pathway effects and impacts

Change in pathway	Carrapateena Project Impact ID[1]	Northern Wellfield Impact ID[3]
Potential for underground inflows, drawdown and depressurisation of the WSA and THA during construction and operations	GW01, GW02 GW05, GW06, GW09*, GW11, GW13, GW15, GW17, GW18, GW19, GW20	NA
Reduction in groundwater quantity (drawdown)	NA	GW01, GW02, GW03, GW04, GW05*, GW06, GW07, GW08, GW13*
Potential formation of a lake in the SLC subsidence zone leads to new equilibrium in groundwater units	GW03, GW04, GW07, GW08, GW10*, GW12*, GW14 GW16, GW17, GW18, GW19, GW20, GW27*	NA
Reduced salt budget from Project water supply demand	NA	GW09, GW10, GW11, GW12
Potential for changes in groundwater quality from the migration of tailings liquor seepage – migration fate	GW21*, GW22, GW23, GW24, GW25, GW26	NA
Potential for changes in groundwater quality from the migration of tailings liquor seepage – geochemical fate	GW21*, GW22, GW23, GW24, GW25, GW26	NA
Potential for changes in groundwater quality from accidental spills of hydrocarbons or chemicals	NA	GW14*

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The results of the assessment of effects suggest that the following changes to baseline groundwater:

- No predicted groundwater drawdown at closest local community.
- Subsidence zone crater will, over time, create drawdown in groundwater but will reach a new steady state.
- Drawdown will occur in the THA and WSA but are not predicted to affect shallow groundwater accessed by third-party users.
- Euro Spring and Gorge Spring occur in Salt Creek and are supported by surface water flows, but are likely to lose their groundwater signature (i.e. no longer supported by groundwater discharge).
- Any seepage from the TSF will be captured by the drawdown caused by SLC subsidence zone.

- The groundwater quality effects assessment undertaken demonstrates that there are negligible changes in the regional groundwater quality environment.

There is high confidence that the modelling is adequate to predict the magnitude of the effect and any resulting impacts. The assessment of effects has been undertaken assuming that no design controls or management controls are applied, and thus represents a worst-case scenario.

The Carrapateena Project MLP Appendix B5 Groundwater Baseline Assessment and MLP Appendix C3 Groundwater Modelling and Assessment of Effects have been subject to an Independent Peer Review (IPR) by Golder Associates Pty Ltd (MLP Appendix F1 Independent Groundwater Assessment Review) (OZ Minerals 2017a).

6.4.1.2 Groundwater users (receptor)

Groundwater can be an important water supply for many arid regions in South Australia. It often forms an important resource for domestic and stock water supplies, and can form an important source of water that sustains ecosystems.

Investigations within the Project Area indicate there is no significant third-party demand on regional groundwater resources – most likely due to high salinity concentrations, meaning that it has no beneficial use without treatment apart from some industrial applications. Groundwater quality measured in the THA and WSA exceed standards for potable, agriculture and stock watering use. Whilst there are some stock water supplies sourced from localised perched groundwater systems, most supplies are sourced from dams that capture surface water runoff (see Section 6.3.1).

Woomera, the closest township, sources its water via a pipeline from the SA Water potable water supply network. Roxby Downs sources its water from groundwater wells within the Great Artesian Basin (GAB), followed by treatment at Olympic Dam.

There are a number of mineral exploration and mineral production tenements within the Project Area. It is assumed that companies that hold exploration licences on adjoining tenements will want to continue to source groundwater to meet their exploration demands. While the Project Area is not generally prospective for oil and gas exploration, it may in the future be considered prospective for geothermal energy using ‘hotrocks’ technology for power generation.

Existing water supply infrastructure is described in Section 6.6.1.1. Effects and impacts at groundwater receptors are described in Section 6.6.1.2 (third-party users), and Section 6.8 (terrestrial and aquatic ecology). Groundwater effects at Lake Torrens and a summary of the relevant impacts and outputs from the Consolidated Assessments (OZ Minerals 2017a; 2018c) are shown in Table 6.6.

Table 6.6 | Groundwater effects and impacts at Lake Torrens (Receptor)

Change in pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in groundwater quantity at Lake Torrens during construction, operations and closure	Yes	No	GW01, GW03	Yes	No	GW01

Change in pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in groundwater quality at Lake Torrens as a result of reduced salt budget during construction operations and closure	Yes	No	GW17	Yes	No	GW09
Change in groundwater quality at Lake Torrens as a result of tailings seepage during operations and closure	No	Yes	GW21*	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The groundwater quality effects assessment undertaken demonstrates that there are no adverse changes in the regional groundwater environment.

6.4.2 Current context

A review of the groundwater baseline was undertaken in 2023. The review assessed new information since 2016 from ongoing compliance monitoring, updated climate datasets, and a review of potential receptors including third-party users and groundwater dependent ecosystems (GDEs).

Carrapateena weather records were reviewed and generally, site data compared to BoM records of nearby weather stations were consistent, with the exception of the Woomera Aerodrome which received approximately 100 mm more rainfall than the other sites over the last two years. Additionally, pan evaporation records were found to vary considerably. It is considered this is largely due to measurements being no longer widely recorded across the BoM networks and pan evaporation data has not been collected since approximately 2016 at the Woomera Aerodrome.

Groundwater monitoring well data was used to review aquifer pressure response for the period immediately prior to mining through to the end of 2022. The greatest amount of drawdown occurred in the immediate vicinity of the mining operations, Radial Wellfield and Northern Wellfield. The greatest drawdown was observed in the vicinity of mining activities directly adjacent to the cave with drawdowns of 11.4 m and 17.8 m in the THA. Minimal drawdown was recorded at the nearest WSA well with 0.7 m. At the Northern Wellfield, a regional response was observed with a reduction in pressure of approximately 3 m in the WSA (ENV N11) since late-2019. Given that there are no other users of the deep saline aquifers in this region, the observed response is likely due to abstraction from the Northern Wellfield, with the nearest active production well (NT-17P) located 18 km to the east of ENV N11. Although NT-17P abstracts groundwater from the Pandurra Formation Aquifer (PFA), this response suggests that the PFA and WSA may be in direct stratigraphic contact in areas near the Pernatty Upwarp.

Regional drawdown at the Radial Wellfield has been propagating to the south and primarily observed in the WSA along the Southern Access Road. It is noted similar drawdown levels have not been observed to the north which is likely due to inferior thinning of the WSA. This may indicate a potential geologic barrier to groundwater flow.

The observed groundwater level response at Bosworth homestead supports the conceptualisation presented in the MLP (OZ Minerals 2017a; Appendix B5), that hypothesised that shallow stock wells in the region are likely to be abstracting water from an aquifer that is not connected with the deeper more saline THA, WSA or PFA. Therefore, it is concluded abstraction from the Carrapateena wellfields is not likely to affect pressures at third-party wells. However, a rise observed in the THA at Bosworth homestead following a rise in the alluvial aquifer at Bosworth after a rainfall event suggests that the THA may be receiving drainage from the shallower alluvial aquifer, ongoing monitoring would be needed to confirm this understanding.

In 2019, monitoring wells were installed downgradient the TSF embankment to assess potential lateral seepage to the alluvial aquifer and seepage to the THA; only one of the four shallow wells encountered groundwater in the shallow alluvium. One TSF alluvial aquifer monitoring well displayed a slight recharge response that is likely due to two large rainfall events recorded in 2022. The deeper THA monitoring wells have shown indications of seepage from the TSF as a result of large rainfall events and water inflows in 2021 and 2022 with THA wells immediately downgradient of the TSF showing increased levels of approximately 5 to 10 m. Limited data suggests there is no clear influence on groundwater quality and trends for total metals in the THA TSF monitoring wells.

The original groundwater baseline for the Project plotted major ion compositions of various water sources with the variation in quality suggesting that the deeper saline HSU have similar water types (Na-Cl dominant), while the shallow alluvial aquifer wells, regional surface water (waterholes) and rainwater are distinct. Salinity trends remain consistent with the MLP (OZ Minerals 2017a; Appendix B5) where it was found salinity in the region increased with increasing depths of HSUs.

A review of third-party user wells was undertaken, and it was found the only installation since 2016 was replacement of several known stock wells. Therefore, no new third-party wells have been identified as potential groundwater receptors.

6.4.3 Updates to understanding

There have been no updates to the understanding of the baseline groundwater environment since submission of the June 2024 PEPR (BHP 2024a).

6.5 Surface water – groundwater interaction

6.5.1 Assessment and current context

6.5.1.1 Surface water – groundwater interaction (pathway)

The description of surface water to groundwater interactions across the Project Area was derived from the surface water baseline assessment and groundwater baseline assessment undertaken for the MLP (OZ Minerals 2017a; MLP Appendix B4 Surface Water Baseline Assessment, and MLP Appendix B5 Groundwater Baseline Assessment). Information has been drawn from surface water and groundwater studies, field surveys and drilling programs.

The assessment of surface water-groundwater interaction included watercourse springs (Euro Spring and Gorge Spring), waterholes, and Lake Torrens, including estimates for Lake Torrens' baseline water balance and salt budget.

A conceptual hydrogeological/hydrological model was developed for Lake Torrens. This provided the basis for developing the water and salt budget for the lake and is presented in the MLP (OZ Minerals 2017a). This has enabled the understanding of the baseline water and salt flux to and from Lake Torrens and this information was carried forward into the surface water assessment of effects and groundwater assessment of effects in the MLP and Northern Wellfield MPL MP.

6.5.1.2 Water-dependent ecosystems (receptor)

Ecosystems that have their species composition and their natural ecological processes determined by the presence of surface water or groundwater are termed surface water-dependent ecosystems or groundwater-dependent ecosystems, respectively. These features occur in locations where surface water and/or groundwater flows are high enough and of a quality suitable for the ecosystem to exist.

Groundwater-dependent ecosystems and surface water-dependent ecosystems were identified and assessed through an ecological baseline assessment undertaken for the MLP (OZ Minerals 2017a; Appendix B6 Ecological Baseline).

The assessment determined that there are no nationally significant ecosystems as protected by the EPBC Act within the groundwater-dependent ecosystems or surface water-dependent ecosystems known within the Project Area.

In order to understand the surface water-groundwater interaction, an assessment of surface water features within Eliza Creek, Salt Creek and Bosworth Creek was undertaken. This provided an understanding of the interaction with regional groundwater and the reliance of vegetation within these systems on groundwater and/or surface water. Effects and impacts at water-dependent ecosystems are described in Section 6.8.1.4.

6.5.2 Updates to understanding

No update to surface water-groundwater interactions has been undertaken. The analysis of interaction of vegetation with groundwater and surface water remains as cited in the MLP (OZ Minerals 2017a).

6.6 Socio-economic environment

6.6.1 Assessment context

6.6.1.1 Social infrastructure (pathway)

Social infrastructure, economy and housing in the region were determined as pathways through which Project changes may impact receptors. The baseline descriptions for these aspects were derived from an independent socio-economic baseline assessment that was undertaken for the MLP (OZ Minerals 2017a; Appendix B7 Socio-economic Baseline Assessment). The magnitude of change to the socio-economic environment as a result of Project activities was assessed in MLP Appendix C5 Socio-Economic Modelling and Assessment of Effects (OZ Minerals 2017a).

The Socio-economic Study Area defined the total anticipated area of influence from activities associated with the Project, and was shaped by Roxby Downs to the north, Lake Torrens to the east, the Stuart Highway to Port Augusta, and the Princess Highway to Port Pirie in the south, and Woomera to the west. The socio-economic study included the towns of Port Augusta, Roxby Downs, Woomera, Pimba, Andamooka, Port Pirie and Whyalla. There is a long-standing presence in many of these communities through the operation of Prominent Hill and Carrapateena.

The Project is remote from significant population centres. The closest residences are listed below:

- Pernatty homestead (less than 1 km from Southern Access Road-Pernatty bypass)
- Yeltacowie (1 km from the Western Access Road)
- Old Oakden Hills homestead (3 km from Western Access Road)
- Bosworth homestead (12 km to the east of the closest Northern Wellfield activities)
- Andamooka homestead (16 km to the north of the closest Northern Wellfield activities)
- South Gap homestead (19 km from the Southern Access Road MPL)
- Arcoona homestead (19 km to the west of the closest Northern Wellfield activities).

The social infrastructure and housing pathway of the existing environment comprises:

- social services and facilities
- health
- education and training
- emergency services
- housing and accommodation
- electricity supply
- water supply
- transport (road, rail, port, and air)
- communication.

The population centres within the region provide a range of social services and facilities, health and emergency services, education and training, and community and recreation facilities. Generally, a broader range of services and facilities are provided in the larger centres of Whyalla, Port Augusta and Port Pirie; with some facilities available in Roxby Downs and Woomera. Andamooka and Pimba both

have limited social infrastructure and facilities due to the small populations in both towns. Regional infrastructure such as power and water is well connected in the larger centres, whilst pastoral stations in the Far North South Australia are generally self-reliant through the use of generators, water dams, and groundwater. Descriptions of transport systems in the Far North South Australia are provided in the MLP (OZ Minerals 2017a; Section 5.6).

The interaction of the Project (Chapter 4) with social infrastructure in the region may result in changes to the baseline socio-economic environment. The pathway changes identified through the assessment of effects and outputs from the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) are shown in Table 6.7.

Table 6.7 | Socio-economic pathway effects and impacts

Change in pathway	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Potential for additional heavy and light vehicle traffic volumes on local road network during construction and operations	SE01, SE02	ID007*, ID009*	SE01, SE02
Potential for road wear from heavy vehicle traffic	SE03*	NA	SE03*
Potential intersection, road and access track upgrade travel delays	SE04, SE05	NA	SE04
Potential increased competition for labour	SE06, SE07	NA	SE05
Potential effects to charter aircraft availability	SE13	NA	NA
Potential in-migration effect on local social service demand, local businesses and housing	SE08, SE10, SE11	NA	SE06, SE08, SE09
Potential Project workforce effect on local inflation of prices for goods and services	SE09	NA	SE07
Potential effect on temporary accommodation in Adelaide, Whyalla and Port Augusta	SE12	NA	SE10
Potential reduction in the income and business viability of Pastoral Leases	SE14, SE15*, SE18	ID013*, ID014*, ID015, ID016*, ID017*	SE11, SE14
Potential effect on public access to Lake Torrens and Lake Torrens National Park	SE16, SE17	NA	SE12, SE13
Potential effects to electricity supply within the State	SE19	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix B Consolidated Assessment (OZ Minerals 2017b)

3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The social infrastructure effects assessment undertaken demonstrates that there are negligible adverse changes to existing social infrastructure, economy or housing in the region.

6.6.1.2 Local community (receptor)

The description of the local community incorporates the regional towns of Port Augusta, Roxby Downs, Woomera, Pimba, Andamooka, Port Pirie and Whyalla; the local pastoralists, and the local Aboriginal community. The information used in preparing the baseline was derived from an independent socio-economic baseline assessment that was undertaken for the MLP (OZ Minerals 2017a; Appendix B7 Socio-economic Baseline Assessment). The magnitude of change to the socio-economic environment as a result of Project activities described in Chapter 4 was assessed in the MLP (OZ Minerals 2017a; Appendix C5 Socio-economic Modelling and Assessment of Effects). The impact significance was determined through an impact assessment prepared for the MLP (OZ Minerals 2017a; Appendix D2 Socio-economic Impact Assessment). The findings of these assessments are reflected in the Carrapateena Response Document (OZ Minerals 2017c; Appendix I Updated Consolidated Assessment) and Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix E Consolidated Assessment).

This section summarises the baseline socio-economic environment with regard to the local community (receptors), and the associated effects and impacts to these receptors.

The broader Far North region of South Australia comprises almost 800,000 km^2 and accounts for approximately 80% of the State's land mass. It is the largest and least populated area of South Australia, has a long history of exploration, pastoralism, tourism, government services and mining, and links transport between Australia's eastern and western states and the Northern Territory. The region has a long and diverse history of mining operations, such as the Tarcoola goldfield, copper mining throughout the Flinders Ranges, opal mining at Coober Pedy and Andamooka, the BHP Olympic Dam copper-uranium mine, and the coal mining at Leigh Creek which ceased in 2015. Metal ore mining is the largest employment industry for the Far North South Australia, particularly in Port Pirie, Roxby Downs and Andamooka for mining and mining support.

Pastoral stations located within or surrounding the Project Area and the closest regional townships are described in Section 6.6.1.1. The most current data available during preparation of the socio-economic baseline for the MLP (ABS 2016) showed that since the 2011 Census, almost half (46%) of the Statistical Areas in the State have decreased in population. The distribution of population across the region varies markedly, with the largest being the Whyalla Statistical Local Area (SLA) with a population of 22,562, and the smallest being Woomera with 216 people (ABS 2011). The median age ranges from 30 years old at Roxby Downs to 42 years old at Andamooka, compared to 40 years old in South Australia.

The Aboriginal people of the Far North South Australia consist of multiple groups. These include Kokatha, Anangu, Antakarinja, Arabana, Nukunu and Barngarla. In most communities, with the exception of Roxby Downs, the Aboriginal population in the Far North region is significantly higher than state or national proportions.

Baseline health status and risk factor data indicates that population centres within the region maintain a level of health broadly equivalent to that of state and national averages, with the exception of higher rates of smoking and avoidable death.

Table 6.8 to Table 6.12 summarise the change in pathways (effects) with impact outputs from the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) to the local community, including Aboriginal communities and third-party users; and the state of South Australia and Australia.

Table 6.8 | Land effects and impacts to the Aboriginal communities, third-party users and local communities (receptors)

Change in land pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Disturbance of artefacts or sites of significance to the heritage, culture and storylines of the Kokatha People	Yes	Yes	L01*, L02*	Yes	Yes	ID001*	Yes	Yes	L01*, L02*
Land disturbance reducing available land for grazing activities during operations and closure	Yes	Yes	L23*	Yes	No	ID015	Yes	Yes	L27*
Effect on the visual amenity of the landscape	Yes	No	L03	Yes	No	ID003, ID010	Yes	No	L03
	No	No	L05, L06	No	No	ID005	No	No	L05, L06
Disturbance of sites of non-Indigenous heritage valued by the State	No	No	L04	No	No	ID004	No	No	L04
Land disturbance creates conditions favourable to the overabundance of existing or introduced weed species	No	Yes	L16*	No	Yes	ID013*	No	Yes	L20*, L28*
Safety to the general public from interaction with Project	No	Yes	L07*, L08*, L09*	No	No	ID012*	No	Yes	L07
				No	Yes	ID050*	No	No	L08, L09
Accidental spills reduce soil quality	No	Yes	L22*	No	Yes	ID014*	No	Yes	L26*
Vibration from blasting activities results in impacts to the local community	No	No	L36, L37	NA	NA	NA	NA	NA	NA
Introduced weed species	No	Yes	L24*	No	Yes	ID013*	NA	NA	NA
Project interaction with stock	No	Yes	L34*	No	Yes	ID051*	No	Yes	L38*
Project waste management objectives not achieved for post completion	No	Yes	L39*	No	Yes	ID049*	No	Yes	L40*
Chemical spill contaminating perched aquifers	No	Yes	L40*	No	Yes	ID048*	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix B Consolidated Assessment (OZ Minerals 2017b)

3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.9 | Air effects and impacts to the local communities, third-party users, state of South Australia and Australia (receptors)

Change in air pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Potential contribution of greenhouse gas to state and national emissions	Yes	No	AQ51	NA	NA	NA	Yes	No	AQ17
Change in air quality from wheel-generated dust along access roads during construction and operations	Yes	Yes	AQ41*	Yes	Yes	ID007*	No	No	AQ14
	No	No	AQ42						
Noise generated along access roads during construction and operations	Yes	Yes	AQ43*	No	No	ID008	No	No	AQ15
	No	No	AQ44	Yes	Yes	ID009			
Change in air quality associated with particulate emissions (TSP PM_{10}, $PM_{2.5}$ and nuisance dust)	No	No	AQ04, AQ05, AQ12, AQ13	No	No	ID006	No	No	AQ04, AQ05
Change in soil quality associated with particulate emissions (TSP PM_{10}, $PM_{2.5}$ and dust)	No	Yes	AQ07*, AQ15*	NA	NA	NA	No	No	AQ07*
Change in air quality associated with radon and radionuclides	No	Yes	AQ20*, AQ27*	NA	NA	NA	NA	NA	NA
Change in soil quality associated with radionuclides during operations	No	No	AQ22	NA	NA	NA	NA	NA	NA
Change in soil quality associated with radionuclides during post closure	No	Yes	AQ29*	NA	NA	NA	NA	NA	NA
Change in air quality associated with gaseous and particulate pollutants during construction and operations	No	No	AQ34	NA	NA	NA	No	No	AQ12
Change in quality associated with acid mist emissions from the Concentrate Treatment Plant during operations	No	No	AQ38	NA	NA	NA	NA	NA	NA
Change in air quality associated with copper concentrate release during transport	No	Yes	AQ40*	NA	NA	NA	NA	NA	NA

Change in air pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Noise and over blast pressures generated as a result of mining activities and operation of the airstrip during construction and operations	No	No	AQ45	No	No	ID011	NA	NA	NA
Generation of odours during operations	No	No	AQ47	NA	NA	NA	NA	NA	NA
Light emissions during construction and operations	No	No	AQ49	NA	NA	NA	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix C Assessment Tables by Receptor (OZ Minerals 2016)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.10 | Surface water effects and impacts to aboriginal communities, third-party users and local communities (receptors)

Change in surface water pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[2]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in surface water quantity or quality at Lake Torrens, Pernatty Lagoon, waterholes and Watercourse Springs that are of value to the Kokatha People	Yes	No	SW15, SW43, SW41, SW49	No	No	SW03, SW04, SW12, SW14
Change in surface water quantity at pastoral dams used for stock water supply	Yes	Yes	SW45*	No	Yes	SW16*
				Yes	No	SW20
Potential changes in surface water quality from tailing transfer and disposal	No	No	SW20	NA	NA	NA
Emergency release of tailings water in the event the flood storage capacity is exceeded	No	No	SW25	NA	NA	NA
Erosion and runoff from TSF final landform	No	Yes	SW10*	NA	NA	NA
Increased sedimentation of surface water at stock dams	No	Yes	SW09*	No	Yes	SW09*, SW10
Change in surface water quality at stock dams as a result of acid rock drainage	No	No	SW30, SW36	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.11 | Groundwater effects and impacts to local communities, aboriginal communities, third-party users and state of South Australia (receptors)

Change in groundwater pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in groundwater quantity or quality at Lake Torrens and watercourse springs that are of value to the Kokatha People	Yes	No	GW02, GW04, GW06, GW08, GW18, GW22	NA	NA	NA	Yes	No	GW02, GW04, GW10
Change in groundwater quantity and quality at third-party wells – Mineral and Petroleum Industry	Yes	No	GW15, GW16	NA	NA	NA	Yes	No	GW08
Change in groundwater available for future generations	Yes	Yes	GW27*	NA	NA	NA	Yes	Yes	GW13*
Change in groundwater quantity and quality of third-party wells – Pastoral Industry	No	Yes	GW09*, GW10*	No	Yes	ID048*	No	Yes	GW05*, GW14*
Change in groundwater quality from seepage of solutes from TSF	No	No	GW24	NA	NA	NA	NA	NA	NA
Change in groundwater quantity and quality at third-party wells – Local Community	No	No	GW13, GW14, GW26	NA	NA	NA	No	No	GW07

* Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.12 | Socio-economic effects and impacts to local communities, aboriginal communities, third-party users, state of South Australia and Australia (receptors)

Change in socio-economic pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[2]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Local communities and third-party users						
Increased heavy and light vehicle traffic resulting in travel time delays for local community and pastoralists	Yes	No	SE01, SE02	Yes	No	SE01, SE02
Increased heavy and light vehicle traffic resulting in road wear	Yes	Yes	SE03*	No	Yes	SE03*
Southern Access Road and Western Infrastructure Corridor turnoff/intersection and other access road/track upgrades resulting in travel time delays and disruption for local community and pastoralists	Yes	No	SE04, SE05	Yes	No	SE04
Effect of the presence of the Project on the property value of pastoral stations	Yes	No	SE14	Yes	Yes	SE11*
Project activities and restricted access effect on pastoralists' activities	Yes	Yes	SE15*	NA	NA	NA
Effects to charter aircraft availability	No	No	SE13	NA	NA	NA
Project employment resulting in increased competition for labour	No	No	SE06, SE07	No	No	SE05
In-migration as a result of the Project placing pressure on local business capacity (retail, recreational etc.)	No	No	SE10	No	No	SE08
In-migration as a result of the Project influences housing availability and/or affordability impacting on the local community	No	No	SE11	No	No	SE09
In-migration places pressure on local social services	No	No	SE08	No	No	SE06
Project workforce and wages influence on local inflation of prices for goods and services	No	No	SE09	No	No	SE07
Workforce drive-in drive-out (DIDO) and fly-in fly-out (FIFO) effect on temporary accommodation in Adelaide, Whyalla and Port Augusta	No	No	SE12	No	No	SE10
Aboriginal Communities						
Project infrastructure restricts traditional owner access to Lake Torrens and areas of cultural significance	Yes	No	SE16	Yes	No	SE12
South Australia and Australia						
Project infrastructure restricts public access to Lake Torrens and Lake Torrens National Park	No	No	SE17	No	No	SE13
Project activities influence regional economic output (gross regional product (GRP)) from effects to pastoral activity	Yes	No	SE18	Yes	No	SE14
Project use of electricity from the NEM via the South Australian grid effects electricity supply within the State	No	No	SE19	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

The assessment of effects demonstrates that there are negligible changes to the baseline socio-economic environment, with potential benefits described in the MLP (OZ Minerals 2017a).

6.6.2 Current context

An update to the socio-economic baseline understanding was developed (Regional Australia Institute 2022) to provide an updated knowledge base related to the local community and economy of the Upper Spencer Gulf and Far North South Australia. The update includes information relating to four local government area (LGAs), being Port Augusta, Whyalla, Port Pirie and Roxby Downs. Feedback on the socio-economic knowledge base was sought from communities in the region, as well as local pastoralists and Traditional Owners through shared workshops and data gathering surveys.

As of 2022, the Carrapateena mine employs more than 1,000 people through direct employment and through contracting partners. This workforce is predominantly FIFO with individuals staying at the 550-person onsite camp and drawing from housing and socio-economic infrastructure in Port Augusta, Whyalla and Port Pirie. The combined workforce includes 65% South Australian-based, 23% interstate-based and 12% local/Upper Spencer Gulf-based workers across both direct employment and contracting partners. The workforce employed directly by OZ Minerals as of July 2022 includes 72% South Australian-based, 14% interstate-based and 13% local/Upper Spencer Gulf-based workers. The local workforce travels to site by chartered flights from Adelaide and Port Augusta, with additional transit services also available to personnel.

In 2020 the Carrapateena Block Cave Expansion Pre-Feasibility Study (OZ Minerals 2020e) was released concluding the potential to deliver further value to stakeholders by replacing the bottom half of the SLC with a larger block cave (operable from 2026). Additionally, in 2020 OZ Minerals also released the Life of Province Plan scoping study which discussed future potential of resource extensions, satellite deposits, exploration targets all working together to provide a multi-generational mine.

Regionally, there is a considerable amount of infrastructure planned and funded for the four LGAs. Across Port Pirie, Port Augusta and Whyalla there are 37 renewable energy infrastructure projects in the pipeline valued at over $17 billion. While in relation to mining, over half of the 30 planned projects for South Australia will be in the Far North region. In June 2022, the South Australian government committed to $593 million over four years to establish a new hydrogen facility in the Whyalla region, and $30 million towards a clean hydrogen industry hub in Port Bonython with a facility scheduled to be completed in 2025. A $71.5 million Stage 1 expansion of the Cultana base is in the pipeline for Department of Defence projects. Additionally, a proposed $31 million National Radioactive Waste Management Facility in Kimba. All projects individually and combined have the potential for flow-on effects in the region.

Since 2016, there have been minimal changes to the regional demography and land use surrounding the site. There have been some fluctuations, however these have occurred in-line with significant infrastructure projects. Across the Socio-economic Study Area, it has been noted the population has generally declined, however this is in-line with national trends in rural and remote areas. Yet, the populations of major centres (Port Augusta and Port Pirie) have remained largely unchanged. With the onset of the Covid-19 pandemic, the availability of overseas migration has sharply declined, reflected in the population growth opportunities for the region.

Despite population declines across all four LGAs, the demand for housing has grown significantly. Supply of housing has also declined with a number of available rental properties dropping to as low as 1%, which is lower than the 3% generally needed in a market. The demand for housing has been driven by a range of factors, including lower median prices which have allowed for greater access to the market, incoming and often short-term construction workforce, industry changes such as the temporary shutdown and job losses related to the Whyalla Steelworks, and the Covid-19 pandemic. While there is opportunity for housing development across the LGAs, there is a lack of local developers with long wait times for building and infrastructure services.

Education and health services are available throughout all four LGAs with the noticeable smaller population in Roxby Downs which correlates to more limited services.

The Indigenous population remains largely unchanged from 2016 with Port Augusta having significantly more Indigenous people than the state national average. The Kokatha People are associated with land across the site and the KAC operates across the Port Augusta, Roxby Downs, and Outback Communities Authority LGAs. The KAC are the registered native title body corporate representing Kokatha People and in October 2021 KAC was appointed as the Recognised Aboriginal Representative Body for its native title determination area under Part 2B of the *Aboriginal Heritage Act 1988* (SA). An NTMA was put in place with KAC supported by a Partnering Agreement which acknowledges the longevity of the partnership with the Kokatha People and the intention to work together towards beneficial outcomes.

The unemployment rate across the Port Pirie, Port Augusta and Whyalla LGAs have remained above the South Australian average over the previous five years. Unemployment rates have ranged between 5.9% and 15.5% across these places. While in comparison, Roxby Downs has a significantly lower unemployment rate than the state average, as well as the other three LGAs with the rate remaining below 2% over the previous five years.

6.6.3 Updates to understanding

There have been no updates to the understanding of the baseline socio-economic environment since submission of the June 2024 PEPR (BHP 2024a).

6.7 Heritage

6.7.1 Assessment context

6.7.1.1 Aboriginal cultural amenity (receptor)

The region has a long history of occupation by Aboriginal people and many Aboriginal people maintain a strong association with the land and water in the region. The Project Area is subject to the Kokatha People (Part A) Native Title Determination (National Native Title Tribunal (NNTT) Number SCD2014/004). The KAC is the Registered Native Title Body Corporate who acts as an agent for the Kokatha People in relation to their native title rights and interests.

OZ Minerals respects the cultural rights of the Kokatha People and will not disclose results of sensitive discussions. For this reason, the Aboriginal heritage summary presented herein and in the MLP (OZ Minerals 2017a) is limited to a high-level overview.

Heritage clearances have been undertaken in accordance with the agreed protocol between OZ Minerals and the Kokatha People, and data collected by a mutually agreed anthropologist has been compiled for ownership by both parties. The presence of any artefacts or mythological landscapes within the area has been handled by the Kokatha Peoples Heritage survey team in accordance with the procedures for heritage management agreed under the current NTMA. Two pathway changes were assessed as impacting Aboriginal Heritage, as shown in Table 6.13, with associated outputs from the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 6.13 | Effects and impacts to Aboriginal Heritage (Receptor)

Change in pathway	SPR Linkage	SPR Material	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Potential for disturbance of sites of Aboriginal heritage during construction	Yes	Yes	L01*, L02*	ID001*, ID002*	L01*, L02*
Potential for reduced visual amenity of the landscape of value to the Kokatha People	Yes	No	NA	ID003	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

6.7.1.2 Non-indigenous heritage (receptor)

The region contains a rich and varied history of non-Indigenous land use. Most sites throughout the region relate to the development of the pastoral industry, as well as the historical themes of transport, mining, exploration and the Woomera Rocket Range. These places link communities with attitudes and values that have shaped the region.

Based on a review of the SA Heritage Places Database, National Heritage List and the Commonwealth Heritage List no sites of non-Indigenous historical significance have been identified within the Project Area. One pathway change was assessed as having no linkage to non-Indigenous heritage, as shown in Table 6.14, with associated outputs from the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c).

Table 6.14 | Effects and impacts to Non-Indigenous Heritage (Receptor)

Change in pathway	SPR Linkage	SPR Material	Carrapateena Project Impact ID[1]	Airstrip and Workers' Accommodation Village Impact ID[2]	Northern Wellfield Impact ID[3]
Potential for disturbance of sites of Non-Indigenous Heritage during construction	No	No	L04	ID004	L04

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

6.8 Ecological environment

6.8.1 Assessment context

This section summarises the ecological receptors in the existing environment, and the magnitude of change to the ecological environment as a result of the Project activities described in Chapter 4. The information used in preparing the baseline description was derived from ecological baseline assessments that were undertaken for the MLP (OZ Minerals 2017a; Appendix B6 Ecological Baseline Assessment) and Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix C Ecological Baseline Assessment). The impact significance was determined through an ecological impact assessment prepared for the MLP (OZ Minerals 2017a; Appendix D1 Ecological Impact Assessment) and an EPBC MNES assessment prepared for the MLP (OZ Minerals 2017a; Appendix E3 EPBC Matters of National Environmental Significance Cross Reference Guide) and for the Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix D EPBC Act Protected Matters Significant Impact Assessment). The findings of these assessments are reflected in the Consolidated Assessments (OZ Minerals 2017a; 2018c).

The Carrapateena Ecology Study Area was situated over the ML area, whilst the Regional Ecology Study Area extended beyond the ML in all directions to provide baseline conditions across the Project Area. The Northern Wellfield Ecology Study Area was situated over MPL 156 and partially overlaps the Carrapateena Ecology Study Area in the south-east corner.

The Project has a robust foundation of ecological knowledge and data that began with an intensive survey in 2007 and has continued with ongoing annual field surveys in autumn and spring which commenced in 2012.

Field surveys undertaken to date include:

- aquatic species surveys
- bi-annual flora and fauna surveys using standard biological survey methods across a total of 16 sites, and an additional five sites for weed species since 2012
- dedicated habitat analysis and mapping for EPBC species: Night Parrot (*Pezoporus occidentalis*), Plains Mouse (*Pseudomys australis*), Thick-billed Grasswren (*Amytornis modestus*), and the Southern Sea-heath (*Frankenia plicata*)
- targeted searches of suitable threatened species habitat
- desktop reviews and assessment of areas to the north of the Project Area
- desktop assessment and field survey of the Western Infrastructure Corridor.

6.8.1.1 Common and state-threatened flora and vegetation (receptor)

Review of the Biological Database of South Australia (BDBSA) records from all surveys conducted indicate that a total of 462 flora species (consisting of 419 native species and 43 exotic species) have been recorded on or around the Carrapateena Ecology Study Area (including a 30 km buffer). Species were largely represented by individuals from the *Chenopodiaceae* family with other dominant representation provided by *Gramineae* (Grass) species, *Compositae* (Daisies), *Leguminosae* (Peas, Wattles) and *Malvaceae* (Abutilon, Sida etc.). The Low Open Shrubland vegetation association (Chenopod Shrublands) dominates the Project Area.

There have been 10 vegetation species of local and state conservation significance recorded on or around the Carrapateena tenements during the course of vegetation survey activities, four of these species are known to occur in the Carrapateena Project Area.

Nine vegetation species of local and state conservation significance were recorded within the BDBSA search area. All nine species identified are considered to have the potential to occur within the Northern Wellfield Ecology Study Area, and three are considered likely to occur. No state-listed flora species were observed in the Northern Wellfield Ecology Study Area.

In general, the semi-arid zone supports few pest flora species. Dispersal mechanisms for these species include rainfall events and fauna transportation (native, introduced and stock). However, these species are also distributed by vehicle movements along access tracks and by earthwork construction. Arid area weed species are also typically annual species that respond to heavy rainfall events and are widespread throughout the arid region.

Species diversity, abundance, cover and threatened species are discussed in detail in the MLP (OZ Minerals 2017a; MLP Appendix B6 Ecological Baseline Assessment) and Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix C Ecological Baseline Assessment). Effects and impacts to flora in the Carrapateena region have been grouped and described in the context of common native vegetation and NPW Act listed flora and fauna; and EPBC Act listed flora and fauna in the tables in the following sections.

6.8.1.2 Common and state threatened fauna and habitat (receptor)

The arid lands, such as the Arcoona tableland system predominantly support Chenopod shrublands, a vegetation community that are typically known to support relatively low mammal and reptile species diversity and richness when compared with other habitats due to the simplicity and uniformity of the habitat structure (i.e. generally no mid-storey or overstorey vegetation layer).

Results of surveys undertaken within the Carrapateena Project Area (2012 to 2017) show that up to 16 ground-dwelling mammalian species are commonly encountered, including five exotic species, with 33 species of reptile and five species of bat also being identified across the survey periods.

Bird species richness is also quite high for this type of landscape, with 112 species being encountered across the Carrapateena Project Area since 2012. Many of these are long-term residents, with 26 species being considered sedentary and resident species that occupy well-defined home ranges throughout the Carrapateena Project Area. The site is also frequented by migratory and transient species, with many of these species frequenting the site during periods that would be classified as preferential, generally after rainfall events.

A desktop survey and site visit of the Western Infrastructure Corridor linking the Mineral Lease to the Stuart Highway was undertaken in 2016, followed by a field survey. The conservation-significant species identified as potentially occurring within the Western Infrastructure Corridor were largely the same as those associated with the Mineral Lease, with the exception of the addition of the State rare Elegant Parrot (*Neophema elegans*) and the Commonwealth critically endangered Curlew Sandpiper (*Calidris ferruginea*).

A number of exotic species have been observed across the Carrapateena region during the surveys. Goats (*Capra hircus*), Sheep (*Ovis aries*), European Rabbits (*Oryctolagus cuniculus*), House Mouse (*Mus musculus*), Cats (*Felis catus*) and Red Foxes (*Vulpes vulpes*) are all recorded within the region. All of these species are widespread throughout Australia and are commonly observed throughout much of the arid lands of South Australia.

Species diversity, species richness and threatened species are discussed in detail in the MLP (OZ Minerals 2017a; Appendix B6 Ecological Baseline Assessment) and Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix C Ecological Baseline Assessment).

Table 6.15 and Table 6.16 summarise the change in pathways (effects) with impact outputs from the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) to common native vegetation and NPW Act listed flora and fauna species. Only the land and air pathways were assessed as viable potential pathways for impacts reaching these receptors.

Table 6.15 | Land effects and impacts at common native vegetation and NPW Act-listed flora and fauna species locations (Receptor)

Change in land pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Land clearing of native vegetation and habitat	Yes	Yes	L10*, L11*	Yes	Yes	ID018*, ID021*	Yes	Yes	L10*, L11*
				No	No	ID019, ID022			
Vibration from blasting activities displaces nearby fauna	Yes	No	L38	NA	NA	NA	NA	NA	NA
Rehabilitation of land	No	Yes	L13*, L14*	No	Yes	ID041*	No	Yes	L17*, L18*
				Yes	Yes	ID042*, ID043*			
Overabundance of existing weed or introduced weed species during construction operations and closure	No	Yes	L17*, L18*	No	Yes	ID024*, ID027*, ID029	No	Yes	L21*, L22*, L29*, L30*
				No	No	ID025, ID028			
Accidental spills reduce soil quality	No	Yes	L20*, L21*	No	No	ID039	No	Yes	L24*, L25*
Accidental fires as a result of ignition sources that result in the loss of abundance and/or diversity of native vegetation	No	No	L35	NA	NA	NA	No	No	L39
Project interaction with native fauna	No	Yes	L31*, L32*	No	No	ID040*	No	Yes	L35*, L36*
Introduced weed species from Project traffic	No	Yes	L25*, L26*	NA	NA	NA	NA	NA	NA
Predatory pests	No	Yes	L28*, L29	NA	NA	NA	No	Yes	L32*, L33*

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.16 | Air effects and impacts at common native vegetation and NPW Act-listed flora and fauna species locations (Receptor)

Change in air pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in air quality associated with particulate emissions (TSP PM_{10} and $PM_{2.5}$) during construction, operations and closure	Yes	No	AQ01, AQ02, AQ09, AQ10	Yes	No	ID030, ID033	Yes	No	AQ01, AQ02
				No	No	ID031, ID032, ID034, ID035			
Change in air quality associated with gaseous pollutants during construction and operations	Yes	No	AQ31, AQ32	NA	NA	NA	Yes	No	AQ01, AQ02
Noise generated as a result of mining activities, vehicles, plant and equipment during construction and operations	Yes	No	AQ46	NA	NA	NA	Yes	No	AQ16
Light emissions during operations	Yes	No	AQ48	NA	NA	NA	NA	NA	NA
Change in soil quality associated with particulate emissions (TSP PM_{10}, $PM_{2.5}$ and dust) during construction, operations and closure	No	Yes	AQ06,*AQ14*	NA	NA	NA	Yes	No	AQ16
Change in air quality associated with radon and radionuclides in dust during construction, operations and closure	No	No	AQ17, AQ18, AQ24, AQ25	NA	NA	NA	NA	NA	NA
Change in soil quality associated with radionuclides during construction, operations and closure	No	Yes	AQ21*, AQ28*	NA	NA	NA	NA	NA	NA
Change in air quality associated with saline aerosols emissions during construction and operations	No	No	AQ35, AQ36	NA	NA	NA	No	No	AQ13
Change in air quality associated with acid mist emissions from the Concentrate Treatment Plant during operations	No	Yes	AQ37*	NA	NA	NA	NA	NA	NA
Change in air quality associated with copper concentrate release during transport	No	Yes	AQ39*	NA	NA	NA	NA	NA	NA
Wheel-generated and construction-related dust emissions along access roads	No	No	AQ50	NA	NA	NA	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

6.8.1.3 Commonwealth-threatened communities, flora and fauna (receptor)

The Protected Matters Search Tool (PMST) for the Carrapateena Project and Northern Wellfield indicated that five EPBC Act listed threatened species might occur within the tenements, but with no threatened ecological communities. With the exception of the Plains Mouse, these species are not known to occur in the Project Area, and with extensive survey effort it is considered unlikely to support populations due to lack of suitable habitat. The five threatened species include:

- Curlew Sandpiper (*Calidris ferruginea*) which is critically endangered and with substantial survey effort is not expected to occur within the Project Area.
- Thick-billed Grasswren (*Amytornis modestus*) which is vulnerable. Targeted surveys found drainage line habitat within the Northern Wellfield to be sub-optimal for Thick-billed Grasswren and as such, it is considered unlikely for the Thick-billed Grasswren to be in the Northern Wellfield.
- Night Parrot (*Pezoporus occidentalis*) which is endangered. Targeted habitat surveys of the Northern Wellfield, undertaken in May 2018, found no Night Parrots, evidence of Night Parrots, nor areas of preferred Night Parrot habitat; and is therefore considered highly unlikely to occur in the Project Area.
- Plains Mouse (*Pseudomys australis*) which is vulnerable, is known to occur in the south of the Northern Wellfield, and habitat within the Ecology Study Area represents only a small portion of the potential regional habitat. Further detail about the Plains Mouse surveys is provided below.
- Southern Sea-heath (*Frankenia plicata*) which is endangered, is not known to occur in the Ecology Study Areas based on extensive baseline survey efforts and has not been recorded within 45 km of the Project footprint. The nearest location of *Frankenia plicata* on Andamooka from the BDBSA was visited and was found to be misreported. (OZ Minerals 2018a and OZ Minerals 2019).

The Plains Mouse has been found within the Project Area during surveys. While the Project Area provides suitable habitat for Plains Mouse, it is considered an area where they disperse to during favourable conditions, rather than critical refuge habitat. It is likely that in times of irruption events, the dominant habitats have mass dispersal in order to satisfy food requirements, and areas such as the Project Area then become home to individuals on a short-term basis. Regionally, virtually all historic records of the Plains Mouse are to the north of the Project Area, suggesting that the records collected during the extensive baseline survey work undertaken for the Project represent (or are located within) the southern-most extent of the population distribution. The area of potential Plains Mouse habitat within the Carrapateena Ecology Study Area and Northern Wellfield Ecology Study Area and within the ML and MPL boundaries represents a small portion of the potential habitat regionally.

The PMST also identified nine migratory fauna species that may occur in the Northern Wellfield, and a further eight migratory species in the BDBSA search area for the Northern Wellfield. Overall it is considered that 14 of the migratory species identified could occur within the Northern Wellfield, with two of these species recorded.

Surveys were undertaken with approval from the South Australian Department of Environment, Water and Natural Resources (DEWNR, now DEW), under a Permit to Undertake Scientific Research and utilising the standard DEW biological survey methods (Owens 2000; Heard and Channon 1997). Information regarding threatened species was sourced from the BDBSA and DCCEEW's Species Profile and Threats Database (SPRAT) (DCCEEW 2018).

Desktop assessments undertaken for baseline ecological assessments for the MLP and Northern Wellfield MPL MP (OZ Minerals 2017a; Appendix B6 Ecological Baseline Assessment and OZ Minerals 2018c; Appendix C Ecological Baseline Assessment) provide the basis for determining the baseline presence of species in the Project Area.

Table 6.17 and Table 6.18 summarise the change in pathways (effects) with impact outputs from the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) to EPBC Act listed threatened flora and fauna species. Only the land and air pathways were assessed as viable potential pathways for impacts reaching these receptors.

Surface water pathway effects assessed within the Consolidated Assessments (OZ Minerals 2016; 2017a; 2018c) were found to be impacting terrestrial ecology in general, rather than specific groups or species of flora and/or fauna. As such, these effects are described separately in Table 6.19 below, however, they are considered in combination with the effects described for Common Native flora and fauna, NPW Act flora and fauna, and EPBC Act listed flora and fauna receptors.

Table 6.17 | Land effects and impacts at EPBC Act listed flora and fauna species locations (Receptor)

Change in land pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Land clearing of native vegetation and habitat	Yes	Yes	L12*	No	No	ID020	No	No	L12, L13, L14, L16
				Yes	No	ID023	Yes	No	L15
Vibration generated by blasting associated with underground mining, pre-conditioning of the SLC, borrow pits and quarries displaces nearby fauna	Yes	No	L38	NA	NA	NA	NA	NA	NA
Rehabilitation of land	No	Yes	L15*	NA	NA	NA	No	Yes	L19*
Creation of conditions favourable to the overabundance of existing weed or introduced weed species during construction operations and closure	No	Yes	L19*, L27*	No	No	ID026	No	Yes	L23*, L31*
				No	Yes	ID029			
Creation of conditions favourable to attract predatory pest species to the Project Area during construction operations and closure	No	Yes	L30	NA	NA	NA	No	Yes	L34*
Vehicle movements interact with native fauna species	No	Yes	L33*	NA	NA	NA	No	Yes	L37*
Accidental fires as a result of ignition sources that results in the loss of abundance and/or diversity of native vegetation	No	No	L35	NA	NA	NA	No	No	L39

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.18 | Air effects and impacts at EPBC Act listed flora and fauna species locations (Receptor)

Change in air pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in air quality associated with particulate emissions (TSP PM_{10} and $PM_{2.5}$) during construction, operations and closure	Yes	Yes	AQ03, AQ11*	No	No	ID032	Yes	Yes	AQ03
				Yes	No	ID035			
Change in air quality associated with gaseous pollutants during construction and operations	Yes	No	AQ33	NA	NA	NA	Yes	No	AQ11
Noise generated as a result of mining activities during construction and operations	Yes	No	AQ46	NA	NA	NA	Yes	No	AQ16
Light emissions during operations	Yes	No	AQ48	NA	NA	NA	NA	NA	NA
Change in air quality associated with radionuclides during construction, operations and closure	No	Yes	AQ19*, AQ26*	NA	NA	NA	NA	NA	NA
Change in soil quality associated with particulate emissions (TSP PM_{10}, $PM_{2.5}$ and dust) during construction, operations and closure	No	Yes	AQ06*, AQ14*	NA	NA	NA	NA	NA	NA
Change in soil quality associated and radionuclides during construction, operations and closure	No	Yes	AQ21*, AQ28*	NA	NA	NA	NA	NA	NA
Change in air quality associated with saline aerosols emissions during construction and operations	No	No	AQ35, AQ36	NA	NA	NA	No	No	AQ13
Change in quality associated with acid mist emissions from the Concentrate Treatment Plant during operations	No	Yes	AQ37*	NA	NA	NA	NA	NA	NA
Change in air quality associated with copper concentrate release during transport	No	Yes	AQ39*	NA	NA	NA	NA	NA	NA
Wheel-generated and construction related dust emissions along access roads	No	No	AQ50	NA	NA	NA	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.19 | Surface water effects and impacts at Terrestrial Ecology Locations (Receptor)

Change in surface water pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in height of flood events along creek lines (including Eliza Creek and Salt Creek) reducing surface water available for terrestrial ecology	Yes	No	SW44	NA	NA	NA	No	No	SW15
Alteration of overland flows leading to reduced surface water quantity for native vegetation and fauna	Yes	No	SW50	Yes	No	ID036	Yes	No	SW19
				No	No	ID037, ID038			
Potential changes in surface water quality from shallow lateral seepage from upstream TSF embankment and upstream of decant dam	Yes	Yes	SW51*, SW53*	NA	NA	NA	NA	NA	NA
Erosion and sedimentation from land disturbance and stockpiles during all phases	No	Yes	SW07*	NA	NA	NA	No	Yes	SW08*
Potential changes in surface water quality from tailing transfer and disposal	No	Yes	SW14*	NA	NA	NA	NA	NA	NA
Emergency release of tailings water in the event the flood storage capacity is exceeded	No	Yes	SW19*	NA	NA	NA	NA	NA	NA
Erosion and runoff from final landforms including rehabilitated surfaces	No	Yes	SW08*, SW24*	NA	NA	NA	NA	NA	NA
Change is surface water quality in creek lines from stockpile acid and metalliferous drainage	No	Yes	SW29*	NA	NA	NA	NA	NA	NA
Change is surface water quality from acid and metalliferous drainage from final landforms	No	No	SW35	NA	NA	NA	NA	NA	NA
Creation of artificial waterbodies that attract native fauna to the Project Area	No	No	SW47	NA	NA	NA	No	No	SW18

*Non-Outcome or Outcome-Based Lease Condition Proposed

1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)

2 Appendix B Consolidated Assessment (OZ Minerals 2017b)

3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

6.8.1.4 Aquatic ecology (receptor)

The region is home to aquatic invertebrates that will lay dormant as eggs until rainfall events stimulate their life cycle. Brine Shrimp (*Artemia sp* and *Parartemia sp*) species lay eggs that survive long periods of drought or dry conditions, before regenerating with sustainable rainfall. Some of these species are also important within food chains, providing large supplies of food resources in areas generally lacking. An example of this is the Banded Stilt, which usually breeds on dry lake beds after the rainfall and feeds on invertebrates such as Brine Shrimp, which occur in large numbers following the same rainfall events.

Shield Shrimp (*Triops australiensis*) and Clam Shrimp (*Limnadopsis* sp.) are freshwater invertebrates that survive as desiccated eggs in clay pans until the next rainfall event that produces pools and creeks. The eggs dry out after being laid and are easily transported by winds ensuring they are distributed widely through the landscape. These have been widely observed within the Project Area.

The only fish species identified during surveys in the surface water bodies within Salt Creek and Eliza Creek was the Desert Hardyhead or Lake Eyre Hardyhead (*Craterocephalus eyresii*), which is a small, elongated fish that grows to 100 mm, and is usually silvery in colour.

Subterranean fauna, or stygofauna, comprise animals that live in groundwater. Stygofauna have not been identified within the regional area (BHP Billiton 2009). Aquifer composition (e.g. compressed, discretely fractured formation) containing groundwater of high salinity levels are considered unsuitable for stygofauna habitat. As such, it is considered unlikely that stygofauna are present within the aquifers located at the Project Area.

Aquatic flora species have been identified at surface water points throughout the region and within arid South Australia. Aquatic flora species are categorised as a plant that is a salt-tolerant freshwater species, which do not grow well in turbid water or low-oxygen substrates.

None of the identifiable species located in the Regional Ecology Study Area are listed under State or Commonwealth legislation, and many are expected to exist in areas that hold water periodically, such as the longer-term waterholes and watercourse springs.

An assessment of surface water features within Eliza Creek, Salt Creek and Bosworth Creek was undertaken to determine their interaction with the regional groundwater system, and the reliance of vegetation within these systems on groundwater and/or surface water (i.e. their groundwater and/or surface water dependence). This is presented in the MLP (OZ Minerals 2017a; Appendix B6 Ecological Baseline Assessment).

Pathway effects and outputs from the Carrapateena MLP Response Document (OZ Minerals 2017c; Appendix I Updated Consolidated Assessment) and Northern Wellfield MPL MP (OZ Minerals 2018b; Appendix E Consolidated Assessment) which may impact upon aquatic ecology are described in Table 6.20, Table 6.21 and Table 6.22.

Table 6.20 | Air effects and impacts at aquatic ecology locations (Receptor)

Change in air pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[2]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in air quality associated with particulate emissions (TSP PM_{10} and $PM_{2.5}$) during construction, operations and closure	No	No	AQ08, AQ16	No	No	AQ08
Change in surface water quality associated and radionuclides during construction, operations and closure	No	No	AQ23, AQ30	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.21 | Surface water effects and impacts at aquatic ecology locations (Receptor)

Change in surface water pathway	Carrapateena Project Impact ID[1]			Airstrip and Workers' Accommodation Village Impact ID[2]			Northern Wellfield Impact ID[3]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in surface water quantity at water holes within the Eliza Creek catchment	Yes	No	SW42*	NA	NA	NA	NA	NA	NA
Change in surface water quantity at Pernatty Lagoon	Yes	No	SW48	NA	NA	NA	NA	NA	NA
Change in surface water catchments leading to reduced water quantity at watercourse springs	Yes	No	SW40	Yes	No	ID045	No	No	SW13
Potential changes in surface water quality from shallow lateral seepage from upstream TSF embankment and upstream of decant dam	Yes	Yes	SW52*	NA	NA	NA	NA	NA	NA
Potential changes in surface water quality from uncontrolled release of hydrocarbons or chemicals	NA	NA	NA	No	Yes	ID046*	NA	NA	NA
Erosion and sedimentation during all phases	No	No	SW05	Yes	Yes	ID044*	No	No	SW05
Erosion and runoff from final landforms	No	No	SW06 SW23	Yes	Yes	ID047*	No	No	SW06
Potential changes in surface water quality from tailing transfer and disposal	No	No	SW13	NA	NA	NA	NA	NA	NA
Change is surface water from acid rock drainage	No	No	SW34	NA	NA	NA	NA	NA	NA
Emergency release of tailings water in the event the flood storage capacity is exceeded	No	No	SW18	NA	NA	NA	NA	NA	NA
Change in surface water quality at waterholes as a result of acid rock drainage	No	No	SW28	NA	NA	NA	NA	NA	NA

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix B Consolidated Assessment (OZ Minerals 2017b)
3 Appendix E Consolidated Assessment (OZ Minerals 2018c)

Table 6.22 | Groundwater effects and impacts at groundwater-dependent ecosystems (Receptor)

Change in groundwater pathway	Carrapateena Project Impact ID[1]			Northern Wellfield Impact ID[2]		
	SPR Linkage	SPR Material	Impact ID	SPR Linkage	SPR Material	Impact ID
Change in groundwater quantity at watercourse springs during construction, operations and closure	Yes	No	GW05, GW07	Yes	No	GW03
Change in groundwater quality at watercourse springs during construction, operations and closure	Yes	No	GW19	Yes	No	GW11
Change in groundwater quality at watercourse springs as a result of tailings seepage during operations and closure	No	No	GW23	NA	NA	NA
Change in groundwater quantity GAB Springs	No	No	GW11, GW12	No	No	GW06
Change in groundwater quality GAB Springs	No	No	GW20, GW25	No	No	GW12

*Non-Outcome or Outcome-Based Lease Condition Proposed
1 Appendix I Updated Consolidated Assessment (OZ Minerals 2017c)
2 Appendix E Consolidated Assessment (OZ Minerals 2018c)

6.8.2 Current context

The Carrapateena Expansion Baseline Ecology assessment was updated (BHP 2024a; Appendix C5 Ecological Baseline) which incorporated a review and updates to baseline knowledge. The review consolidated desktop and field studies from 2007 to 2019.

The Ecology Study Areas span across three broad vegetation types with a majority of the Study Area being mapped as chenopod shrubland on stony plains. Eleven distinct habits and vegetation associations occur across the Ecology Study Areas with the dominant vegetation association being Bladder Saltbush (*Atriplex vesicaria*) and Samphire (*Tecticornia medullosa*). While other key habits include Gilgais with Cane-grass grasslands, drainage lines with Red Gum and Western Myall Woodlands, dune fields with Mulga, saline areas with Samphire and sandplains, claypans and salt lakes.

The environment supports boom and bust species population numbers which is dependent on water availability. A review of flora species diversity by season and year between 2012 to 2019 displayed great variation in diversity of short-lived species, yet relatively stable of long-lived species. Drought impacts to fauna species were more evident with variations in diversity, particularly reptiles. Diversity for small mammals, birds remained stable, yet less diverse in later years potentially as a result of prolonged dry periods. No Threatened Ecological Communities listed under the EPBC Act occur within the Ecology Study Areas.

A total of 342 flora species were recorded, of which 41 were introduced species. In addition, 213 fauna species were recorded including 201 native species and 12 introduced species. Birds and reptiles represented the majority of species recorded, with counts of 128 and 54 respectively.

The EPBC Act PMST output highlighted nine listed threatened species as potentially occurring within the Ecology Study Areas. These included the Sea Heath (*Frankenia plicata*) which is considered unlikely to occur due to a lack of verified records or presence of suitable preferred habitat. Then eight fauna species, one of which is known to be present, Plains Mouse (*Pseudomys australis*), two which are considered possible, Thick-billed Grasswren (*Amytornis modestus* ssp. *Indulkanna*) and Curlew Sandpiper (*Calidris ferruginea*). The remaining five species were assessed as unlikely to be present.

There were 10 migratory species identified as potentially present, including two which have an EPBC Act threatened species rating, these being Eastern Curlew (*Numenius madagascariensis*) and Curlew Sandpiper (*Calidris ferruginea*). Four species are known to be present being the Common Sandpiper (*Actitis hypoleucos*), Sharp-tailed Sandpiper (*Calidris acuminata*), Pectoral Sandpiper (*Calidris melanotos*) and Common Greenshank (*Tringa nebularia*). Two species are considered possible to occur being Fork-tailed Swift (*Apus pacificus*) and Curlew Sandpiper (*Calidris ferruginea*). The remaining species are considered unlikely to occur.

Of the NPW Act listed species, 12 flora species have been recorded within a 50 km buffer of the Ecology Study Areas, of which four are known to be present in the Ecology Study Areas. These being Round Sea-heath (*Frankenia subteres*), Sandalwood (*Santalum spicatum*), Western Tar-vine (*Gilesia biniflora*), Annual Buttercup (*Ranunculus sessiliflorus* var. *pilulifer*). Seven other State-listed flora are considered possible to occur, and one is considered unlikely to occur. Additionally, 13 fauna species have been recorded within a 50 km buffer of the Ecology Study Areas. Eight are known to be present within the Ecology Study Areas, these being Slender-billed Thornbill (Western) (*Acanthiza iredalei iredalei*), Blue-winged Parrot (*Neophema chrysostoma*), Blue-billed Duck (*Oxyura australis*), Wood Sandpiper (*Tringa glareola*), Peregrine Falcon (*Falco peregrinus*), Freckled Duck (*Stictonetta naevosa*), Australian Bustard (*Ardeotis australis*) and Pernatty Knob-tailed Gecko (Nephrurus deleani). One species is considered likely to occur being the Banded stilt (*Cladorphynchus leucocephalus*), five are considered as possible occurrences and one is considered unlikely.

A review of the 2021 baseline ecology report was undertaken in 2023 (BHP 2024a; Appendix C5.1 Ecological baseline – Carrapateena Operations). The 2023 review assessed the 2021 baseline report against ecological data collected from surveys conducted over 2020 to 2023. This was then used to assess whether the outcomes of the 2020 to 2023 surveys were consistent. The review provided a high-level summary of outcomes, undertook a comparison of the EPBC Act PMST and NPW Act outputs and reviewed the likelihood of occurrence information incorporating new species where relevant. This information is summarised below, with both the report and the related review included (BHP 2024a; Appendix C5.1).

Annual fauna surveys found no previously listed EPBC Act threatened flora or fauna were detected onsite. Of note, during the 2020 to 2022 survey periods:

- The newly listed bird species, the Southern Whiteface (*Aphelocephala leucopsis*) was recorded at Yeltacowie Creek in 2021, noting this species has been detected on previous surveys.
- The Blue-winged Parrot (*Neophema chrysostoma*) which has historically been detected in 2013 and 2014, was not detected during 2020 to 2022 and was detected again in 2023.
- No new migratory species were detected, however one existing EPBC Act listed migratory species was detected in 2021, being the Sharp-tailed Sandpiper (*Calidris acuminata*).
- There were no new state-listed flora or fauna species.
- Five new, but common, species were detected, being the Sandy Inland Mouse (*Pseudomys hermannsburgensis*), Silver Gull (*Chroicocephalus novaehollandiae* syn. *Larus novaehollandiae*), Pied Honeyeater (*Certhionyx variegatus*), Lined Earless Dragon (*Tympanocryptis petersi*), and the Australian Pied Cormorant (*Phalacrocorax varius*). These species occur within the site, and BDBSA records of these species are recorded within the broader region.
- Overall the numbers for fauna recorded at the site or immediate surrounds are 230 fauna (218 native, 12 introduced) including 137 birds, 60 reptiles, 30 mammals, 1 fish and 2 frogs. Additionally, the floristic diversity has increased in short-lived species and stable numbers of long-lived species due to the transition from ongoing drought conditions to non-drought conditions over 2021 and 2022, gradual destocking and the occasional higher rainfall event.

A new PMST was run which highlighted 14 fauna, including Plains Mouse (*Pseudomys australis*), Thick-billed Grasswren (*Amytornis modestus* spp. *indulkanna*), Western Grasswren (*Amytornis textilis myall*), Southern Whiteface (*Aphelocephala leucopsis*), Curlew Sandpiper (*Calidris ferruginea*), Grey Falcon (*Falco hypoleucos*), Malleefowl (*Leipoa ocellata*), Blue-winged Parrot (*Neophema chrysostoma*), Eastern Curlew (*Numenius madagascariensis*), Night Parrot (*Pexoporus occidentalis*), Australian Painted Snipe (*Rostratula australis*), Western Quoll (*Dasyurus geoffroii*), Greater Bilby (*Macrotis lagotis*) and Dusky Hopping Mouse (*Notomys fuscus*). Additionally, six new fauna species were highlighted in 2023 that were not considered as EPBC Act listed species in the baseline ecology report (BHP 2024a; Appendix C5.1), these being the Grey Falcon, Southern Whiteface, Blue-winged parrot, dusky Hopping Mouse, Western Quoll and greater Bilby.

The likelihood assessment from the 2021 baseline ecology report (BHP 2024a; Appendix C5.1) was reviewed which considers that the Thick-billed Grasswren and Curlew Sandpiper are still possible, however noting they haven't been detected throughout surveys. The closest records for Curlew Sandpiper are Roxby Lakes in 1991 to 1995 and there are no records within 50 km for the Thick-billed Grasswren. While the Plains Mouse is considered to be present, this is an irruptive species and the Carrapateena site occurs in the southern portion of the species known restricted range. The species is most easily detected following consecutive years of good rainfall where populations can increase rapidly with population numbers remaining high whilst conditions are favourable. Yet it is noted that the Carrapateena

population is considered to form part of the wider Arcoona tableland population which is considered 'important' and persist through drought conditions.

The likelihood assumptions for the EPBC Act listed fauna species are:

- present/known – Plains Mouse (*Pseudomys australis*), Southern Whiteface (*Aphelocephala leucopsis*), Blue-winged parrot (*Neophema chrysostoma*)
- possible – Thick-billed Grasswren (*Amytornis modestus* spp. *indulkanna*), Curlew Sandpiper (*Calidris ferruginea*), Grey Falcon (*Falco hypoleucos*), Dusky Hopping Mouse (*Notomys fuscus*)
- may occur – Desert Greenhood (*Pterostylis xerophila*) (not considered in the 2021 baseline report (BHP 2024a; Appendix C5.1))
- unlikely – Night Parrot (*Pexoporus occidentalis*), Australian Painted Snipe (*Rostratula australis*), and Sea Heath (*Frankenia plicata).*

No new state-listed fauna was detected between 2020 to 2022, however in 2023 the Major Mitchell's/Pink Cockatoo (western subspecies) (*Lophochroa leadbeateri mollis*) and the Musk Duck (*Biziura lobata*) was detected.

6.8.3 Updates to understanding

An annual ecological survey was undertaken at Carrapateena in spring 2024 (Appendix C1) which builds upon the previous ecological compliance monitoring surveys undertaken since the commencement of construction in autumn 2018. The majority of surveys were conducted in spring (from September 2018), however an autumn survey was also conducted in 2023, given the change in rainfall in the preceding years. The intention of the 2023 autumn survey was to detect a different suite of flora and fauna and to provide an additional opportunity to capture the EPBC listed Plains Mouse. In 2024, Carrapateena rainfall was below average and fluctuated, with only two larger events in March (over 20 mm) and July (40 mm), hence a spring survey was conducted rather than an autumn survey.

Flora survey methods undertaken were generally consistent with methods that have been used at Carrapateena for baseline studies undertaken prior to construction (2012 to 2017), with minor modifications to align data collection with the outcomes and mine approval conditions. Fauna survey methods followed a modified version of the biological survey methods, with a focus on pitfall trapping to address the lease area condition relating to small mammal and reptile diversity, including the EPBC listed as Vulnerable Plains Mouse (*Pseudomys australis*). A single trap line was installed at 8 established fauna sites, and bird surveys were undertaken at 20 sites, aligning with vegetation survey sites. One un-baited camera trap was also installed at each trap line site, and Song Meters were deployed at 10 sites to record bird calls and at 3 sites to record microbat calls. Opportunistic observation/capture of all vertebrate species across the site was also recorded to provide information about overall species diversity at Carrapateena, which is comparable with previous surveys.

6.8.3.1 Flora and vegetation

In 2024, total species diversity recorded across all flora sites (141 native species) was the equal highest recorded during compliance monitoring, due to a very high diversity of short-lived species being recorded. During construction monitoring, variation in total species diversity within the mining lease has largely been due to variation in diversity of short-lived species that germinate in response to rainfall events, such as the well above average rainfall received in July 2024. Grazing impact continued to be low in 2024, following widespread destocking across the mining lease, which also likely influenced short-lived species diversity and widespread increased abundance of palatable species (e.g. Bladder Saltbush, Bush Minuria and Plains Lantern Bush). Similar to 2023, in 2024 the mean total species diversity for impact sites and

for control sites was not significantly different, were within the baseline range, and comparable with mean total species diversities recorded in 2018 (early compliance). Based on the above, mining activities are not considered to be impacting either short-lived or long-lived species diversity within the mining lease.

The population abundance of the 5 most abundant and/or widespread long-lived perennials declined during 2018 to 2020, but have all increased since 2021 (Bladder Saltbush, Samphire, Sea-heath, Bush Minuria, Plains Lantern Bush). The declines and increases in long-lived perennial species are attributed to yearly and long-term rainfall totals rather than mining impacts (e.g. the 50% increase in Plains Lantern Bush and Cunningham's Daisy abundance in 2022 and 2023 in particular).

Since 2018, there has been no distinct trend in species diversity for any of the Eliza Creek sites, with both small increases and decreases occurring yearly at each site. There are also no distinct differences in species diversity between sites. There is no clear pattern emerging in species diversity data relating to the time since the TSF establishment and the distance from the TSF.

Ten of the most abundant long-lived woody perennials recorded at the Eliza Creek Jessup transects were separately analysed. All 10 species have shown yearly fluctuations, but no downward population trends at any of the Eliza Creek sites since 2018, with the exception of Dead Finish at one site. The slight downward trend of Dead Finish may be attributable to fluctuating numbers between surveys and difficulty in separating dense clusters of spiky plants into individuals. Regardless, the Eliza Creek Jessup transects have shown an increase in total perennial species abundance.

Canopy cover assessments have also shown positive tree health for the sites downstream of the TSF. Western Myall trees have shown an increase in foliage and recruitment and River Red Gums have regained canopy losses, but there was still no recruitment of Red Gums recorded along transects.

Based on diversity, abundance and canopy cover assessments, no impact from mining activities is considered evident at the formal Eliza Creek sites.

6.8.3.2 Weeds

Weed species were surveyed at existing flora sites; at designated weed transects, and at opportune locations throughout the mining lease area, including the camps and dams. Most weeds recorded were annual herbs or grasses. Most annual weed records were from dams or drainage lines, areas naturally susceptible to weed invasion, and from the dune habitats, and their presence is unrelated to mining activities.

There were no new weeds recorded in 2024 and no overall increase in abundance or extent of weeds declared under legislation. Although not declared, Wards Weed was recorded along the Western Access Road for the first time, however was previously recorded along the Southern Access Road in 2021.

6.8.3.3 Fauna and habitat

The 2024 spring fauna survey identified a total of 107 vertebrate species from the 8 survey sites and opportunistically across the Ecological Study Area. Capture rates for small mammals and reptiles were within baseline and compliance ranges. Reptile and bird diversity, and total species diversity across the whole of Carrapateena was however within or above the range of diversity that has been recorded during baseline surveys, meaning construction and early operational activities do not appear to have resulted in a loss of abundance or diversity. Compared to recent years, increased reptile captures and the highest diversity recorded were most likely influenced by the warmer temperatures during the survey.

Bird diversity was within baseline and compliance range, with waterbird presence increased as a result of water present in dams and a temporary water source at South Eliza. Mammal captures were within baseline and compliance ranges, but diversity was slightly lower for rodents and no planigales were detected.

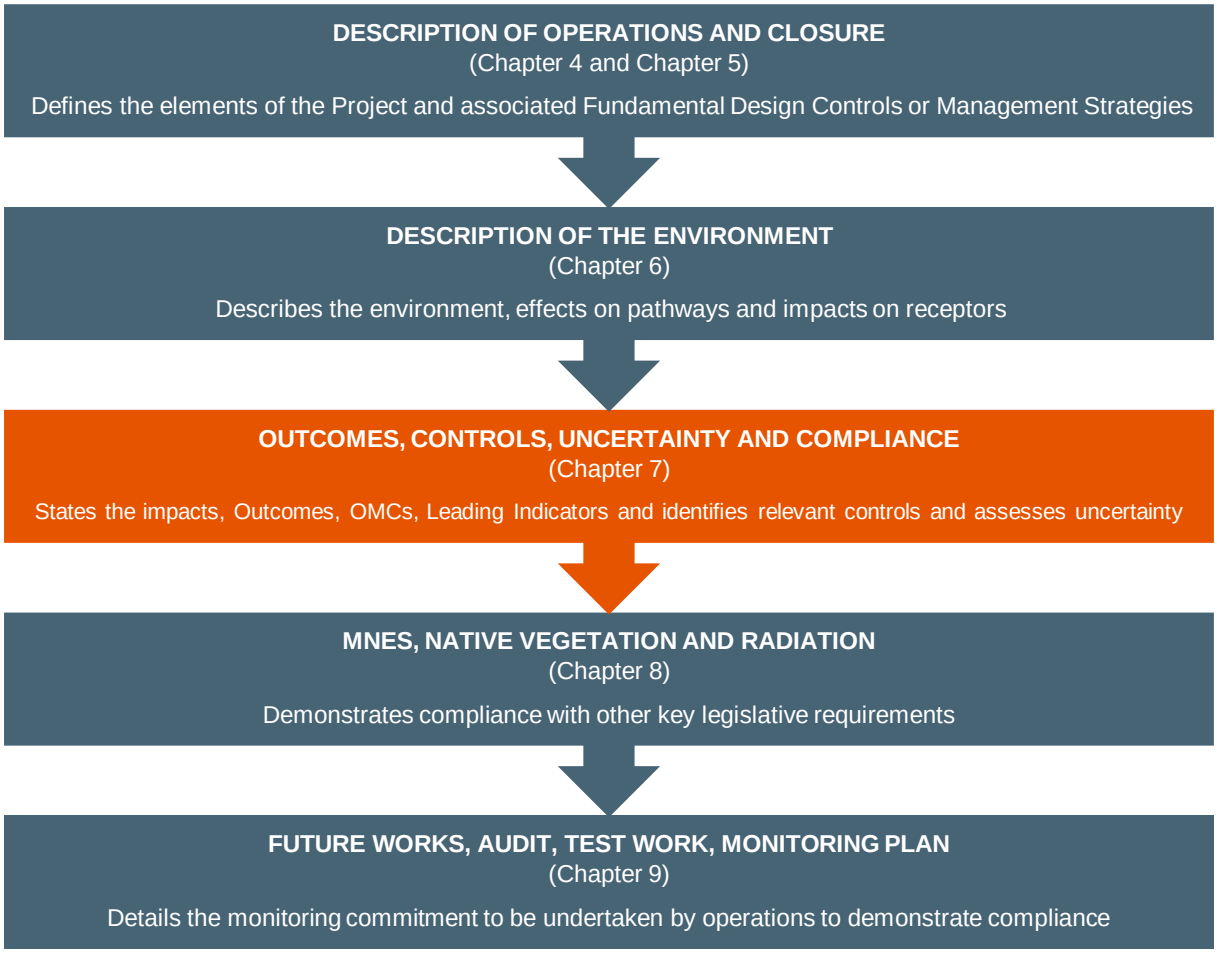
Diversity of species and families was comparable to baseline data, and birds and reptiles showed evidence of breeding (e.g. plumage, multi-sex groupings and presence of juveniles), suggesting that mining-related construction activities are not negatively impacting fauna at Carrapateena.

One species EPBC listed as threatened and migratory was detected (Sharp-tailed Sandpiper) and one species EPBC listed as migratory (Common Sandpiper) was detected throughout the spring 2024 survey; both detected in small numbers at South Eliza Dam. Both species have previously been detected at Carrapateena at dams or effluent irrigation areas with run off. During the survey, there were also 3 fauna species detected that had not been previously recorded within the mining lease during baseline and previous compliance monitoring surveys, specifically the Pelican, Red-necked Avocet and Rufous Songlark.

6.8.3.4 Landscape Function Analysis sites

The current status and trends at 4 rehabilitation sites (Aerodrome laydown, Ventia laydown, Midway Quarry and Tjungu) were again measured by landscape function analysis (LFA), using the Established Method and Point Centre Quarter (PCQ) method for all sites. The LFA and PCQ method show a positive trend in the number and area of plants per hectare at all 4 rehabilitation sites, but also demonstrate that differences between application of rehabilitation techniques may affect flora recruitment. These include deeper contour ripping and application of rocky surface strew at the Aerodrome, Midway Quarry and Tjungu sites compared with shallow contour ripping at the Ventia site.

7. Environmental Outcomes, controls, uncertainty and compliance



This chapter sets out the following regulatory requirements for Carrapateena:

- statement of Environmental Outcomes
- design and management strategies
- uncertainties, sensitivities and assumptions
- OMC to demonstrate how the Environmental Outcomes are being achieved
- Leading Indicators
- strategies to verify uncertainties (future works).

Regulatory requirements regarding MNES and EPBC Act offsets are discussed separately in Chapter 8.

Tables have been provided for each tenement to provide line-of-sight from the impact events that have resulted in the application of an Environmental Outcome.

The statement of Environmental Outcomes specified in the Sixth Schedule of each tenement document (Appendix A) is linked to the impact events and associated risk events identified in:

- Carrapateena MLP Response Document (OZ Minerals 2017c; Appendix I Updated Consolidated Assessment)

- Airstrip and Workers' Accommodation Village MPL MP (OZ Minerals 2016; Appendix C Assessment Tables by Receptor)
- Northern Wellfield MPL MP (OZ Minerals 2018c; Appendix E Consolidated Assessment).

The assessment tables are grouped by phase and prepared in accordance with the impact assessment framework discussed in Section 3.5. The Environmental Outcomes are discussed in the context of design and management strategies that BHP has adopted or proposes to adopt to achieve the Environmental Outcomes.

A review of the uncertainties, sensitivities and assumptions related to the design and management strategies is presented in the context of BHP's ability to achieve the Environmental Outcomes. Actions to reduce significant uncertainties are managed through the application of strategies (future works) that will be progressively achieved and aligned with the tenement conditions. This provides Carrapateena an outline of what activities to plan for in future years to reduce significant uncertainty.

OMC and Leading Indicators allow the demonstration that the Environmental Outcomes are being, or will be, achieved. The OMCs have been developed using key elements including measurement methods, monitoring locations, achievement values, monitoring frequency and relevant control or baseline data.

This chapter presents a framework for the ongoing environmental management of Carrapateena to ensure that the Environmental Outcomes are achieved through the construction, operation and closure phases. This is supported by the Monitoring Plan provided in Chapter 9. The Monitoring Plan provides Carrapateena operations a summary for all monitoring commitments to be undertaken to demonstrate compliance against all legislative requirements.

The design and management strategies have been carefully considered to ensure they are proportionate to the significance of the impact, or consequence of the risks on environmental receptor(s); achieve compliance with other applicable statutory requirements; are technically and economically achievable; and are best practice in mining and environmental management.

7.1 Changes to environmental impact assessments

No changes to the original impact assessments are predicted as a result of preparation of this PEPR and the implementation of the proposed changes to approved operations described in Section 1.2.

Further baseline environment information has been collected following lodgement of the MLP (OZ Minerals 2017a) and the original PEPR (OZ Minerals 2017b) as part of routine environmental monitoring (see Chapter 9), however the understanding of the baseline environment (see Chapter 6) has not fundamentally changed, and as such there are no associated changes to the impact assessment. Additional impacts have been added where they were identified through the government assessment process of the Management Plans.

7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria

This chapter provides the Statement of Environmental Outcomes, and Design and Management Strategies, which provide the following:

- sets out the Environmental Outcomes specified in the Sixth Schedule of the respective tenement documents (Appendix A)
- links the Environmental Outcomes to the impact events and associated risk events identified in the MLP and MPL MPs (OZ Minerals 2016; 2017a; 2018c)

- provides context with a line-of-sight from the impact events that led to the Environmental Outcomes, therefore only impacts that resulted in an Environmental Outcome are presented
- identifies relevant design and management strategies that will be adopt to achieve the Environmental Outcomes, with reference to the following:
    - where design and management strategies are relevant to specific Carrapateena elements they are identified in Chapter 4 and Chapter 5.
    - where there is a high reliance on a design or management strategy identified to achieve an Environmental Outcome this has been identified.

Any significant uncertainties, sensitivities and assumptions pertaining to the likely effectiveness of design or management strategies have been described. Future activities to reduce uncertainty will be managed by the application of OMC that will be progressively achieved and reported against in annual Compliance Reports.

Environmental Outcomes demonstrate a commitment to limit an impact that an activity can have on the environment and community. BHP has recommended, where required, OMC and Leading Indicators for different scenarios described below. Demonstrated commitment to comply with conditions to the extent to which an activity would limit impact on the environment and community is provided in Appendix A7.

Outcome Measurement Criteria (OMC) set out the measurement methods, location, achievement, frequency and baseline data that are used to measure performance against a stated Outcome during construction, operation and closure phases.

A Leading Indicator is required when there is a high reliance on a control strategy to achieve the Environmental Outcome. A Leading Indicator is used to give an early warning that a control strategy may fail or be failing and may subsequently lead to not achieving the Outcome.

Leading Indicators set out measurable standards which, when monitored, provide an early warning that a control measure is failing and/or that an Outcome is potentially at risk of not being achieved.

Through the development of the Outcomes, OMC and Leading Indicators a consistent set of terminology has been used, as defined below.

Audit: Systematic review undertaken by an expert of performance against design systems, records, standards and/or legislation that is documented in an audit report.

Inspection: Documented collection of visual evidence, including photographs.

Investigation: Documented systematic assessment, undertaken by an expert, to ascertain the root cause behind an incident, including corrective actions if required.

Monitoring/Survey: Documented collection of data and analysis using scientific methods.

7.3 Statement of Environmental Outcomes and OMC

Environmental Outcomes and OMC are provided in Section 7.3.1 to Section 7.3.13 below.

7.3.1 Aboriginal heritage

Table 7.1 | Environmental Outcome(s) and OMC relevant to Aboriginal heritage

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L01	Land clearing associated with the construction of the project results in the removal, relocation or damage of artefacts that are of significance to the heritage and culture of the Kokatha People.	Design Strategies • Avoidance of sites of cultural heritage significance as determined in consultation with the Kokatha People Management Strategies • Cultural heritage surveys with the Kokatha People • Cultural Heritage Obligations Register and supporting GIS information (shapefiles) to record/identify clearance areas and status • Land disturbance approval process* • Cultural respect training for all operational staff • Area-specific and site inductions and training • Employment of suitably qualified people • Cultural Heritage Management Plan, including new discovery reporting procedures* • Identification and fencing of sites of cultural heritage significance • Monthly (construction) or annual (operations) land disturbance reconciliation* • Annual review of Cultural Heritage Management Strategy by KAC	No significant uncertainties, sensitivities or assumptions identified.	ML 6471 MPL 152 to 154 MPL 156 Schedule 6 Condition 1 The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation. MPL 149 Schedule 6 Condition 7 The Tenement Holder must during construction and operation ensure that there is no disturbance to Aboriginal heritage sites, objects or remains unless it is authorised under relevant legislation.	**Outcome Measurement Criteria**						
L02	The project results in the disturbance of sites that are of significance to the culture and storylines of the Kokatha People.				AH1	Audit of land disturbance permits	Infrastructure locations (Figure 4.2 to Figure 4.7)	Prior to any ground disturbance occurring infrastructure locations are: • within approved work areas • within cultural heritage survey report conditions • have authorisation in accordance with the *Aboriginal Heritage Act 1988* (SA)	Annual	Construction and operations	ML 6471 MPL 149 MPL 152 to 154 MPL 156
					AH2	Audit of cultural heritage survey records	Infrastructure locations (Figure 4.2 to Figure 4.7)	Upon discovery of new Aboriginal heritage sites, objects or remains were treated in accordance with the Cultural Heritage Management Plan until authorisation under the *Aboriginal Heritage Act 1988* (SA) was obtained	Annual	Construction and operations	ML 6471 MPL 149 MPL 152 to 154 MPL 156
					Leading Indicator						
					AH3	Inspection (ground survey, drone flyover or suitable alternative method)	Infrastructure locations (Figure 4.2 to Figure 4.7)	Land clearing has not been undertaken outside of areas defined in the associated land disturbance permit	Following completion of land clearance	Construction and operations	ML 6471 MPL 149 MPL 152 to 154 MPL 156

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.2 Public nuisance

Table 7.2 | Environmental Outcome(s) and OMC relevant to public nuisance

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
AQ41 ID007	Traffic movements along access roads releases dust that is transported by prevailing winds resulting in nuisance impacts to the local community (pastoral homestead).	Design Strategies • Pernatty Station Homestead bypass road Management Strategies • Maintenance of unsealed roads • Dust suppression on unsealed roads* • Speed limit restrictions at homestead* • Operating Protocols • Heavy vehicle transport movements adjacent to the Pernatty Homestead limited to hours between 7 am and 7 pm without prior agreement	Procedures that support the existing Operation have been developed and incorporate aspects related to the maintenance and dust suppression of the unsealed roads, including meteorology-related factors that influence frequency. Transport of material to and from the previous RL-related operations and current ML activities is undertaken on the existing Southern Access Road alignment (located 200 m from a residence), and the response of the residents to amenity impacts is understood. OMC demonstrate the effectiveness of the controls to ensure the Outcome is achieved. If the supporting Leading Indicator is triggered the operations will review the effectiveness of the controls and adjust if required.	ML 6471 MPL 152 to 154 Schedule 6 Condition 4 The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining-related traffic. MPL 149 Schedule 6 Condition 5 The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining related traffic.	**Outcome Measurement Criteria**						
AQ43 ID009	Traffic movements along access roads resulting in noise emissions and nuisance impacts to the local community (pastoral homestead).				PN1	Audit of stakeholder engagement records	Access roads (Figure 4.2 to Figure 4.7)	• all traffic related dust and noise concerns associated with access roads are responded to in accordance with the Local Area Agreement - Operating Protocols within 24 hours upon notification • any corrective actions are closed out within 14 days or as agreed with the Director of Mines (or other authorised officer)	Quarterly	Construction and operations	ML 6471 MPL 149 MPL 152 to 154
					PN2	Gravimetric analysis of continuous dust deposition	Monitoring site adjacent to Pernatty Homestead (Figure 9.1; ERML09)	Dust deposition rates do not exceed 4 g/m^2/month (total) as per Table 7.1 of Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005)	Quarterly collection and analysis during operation of the southern access road	Construction and operations	ML 6471 MPL 149
					Leading Indicator						
					PN3	Gravimetric analysis of continuous dust deposition	Monitoring site adjacent to Pernatty Homestead (Figure 9.1; ERML09)	Exceedances of baseline levels of 1.6 g/m^2/month over three consecutive months	Monthly collection and analysis	Construction	ML 6471 MPL 149

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.3 Traffic

Table 7.3 | Environmental Outcome(s) and OMC relevant to traffic

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L09	Increased traffic associated with the project result in traffic accidents with the general public resulting in serious injury or death.	Design Strategies • Intersections with the Stuart Highway constructed in accordance with appropriate standards and other requirements established in consultation with DPTI Management Strategies • Traffic Management Plans and speed limits • Area-specific and site inductions and training	No significant uncertainties, sensitivities or assumptions identified.	ML 6471 MPL 152 to 154 Schedule 6 Condition 5 MPL 156 Schedule 6 Condition 2 The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.	Outcome Measurement Criteria						
					INC1	Investigation and corrective actions	Access roads (Figure 4.2 to Figure 4.7)	• the incident could not have been reasonably prevented • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer)	Triggered as a result of an accident associated with mine related traffic	Construction and operations	ML 6471 MPL 152 to 154 MPL 156

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.4 Public safety

Table 7.4 | Environmental Outcome(s) and OMC relevant to public safety

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L07 ID012	Access to the site by the general public during construction and operation results in serious injury or death. During operations, unauthorised public access to the airstrip results in serious injury or death as a result of interaction with aircraft.	Design Strategies • Access area gatehouse and signage at site access points. • Exclusion fencing around mine compounds. • Livestock fencing around TSF. • Security gatehouse would be established at the entry to the proposed Mineral Lease area. • Signage at mine access points. • 1.2–1.5 m high wildlife and stock control fence surrounding the airstrip. Management Strategies • Airstrip clearance and foreign object inspections. • Airstrip operating procedures.	There is low uncertainty relating to this impact event and associated risks due to the remote nature of the site. Authorised entry will be limited to pastoralists.	ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 2 The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented. MPL 149 Schedule 6 Condition 3 The Tenement Holder must during construction and operation ensure that unauthorised entry to the site does not result in public injuries and or deaths that could have been reasonably prevented.	Outcome Measurement Criteria						
					PS1	Investigation and review of incident report records	Infrastructure locations (Figure 4.2 to Figure 4.6)	• the incident could not have been reasonably prevented • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer)	Triggered as a result of an incident associated with unauthorised entry	Construction and operations	ML 6471 MPL 149 MPL 152 to 154
L08 ID050	Access to the site at closure by the general public at closure results in serious injury or death.	Design Strategies • Design measures to minimise risks at closure (e.g. SLC abandonment bund, decline portal plug, box cut backfilled, ventilation raises capped) Management Strategies • Decommissioning and Rehabilitation Plan • Removal of infrastructure • Cave Monitoring Plan	Basis of Closure Design Public safety with respect to the post-completion Project Area must be able to be managed in perpetuity, and therefore must rely on passive controls over the long-term. OZ Minerals is confident that the closure activities identified in Section 4.16 will achieve the Outcome. Abandonment Bund There is an identified uncertainty associated with the final location of the abandonment bund in relation to the final subsidence zone footprint. OMC have been applied to management this uncertainty post completion**.	ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 3 MPL 149 Schedule 6 Condition 4 The Tenement Holder must demonstrate that post completion, the risks to the health and safety of the public so far as it may be affected by mining-related activities are as low as reasonably practicable.	Outcome Measurement Criteria						
					PS2	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) against the Guideline 'Safety Bund Walls Around Abandoned Open Pit Mines' (Department of Industry and Resources 1997), including a review of: • the underground caving system • geotechnical data and other relevant data from the Cave Monitoring Plan.	Underground mine SLC subsidence zone and abandonment bund (Figure 4.19)	• the underground mine has been operated within design parameters • the predicted vertical and lateral extent of the SLC Subsidence Zone is validated • the abandonment bund is adequately located outside of the subsidence zone	Prior to placement of the abandonment bund	Closure	ML 6471
					PS3	Electronic and hard copies of a topographical survey of the SLC subsidence zone	SLC subsidence zone and abandonment bund (Figure 4.19)	Provided to the Director of Mines (or other authorised officer) to confirm the extent of the surface expression at mine completion	Prior to application of lease surrender	Closure	ML 6471
					PS4	Construct to design audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Decline portals and box cut (Figure 4.2)	Confirms the decline portals and box cut have been closed in accordance with the basis of design (Section 5.4.2)	Prior to application of lease surrender	Closure	ML 6471
					PS5	Construct to design audit undertaken by an independent and suitably qualified expert approved by	Vent rise plug and vent rises (Figure 4.16)	Confirms vent rise closure has been undertaken in accordance with the	Prior to application of lease surrender	Closure	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
						the Director of Mines (or other authorised officer)		basis of design (Section 5.4.3.1)			
					PS6	Construct to design audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	SLC subsidence zone and abandonment bund (Figure 4.19)	Confirms the abandonment bund around the subsidence zone has been constructed in accordance with the Guideline 'Safety Bund Walls Around Abandoned Open Pit Mines' (Department of Industry and Resources 1997)	Prior to application of lease surrender	Closure	ML 6471
					PS7	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Infrastructure locations (Figure 4.3 to Figure 4.6)	All infrastructure is removed or left in-situ as agreed with stakeholders (OMC – LUP2) in a manner that risks to the health and safety of the public so far as it may be affected by mining-related activities are as low as reasonably practicable	Prior to application of lease surrender	Closure	MPL 149 MPL 152 to 154
					PS8	Construct to design audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Mine area borrow pit (Figure 4.2)	Confirms the Mine area borrow pit has been closed in accordance with a closure design endorsed by DEM. The closure design will be provided to DEM through a future PEPR update prior to completion	Prior to application of lease surrender	Closure	ML 6471

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed
** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

7.3.5 Native vegetation

Table 7.5 | Environmental Outcome(s) and OMC relevant to native vegetation

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L10 ID018 ID021	Land clearing associated with the construction of project infrastructure results in a loss of abundance and/or diversity of common native vegetation and fauna.	Design Strategies • Avoidance of critical habitat during site selection • Completing pre-construction 'clearance' surveys to identify any critical and preferred habitat of plains mouse (e.g. cracking clays on run-ons, drainage channels or gilgais), thick billed grasswrens (e.g. patches of taller and dense shrubland habitat, often associated with drainage channels) and night parrots (e.g. spinifex hummock grasslands) by a suitably qualified and experienced ecologist • Flag off any populations or preferred habitat identified in close proximity to the disturbance footprint identified during the pre-construction 'clearance' surveys • Access track upgrade or construction will include flow disruptors and diversion drains to minimise erosion Management Strategies • Land disturbance approval process* • Area-specific and site inductions and training • Monthly (construction) or annual (operations) audits of the land disturbance register (which captures all land disturbance permits) for infrastructure locations* • Land Disturbance Register and supporting GIS information (shapefiles) to record/identify clearance areas and status* • Identifying location of *Sclerolaena* sp. Yeltacowie with flagging during construction • Inspections (via ground survey, drone flyover or suitable alternative method) of the Northern Wellfield during construction to ensure that land clearing does not occur outside of approved areas defined in the land disturbance permits • Including awareness training regarding the conservation significance of flora and fauna species in the area as part of the induction process	Land Disturbance Land disturbance associated with project infrastructure has been determined and assessed against the known vegetation associations in the Project Area. Baseline Ecology Baseline ecology is well understood with extensive survey efforts undertaken in Autumn and Spring from 2012 to 2017 following an intensive survey in 2007. New sites to assess the potential impacts from air quality and surface water will have surveys undertaken prior to the commencement of construction activities. SEB Management It is recognised that reconciliation of actual land disturbance is retrospective, and thus land disturbances beyond the significant environmental benefit provision may occur prior to reconciliation if both the significant environmental benefit provision and the land disturbance is not managed appropriately. OMC have been applied to require reconciliation to ensure adequate offsetting provisions are available** MNES Baseline information supported by a comprehensive understanding of the ecological environment which describes the likelihood of occurrence of each relevant EPBC Act listed species based on extensive baseline survey effort and assessment of key habitat and vegetation communities within the Project Area. Data collection methods relating to EPBC listed threated species included: • Bi-annual flora and fauna surveys utilising widely accepted State Government biological survey methods across a total of 16 sites, including habitat types suitable for potentially present EPBC listed species. • Dedicated habitat analysis and mapping for EPBC species: Plains Mouse (*Pseudomys australis*) and the Thick-billed Grasswren (*Amytornis modestus*). • Targeted threatened species survey in habitat considered suitable for Thick-billed Grasswren (*Amytornis modestus*). • Desktop reviews and assessment to assess the potential presence of threatened species and communities	ML 6471 MPL 152 to 154 Schedule 6 Condition 11 Tenement Holder must, during construction and operation, ensure that there is no permanent loss of abundance and/or diversity of native vegetation on or off the Land as a result of mining-related activities unless a significant environmental benefit has been approved in accordance with the relevant legislation. MPL 149 Schedule 6 Condition 9 The Tenement Holder must during construction and operation ensure no loss of abundance or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation. MPL 156 Schedule 6 Condition 8 The Tenement Holder must during construction, operation and post Completion, ensure that there is no loss of abundance and/or diversity of native vegetation on or off the land unless a significant environmental benefit has been approved in accordance with the relevant legislation.	**Outcome Measurement Criteria**						
					NV1	Audit (reconciliation) of land disturbance register	Infrastructure locations (Figure 4.2 to Figure 4.7)	Native vegetation clearance does not exceed the significant environmental benefit approved under the *Native Vegetation Act* 1991 (SA)	Annual	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
								Plains mouse habitat clearance does not exceed that approved under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth)			ML 6471 MPL 152 to 154
L11	Land clearing of fauna habitat associated with the construction of project infrastructure results in a loss of abundance and/or diversity of NPW Act listed flora and fauna.				EC01	Baseline ecological surveys	At water dependent ecosystems including, but not limited to SW-6 and SW-7 (Figure 9.5)	Completed # # Linked to Native Vegetation Strategy (Schedule 6 Condition 9.1)	Prior to the impact of mining operations or mining-related activities on the existing environment	Not applicable	MPL 156
L12	Land clearing of fauna habitat associated with the construction of project infrastructure results in a loss of abundance and/or diversity of EPBC Act listed native flora and fauna.				**Leading Indicator**						
					NV2	Inspection (ground survey, drone flyover or suitable alternative method)	Infrastructure locations (Figure 4.2 to Figure 4.7)	Demonstrates land clearing has not been undertaken outside of areas defined in the associated land disturbance permit	Following completion of land clearance	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

7.3.6 Weeds and pests

Table 7.6 | Environmental Outcome(s) and OMC relevant to weeds and pests

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Outcome Measurement Criteria						
L16 L20 ID013	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing or new weeds (overabundance) reducing the quality of grazing land and impacting the income and business viability of surrounding pastoral stations.	Management Strategies • Vehicle inspections and wash-down procedures* • Weed inspection program within disturbance footprint* • Priority Weed list for quick identification (Plate 9.1) • Weed and pest eradication programmes* • Waste Management Plan and practices • Landfill Environment Management Plan • Pest eradication program • Waste Management Plan and practices • Daily cover of landfill face	**Overabundance** As arid area weed species are also typically annual species, which respond to heavy rainfall events and are widespread throughout the arid region, it is expected that the abundance of weeds will fluctuate naturally in response to the prevailing meteorology.	ML 6471 Schedule 6 Condition 6 Schedule 6 Condition 28.1 MPL 152 to MPL 154 Schedule 6 Condition 6 MPL 149 Schedule 6 Condition 10 MPL 156 Schedule 6 Condition 3 The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining-related activities.	WP1	Flora and fauna surveys undertaken by independent and suitably qualified ecologists	Flora, fauna and weeds monitoring locations (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	No introduction of: • new species of weeds declared or listed under relevant legislation • plant pathogens • pests (including feral animals) when compared to previously recorded weed species (Table 9.12) and introduced fauna (Table 9.13)	Annual (Spring)	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
L17 L21 ID024 ID027	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of common native vegetation and fauna										
L18 L22	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a reduction of habitat and a subsequent loss of abundance and/or diversity of NPW Act listed native flora and fauna.				WP2	Flora and fauna surveys undertaken by independent and suitably qualified ecologists	Flora, fauna and weeds monitoring locations (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	No increase in the abundance of existing weeds or pest species in the land compared to previous survey records	Annual (Spring)	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
					Leading Indicator						
L19 L23	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a reduction of habitat and a subsequent loss of abundance and/or diversity of EPBC Act listed flora and fauna.				WP3	Inspection (including photographic evidence)	A selected infrastructure location (Figure 4.2 to Figure 4.7) Alternative locations must be selected until all locations have been complete, or on a demonstrated risk-based approach	Identifies weeds listed as a Priority Weed (Plate 9.1) and triggers a review of the effectiveness of management strategies	Monthly	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L24 L28	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds reducing the quality of grazing land and impacting the income and business viability of surrounding pastoral stations.				WP4	Audit of inspection records (including photographic evidence)	Maintained at the site by the waste contractor	Prior to collection food waste containers that service the accommodation village kitchen are closed to prevent feral animal scavenging	Quarterly	Construction and operation	ML 6471
L25 L29	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of common native vegetation and fauna.				WP5	Audit of inspection records (including photographic evidence)	Maintained at the site by the waste contractor	The tip face has been covered at the end of each day to prevent feral animal scavenging	Quarterly	Construction and operation	ML 6471
L26 L30	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of NPW Act listed flora and fauna.				WP6	Audit of records	Maintained at the site by all contractors	Demonstrates that all incoming vehicle, plant and equipment have been subject to weed hygiene procedures	Quarterly	Construction and operation	ML 6471 MPL 152 to 154 MPL 156
L27 L31	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of EPBC Act listed flora and fauna.										
L28 L32	Project activities attract predatory pest species to the Project Area that impact on the abundance and/or diversity of common native fauna species.										
L29 L33	Project activities attract predatory pest species to the Project Area that impact on the abundance and/or diversity of NPW Act listed fauna.										
L30 L34	Project activities attract predatory pest species to the Project Area that impact on the abundance and/or diversity of EPBC Act listed fauna.										

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed
** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

7.3.7 Native fauna

Table 7.7 | Environmental Outcome(s) and OMC relevant to native fauna

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L31 L32 L33 ID040 L35 L36 L37	Project activities including the electricity line, vehicle movements or airstrip operations interact with native fauna species cause serious injury or death impacting on the abundance and/or diversity common, NPV Act listed and EPBC Act listed native fauna.	Design Strategies • 1.2–1.5 m high wildlife and stock control fence surrounding the airstrip • Airstrip clearance and foreign object inspections • Transmission line spacing between phase and ground conductors greater than 150 cm • Insulation of phase and/or ground conductors where necessary • Installation of perch discourages on transmission line. Management Strategies • Traffic Management Plan and speed limits. • Area-specific and site inductions and training. • Wherever possible, open excavations and drillholes will be covered as soon as practicable or managed to ensure no entrapment can occur through the use of ramps • Incident reporting procedures. • Airstrip operating procedures • Airstrip clearance and foreign object inspections • Wildlife and stock control fence maintenance program	MNES Baseline information supported by a comprehensive understanding of the ecological environment which describes the likelihood of occurrence of each relevant EPBC Act listed species based on extensive baseline survey effort and assessment of key habitat and vegetation communities within the Project Area. Data collection methods relating to EPBC listed threated species included: • Bi-annual flora and fauna surveys utilising widely accepted State Government biological survey methods across a total of 16 sites, including habitat types suitable for potentially present EPBC listed species. • Dedicated habitat analysis and mapping for EPBC species: Plains Mouse (Pseudomys australis) and the Thick-billed Grasswren (*Amytornis modestus*). • Targeted threatened species survey in habitat considered suitable for Thick-billed Grasswren (*Amytornis modestus*). • Desktop reviews and assessment to assess the potential presence of threatened species and communities.	ML 6471 Schedule 6 Condition 13 MPL 149 Schedule 6 Condition 8 MPL 152 to MPL 154 Schedule 6 Condition 12 The Tenement Holder must ensure during construction, operation and post completion that there are no native fauna injuries or deaths due to mining-related activities that could reasonably have been prevented. MPL 156 Schedule 6 Condition 10 The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.	**Outcome Measurement Criteria**						
					NF1	Investigation and review of incident report records	Infrastructure locations (Figure 4.2, Figure 4.4 to Figure 4.7)	• the incident could not have been reasonably prevented • animal welfare was handled in accordance with the *Animal Welfare Act 1985* (SA) • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or authorised officer)	Triggered as a result of serious harm or death of native fauna Serious harm is defined in the *Animal Welfare Act 1985* (SA)	Construction and operation	ML 6471 MPL 152 to 154 MPL 156
					NF4	Inspection (ground survey)	Wildlife and stock control fence surrounding the airstrip (Figure 4.3)	The integrity of the fence is maintained	Monthly	Construction and operation	MPL 149
					Leading Indicator						
					NF2	Audit signed by construction manager	Transmission Line (Figure 4.4)	Demonstrates infrastructure has been constructed in accordance with the transmission line design including: • Line spacing between phase and ground conductors greater than 150 cm • Insulation of phase and/or ground conductors where necessary • Installation of perch discourages	Completion of construction	Construction	MPL 152
					NF3	Audit signed by construction manager	Transmission Line (Figure 4.4)	Demonstrates speed limit signage has been installed at entry points and at a minimum of 5 km intervals in accordance with the design plans	Completion of construction	Construction	MPL 152
					NF5	Airstrip clearance and foreign object inspections	Airstrip (Figure 4.3)	Identify a rising trend in kangaroo, emu and stock assess to the internal permitter of the wildlife and stock control fence surrounding the airstrip	Prior to the landing and take-off of aircraft	Operations	MPL 149

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L12	Land clearing of fauna habitat associated with the construction of project infrastructure results in a loss of abundance and/or diversity of EPBC Act listed native fauna.	Design Strategies • Avoidance of critical habitat during site selection Management Strategies • Land disturbance approval process* • Area-specific and site inductions and training • Monthly (construction) or annual (operations) land disturbance reconciliation* • Land Disturbance Register and supporting GIS information (shapefiles) to record/identify clearance areas and status*		ML 6471 Schedule 2 Condition 28.2 MPL 152 Schedule 2 Condition 13.2 Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. ML 6471 Schedule 2 Condition 28.3 MPL 152 Schedule 2 Condition 13.3 Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. ML 6471 Schedule 2 Condition 28.4 MPL 152 Schedule 2 Condition 13.4 Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team.	EPBC1	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	Records of the Thick-billed Grasswren are provided to the Biological Database of South Australia BDBSA if observed # Linked to MNES Condition (Schedule 2 Condition 28.2)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154
					EPBC2	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	Records of the Plains Mouse are provided to the Biological Database of South Australia BDBSA if observed # Linked to MNES Condition (Schedule 2 Condition 28.4)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154
					EPBC3	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	Records of the Night Parrot are provided to the Night Parrot Recovery Team if observed # Linked to MNES Condition (Schedule 2 Condition 28.3)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154

7.3.8 Land use and property

Table 7.8 | Environmental Outcome(s) and OMC relevant to land use and property

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Outcome Measurement Criteria						
L23 L27	Permanent decrease in pastoral activity as a result of restricted access around project infrastructure impacts the income and business viability of Pastoral Stations.	Design Strategies • Rehabilitation of land to achieve a landscape function equivalent to the surrounding landscape • Airstrip clearance and foreign object inspections • 1.5 m high wildlife and stock control fence surrounding the airstrip • Separation of overland surface water flows originating from undisturbed areas of the Project Area from the surface water runoff that has interacted with stockpiles and access roads. • Provision of sediment basins/ponds and appropriate drainage on roadways adjacent to surface water bodies or catchments for the collection of sediments in surface water transported along the roadway (longitudinal flows). • Existing fords, culverts, diversion drains, bunding and sedimentation/event basins designed and installed in accordance with Best Practice Operating Procedures endorsed by the SA Arid Lands Natural Resources Management Board or a Water Affecting Activity Permit under the *Natural Resources Management Act 2004* (SA). Future infrastructure would be subject to a Water Affecting Activity Permit under the *Landscape South Australia Act 2019* (SA). • Infrastructure designed with consideration to facilitating closure and permitting progressive rehabilitation (e.g. layout of temporary and permanent site infrastructure, placement of stockpiles, design of plant and equipment modules etc.). Management Strategies • Local Area Agreement - Operating Protocol	Land Use Uncertainty Conservative assumptions to the use and stocking levels of pastoral land in the Project Area. Fencing arrangements are not yet confirmed and access arrangements will be discussed with pastoralists through local level agreements. No significant uncertainties, sensitivities or assumptions identified. Rehabilitation Method The rehabilitation methodology has not been finalised. Historical rehabilitation of exploration sites has successfully achieved landscape functions equivalent to surrounding analogues, however a systematic methodology to achieve this has not been documented**. Land Disturbance Land disturbance associated with Project infrastructure has been determined and assessed against the known vegetation associations in the Project Area. Baseline Ecology Baseline ecology is well understood with extensive survey efforts undertaken in Autumn and Spring from 2012 to 2017 following an intensive survey in 2007. MNES EPBC Act Protected Matters Significant Impact Assessments (MPL MP OZ Minerals 2018c; Appendix D) were also undertaken for the Project and found no significant impacts predicted in line with the EPBC Significant Impact Criteria. Groundwater Modelling Two conceptualisations were developed for shallow	ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 7 The Tenement Holder must during construction and operation ensure there are no impacts to third-party land use or property on or off the Land as a result of mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register). MPL 149 Schedule 6 Condition 6 The Tenement Holder must during construction and operation ensure no impacts to agricultural productivity for third-party land users on or off the Land as a result of mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register). MPL 156 Schedule 6 Condition 4 The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than	LUP1	Audit of stakeholder engagement records	Arcoona, Pernatty and Bosworth Pastoral Lease or adjacent pastoral leases (Figure 4.2 to Figure 4.7)	• concerns associated with agricultural productivity of Pernatty, Arcoona or Bosworth Pastoral Lease or adjacent pastoral leases as a result of ML or MPL-activities are responded to in accordance with the Local Area Agreement - Operating Protocol within 24 hours • any corrective actions are closed out within 14 days or as agreed with the Director of Mines (or other authorised officer)	Quarterly	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
SW09	Erosion and runoff from stockpiles and disturbed surfaces leads to increased sedimentation of surface water at stock dams and impacts the income and business viability of pastoral stations.				LUP2	Audit of all infrastructure locations against any relevant third party liability legal transfer agreements and Government agreements	Infrastructure locations (Figure 4.2 to Figure 4.7)	All infrastructure have been removed, unless otherwise agreed with Government or signed legal documentation to transfer on going liability of the infrastructure to third parties is provided prior to the relinquishment of the tenement(s)	Prior to application of lease surrender	Closure	ML 6471 MPL 149 MPL 152 to 154 MPL 156
SW10	Erosion and runoff from final landforms including rehabilitated surfaces, TSF embankment and subsidence zone abandonment bund leads to increased sedimentation of surface water at stock dams and impacts the income and business viability of pastoral stations.				LUP3	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Infrastructure locations (Figure 4.2 to Figure 4.7)	LFA monitoring results indicate that the LFA curve has moved above, or is likely to move above the critical threshold of sustainability at infrastructure locations.	Prior to application of lease surrender	Closure	ML 6471 MPL 149 MPL 152 to 154 MPL 156
SW45 SW16	Construction of infrastructure within the Eliza Creek and Salt Creek catchments leads to a reduction of surface water quantity at stock dams and impacts the income and business viability of pastoral stations.				LUP5	Inspection (ground survey)	Wildlife and stock control fence surrounding the airstrip (Figure 4.3)	Demonstrates the integrity of the fence is maintained	Monthly	Construction and operation	MPL 149
GW10	Formation of a lake in the sub-level cave subsidence zone leads to new equilibrium in groundwater units impacting on the income and business viability of pastoral stations.										

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
SE03	Increased traffic on the roads from the project will contribute to the general deterioration of condition of the roads over time that will require maintenance, resulting in impacts to local communities and pastoralists.	• Regular meetings with pastoral land managers • Waivers in place for any water point infrastructure in close proximity to Project activities • Destocking infrastructure locations • Airstrip operating procedures • Traffic Management Plan • Area-specific and site inductions and training • Decommissioning and Rehabilitation Plan • Progressive rehabilitation • Rehabilitation procedures* • Rehabilitation trials • All commercial or industrial waste is disposed of in an EPA licensed facility • Wildlife and stock control fence maintenance program • Rehabilitation procedures* • Stockpile management procedures to ensure quality and quantity is maintained	occurrences of groundwater. The base-case scenario suggests there is no connection between shallow groundwater in alluvial sediments and regional groundwater flow systems (e.g. THA). If connection exists (as presented in the alternative scenario), 2 m of drawdown may occur in the pastoral wells Garden Well, North Well, Well Number 3 and Well Number 4 on the Bosworth pastoral lease as a result of a 30 year operation of the Northern Wellfield. The use of North Well after 30 years of Northern Wellfield operation may limit its use for stock watering, if drawdown is realised, until groundwater levels recover.	those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register). ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 8 MPL 156 Schedule 6 Condition 5 Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post completion. MPL 149 Schedule 6 Condition 1 Before mine completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-mining land use can be recommenced post completion. ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 9 MPL 156 Schedule 6 Condition 6 The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use	Leading Indicator						
SE15 SE11	Permanent decrease in pastoral activity as a result of restricted access around project infrastructure and the presence of heavy industry impacts the income and business viability of Pastoral Stations.				LUP4	Comparison of rehabilitation trials results and LFA monitoring	Areas of disturbed land that has no further mining-related use At least one area per closure domain. LFA monitoring sites (Figure 9.3; CEF1–CEF7)	Rehabilitation has achieved, or is likely to achieve, a landscape function equivalent to that of adjacent analogue LFA sites	Annual LFA monitoring	Closure	ML 6471 MPL 149 MPL 152 to 154 MPL 156
GW09 GW05	Water effecting activities undertaken during the life of the mine leads to a reduction of groundwater quantity at third party user wells impacting on the income and business viability of pastoral stations.				LUP6	Airstrip clearance and foreign object inspections	Airstrip (Figure 4.3)	Identify a rising trend in kangaroo, emu and stock assess to the internal permitter of the wildlife and stock control fence surrounding the airstrip	Prior to the landing and take-off of aircraft	Operations	MPL 149
L13 L17	Rehabilitation is not effective in in achieving a pre-mining landscape function resulting in the long-term loss of abundance and/or diversity of common native vegetation and fauna.										
L14 L18	Rehabilitation is not effective in in achieving a pre-mining landscape function resulting in the long-term loss of abundance and/or diversity of NPW Act listed flora and fauna.										
L15 L19	Rehabilitation is not effective in in achieving a pre-mining landscape function resulting in the long-term loss of abundance and/or diversity of EPBC Act listed native flora and fauna.										

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed
** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

7.3.9 Land and soil

Table 7.9 | Environmental Outcome(s) and OMC relevant to land and soil

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L20 ID014 L24	The transport, storage and handling of hydrocarbons, chemicals and saline water contaminates land leading to a decrease in soil quality resulting in a loss of abundance and/or diversity of native vegetation.	Design Strategies • Hydrocarbon and chemical storage facilities designed in accordance with Australian Standards. • Storages bunded in accordance with EPA Bunding Guidelines and/or relevant Australian Standards* • Landfill is constructed and operated in accordance with EPA Guidelines and is appropriately licensed under the *Environment Protection Act 1993* (SA). Management Strategies • All commercial or industrial waste is disposed of in an EPA licensed facility which is closed in accordance with relevant EPA Guidelines* • Licenced chemical and waste transporters • Establishment of Chemical Database including copies of SDS and storage, handling and disposal requirements* • Contaminated land register • Contracts contain conditions relevant to the bringing of chemicals and hydrocarbons onto site • Induction contains process for bringing chemicals and hydrocarbons onsite including requirements for storage, handling and disposal • Contracts contain conditions relevant to design, management of the storage and handling of chemicals and hydrocarbons • Spill and emergency response procedures • Equipment maintenance to prevent spills • Incident reporting procedures • Regular inspection programs where bunding either temporary or permanent is installed to ensure appropriate use, placement of spill kits, clean up procedures and handling procedures • Decommissioning and Rehabilitation Plan	Effectiveness of Management Controls Spill and emergency response procedures that support the existing Operation have been developed and include remediation methods. Operational performance has demonstrated that BHP can respond to any spills and implement corrective actions where required. OMC have been applied to ensure storage areas are constructed and operated appropriately and waste records are maintained. Rehabilitation The rehabilitation methodology has not been finalised. Historical rehabilitation of exploration sites has successfully achieved landscape functions equivalent to surrounding analogues, however a systematic methodology to achieve this has not been documented.	ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 10.1 MPL 156 Schedule 6 Condition 7.1 The Tenement Holder must ensure that there is no contamination of land and soils either on or off the Land as a result of mining operations or mining-related activities. MPL 149 Schedule 6 Condition 2.1 Schedule 2 Condition 9 The Tenement Holder must, ensure that there is no contamination of land and soils either on or off the Land as a result of mining related activities. MPL 152 to MPL 154 Schedule 6 Condition 10.2 MPL 156 Schedule 6 Condition 7.2 The Tenement Holder must ensure that no contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining-related activities. MPL 149 Schedule 6 Condition 2 Schedule 2 Condition 9 The Tenement Holder must, ensure that no contamination of land and soils either on or off the Land post completion occurs as a result of mining related activities. MPL 149 Schedule 6 Condition 1 Before mine completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-mining land use can be recommenced post completion.	**Outcome Measurement Criteria**						
L21 L25	The transport, storage and handling of hydrocarbons, chemicals and saline water contaminate land leading to a decrease in soil quality resulting in a loss of habitat impacting on the abundance and/or diversity of native fauna				LS1	Accidental spill reporting, investigation and corrective actions	Infrastructure locations (Figure 4.2 to Figure 4.7)	• spill reported to the Director of Mines (or other authorised officer) as soon as reasonably practicable after becoming aware of the harm or threatened harm • all risks were minimised so far as is reasonably practicable • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer)	Triggered as a result of an accidental spill that results or threatens to result in material or serious environmental harm (as defined in Section 5(3) of the *Environment Protection Act 1993* (SA)) to native vegetation, native fauna and/or groundwater	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
L22 L26	The transport, storage and handling of hydrocarbons, chemicals and saline water contaminates land leading to a decrease in soil quality impacting on the income and business viability of pastoral stations.										
L39 ID049 L40	Waste generated during construction and operation activities is not managed correctly to ensure achievement of the post completion land use.				LS5	Internal audit of rehabilitation activities and waste disposal records	Infrastructure locations (Figure 4.2 to Figure 4.7)	• Commercial and/or industrial wastes have been disposed of to an EPA licenced facility	Prior to application of lease surrender	Closure	ML 6471 MPL 149 MPL 152 to 154 MPL 156
ID041	Rehabilitated areas where infrastructure items have been decommissioned are identified as having contaminated soil leading to impacts on the abundance and/or diversity of native vegetation.					Site contamination audit conducted by an independent and qualified auditor		No soil contamination (as defined in the National Environment Protection (Assessment of Site Contamination) Measure 2013) remains in areas used for the handling and storage of hazardous materials			
ID016	Rehabilitated areas where infrastructure items have been decommissioned are identified as having contaminated soil impacting the future income and business viability of Pernatty Station.				**Leading Indicator**						
ID042	Rehabilitated areas where infrastructure items have been decommissioned are not				LS2	Audit of waste disposal records	Maintained at the site	Commercial and/or industrial wastes have been disposed of to an EPA licenced facility	Annual	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
					LS3	Audit of chemical storages	Infrastructure locations	They have been constructed and are operating in	Monthly	Construction and operation	ML 6471 MPL 149

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
	returned to a landscape function preventing the re-establishment of native vegetation and results in the loss of abundance and/or diversity of native vegetation.	• Establishment of a landscape function criteria and rehabilitation methodology • Rehabilitation of land to achieve a landscape function equivalent to the surrounding landscape • Rehabilitation trials • Progressive rehabilitation • Stockpile management procedures to ensure quality and quantity is maintained • Landfill Environmental Management Plan • Waste Management Plan and practices, including daily covering of the landfill face					(Figure 4.2 to Figure 4.7)	accordance with the EPA Guideline 080/16 Bunding and Spill Management (2016)			MPL 152 to 154 MPL 156
ID043	Rehabilitated areas where infrastructure items have been decommissioned are not returned to a landscape function that creates conditions favourable for an increase in density of existing weeds (overabundance) and/or introduced weeds and a loss of abundance and/or diversity of native vegetation.				LS4	Audit of chemical storages	Infrastructure locations (Figure 4.2 to Figure 4.7)	All chemicals are recorded (including volumes) in the chemical database	Monthly	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
ID017	Rehabilitated areas where infrastructure items have been decommissioned is not returned to a landscape function that allows grazing to be recommenced, impacting the income and business viability of Pernatty Station										

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.10 Air quality

Table 7.10 | Environmental Outcome(s) and OMC relevant to air quality

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
AQ06	Activities including land clearing, progressive rehabilitation, material movements and material stockpiles generate particulate emissions that deposit on the land leading to reduce soil quality and subsequent impacts on the abundance and diversity of terrestrial ecology including NPW Act and EPBC Act listed flora and fauna.	Design Strategies • Buffer applied to disturbance footprint to account for edge effects on native vegetation and habitat. • 25 km distance to homestead and water tanks. • Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation). • Enclosure of concentrate storage and handling facilities • Copper concentrate transport containers* Design Strategies for TSF • Rock armouring of final landforms external slopes • Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation) • No-cover capping for TSF surface • Design Strategies for Disturbed Operational Areas • Progressive rehabilitation of disturbed areas • All disturbed areas rehabilitated except for TSF top surface and subsidence zone crater Design Strategies for CTP • Acid mist scrubbers fitted to the CTP flash steam discharge vents* (Fundamental Design Control) Management Strategies • Dust suppression on disturbed land and unsealed roads • Dust suppression systems on crushing operations • Dust suppression at conveyor transfer points • Maintenance of unsealed roads • Dust suppression water sprays on Coarse Ore Stockpile • Destocking infrastructure areas • Waivers will be in place for any water point infrastructure in close proximity to Project activities. • Field trials to confirm outputs of the air quality modelling outputs*	Pathway Uncertainty Baseline air quality has been established across many years of monitoring within the Carrapateena region, spanning multiple seasons and meteorological conditions. Air quality modelling was undertaken using conservative values order to present a worst-case scenario of resultant pollutant concentrations. Further, particulate and dust deposition modelling was undertaken using a range of applied dust mitigation measures, presenting a range of results that assumed best case (all possible mitigation measures applied), most likely (all reasonably practicable mitigation measures applied) and worst case (no mitigation measures applied) scenarios. The assessment of impact significance has assumed that no mitigation measures are applied. A key assumption is the application of a dust threshold lift off speed of 5.4m/s. Uncertainty relates to the accuracy of this assumption in real time and how does this assumption change with the development of the tailings surface area over the long term (1-20 years). Dust lift off speed will be influenced by moisture content, crust thickness, wind speed and particle size.** OMC been applied to validated that the post completion air quality modelling prediction with operational data based on results of a tailing beach trial established early in operations. No-cover capping methodology Reliance on the air quality model to justify the no-cover capping methodology of the TSF. Secondary Pathway – Soil Quality Geochemical modelling was undertaken to determine the potential for soil contamination from metals in dust as presented in Carrapateena MLP Response Document Appendix G Air Quality and Soils Quality Geochemical Effects Assessment. The potential	ML 6471 Schedule 6 Condition 14 The Tenement Holder must during construction, operation and post Completion ensure no adverse change to the air quality environment as a result of particulate emissions and/or dust generated by mining operations or mining-related activities.	Outcome Measurement Criteria						
					AQ1	Gravimetric analysis and review of continuous dust deposition	Monitoring sites adjacent to the TSF (Figure 9.1; ERML16–ERML19)	Dust deposition rates do not exceed 4 g/m^2/month (total) as per Table 7.1 of Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005)	Quarterly collection and analysis	Construction and operations	ML 6471
AQ07	Activities including land clearing, progressive rehabilitation, material movements and material stockpile generate particulate emissions that deposit on the land, stock or stock water points subsequently impacting the income and business viability of Pastoral Stations.				AQ2	Ecological survey undertaken by a suitably qualified and experienced expert	Monitoring sites (Figure 9.3 Flora)	No adverse impact on the diversity and abundance of native vegetation at monitoring sites directly attributed to dust deposition from mining operations or mining-related activities when compared to baseline native vegetation conditions (BHP 2024a; Appendix C5 Ecological Baseline) unless a significant environmental benefit has been approved in accordance with the relevant legislation	Annual (Spring)	Construction and operations	ML 6471
AQ11	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces generate particulate emissions that reduce vegetation health impacting on the abundance and/or diversity of EPBC Act listed flora and fauna.				AQ3	Audit (TSF Closure Strategy Verification Report) undertaken by an independent suitably qualified expert approved by the Director of Mines (or other authorised officer)	Not applicable	Demonstrates: • data has been collected for the calibration of the Air Quality Model and Landform Evolution Model as per Leading Indicators AQ5, AQ6, TSF8 and TSF9 • data collected as per Leading Indicators AQ5, AQ6, TSF8 and TSF9 (and any other relevant data) demonstrates that the TSF closure strategies set out in the PEPR (Section 5.4.8.2), specifically the requirement for no TSF cover system, would be effective in achieving the relevant Environmental Outcomes The audit must also include the following information in each TSF closure strategy verification report: • recommendations for any changes to existing TSF closure strategies to	The audit will be provided to the Mining Regulator at the following frequencies: • initial report at 6 years after lease grant (allowing for 2 years to reach first tailings deposition, and 4 years to conduct the relevant scientific investigations) • 8 years after lease grant • 10 years after lease grant any other timeframe as	Construction and operations	ML 6471
AQ14	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces generate particulate emissions that deposit on the land leading to reduce soil quality and subsequent impacts on the abundance and diversity of terrestrial ecology including NPW Act and EPBC Act listed flora and fauna.										

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
AQ15	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces generate particulate emissions that deposit on the land, stock or stock water points subsequently impacting the income and business viability of Pastoral Stations.	• Acid mist scrubber maintenance and monitoring program including • Continuous monitoring of scrubber performance through the site PCS • Implementation of preventative maintenance and/or condition monitoring processes Regular verification of scrubber performance through third-party isokinetic sampling of the stack vent gases (pre- and post-scrubber). • Copper concentrate transport container maintenance and monitoring program including regular visual inspection of the containers, including the sealing of the lids. • Establishing container filling procedures, with appropriate training and supervision for personnel involved in this task, and the use of container weighing/load information to inform loading activities.	risk to environmental receptors was assessed by adopting previously modelled dust generation/deposition plots and calculating dust loading (and thus deposition) of chemical substances over a 100-year period (and also a 1,000 year period). Such calculations indicated that this scenario/pathway was not significant with respect to potential harm to the environment (being flora and fauna using the soils adjacent to the TSF) with respect to copper relative to 'areas of significant ecological value' (20 mg/kg) over a 1,000-year period. Only cobalt exceeded the HIL A tier 1 criteria for residential land use, but not the commercial/industrial criterion. As such, there is no exceedance of soil tier 1 criteria for open space land use or commercial and industrial land use that is considered applicable for the final land use. OMC has been applied to demonstrate this is achieved post completion** Fundamental Design Control – Acid Mist Scrubbers The robustness of the control has been demonstrated in the Layers of protection analysis presented in MLP Appendix C6 Layers of Protection Analysis. Fundamental Design Control – Copper Concentrate Transport Containers The robustness of the control has been demonstrated in the Layers of protection analysis presented in MLP Appendix C6 Layers of Protection Analysis.				ensure achievement of the relevant Environmental Outcomes; and • recommendations for any new TSF closure strategies to ensure achievement of the relevant Environmental Outcomes. Achievement of the outcome will be met through the independent and suitably qualified expert verifying the requirement for no TSF cover system at any of the stated time intervals. If the independent and suitably qualified expert can not verify the requirement for no TSF cover system, demonstration of achievement of the outcome will be met through: • PEPR review which details the changed and/or new TSF closure strategies; and • payment of a Bond (or top up to the existing Bond) to reflect the rehabilitation liability of the changed and/or new TSF closure strategies	agreed between the Tenement Holder and Director of Mines (or other authorised officer)		
AQ37	Concentrate treatment process generates acid mists that are emitted to atmosphere that reduces vegetation health impacting on the abundance and/or diversity of native vegetation including NPW Act and EPBC Act listed flora and fauna.										
AQ39	Transport of copper concentrate along transport routes results in particulate matter emissions that deposit onto native vegetation reducing vegetation health impacting on the abundance and/or diversity of native vegetation including NPW Act and EPBC Act listed flora and fauna.										
AQ40	Transport of copper concentrate along transport routes results in particulate matter emissions to the atmosphere that reduces air quality resulting in health impacts to the local community (pastoral homestead).				AQ11	Gravimetric analysis of continuous dust deposition	Monitoring sites adjacent to the TSF (Figure 9.1; ERML16–ERML19)	Dust deposition rates do not exceed 4 g/m^2/month as per Table 7.1 of Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005)	Monthly collection post completion for a period of no less than one year (dry weather cycle of below average annual rainfall and tailings must be of a moisture content and crust thickness as per the air quality model inputs	Closure	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					AQ12	Ecological risk assessment including soil sampling undertaken in accordance with NEPM (Assessment of Site Contamination 1999) by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Monitoring sites adjacent to the TSF (Figure 9.1; ERML16–ERML19)	Verifies concentrations of metals are within the site specific Ecological Investigation Levels (Table 9.11). Ecological Investigation levels to be derived based on the ecological risk assessment framework detailed in Schedule B5a “Guideline on Ecological Risk Assessment” (NEPC 2013) Linked to Land and Soil Outcome (Schedule 6 Condition 10.2)	Prior to application of lease surrender	Closure	ML 6471
					Leading Indicator						
					AQ4	Laboratory analysis of continuous metals in dust	Monitoring sites adjacent to the TSF (Figure 9.1; ERML16 – ERML19)	Rising trend in metals concentrations over three consecutive years when compared to previous monitoring results (Table 9.11; ERML1–ERML15)	Annual	Construction and operation	ML 6471
					AQ5	Calibration of the air quality model (OZ Minerals 2017a; Appendix C1 Air Quality Modelling and Assessment of Effects) with operational monitoring data and dust threshold lift data established in the tailings beach trials	TSF	Validates modelling outputs (Table 9.10) • Linked to OMC – AQ3	• At years 6/8/10 of the TSF operation	Construction and operation	ML 6471
					AQ6	Audit by an independent and suitably qualified expert of dust threshold lift data from the tailings beach trials	TSF	Should the threshold lift speed be determined to be below the Air Quality Model dust threshold lift speed of 5.4 m/s, an assessment will be undertaken by an independent and suitably qualified expert to determine if there is a material deviation expected on modelling outputs that triggers a model calibration. Linked to OMC – AQ3	Annual	Construction and operation	ML 6471
					AQ7	Soil sampling and laboratory analysis	Monitoring sites adjacent to the TSF (Figure 9.1;	Rising trend in metals concentrations over three consecutive years when compared to previous	Annual	Construction and operation	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
							ERML16 – ERML19)	monitoring results (Table 9.11) Linked to Land and Soil Outcome (Schedule 6 Condition 10.1)			
					AQ8	Iso-kinetic sampling of the Flash Steam Heat Recovery Stack, Plant Extraction Scrubber Stack and Nonox Vent Scrubber Stack	Concentrate Treatment Plant	Compliance with Schedule 1 of the Environment Protection (Air Quality) Policy 2016 (SA) (Table 9.10) Linked to CTP Condition (Schedule 2 Condition 15)	Quarterly	Construction and operation	ML 6471
					AQ9	Analysis of the Concentrate Treatment Plant scrubber efficiencies (continuous data logging)	Concentrate Treatment Plant	Decrease in the performance of the scrubbing systems for three consecutive months when compared to previous months Linked to CTP Condition (Schedule 2 Condition 15)	Monthly	Construction and operation	ML 6471
					AQ10	Audit of inspection records (including photographic evidence)	Maintained at the site by the transport contractor	Integrity of containers have been checked prior to departure to ensure no release of concentrate to the environment Linked to Concentrate Transport Condition (Schedule 2 Condition 16)	Quarterly	Construction and operation	ML 6471

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed
** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

7.3.11 Radiation

Table 7.11 | Environmental Outcome(s) and OMC relevant to radiation

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
AQ19	Material handling of ore, waste rock and tailings generates radon and radionuclide in dust emissions that reduce vegetation health impacting on the abundance and/or diversity of EPBC Act listed flora and fauna.	Design Strategies • Buffer applied to disturbance footprint to account for edge effects on native vegetation and habitat. • Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation). • Enclosure of concentrate storage and handling facilities. • No mineralised material left on the surface post closure. • No- capping for TSF surface	Radiation Baseline and Modelling Radon was modelled conservatively, assuming that all radon contained within ore was released into the environment, and assessments of dose (OZ Minerals 2017a; MLP Appendix C7 Environmental and Public Radiation Impact Assessment) assumed that all dust was ore in terms of mineralogy and thus contained around 240 ppm uranium. In practice, it is estimated that ore comprises around 65% of all dust emissions during operations, and none following closure. Conservative modelling has allowed the generation of low, most likely and high emissions scenarios, which were modelled to produce a range of predicted ground-level concentrations for the purpose of understanding the model sensitivity and the range of potential impacts. The Public Radiation Impact Assessment used industry standard approaches and was undertaken by independent radiation expert. Tailings – No Capping Methodology Reliance on the air quality model to justify the no-cover capping methodology of the TSF. OMC has been applied to demonstrate that the modelling outputs can be achieved to reduce uncertainty an demonstrate that the no capping methodology is suitable in relation to radiation predictions.	ML 6471 Schedule 6 Condition 16 The Tenement Holder, must during construction, operation and post Completion ensure no public health or environmental impacts from radionuclides (including radon) as a result of mining operations or mining-related activities	Outcome Measurement Criteria						
AQ20	Material handling of ore, waste rock and tailings generates radon and radionuclide in dust emissions that reduces air quality resulting in health impacts to the local community (pastoral homestead).				RAD1	Audit undertaken by an independent and suitably qualified expert of radon and radionuclides data (methods outlined in the approved Radioactive Waste Management Plan)	Monitoring sites (Figure 9.1; ERML1–ERML19)	Demonstrates total radiation doses do not exceed 1 mSv/annum for members of the public	Annual	Operations	ML 6471
AQ21	Material handling of ore, waste rock and tailings generates radon and radionuclide in dust emissions that deposit on the land leading to reduce soil quality and subsequent impacts on the abundance and diversity of terrestrial ecology including NPW Act and EPBC Act listed flora and fauna.				RAD2		Monitoring sites adjacent to the TSF (Figure 9.1; ERML16–ERML19)	Demonstrates total radiation doses do not exceed 10 µGy/hour for non-human biota			
AQ26	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces generate radon and radionuclides in dust emissions that reduce vegetation health impacting on the abundance and/or diversity of EPBC Act listed flora and fauna.				RAD3		Monitoring sites adjacent to the TSF (Figure 9.1; ERML16–ERML19)	Demonstrates total radiation doses do not exceed 1 mSv/annum for members of the public	Annual post completion for a period of no less than one year (dry weather cycle of below average annual rainfall and tailings must be of a moisture content and crust thickness as per the air quality model inputs (OZ Minerals 2017a; Appendix C1 Air Quality Modelling and Assessment of Effects))	Closure	ML 6471
AQ27	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces generate radon and radionuclides in dust emissions that reduces air quality resulting in health impacts to the local community (pastoral homestead).				RAD4		Monitoring sites (Figure 9.1, ERML1–ERML19)	Demonstrates total radiation doses do not exceed 10 µGy/hour for non-human biota			
AQ28	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces generate radon and radionuclides in dust emissions that reduce soil quality and impacts on the abundance and diversity of terrestrial ecology including NPW Act and EPBC Act listed species.										
AQ29	Final landforms including the TSF, sub-level cave subsidence zone crater and rehabilitated surfaces										

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
	generate radon and radionuclides in dust emissions that deposit on the land, stock or stock water points subsequently impacting the income and business viability of Pastoral Stations.										

7.3.12 Surface water

7.3.12.1 Erosion and sedimentation

Table 7.12 | Environmental Outcome(s) and OMC relevant to surface water erosion and sedimentation

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Outcome Measurement Criteria						
SW07 ID044	Erosion and runoff from stockpiles and disturbed surfaces leads to increased sedimentation of surface water along creek lines impacting on the abundance and/or diversity of aquatic ecology and native vegetation	Design Strategies • Separation of overland surface water flows originating from undisturbed areas of the Project Area from the surface water runoff that has interacted with stockpiles, MPP and mining infrastructure. • Provision of sediment basins/ponds and appropriate drainage on roadways adjacent to surface water bodies or catchments for the collection of sediments in surface water transported along the roadway (longitudinal flows)* • TSF embankment and decant collection dam and ponds. • Existing fords, culverts, diversion drains, bunding and sedimentation/event basins designed and installed in accordance with Best Practice Operating Procedures endorsed by the SA Arid Lands Natural Resources Management Board or a Water Affecting Activity Permit under the *Natural Resources Management Act 2004* (SA). Future infrastructure would be subject to a Water Affecting Activity Permit under the *Landscape South Australia Act 2019* (SA). • Progressive rock armoured TSF Embankment • Rehabilitation of land to achieve a landscape function equivalent to	Robustness of Controls Temporary sediment and erosion controls will be placed based on experience and basic surface water flow modelling, rather than as a result of detailed hydrodynamic modelling. This is considered appropriate due to the arid nature of the environment. Surface water management infrastructure has been broadly designed to retain surface water events of up to a 1-in-50 year average recurrence interval event, however detailed modelling of surface water flows within the as-built MPL infrastructures is not proposed to be undertaken. As such, surface water management infrastructure (i.e. drains and sedimentation ponds) have been conservatively sized. OMC proposed to ensure controls are constructed and operate in accordance with the basis of design Material Sources and Suitability Final landform material sources, volumes types, erodability of materials used for final landforms. OMC has been applied to ensure uncertainty relating to this is reduced prior to the placement of material. Landform Evolution Modelling – TSF Embankment Preliminary modelling of the risk of surface water erosion of the TSF embankments indicated that average soil loss was expected to be very low as presented in MLP Appendix A7 Closure Strategy (Erosion Modelling) (OZ Minerals 2017a). OMC has been applied to ensure verification of the modelling inputs using actual particle sizes of the TSF Embankment construction. Rehabilitation Methods The final rehabilitation method to achieve the landscape function of surrounding landscapes has not been confirmed. Trials are currently underway to determine suitable rehabilitation methods for the existing Retention Lease and will guide the rehabilitation methods for the current tenements.	ML 6471 Schedule 6 Condition 17 MPL 152 to MPL 154 Schedule 6 Condition 13 MPL 152 to MPL 154 Schedule 6 Condition 14 MPL 156 Schedule 6 Condition 11 Schedule 6 Condition 12 (12.1 to 12.4) Schedule 6 Condition 13 The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities. MPL 149 Schedule 6 Condition 12 The Tenement Holder must ensure that during construction, operation and post completion that no surface water contaminated (including sedimentation) as a result of mining-related activities leaves the Land.	SWES1	Surface water sampling and laboratory analysis (rising stage samplers or grab samples)	Surface water sampling sites (Figure 9.5; SW01 to SW12, SW-1, SW-6, SW-7, SW-14 to SW-17, Gorge Spring and Euro Spring)	Water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (whichever is greater) for pH, EC, SS and hydrocarbons (Table 9.16)	Opportunistic Undertaken at least once a year within seven days of a rainfall event required to create flows	Construction and operation	ML 6471 MPL 149 MPL 156
SW08 ID047	Erosion and runoff from final landforms including rehabilitated surfaces, TSF embankment and subsidence zone abandonment bund leads to increased sedimentation of surface water along creek lines impacting on the abundance and/or diversity of aquatic ecology and native vegetation.				SWES4	Construct to design audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Abandonment bund around the subsidence zone (Figure 4.19) TSF Final Embankment (Figure 4.2)	Confirms the abandonment bund and TSF final embankment have been rock armoured in accordance with the identification of material types identified in detailed design Linked to strategies SWES13 and SWES14	Prior to application of lease surrender	Closure	ML 6471
SW10	Erosion and runoff from final landforms including rehabilitated surfaces, TSF embankment and subsidence zone abandonment bund leads to increased sedimentation of surface water at stock dams and impacts the income and business viability of pastoral stations				SWES5	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Culverts, fords, and surface water management infrastructure (Figure 4.22, Figure 4.43, Figure 4.44, Figure 4.45)	All culverts, fords, and surface water management infrastructure that is not required post completion is removed in a manner to ensure long term physical stability in consideration of potential erosion and sedimentation and natural flow regimes have been restored	Prior to application of lease surrender	Closure	ML 6471
					SWES6	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Waste rock, ore stockpiles and soil stockpiles (Figure 4.36)	Have been removed from the ground surface	Prior to application of lease surrender	Closure	ML 6471
					ECO1	Baseline ecological surveys	At water dependent ecosystems including, but not limited to SW-6 and SW-7 (Figure 9.5)	Survey completed Linked to Native Vegetation Strategy (Schedule 6 Condition 9.1)	Prior to the impact of mining operations or mining-related activities on the existing environment	Not applicable	MPL 156

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Leading Indicator						
		the surrounding landscape. • Storages bunded in accordance with EPA Bunding Guidelines and/or relevant Australian Standards Management Strategies • Temporary sediment and erosion controls (e.g. mobile sediment booms, sediment fencing) • Surface water management infrastructure maintenance and inspection programs. • Culvert and ford maintenance and inspection programs* • Rock armouring of the TSF embankment and SLC abandonment bund* • Rehabilitation procedures and inspection program. • Abandonment bund construction quality assurance procedures* • Best Practice Operating Procedures	Landform Evolution Modelling - Embankment The results of the 1,000 year detailed embankment simulation detailed in MLP Appendix A7 Closure Strategy (Erosion Modelling) (OZ Minerals 2017a) indicate very little erosion of the TSF embankment as there is no contributing upstream catchment: any surface water runoff is a result of direct precipitation on the embankment only. Erosion of the embankment is concentrated on the upper and intermediate crests and eroded materials are deposited on the subsequent embankment bench, i.e. the benched surface is gradually flattened to a continuous slope. Erosion was also shown to be concentrated to the natural materials at the downstream toe of the embankment, where any surface water runoff from the embankment flows along the toe and continues downstream. Strategy has been applied to ensure verification of the modelling inputs using actual particle sizes of the TSF Embankment construction and rainfall intensity.		SWES2	Inspection	Key surface water management infrastructure (Figure 4.22, Figure 4.42, Figure 4.43)	• are as constructed • have been maintained in accordance with the design • corrective actions closed out within 14 days	Annually (prior to summer)	Construction and operation	ML 6471 MPL 149
					SWES3	Inspection		• have performed in accordance with the design • corrective actions closed out within 14 days	Within seven days of a rainfall event required to create flows		ML 6471 MPL 149

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.12.2 Reduced flows

Table 7.13 | Environmental Outcome(s) and OMC relevant to surface water reduced flows

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
SW42	Construction of infrastructure within the Eliza Creek catchment leads to a reduction of surface water quantity at water holes impacting on the abundance and/or diversity of aquatic ecology	Design Strategies • TSF site selection considered 12 sites with the minimisation of footprint and catchment disturbance of Eliza Creek a key consideration • Diversion Infrastructure	Surface Water Modelling Inherent uncertainties in assumption relating to site-specific rainfall and evaporation data. Modelling calibration required following collection of site-specific field data.	ML 6471 Schedule 6 Condition 17 The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Outcome Measurement Criteria						
					SWRF1	Ecological surveys and survey report completed by an independent and suitably qualified expert	Eliza Creek monitoring (Figure 9.2 fauna and Figure 9.3 flora)	No adverse impact on the diversity and abundance of native vegetation and water dependant ecosystems attributed to reduced surface water flows caused by mining operations when compared to baseline conditions (BHP 2024a; Appendix C5 Ecological Baseline) unless a significant environmental benefit has been approved in accordance with the relevant legislation Linked to Native Vegetation Outcome (Schedule 6 Condition 11)	Annual	Operations	ML 6471

7.3.12.3 Tailings storage facility

Table 7.14 | Environmental Outcome(s) and OMC relevant to the surface water aspects of the TSF

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
SW14	Transfer and disposal of tailing to the TSF results in reduced surface water quality along creek lines impacting on the abundance and/or diversity of native vegetation.	Fundamental Design Control • Final detailed design to be provided in accordance with ANCOLD design criteria • Spillway designed for the PMP, critical duration event, in accordance with ANCOLD • Rock armouring of the TSF embankment Management Strategies • Field trials to confirm outputs of the landform evolution modelling	Landform Evolution Modelling – TSF Surface Operational field trials are proposed to test the sensitivity of modelling inputs.	ML 6471 Schedule 6 Condition 17 The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Outcome Measurement Criteria						
SW19	Emergency discharge of water from the TSF during operations results in reduced surface water quality along creek lines impacting on the abundance and/or diversity of native vegetation				TSF1	Groundwater sampling and laboratory analysis (pH, metals and EC)	Shallow monitoring wells downstream of the TSF (Figure 9.6; TSFMB1s–TSFMB4s)	Water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (whichever is greater) for pH, EC and metals (Table 9.22)	Quarterly sampling and analysis	Construction and operation	ML 6471
SW24	Erosion and runoff from the surface of the TSF at closure leads to increased sedimentation and reduced surface water quality along creek lines impacting on the abundance and/or diversity of native vegetation				TSF2	Groundwater levels monitoring	Shallow monitoring wells downstream of the TSF (Figure 9.6; TSFMB1s–TSFMB4s)	Standing water levels are trending in accordance with modelled predictions and do not exceed the maximum predicted drawdown at each well (Table 9.21)	Quarterly	Construction and operation	ML 6471
SW51	Shallow lateral seepage from upstream of the TSF embankment reports to downstream surface water features leading to a decrease in surface water quality including salinity in Eliza Creek that impacts the abundance and/or diversity of terrestrial ecology.				TSF3	Surface water sampling and laboratory analysis (rising stage samplers or grab samples)	Eliza Creek (Figure 9.5; SW05–SW09)	Water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (whichever is greater) for pH, EC and metals (Table 9.16)	Opportunistic At least once a year within seven days of a rainfall event required to create flows	Construction and operation	ML 6471
SW52	Shallow lateral seepage from upstream of the TSF embankment reports to downstream surface water features leading to a decrease in surface water quality including salinity in Eliza Creek that impacts the abundance and/or diversity of aquatic ecology.				TSF4	Sediment sampling and laboratory analysis for metals	Eliza Creek (Figure 9.6; IT01–IT03)	Sediments meet ANZECC/ARMCANZ (2000) Sediment Quality Guidelines or baseline ranges (Table 9.15) whichever is greater	Annual	Construction and operation	ML 6471
SW53	Shallow lateral seepage from upstream of the decant dam triggered by a rainfall event during operations, exceeds the design capacity of the lined decant pond lead to decreased surface water quality in Eliza Creek that impacts the abundance and/or diversity of terrestrial ecology.				TSF5	Accidental spill reporting, investigation and corrective actions	TSF and tailings delivery infrastructure (Figure 4.2)	• spills are reported to the Director of Mines (or other authorised officer) as soon as reasonably practicable after becoming aware of the harm or threatened harm • all risks were minimised so far as is reasonably practicable • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer)	Triggered as a result of an accidental spill from tailings delivery infrastructure or seepage from the TSF (as identified through Leading Indicators TSF7, TSF10 or TSF11) that result or threaten to result in material or serious environmental harm (as defined in Section 5(3) of the *Environment Protection Act 1993* (SA)) to native vegetation, native fauna and/or groundwater	Construction and operation	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
SW54	Shallow lateral seepage from upstream of the decant dam triggered by a rainfall event during operations, exceeds the design capacity of the lined decant pond lead to decreased surface water quality in Eliza Creek that impacts the abundance and/or diversity of terrestrial ecology.				TSF6	Ecological survey and survey report completed by an independent and suitably qualified expert	Eliza Creek monitoring (Figure 9.2 Fauna and Figure 9.3 Flora)	No adverse impact on the diversity and abundance of native vegetation and water dependant ecosystems attributed to tailings seepage when compared to baseline conditions (C5 Ecological Baseline) unless a significant environmental benefit has been approved in accordance with the relevant legislation Linked to Native Vegetation Outcome (Schedule 6 Condition 11)	Annual	Operations	ML 6471
					TSF7	Audit (TSF Closure Strategy Verification Report) undertaken by an independent suitably qualified expert approved by the Director of Mines (or other authorised officer)	TSF (Figure 4.2)	Demonstrates: • data has been collected for the calibration of the Air Quality Model and Landform Evolution Model as per Leading Indicators AQ5, AQ6, TSF8 and TSF9 • data collected as per Leading Indicators AQ5, AQ6, TSF8 and TSF9 (and any other relevant data) demonstrates that the TSF closure strategies set out in the PEPR (Section 5.4.8.2), specifically the requirement for no TSF cover system, would be effective in achieving the relevant Environmental Outcomes The audit must also include the following information in each TSF closure strategy verification report: • recommendations for any changes to existing TSF closure strategies to ensure achievement of the relevant Environmental Outcomes; and • recommendations for any new TSF closure strategies to ensure achievement of the relevant Environmental Outcomes Demonstration of achievement of the outcome will be met through the independent and suitably qualified expert verifying the requirement for no TSF cover system at any of the time intervals stated above. If the independent and suitably qualified expert can not verify the requirement for no TSF cover system, demonstration of achievement of the outcome will be met through: • PEPR review which details the changed and/or new TSF closure strategies; and • payment of a Bond (or top up to the existing Bond) to reflect the rehabilitation liability of the changed and/or new TSF closure strategies.	The audit will be provided to the Mining Regulator at the following frequencies: • an initial report at 6 years after lease grant (allowing for 2 years to reach first tailings deposition, and 4 years to conduct the relevant scientific investigations); and • 8 years after lease grant; and • 10 years after lease grant; or any other timeframe as agreed between the Tenement Holder and Director of Mines (or other authorised officer)	Operations	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
								The scope of the audit will be agreed by the Tenement Holder and the Director of Mines (or other authorised officer) at an appropriate time ahead of delivery of the initial report.			
					TSF35	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) including a review of the operational TSF audit reports and other relevant information	TSF (Figure 4.2)	Demonstrates that the TSF has been operated within design (OZ Minerals 2017a; MLP Appendix A2 TSF Design) or any operational deviations from design parameters have been assessed and addressed appropriately and therefore can be expected function in the long term as per the design TSF Audits (Schedule 2 Condition 4.5). The expert reports for the audits of Stage 1 of TSF embankment construction must address all items as specified in Schedule 2 Condition 10	After the final discharge of tailings into the TSF and prior to commencement of final rehabilitation, closure and decommissioning of the TSF and Decant Dam	Closure	ML 6471
					TSF36	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	TSF embankment and spillways (Figure 4.2)	Demonstrates that the TSF embankment and spillways have been constructed to design (OZ Minerals 2017a; MLP Appendix A2 TSF Design) to ensure long term physical stability in consideration of potential erosion and sedimentation of the downstream environment TSF Audits (Schedule 2 Condition 4.6). The expert reports for the audits of Stage 1 of TSF embankment construction must address all items as specified in Schedule 2 Condition 11	After the final TSF and Decant Dam rehabilitation, closure and decommissioning works have been completed	Closure	ML 6471
					TSF37	Groundwater sampling and analysis of pH, metals and EC	Shallow monitoring wells downstream of the TSF (Figure 9.6; TSFMB1s–TSFMB4s)	Water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (whichever is greater) for pH, EC and metals (Table 9.22)	Quarterly sampling and analysis At the cessation of tailings discharge for a period of no less than one year	Closure	ML 6471
					Leading Indicator						
					TSF8	Calibration of the Landform Evolution Model with erosion field study data	TSF (Figure 4.2)	Validates modelling outputs (MLP Appendix A7 Closure Strategy (Erosion Modelling) (OZ Minerals 2017a) Linked to OMC – TS7	2 years after Stage 3 embankment construction and year 8 to 10 of the TSF operation	Construction and operation	ML 6471
					TSF9	Audit by an independent and suitably qualified expert of laboratory and field data including rainfall intensity, tailings particle sizes, in-channel lateral erosion parameters, ‘m’ from the	TSF (Figure 4.2)	Should values deviate outside of the sensitivities in (Table 9.9) an assessment will be undertaken by an independent and suitably qualified expert to determine if there is a material deviation expected on modelling outputs that model calibration	Annual	Construction and operation	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
						tailings beach trials at the TSF against the Landform Evolution Model (MLP Appendix A7 Closure Strategy (Erosion Modelling) (OZ Minerals 2017a) input assumptions		Linked to OMC – TS7			
					TSF10	Inspection (including photographic evidence)	Eliza Creek bed (Figure 9.6; IT01–IT03)	Demonstrates visual evidence of shallow lateral seepage surface expressions (salt crystals, salinisation or water logging) and triggers further investigation (OMC TSF5)	Quarterly	Construction and operation	ML 6471
					TSF11	Audit undertaken by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including quality assurance inspections, and signed by construction manager	TSF (Figure 4.2)	Demonstrates that seepage design controls (Figure 4.28) and TSF and Decant embankment foundation preparation (Figure 4.29 and Figure 4.30) have been constructed in accordance with the design (MLP Appendix A2 TSF Design) (OZ Minerals 2017a). # TSF Audits (Schedule 2 Condition 4.1). The expert reports for the audits of Stage 1 of TSF embankment construction must address all items as specified in Schedule 2 Condition 10	Undertaken during construction prior to commissioning Stage 1 TSF	Construction	ML 6471
					TSF15	Audit undertaken by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including quality assurance inspections undertaken during construction prior to commissioning of Stages 2, 3, 4 and 5 of the TSF and signed by construction manager	TSF (Figure 4.2)	Demonstrates embankment foundation preparation (Figure 4.29) have been constructed in accordance with the design (MLP Appendix A2 TSF Design) (OZ Minerals 2017a) # # TSF Audits (Schedule 2 Condition 4.2). The expert reports for the audits of Stages 2, 3, 4 and 5 of TSF embankment construction must address all items as specified in Schedule 2 Condition 10	Prior to commissioning of Stages 2,3,4 and 5	Construction and operation	ML 6471
					TSF16	Audit undertaken by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including quality assurance inspections and audit of records of the Operations, Maintenance and Surveillance Manual of the TSF	TSF (Figure 4.2)	Demonstrates that the TSF is being operated in accordance with design (MLP Appendix A2 TSF Design) (OZ Minerals 2017a) and the Operations, Maintenance and Surveillance Manual TSF Audits (Schedule 2 Condition 4.3 and 4.4)	Every 3 months during Stage 1 and 2 Every 6 months for Stage 3, 4, 5 and 6	Construction and operation	ML 6471
					TSF21	Water sampling and laboratory analysis of pH, EC, and, metals validates geochemical modelling	From the TSF supernatant pond and lined decant pond	Should values deviate by +/- 10% an investigation will be undertaken and seepage model re-run #	Monthly	Construction and operation	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
						predictions (Table 9.17; pH, EC and metals)		# Surface Water Strategy (Schedule 6 Condition 22) and Groundwater Strategy (Schedule 6 Condition 26.2)			
					TSF23	Water sampling and analysis of pH, EC and metals is compared to geochemical modelling prediction (Table 9.17; pH, EC and metals).	In the tailings downstream seepage control trench (Figure 4.28;SCD1)	Should values deviate by +/- 10% an investigation will be undertaken and seepage model re-run # # Groundwater Strategy (Schedule 6 Condition 26.2)	Quarterly	Construction and operation	ML 6471
					TSF24	Water sampling and analysis of pH, EC and metals is compared to geochemical modelling prediction (Table 9.17; pH, EC and metals).	In the tailings downstream seepage control trench (Figure 4.28;SCD1)	Should values deviate by +/- 10% an investigation will be undertaken and seepage model re-run	After a rainfall event that results in the activation of the flood storage area of the decant dam (Figure 4.27)	Construction and operation	ML 6471

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.12.4 Acid and metalliferous drainage

Table 7.15 | Environmental Outcome(s) and OMC relevant to the surface water aspects of acid metalliferous drainage

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
SW29	Acid and Metalliferous Drainage from operational stockpiles enters surface water leading to a decrease in surface water quality along creek lines impacting on the abundance and/or diversity of native vegetation.	Design Strategies • Production stockpile pad* • Separation of overland surface water flows originating from undisturbed areas of the Project Area from the surface water runoff that has interacted with stockpiles, MPP and mining infrastructure. Management Strategies • PAF material (marginal ore) would be preferentially left underground where possible if brought to surface, marginal ore would be stored on the ROM stockpile (ex-Development Production Ore Stockpile)* • Block modelling of ore and waste units* • Sulphur cut-off grade determined* • QA/QC procedures and record keeping* • Development of a AMD Management Plan*	Material Balance The future volumes of AMD remains uncertain and OMC applied to ensure appropriate forward planning and management of AMD.	ML 6471 Schedule 6 Condition 17 The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities	**Outcome Measurement Criteria**						
SW31	Acid and Metalliferous Drainage from operational stockpiles enters secondary pathways including groundwater and/or land				AMD1	Surface water sampling and laboratory analysis (rising stage samplers or grab samples)	Eliza Creek (Figure 9.5; SW06, SW07, SW09)	Water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (whichever is greater) for pH, EC and metals (Table 9.16)	Opportunistic At least once a year within seven days of a rainfall event required to create flows	Construction and operations	ML 6471
					AMD5	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Ore stockpiles (Figure 4.34)	Have been removed from the ground surface Surface Water Strategy (Schedule 6 Condition 21.12)	Prior to application of lease surrender	Closure	ML 6471
					AMD6	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer including a review of mine block model records, reconciliation records, geological and sulphur assay data, updates of sulphur cut-off grade and other relevant information	Waste rock and ore stockpiles (Figure 4.34)	Have been managed appropriately to prevent AMD	Prior to application of lease surrender	Closure	ML 6471
					Leading Indicator						
					AMD2	Audit signed by construction manager	Production stockpile pad	Has been constructed in accordance with the basis of design (Figure 4.36)	At the completion of construction and prior to the placement of material above the sulphur cut-off grade	Construction and operations	ML 6471
					AMD3	Audit of the block model with updated geological and sulphur assay data	Maintained at the site	• Determine the sulphur distribution of all waste for the forward year • Estimate the distribution and estimation of volume of AMD material using the sulphur cut off grade • Develop or adjust management requirements if needed	Annual	Construction and operations	ML 6471
					AMD4	Audit including reconciliation of volumes	Waste rock and ore stockpiles (Figure 4.34)	All potential AMD material has been handled in accordance with: • the management requirements determined by the annual block model review • the AMD Management Plan	Annual	Construction and operations	ML 6471

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.13 Groundwater

7.3.13.1 Tailings storage facility

Table 7.16 | Environmental Outcome(s) and OMC relevant to the groundwater aspects of the TSF

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
GW21	Seepage of solutes from the TSF during operations enters aquifers leading to a decrease in groundwater quality at Lake Torrens resulting in impacts on the State of South Australia	Design Strategies • Lining of water-holding ponds and barren liquor evaporation ponds. • Design of a thickened tailings disposal system (65% w/w solids). • TSF located upstream of the sub-level cave subsidence zone. Management Strategies • TSF Water balance to be updated in accordance with Life-Of Mine Plan and verified against modelling inputs. • Continued tailings physical and geochemical characterisation undertaken and verified against modelling inputs. • Flow and sump meters to monitor tailings inputs and outputs. • Ongoing calibration of the groundwater model using data obtained from groundwater monitoring	Deep Regional Seepage Fate Modelling of groundwater flow paths from beneath the TSF and seepage fate transport shows that evaporation from the subsidence zone void alters the groundwater flow field, in the area of the Mining Lease, to such an extent that any tailings leachate that may reach groundwater beneath the TSF will ultimately be captured by the subsidence void groundwater sink. Seepage may reach Lake Torrens beyond 5,000 years post-closure, however geochemical modelling indicates that compositional changes to groundwater assuming TSF seepages mixes with the THA are not expected beyond 500m from the TSF. OMC applied to confirm both geochemical and fate modelling. Validation of the groundwater model will be undertaken every two years including the consideration of seepage fate based on operational data.	ML 6471 Schedule 6 Condition 24 The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quality within aquifers outside of the TSF seepage zone of influence area delineated by the groundwater model as a result of mining operations or mining-related activities.	Outcome Measurement Criteria						
					GW1	Groundwater sampling and laboratory analysis (pH, EC, metals)	Tent Hill Aquifer Wells downstream of the TSF (Figure 9.6; TSFMB1d, TSFMB3d and TSFMB4d)	Demonstrates water quality are within the site groundwater baseline composition ranges (Table 9.22) Groundwater Criteria (Schedule 6 Condition 27.2)	Quarterly sampling and analysis	Construction and operations	ML 6471
					GW2	Groundwater levels monitoring	Tent Hill Aquifer monitoring wells downstream of the TSF (Figure 9.6; TSFMB1d, TSFMB3d and TSFMB4d)	Standing water levels are trending in accordance with modelled predictions and do not exceed the maximum predicted drawdown at each well (Table 9.21) Groundwater Criteria (Schedule 6 Condition 27.1)	Quarterly	Construction and operations	ML 6471

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

7.3.13.2 Quantity

Table 7.17 | Environmental Outcome(s) and OMC relevant to groundwater drawdown

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
GW27 GW13	Water effecting activities undertaken during the life of the mine and formation of a subsidence zone lake at closure leads to a reduction of groundwater quantity available for future generations.	Design Strategies • Site Water Balance based on modelling inputs and LOM plan* • Production wellfield and mine dewatering will not exceed maximum daily abstraction rate (Table 4.55)* • Abstraction rates designed to sustainable yields • Telemetric controls/headwork engineering and flow meters to monitor abstraction rates Management Strategies • Water balance to be updated in conjunction with Life of Mine Plans • Flow/sump meters to monitor abstraction and mine dewatering rates • Ongoing calibration of the groundwater model using data obtained from groundwater monitoring*	Groundwater Modelling The hydrogeological data and information that supports development of the conceptual and numerical models is significant, and is drawn from groundwater related observations made during drilling, testing and sampling of almost 50 groundwater investigation wells within the broader Groundwater Study Area, in addition to comprehensive studies completed for BHP Billiton's Olympic Dam expansion project (BHP Billiton 2009; 2011) and other publicly available reference materials (e.g. geological map sheets and Government of South Australia's water-related databases). The groundwater environment where the Northern Wellfield is located (the Stuart Shelf) is considered to be well understood. BHP has undertaken groundwater exploration drilling within the regional area since 2012 and within the Northern Wellfield area since 2013. Groundwater baseline conditions have been developed and established by OZ Minerals (2017a) that incorporate the Northern Wellfield.	ML 6471 Schedule 6 Condition 25 ML 6471 Schedule 6 Condition 26 MPL 152 to MPL 154 Schedule 6 Condition 15 The Tenement Holder must during construction, operation and post completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining-related activities. MPL 156 Schedule 6 Condition 14 Schedule 6 Condition 16 The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model (Appendix B of the MPL MP for the Northern Wellfield June 2018), as a result of mining operations or mining related activities.	**Outcome Measurement Criteria**						
					GW3	Groundwater levels monitoring	Groundwater compliance monitoring wells simulated in the groundwater model (Figure 9.8; MS2, MS3, MD3, ENV S2 and ENV W3)	Standing water levels are trending in accordance with modelled predictions and do not exceed the maximum predicted drawdown at each well (Table 9.19)	Quarterly	Construction and operations	ML 6471
							Groundwater compliance monitoring wells not simulated in the groundwater model (Figure 9.8; ENV N4, ENV N8)	No evidence of a trend in standing water levels over three consecutive quarters			
					Leading Indicator						
					GW4	Analysis of groundwater abstraction volumes from flow meter reading records	Groundwater production wells (Figure 9.7)	Abstraction is not trending to exceed the predicted water demand (12.9 ML/d)	Quarterly	Construction and operations	ML 6471 MPL 152 to 154
								No more than an average of 7 ML/d was abstracted from the Northern Wellfield			MPL 156
					GW5	Groundwater levels monitoring	Groundwater leading indicator monitoring wells simulated in the groundwater model (Figure 9.8; Table 9.20)	Standing water levels are trending in accordance with modelled predictions and do not exceed the maximum predicted drawdown at each well (Table 9.20)	Quarterly	Construction and operations	ML 6471 MPL 152 to 154 MPL 156
							Groundwater leading indicator monitoring wells not simulated in the groundwater model (Figure 9.8; Table 9.20)	No evidence of a trend in standing water levels over three consecutive quarters			

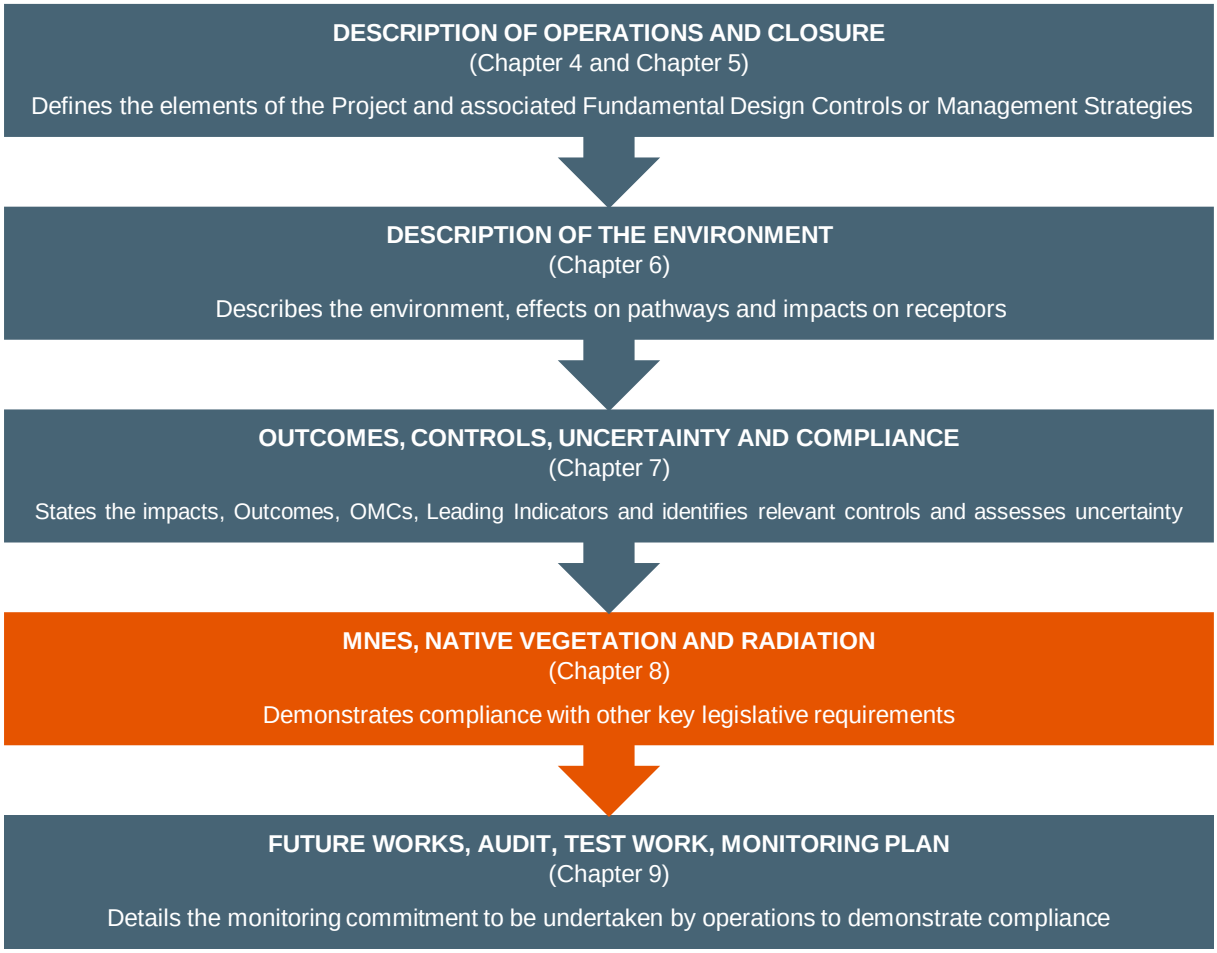
* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

Table 7.18 | Environmental Outcome(s) and OMC relevant to groundwater quality

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L40 GW14	The transport, storage and handling of hydrocarbons and chemicals contaminates the shallow perched aquifer leading to a decrease in groundwater quality at third party user wells impacting on the income and business viability of pastoral stations.	Design Strategies • Hydrocarbon and chemical storage facilities designed in accordance with relevant Australian Standards • Landfill is constructed and operated in accordance with EPA Guidelines and is appropriately licensed under the *Environment Protection Act 1993* (SA) • Storages bunded in accordance with EPA Bunding Guidelines and/or relevant Australian Standards Management Strategies • Spill and emergency response procedures • Equipment maintenance to prevent accidental releases • Licenced chemical and waste transporters • Incident reporting procedures • Regular inspection programs where bunding either temporary or permanent is installed to ensure appropriate use, placement of spill kits, clean up procedures and handling procedures • Induction contains process for bringing chemicals and hydrocarbons onsite including requirements for storage, handling and disposal • Contracts contain conditions relevant to design, management of the storage and handling of chemicals and hydrocarbons • Establishment of Chemical Database including copies of MSDS and storage, handling and disposal requirements	Effectiveness of Management Controls Spill and emergency response procedures that support the existing Operation have been developed and include remediation methods. Operational performance has demonstrated that BHP can respond to any spills and implement corrective actions where required.	ML 6471 Schedule 6 Condition 23 ML 6471 Schedule 6 Condition 17 MPL 149 Schedule 6 Condition 11 MPL 156 Schedule 6 Condition 15 The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to the Environmental Values of the groundwater within the shallow perched aquifer within the Land as a result of chemicals or hydrocarbons from mining operations or mining-related activities.	Outcome Measurement Criteria						
					GW7	Accidental spill reporting, investigation and corrective actions	Infrastructure locations (Figure 4.2)	• spill reported to the Director of Mines (or other authorised officer) as soon as reasonably practicable after becoming aware of the harm or threatened harm • all risks were minimised so far as is reasonably practicable • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer) Refer to Section 7.3.9 Land and Soils relating to the transport, storage and handling of hydrocarbons and chemicals and associated Leading Indicator – LS2, Leading Indicator – LS3, Leading Indicator – LS4 and OMC – LS5	Triggered as a result of an accidental spill that results or threatens to result in material or serious environmental harm (as defined in Section 5(3) of the *Environment Protection Act 1993* (SA)) to native vegetation, native fauna and/or groundwater	Construction and operations	ML 6471 MPL 149 MPL 156

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

8. Matters of National Environmental Significance and native vegetation



BHP is required to comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken as a part of the development, operation and closure of the tenements. The alignment between secondary permitting requirements and the PEPR allows an all-inclusive operational document that meets all legislative requirements and ultimately reduces the burden of duplication on the operation.

A monitoring plan is provided in Chapter 9, which provides a foundation for operational regulatory compliance.

BHP understands and will comply with all relevant State and Commonwealth legislation and regulations applicable to Carrapateena.

8.1 Matters of National Environmental Significance

8.1.1 Approvals, conditions and outcomes

The EPBC Act is the Commonwealth legislation established to protect and manage MNES, including nationally and internationally important flora, fauna, ecological communities and heritage places.

Under the EPBC Act, an action requires approval from the Minister if the action has, will have, or is likely to have, a significant impact on an MNES. The Significant Impact Guidelines 1.1 (DoE 2013) define a 'significant impact' as an impact that is important, notable or of consequence, having regard to its context or intensity.

In undertaking this PEPR review, BHP has considered the changes to approved operations against the scope of the referral under the EPBC Act.

The airstrip and workers' accommodation village was referred to the then Australian Government's Department of the Environment and Energy (DoEE) (now DCCEEW) as part of RL 127 under EPBC Referral 2012/6494 and was deemed not to be a controlled action.

A self-assessment was undertaken of the potential for the Northern Wellfield to result in a significant impact to MNES which was supported by a detailed Significant Impact Assessment (OZ Minerals 2018c; Appendix D of Northern Wellfield MPL MP). The Significant Impact Assessment concluded that the action can be undertaken in a manner that prevents significant impacts on MNES, and on this basis the action was not referred under the EPBC Act.

A referral for the Carrapateena Project was submitted to the DoEE on 10 March 2017 (EPBC Referral 2017/7895). On 12 April 2017, DoEE released their decision on the referral as a 'controlled action'. The referral and controlled action decision for the Carrapateena Project triggered the Assessment Bilateral Agreement between the Commonwealth and the State of South Australia.

The class of EPBC action is as per Schedule 1, Clause 2 of the Assessment Bilateral Agreement and was assessed under a Mineral Lease Application under Part 6 of the Mining Act, which included an application, and Mining Proposal, under section 35 of the Mining Act.

Detailed assessments of any likely impact that the Project may facilitate on MNES was undertaken for the MLP including the consideration of Schedule 4 of the EPBC Regulations 2000 and the Significant Impact Guidelines (DoE 2013).

The OMCs relevant to EPBC related impacts are described and referenced in Table 8.1. The Consolidated Monitoring Plan in Chapter 9 provides a framework for demonstrating compliance annually against the Environmental Outcomes in Chapter 7 and as summarised.

The EPBC Act conditions of approval for the Carrapateena Project (14 December 2018) are provided in Table 8.2.

Table 8.1 | OMC relevant to EPBC Act listed species

OMC	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
EPBC1	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	Records of the Thick-billed Grasswren are provided to the Biological Database of South Australia BDBSA if observed # Linked to MNES Condition (Schedule 2 Condition 28.2)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154
EPBC2	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	Records of the Plains Mouse are provided to the Biological Database of South Australia BDBSA if observed # Linked to MNES Condition (Schedule 2 Condition 28.4)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154
EPBC3	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 9.2 Fauna Figure 9.3 Flora Figure 9.4 Weeds)	Records of the Night Parrot are provided to the Night Parrot Recovery Team if observed # Linked to MNES Condition (Schedule 2 Condition 28.3)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154

Table 8.2 | EPBC Act conditions of approval

Number	Condition	Demonstrated commitment
1	To manage the impacts of the action on the environment, the person taking the action must implement the conditions of the SA approval.	Conditions of the SA Government approval detailed in Appendix A1 to Appendix A6.
2	The person taking the action must not impact more than 1740 hectares of Plains Rat habitat within the disturbance footprint.	Commitment acknowledged
3	Prior to commencement of the action, to compensate for residual impacts to the Plains Rat, the person taking the action must acquire an offset property which must contain: (a) a population of the Plains Rat (b) no less than 1740 hectares of Plains Rat habitat (c) habitat quality equal to that of the Plains Rat habitat within the disturbance footprint.	'Agreement to Underlease' (CA-APR-AGR-1037) established with the Pastoral Lessee of South Gap Pastoral Station that sets aside 3,525 ha of land across two offset areas (the Southern Paddock and Northern Paddock) that is viable Plains Rat habitat. Historical observations of Plains Rats have been recorded within the offset area.
4	The person taking the action must maintain or improve the habitat quality of the existing Plains Rat habitat at the acquired offset property for the life of this approval.	Commitment acknowledged. A Environmental Offset Management Plan has been developed that presents objectives and management strategies to address EPBC Act offset liability and associated legislative and policy obligations for the first 10-year period of management.
5	Within 2 years from commencement of the action, the person taking the action must change the tenure of the offset property for conservation purposes using an appropriate legal mechanism for long term protection.	Commitment acknowledged
6	Prior to the commencement of the action, the person taking the action must engage a suitably qualified expert to undertake a Night Parrot survey within the development envelope. The Night Parrot survey must be undertaken in' accordance with the EPBC Act Night Parrot survey guidelines. Within three months of the Night Parrot survey being completed, the person taking the action must provide the Department with the Night Parrot survey results.	Targeted threatened species survey for the Night Parrot completed in March 2018 (CA-ENV-REP-1040). There were no Night Parrots or evidence of Night Parrots detected during the survey. The results of the survey were provided to the Department of the Environment and Energy (DoEE) (CA-APR-EML-1077).
7	Should the Night Parrot or evidence of the Night Parrot be recorded during the survey, the person taking the action must submit for the Minister's approval, a Night Parrot Management Plan that must include: (a) Details of the Night Parrot survey results, including the methodology, timing and area surveyed. (b) An assessment of the impacts to the Night Parrot that will result from the action (c) Management actions that will avoid, minimise and/or offset both the immediate and long-term impacts of the action on the Night Parrot. (d) Monitoring and reporting requirements that demonstrate the management actions are effectively being implemented and achieve the intended results. This should include the frequency, intensity and duration of monitoring. The person taking the action must not commence the action prior to the Minister approving the Night Parrot Management Plan. The approved Night Parrot Management Plan must be implemented.	Commitment acknowledged
8	Prior to the commencement of the action, the person taking the action must engage a suitably qualified expert to undertake a *Frankenia plicata* survey within the development envelope. The *Frankenia plicata* survey must be undertaken in accordance with contemporary survey methods. Within three months of the *Frankenia plicata* survey being completed, the person taking the action must provide the Department with the *Frankenia plicata* survey results.	Targeted threatened species survey for *Frankenia plicata* completed in March 2018 (CA-ENV-REP-1040). *Frankenia plicata* was not detected during the survey. The results of the survey were provided to the Department (CA-APR-EML-1077).
9	Should the *Frankenia plicata* be recorded during the survey, the person taking the action must submit for the Minister's approval, a *Frankenia plicata* Management Plan that must include: (a) Details of the *Frankenia plicata* survey results, including the methodology, timing and area surveyed. (b) An assessment of the impacts to the Frankenia plicata that will result from the action. (c) Management actions that will avoid, minimise and/or offset both the immediate and long-term impacts of the action on the *Frankenia plicata*. (d) Monitoring and reporting requirements that demonstrate the management actions are effectively being implemented and achieve the intended results. This should include the frequency, intensity and duration of monitoring. The person taking the action must not commence the action prior to the Minister approving the *Frankenia plicata* Management Plan. The approved *Frankenia plicata* Management Plan must be implemented.	Commitment acknowledged

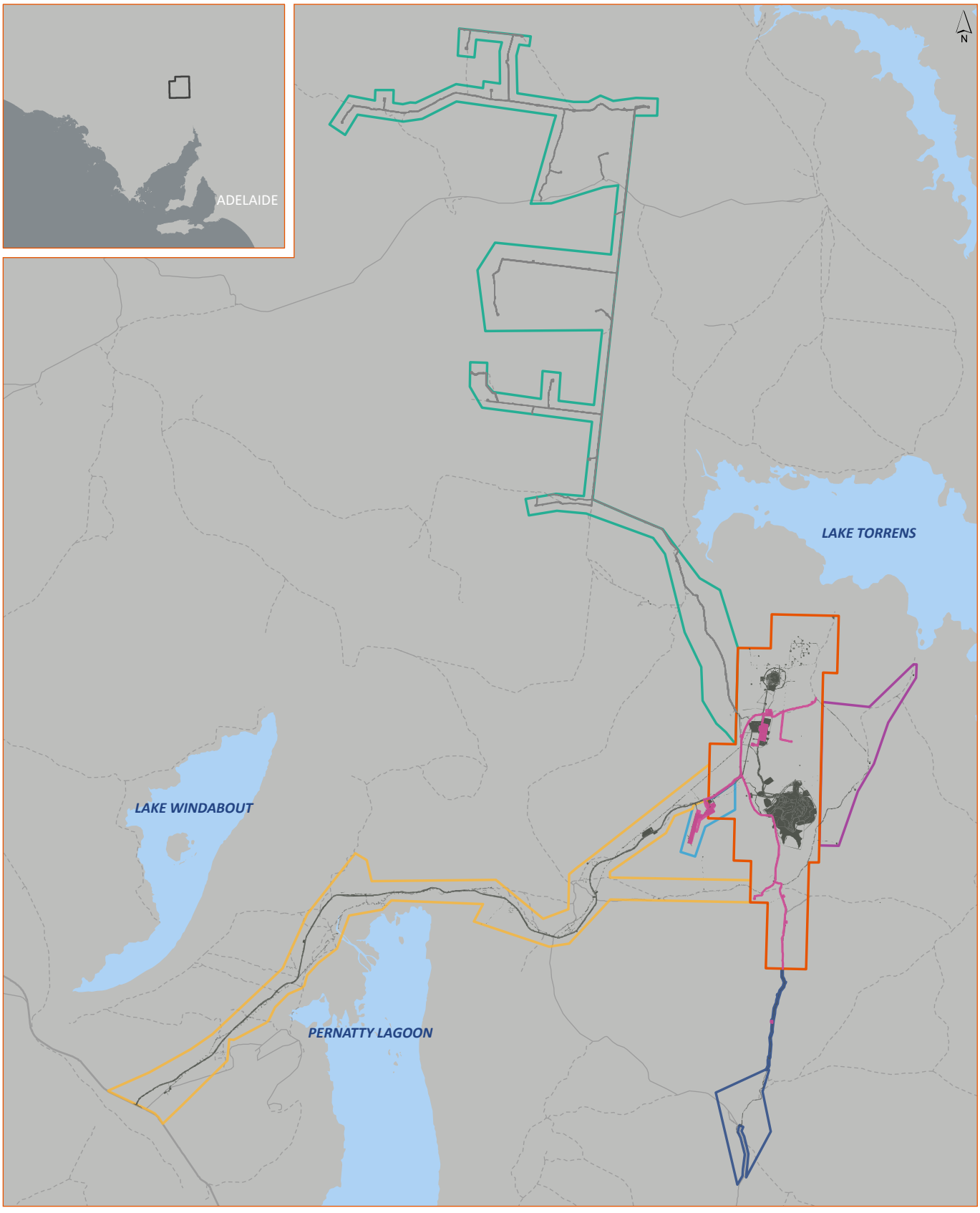
Number	Condition	Demonstrated commitment
10	Within 3 months following the change of tenure referred to in condition 5) the person taking the action must provide the Department with written evidence that the offset property has been secured for conservation purposes using an appropriate legal mechanism.	Commitment acknowledged
11	Within 30 days after the commencement of the action, the person taking the action must advise the Department in writing of the actual date of commencement.	OZ Minerals advised DoEE of the commencement of action on 21 April 2018 (CA-ENV-LET-1001)
12	The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.	OZ Minerals maintains an Environmental Management System that includes electronic data management systems for document control (InEight), obligations management and land access (Land Folio) and consultation/correspondence (Borealis). Data collected during monitoring is recorded on the site environmental data management system (MonitorPro) or within ArcGIS.
13	Within 30 days after completion of the action, the person taking the action must advise the Department in writing of the actual date of completion and provide a map clearly defining the date, location and actual impact within the Disturbance footprint of the action and be accompanied with a shapefile.	Commitment acknowledged
14	The approval holder must prepare a compliance report for each 12 month period following the date of commencement of the action, or as otherwise agreed to in writing by the Minister. The approval holder must: (a) publish each compliance report on the website within 60 business days following the relevant 12 month period; (b) notify the Department by email that a compliance report has been published on the website within five business days of the date of publication; (c) keep all compliance reports publicly available on the website until this approval expires; (d) exclude or redact sensitive ecological data from compliance reports published on the website; and (e) where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication. Note: The first compliance report may report a period less than 12 months so that it and subsequent compliance reports align with the similar requirement under state approval.	EPBC 2017/7895 Compliance Report is posted annually in March to the BHP website (https://www.bhp.com/sustainability/environment/regulatory-information) with copies of previous Compliance Reports.
15	Upon the direction of the Minister, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	Commitment acknowledged
16	If, at any time after 5 years from the date of this approval, the person taking the action has not commenced the action, then the person taking the action must not commence the action without the written agreement of the Minister.	Action commenced in March 2018, as communicated to DoEE in April 2018 (CA-ENV-LET-1001)
17	The approval holder must notify the Department in writing of any: incident; non-compliance with the conditions; or non-compliance with the commitments made in plans. The notification must be given as soon as practicable and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify: (a) the condition which is or may be in breach; and (b) a short description of the incident and/or non-compliance.	Commitment acknowledged
18	The approval holder must provide to the Department the details of any incident or non-compliance with the conditions or commitments made in plans as soon as practicable and no later than 30 days after becoming aware of the incident or non-compliance, specifying: (a) any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future; (b) the potential impacts of the incident or non-compliance; and (c) the method and timing of any remedial action that will be undertaken by the approval holder.	Commitment acknowledged

8.1.2 Land disturbance

Land disturbance refers to the area to be cleared for infrastructure elements and includes a buffer on dust generating areas for the purposes of conservatism and to allow for indirect edge effects. This buffer is included in the land disturbance footprint. Land disturbance refers to the area that will be approved to be disturbed and authorised under the NV Act (see Section 8.2) and the EPBC Act. It should be noted that the 2,924 ha stated in the March 2017 EPBC referral document included the Advanced Exploration Activities that are now excluded from the proposed action in the variation dated 2 June 2017.

As described in the MLP Response Document (OZ Minerals 2017c), further works have been undertaken to clearly identified which activities form part of EPBC Referral 2017/7895, the previous referral for Advanced Exploration Activities (EPBC Referral 2012/6494) and pre-existing disturbance; as provided in separate correspondence dated 11 August 2017.

The land disturbance footprint, as described in Section 4.5, is approximately 2,224 ha as shown in Figure 8.1. For clarity, Figure 8.1 shows the previous advanced exploration works and other activities that are specifically excluded from EPBC Referral 2017/7895.



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156

TSF Stage 3 PEPR footprint

- Carrapateena
- Northern Wellfield
- Disturbance excluded from EPBC Referral 2017-7895

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 8.1 | Carrapateena disturbance footprint and areas excluded from EPBC referral 2017-7895

8.1.3 Impact significance and environmental offsets

A detailed assessment of impact significance has been undertaken for each MNES against Schedule 4 of the EPBC Regulations 2000 and the Significant Impact Guidelines (DoE 2013).

The Significant Impact Guidelines for MNES defines a 'significant impact' as an impact that is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment that is impacted, and upon the intensity, duration, magnitude and geographical extent of the impacts. The impact assessment against MNES has demonstrated that through the project lifecycle, there will be no significant impacts and this statement is provided to a high level of certainty. A summary of the predicted impacts against each MNES is provided in Table 8.3.

In the context of the EPBC Act the term '**environmental offset**' refers to the measure commensurate for the residual adverse impacts on an action on the environment. Offsets provide environmental benefits to counterbalance impacts that remain after avoidance and mitigation measures have been applied. Remaining unavoidable impacts are termed '**residual impacts**'.

For assessments under the EPBC Act, offsets are only required if residual impacts of a controlled action are significant. No significant impact on MNES is predicted, however an environmental offset containing suitable habitat for the plains mouse will be provided in accordance with Condition 27 of Schedule 2 of ML 6471 (Appendix A1 ML 6471 Mineral Lease) and relevant conditions of the separate EPBC Act approval.

Table 8.3 | Impact significance summary

MNES	Impact significance summary
Frankenia plicata Thick-billed Grasswren Nigh Parrot Curlew Sandpiper	Substantial survey effort and understanding of available habitat in relation to *F. plicata* to support the statement that this species is considered 'Unlikely' to occur within the Project Area and therefore no impacts are predicted to a high level of certainty.
Plains Mouse	Whilst impact as a result of reduced habitat is predicted the impacts are considered to be local and no significant impacts are predicted to a high level of certainty. The Prominent Hill mine operated by BHP is a controlled action in relation to the Plains Mouse and the survey effort undertaken during operations indicates the Plains Mouse has persisted in relatively close proximity to the mine during boom years and no significant impacts have been observed.
Migratory Bird Species	Migratory bird species are considered unlikely to occur in the Project Area and are likely to pass over on migration to larger salt lake systems in this region and more southerly regions. It is improbable that the site contains habitat 'that may support a population of the species', however, the known distributions of each of these species are broad (cross-continental) so the Project Area likely falls within these distributions. Migratory species are considered 'unlikely' to occur onsite, and even if present in transit, would not be impacted.

MNES	Impact significance summary
Nuclear Action – Surface Water	There is not predicted to be significant impacts on surface water resources and this prediction is based on a high level of certainty. The effect to the surface water environment is predicted to be local in nature in relation to reduced surface water availability. Changes to surface water quality are not anticipated to occur without an unplanned (risk) event and there is a high level of confidence in the controls applied to the project to prevent these from occurring.
Nuclear Action – Air Quality	There is not predicted to be significant effects on air quality and this prediction is based on a high level of certainty. The effect to the air quality environment has been demonstrated to be local in nature (see Section 6.2).

8.1.4 Conservation advice, recovery plans and threat abatement plans

Section 139 of the EPBC Act has been considered for each individual Listed Threatened, and Migratory, species (see Table 8.4). Section 139 of the EPBC Act outlines the considerations that the Minister must take in deciding whether or not to approve an action. The requirements include consideration of any recovery or threat abatement plans for potentially impacted threatened species or endangered communities. If the Minister is considering approving an action, and the action will have, or is likely to have, a significant impact on a threatened species or ecological community, the Minister must have regard for any approved conservation advice for the species or community. Conservation advice available for each species has been considered below including a commitment to implement relevant management actions.

Table 8.4 | EPBC Act-listed species conservation considerations

MNES	Conservation considerations
Frankenia Plicata (Sea-heath)	No current recovery plan exists for *F. plicata* and the SPRAT profile indicates a decision has been made that a recovery plan is not required.
Calidris ferruginea (Curlew Sandpiper)	Management actions include control of feral animal populations, including cats and foxes, which align with the conservation actions. These are standard management controls that apply at all BHP operations.
Amytornis modestus (Thick-billed Grasswren)	BHP notes the Threat Abatement Plans relevant to Thick-billed Grasswren include management of feral cats, competition and land degradation by rabbits and goats. Management actions include control of feral animal populations, including cats and foxes, which align with the conservation actions. BHP also notes the adopted 2002 Recovery Plan for Thick-billed Grasswren (eastern subspecies) (NPWS 2002). BHP commit to providing data from any future records of Thick-billed Grasswren to the BDBSA to enable effective monitoring and record keeping, as per the Recovery Plan actions.
Pezoporus occidentalis (Night Parrot)	The approved conservation advice for Night Parrot is noted (TSSC 2016), and that there are no existing or adopted recovery plans for this species. BHP acknowledges the Threat Abatement Plans relevant to Night Parrot, including management of feral cats and foxes, and competition and land degradation by rabbits. Management of cats and foxes will be adopted as standard practice across the operation. BHP commits to reporting any sightings or evidence of calls or activity to the Night Parrot Recovery Team throughout the Carrapateena operation.

MNES	Conservation considerations
Pseudomys australis (Plains Mouse or Plains Rat)	The Threat Abatement Plans relevant to Plains Mouse are noted, including management of feral cats and foxes, and competition and land degradation by rabbits. BHP commits to ongoing fauna surveys at the site and will continue to report any future records of Plains Mouse to the BDBSA to assist with ongoing state-wide monitoring of this species. BHP management actions include control of feral animal populations, including cats and foxes around the Project Area, which aligns with the conservation actions outlined by Moseby (2012).
Migratory Bird Species	Whilst migratory bird species do not form part of the Controlling Provisions BHP note and acknowledge the relevant Threat Abatement Plans for these and other migratory species, as well as the Wildlife Conservation Plan for Migratory Shorebirds and relevant Marine Bioregional Plans. Management measures proposed for the project include threat abatement activities such as feral animal control, which are standard management controls that apply at all BHP operations.

BHP commits to the following monitoring and management controls (Chapter 7 and Chapter 9) in relation to conservation significant species. The actions are based on consideration of the relevant conservation advice for each species; and provided as OMC. Relevant actions include the following:

- Management actions include control of feral animal populations, including cats and foxes, which aligns with the conservation actions and will be an extension of existing management strategies undertaken at the site and as undertaken at the Prominent Hill mine.
- Records of the Thick-billed Grasswren are to be provided to the BDBSA to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites (Figure 9.2 fauna and Figure 9.3 flora)
- Records of the Plains Mouse are to be provided to the BDBSA to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites (Figure 9.2 fauna and Figure 9.3 flora)
- Records of the Night Parrot are provided to the Night Parrot Recovery Team to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites (Figure 9.2 fauna and Figure 9.3 flora)

8.2 Native vegetation clearance

The NV Act controls the clearance of native vegetation. On 1 July 2017, the Native Vegetation Regulations 2003 (SA) were replaced with the Native Vegetation Regulations 2017 (SA). Accompanying this change were revised assessment methodologies relating to proposed clearance of native vegetation and revised guidance regarding the calculation of SEB offset requirements. The new policy also strengthens the mitigation hierarchy, requiring a proponent to identify and document measures to avoid and minimise negative impacts (either direct or indirect) prior to undertaking steps to rehabilitate/restore or offset.

BHP is required to provide an SEB for vegetation clearance under the NV Act (DEWNR 2017a; 2017b). An SEB must provide an environmental gain over and above the impacts of an approved clearance. The SEB may be established via a number of different pathways, including monetary contribution to the Native Vegetation Fund (NVF), purchase of SEB credits from an approved third-party provider, active management of native vegetation for conservation purposes, direct revegetation and/or on-ground works.

The land disturbance and clearance of native vegetation would be offset by the provision of an SEB as required under the NV Act. SEB offsets have been initiated through a staged approach covering the total projected clearance, since grant of RL 127, of up to 2,224 ha of native vegetation as detailed in Appendix D (across Carrapateena and Northern Wellfield Projects as presented separately within).

The proposed changes to approved operations described in Section 1.2 have been reviewed in the context of the requirement or potential for additional native vegetation clearance, and footprint and SEB requirements have been incorporated in the description provided in Section 4.5 and in the corresponding updated Native Vegetation Management Plan (see Appendix D).

In the event of further (future) project variations (see Section 3.6) BHP will ensure an adequate SEB is available.

8.2.1 Approvals and offsets

Reconciliation of the disturbance footprint is undertaken on a regular basis to demonstrate compliance with the SEB-approved vegetation associations and disturbance footprint. DEM has delegated authority under the NV Act and the SEB offset requirements are to be managed through the PEPR prior to the commencement of activities. The approach to native vegetation clearance including proposed disturbance footprint, minimisation and management is described in detail within Appendix D. Aerial photography (or alternative methods) and land disturbance reconciliation are important management controls to ensure land disturbance does not exceed the approved footprint.

Native vegetation-specific OMC were described in Chapter 7. These criteria are addressed through the Monitoring Plan provided in Chapter 9.

8.2.2 Land clearance process and outcomes

All clearing activities undertaken onsite will require site-based Land Clearance Approval to ensure there is no clearing of vegetation without approval under the NV Act and is within the SEB offset provisions established for Carrapateena.

The Land Clearance Approval process is detailed in site-specific procedures and practices.

8.3 Radiation management

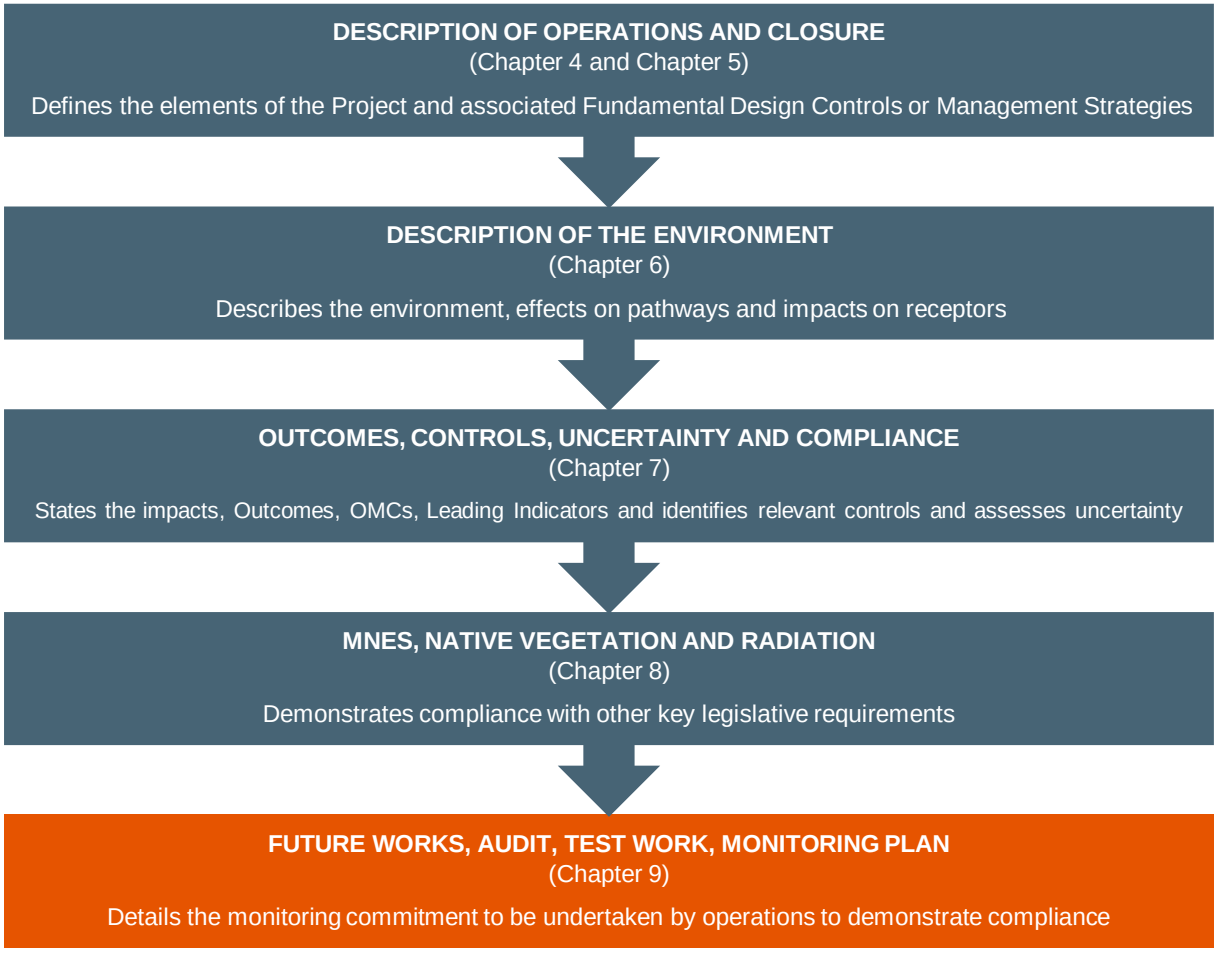
In South Australia, the legislation for radiation control is the RPC Act, and associated Radiation Protection and Control Regulations 2022. The purpose of the RPC Act is to control activities involving radiation sources and to provide for the protection of people and the environment from the effects of radiation.

Key requirements of the RPC Act include the development and approval of a Radiation Management Plan (RMP) and a Radioactive Waste Management Plan (RWMP) with the EPA being the agency responsible for endorsement of the plans. An RMP and RWMP are also required under the Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing 2005 (Mining Code) (ARPANSA 2005a).

The potential for personnel working in the underground mining operations to be exposed to radiation necessitate the implementation of a number of controls and mitigation to ensure that doses remain as low as reasonably achievable (ALARA). These measures, and the anticipated radiation doses and monitoring practices, are incorporated into the respective RMP and RWMP, which have been prepared for Carrapateena and are approved by the EPA under the RPC Act. Both the RMP and RWMP are presented to the EPA before the commencement of any stage of the mining operation to which the Mining Code (ARPANSA 2005a) applies. The RMP describes the measures that will be undertaken to control the exposure of employees and members of the public to radiation. The RWMP provides for the proper management of radioactive waste arising from the mining operation.

A fit-for-purpose environmental monitoring and occupational radiation monitoring program has been developed and incorporated into Chapter 9, to provide data for the assessment of radiological risk to non-human biota, the public and workers to ensure radiation controls are effective. The monitoring plan forms part of the RMP and RWMP and has been developed in accordance with the RPC Act.

9. Future works, audits and monitoring



This chapter provides a monitoring plan focussed on the operational requirements to ensure adequate data is collected to demonstrate achievement of each Environmental Outcome, strategy and BHP's other regulatory requirements. The monitoring plan is derived from the OMC, Leading Indicators and strategies identified in Chapter 7 and from other regulatory requirements identified in Chapter 3. The works described in this chapter are the responsibility of different personnel and therefore it has been tailored for the different functional areas followed by a breakdown in tasks by frequency. This aims at making this chapter and its accountabilities transparent for each functional area. The monitoring plan is separated into the categories described in Table 9.1 with a summary of key accountabilities.

Table 9.1 | Future works, audit, test work and monitoring plan categories and accountabilities

Category	PEPR reference	Lead responsibility
TSF Design, Audits, Monitoring and Test Work	Section 9.1	Tailings Construction, Tailings Operations and Environment Leads
Ore Stockpiles Design, Audits, Monitoring and Test Work	Section 9.2	Mining and Processing Leads
Surface Water Infrastructure and Topsoil Design, Audits, Monitoring and Test Work	Section 9.3	Construction
Environmental Baseline, Well Commissioning, Field Trials and Model Calibration	Section 9.4	Environment
Environmental Audits, Inspections, Surveys and Monitoring	Section 9.5	Environment Safety and Health and Community Leads

9.1 Tailings storage facility design, audits, monitoring and test work

Table 9.2 | TSF design, audits, monitoring and test work

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Corrective actions, design further works and modelling review									
Suitably Qualified Expert Approval	Apply in writing and provide Curriculum Vitae showing their academic qualifications, publications (if any) and practical experience for nominated employee of the Tenement Holder associated with Audits for Leading Indicator TSF14	TSF (Figure 4.2)	The DPC is seeking to ensure that if the auditing and reporting person is an employee of the Tenement Holder that they are suitably qualified and that an independent audit is conducted at least once for each twelve (12) month period.	Prior to commencement of construction of the TSF and change of personnel	ML 6471 Schedule 2 Condition 14	Tailings Construction Lead	Audit reports associated with Leading Indicator TSF14	Provision to DEM	Completed (reported in 2020 PEPR Compliance Report)
Observed lateral and vertical seepage	Update the assumptions and inputs in the Tailings Storage Facility: Surface Water and Groundwater Geochemical Effects Assessment 2017 (OZ Minerals 2017c, Appendix F) will be revisited to determine if there is likely to be any ongoing change to the predicted effects and impacts and to derive new water quality targets in shallow and deep TSF monitoring wells with consideration to observed rates, new assumptions and new parameters from TSF Stage 2 operations	TSF (Figure 4.2)	Provision of the outcomes of the reviews and the implementation of corrective actions to the satisfaction of DEM.	Single review event	Corrective actions arising from non-compliance with OMCs TSF1, GW1, TSF2 and GW2	Senior Environment Advisor	Internal reports from specialist consultants	Provision to DEM via PEPR Annual Compliance Report	Ongoing
	Review seepage fate analysis to confirm that vertical seepage still reports to the subsidence zone								
	Review relevant OMCs to determine suitability of existing monitoring locations and achievement values								
	Develop of site specific guideline values for groundwater and surface water as an alternative to ANZECC/ARMCANZ (2000) freshwater and limited baseline ranges to update relevant leading indicators if determined to be required								
Stage 1 audits and test work									
Stage 1 Commissioning Audit	Audit undertaken by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including quality assurance inspections and signed by construction manager	TSF (Figure 4.2)	Demonstrates that seepage design controls and TSF and Decant embankment foundation preparation have been constructed in accordance with the design (MLP Appendix A2 TSF Design; OZ Minerals 2017a). The expert reports for the audits of Stage 1 of TSF embankment construction must address all items as specified in Schedule 2 Condition 10.	Undertaken during construction prior to commissioning of Stage 1	Leading Indicator – TSF11	Tailings Construction Lead	Audit report	Annual Compliance Report	Completed (reported in 2020 PEPR Compliance Report)
Stages 2, 3, 4 and 5 audits and test work									
Embankment Foundation	Audit undertaken by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including quality assurance inspections undertaken during construction and signed by construction manager	TSF (Figure 4.2)	Demonstrates embankment foundation preparation have been constructed in accordance with the design (MLP Appendix A2 TSF Design; OZ Minerals 2017a). The expert reports for the audits of Stages 2, 3, 4 and 5 of TSF embankment construction must address all items as specified in Schedule 2 Condition 10.	Prior to commissioning of Stages 2, 3, 4 and 5	Leading Indicator – TSF15	Tailings Operations Lead	Audit report	Annual Compliance Report	Completed (embankment foundations, TSF Comprehensive Annual Report December 2019 to March 2021, CA-3630-PRM-REP-1503) Ongoing (Stages 2, 3, 4 and 5)

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Incident and event monitoring									
Decant Flood Storage Area Activation	Water sampling and analysis of pH, metals and EC	Decant dam (Figure 4.2)	Compared to geochemical modelling prediction (Table 9.19; pH, EC and metals). Should values deviate by +/- 10% an investigation will be undertaken and seepage model re-run.	Rainfall event that result in the activation of the flood storage area	Leading Indicator – TSF24	Tailings Operations Lead Environment Lead	Monitoring records updated	Annual review and reporting in Annual Compliance Report	Ongoing
Monthly audits, monitoring and test work									
Supernatant Characterisation	Supernatant water sampling and laboratory analysis of pH, EC, and metals	Collected from the TSF supernatant pond and lined decant pond	Validates geochemical modelling predictions (Table 9.19; pH, EC and metals). Should values deviate by +/- 10% an investigation will be undertaken and seepage model re-run.	Monthly	Leading Indicator – TSF21	Tailings Operations Lead Environment Lead	Monitoring records updated	Annual review and reporting in Annual Compliance Report	Ongoing
Seepage	Water sampling and laboratory analysis of pH, EC and metals	Tailings downstream seepage collection trench (Figure 4.28)	Compared to geochemical modelling prediction (Table 9.19; pH, EC and metals). Should values deviate by +/- 10% an investigation will be undertaken and seepage model re-run.	Monthly	Leading Indicator – TSF23	Tailings Operations Lead Environment Lead	Monitoring records updated	Annual review and reporting in Annual Compliance Report	Ongoing
Quarterly and half-yearly audits, monitoring and test work									
Operational Audits and Testing	Audit undertaken by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including quality assurance inspections and audit of records of the Operations, Maintenance and Surveillance Manual and signed by manager	TSF (Figure 4.2)	Demonstrates that the TSF is being operated in accordance with design (MLP Appendix A2 TSF Design; OZ Minerals 2017a) and the Operations, Maintenance and Surveillance Manual.	Quarterly Stages 1 and 2 Half yearly Stages 3, 4, 5 and 6	Leading Indicator – TSF16 ML 6471 Schedule 2 Condition 4.3 and 4.4	Tailings Operations Lead	Audit report	Annual Compliance Report	Ongoing

9.2 Ore stockpiles design, audits, monitoring and test work

Table 9.3 | Ore stockpiles design, audits, monitoring and test work

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Design further works									
AMD Management Plan Development	Develop an appropriate AMD Management Plan	Ore stockpiles (Figure 4.34)	Includes the following: • Develop a program to investigate the potential for metalliferous drainage to be generated by NAF material which contains sulphides. • Refine the sulphur cut-off grade for PAF material through further testing of waste units. • Develop an ore, waste rock and sulphur block model. • Develop the block model to include the sulphur distribution of all waste and ore to be mined for the purpose of determining the distribution and estimating the volume of NAF and PAF using the sulphur cut-off grade. • Regular updating of the block model with new geological and sulphur assay data in the course of operations and aligning to the materials handling program. • Develop a QA/QC process for validation of Acid Base Accounting (ABA) characteristics. • Develop a QA/QC process for the waste rock block model and testing to ensure the correct rock is placed in the correct destination. • Segregation of PAF waste rock, NAF waste rock, and waste rock with the potential for metalliferous drainage (based on a classification process) and a mining schedule for each. • Ensure stockpiles containing PAF material are appropriately located. • Develop appropriate stockpile management strategies. • Confirm final end uses for waste rock and marginal ore based on geochemical classification.	Prior to the commencement of construction activities	Schedule 6 Condition 21.4.2 to 21.4.12	Mining Lead	AMD Management Plan implementation	AMD Management Plan to be provided to DEM	Completed (reported in 2019 Annual Compliance Report)
Commissioning audits									
Stockpile Pad Construction	Audit of the production stockpile pad and signed by construction manager	Production stockpile pad	Demonstrates the production stockpile pad has been constructed in accordance with the basis of design (Figure 4.36).	Completion of construction and prior to the placement of material above the sulphur cut-off grade	Leading Indicator – AMD2	Mining Lead	Audit report	Annual Compliance Report	Completed (reported in 2019 Annual Compliance Report))
Operational audits									
Block Model Review	Audit of the block model with updated geological and sulphur assay data	Maintained at the site	• Determine the sulphur distribution of all waste for the forward year. • Estimate the distribution and estimation of volume of AMD material using the sulphur cut off grade. • Develop or adjust management requirements if needed.	Annual	Leading Indicator – AMD3	Mining Lead	Audit report	Annual Compliance Report	Ongoing
Material Reconciliation	Audit of waste rock and ore stockpiles at the surface including reconciliation of volumes undertaken annually	Waste rock and ore stockpiles at the surface (Figure 4.34)	All potential AMD material has been handled in accordance with: • the management requirements determined by the annual block model review • the AMD Management Plan.	Annual	Leading Indicator – AMD4	Mining Lead	Audit report	Annual Compliance Report	Ongoing

9.3 Surface water infrastructure and topsoil stockpile design, audits and monitoring

Table 9.4 | Surface water infrastructure and topsoil design, audits and monitoring

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Design further works									
Topsoils	Stockpiling of topsoil	Stockpile locations (Figure 4.37)	Topsoil must be stockpiled and measures adopted to preserve stockpiled materials until the material is reused or determined to be no longer required.	During construction activities and until closure	Schedule 6 Condition 12.4	Construction Lead	Stockpile locations recorded	Stockpile locations and volumes reported in Annual Compliance Report	Ongoing
SLC Subsidence Zone Abandonment Bund	Updated detailed design of the abandonment bund undertaken by a suitably qualified expert	SLC Subsidence Zone Abandonment bund (Figure 4.19)	Address the identification of material types, sources, volumes and completion of laboratory testing to determine erodibility for materials placed on the abandonment bund to demonstrate that the material is suitable to prevent long-term erosion and sedimentation.	Prior to placement of the material	Schedule 6 Condition 19.7 and 19.9	Construction Lead	Materials test reports maintained at site	Design detail maintained at site for auditing purposes and reporting in Annual Compliance Report	Ongoing
Surface Water – Infrastructure	Inspection	Key surface water management infrastructure (Figure 4.22, Figure 4.42)	Surface water management infrastructure is as constructed and have been maintained in accordance with the design and corrective actions closed out within 14 days.	Within seven days of a rainfall event required to create flow	Leading Indicator – SWES3	Construction Lead Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report	Ongoing
Surface Water – Infrastructure	Inspection	Key surface water management infrastructure (Figure 4.22, Figure 4.42)	Surface water management infrastructure is as constructed and have been maintained in accordance with the design and corrective actions closed out within 14 days.	Annually (prior to summer)	Leading Indicator – SWES2	Construction Lead Environment Lead	Audit report	Reporting in Annual Compliance Report	Ongoing

9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration

Table 9.5 | Baseline information, agreements, well commissioning, field trials and model calibration

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Additional environmental baseline information required									
Bosworth Creek Waterholes/Springs Ecology Assessment	Baseline ecological survey	Bosworth Creek waterhole/spring monitoring sites (Figure 9.5; including SW-6 and SW-7)	Establish baseline data and added to Appendix C5 Ecological Baseline (BHP 2024a).	Prior to commencement of Northern Wellfield operations	OMC – ECO1 (Schedule 6 Condition 13)	Environment Lead	A single event to establish baseline prior to wellfield operation (update to MLP Appendix B6 Ecological Baseline (OZ Minerals 2017a))	Reporting in Annual Compliance Report	Completed (reported in 2019 Annual Compliance Report as Appendix E, and reflected in Section 6.4 of this PEPR)
Bosworth Creek Groundwater Dependant Ecosystem Assessment	Baseline groundwater-dependent ecosystem study using soil/plant/water assessment	Bosworth Creek waterhole/spring monitoring sites (Figure 9.5; including SW-6 and SW-7)	Establish baseline data and added to Appendix C5 Ecological Baseline (BHP 2024a).	Prior to commencement of Northern Wellfield operations	OMC – ECO1 *(Schedule 6 Condition 13)*	Environment Lead	A single event to establish baseline prior to wellfield operation (update to MLP Appendix B6 Ecological Baseline (OZ Minerals 2017a))	Reporting in Annual Compliance Report	Completed (reported in 2019 Annual Compliance Report as Appendix E, and reflected in Section 6.4 of this PEPR)
Groundwater well construction, baseline and commissioning									
Well Commissioning	Pumping rate at commissioning	Production wells (Figure 9.7)	Confirms the design pumping rates can be sustained over the required period of operation.	Immediately upon commissioning of well. Commissioned wells require further intense monitoring in the first year in accordance with Table 9.18	To confirm sustained longevity of groundwater production to meet peak maximum project water demand (14.5 ML./d in total, with 7 ML/d from the Northern Wellfield)	Environment Lead Construction Manager	Capture in site database and review periodically.	WaterConnect and SARIG	Completed (reported in Well Completion Reports to the DEW by the drilling hydrogeological consultant, and reflected in Section 4.12.4.2 of this PEPR)
	Groundwater level monitoring at commissioning	Production and observation wells (Figure 9.7) Leading Indicator and compliance wells (Figure 9.8)	Confirms aquifer response at design pumping rates.	Immediately upon commissioning Commissioned wells require further intense monitoring in the first year in accordance with Table 9.18	To confirm sustained longevity of groundwater production to meet peak maximum project water demand (14.5 ML/d in total, with 7 ML/d from the Northern Wellfield) and to inform the extent of drawdown at compliance wells Leading Indicator – GW4	Environment Lead	Capture in site database and review periodically.	WaterConnect and SARIG	Completed (reported in Well Completion Reports to the DEW by the drilling hydrogeological consultant, and reflected in Section 4.12.4.2 of this PEPR)
TSF monitoring well baseline	Groundwater monitoring of standing water levels	Shallow monitoring wells downstream of the TSF (Figure 9.6; TSFMB1s–TSFMB4s) Tent Hill Aquifer Wells downstream of the TSF (Figure 9.6; TSFMB1d, TSFMB3d and TSFMB4d)	Establish baseline standing water levels.	Prior to commencement Stage 1 Tailings commissioning	OMC – TSF2 OMC – GW2	Environment Lead TSF Construction Lead	Monitoring database updated	Annual review and reporting in Annual Compliance Report	Completed (reported in 2020 Annual Compliance Report – Appendix C, and reflected in Section 6.4.2 of this PEPR)
	Groundwater sampling and laboratory analysis for pH, metals and EC		Establish baseline water quality.	Prior to commencement Stage 1 Tailings commissioning	OMC – TSF1 OMC – GW1	Environment Lead TSF Construction Lead	Monitoring database updated	Annual review and reporting in Annual Compliance Report	Completed (reported in 2020 Annual Compliance Report – Appendix C, and reflected in Section 6.4.2 of this PEPR)

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Northern Wellfield regional groundwater monitoring well baseline	Groundwater monitoring of standing water levels	Shallow monitoring well within the vicinity of Bosworth Homestead (Figure 9.8; Bosworth Alluvium) Tent Hill Aquifer monitoring wells within the Northern Wellfield monitoring network (Figure 9.8; Bosworth THA, BI-6 THA, ENV-N10 and ENV N4) WSA monitoring wells within the Northern Wellfield monitoring network (Figure 9.8; ENV N8 and ENV-N11) Pandurra Formation monitoring well within the Northern Wellfield monitoring network (Figure 9.8; BI-6 PAN)	Establish baseline standing water levels.	Prior to commencement of Northern Wellfield operations	OMC – GW3 Leading Indicator – GW5 (Schedule 6 Condition 16.2)	Environment Lead	A single event to establish baseline once groundwater environment has established post-monitoring well installation Monitoring database updated	Annual review and reporting in Annual Compliance Report	Completed (reported in 2019 Annual Compliance Report as Appendix E, and reflected in Section 6.4 of this PEPR)
	Groundwater sampling and laboratory analysis for pH, metals and EC		Establish baseline water quality.	Prior to commencement of Northern Wellfield operations	To determine baseline water quality at the location the of shallow sediment wells, THA wells, WSA wells and Pandurra Formation wells *(MPL 156 Schedule 6 Condition 15)*	Environment Lead	A single event to establish baseline once groundwater environment has established post-monitoring well installation Monitoring database updated	Annual review and reporting in Annual Compliance Report	Completed (reported in 2019 Annual Compliance Report as Appendix E, and reflected in Section 6.4 of this PEPR)
Western Access Road and electricity transmission line commissioning audits									
Transmission Line	Audit of the Transmission Line	Transmission Line (Figure 4.4)	Infrastructure has been constructed in accordance with the transmission line design including: • line spacing between phase and ground conductors greater than 150 cm • insulation of phase and/or ground conductors where necessary • installation of perch discourages.	Completion of construction	Leading Indicator – NF2	Environment Lead Construction Lead	Audit report signed by construction manager	Annual Compliance Report	Completed (reported in 2019 Annual Compliance Report, and reflected in Section 4.13.3.3 of this PEPR)
Western Access Road – Speed Signage	Audit of the Western Access Road	Western Access Road (Figure 4.4)	Demonstrates speed limit signage has been installed at entry points and at a minimum of 5 km intervals in accordance with the design plans.	Completion of construction	Leading Indicator – NF3	Environment Lead Construction Lead	Audit report signed by construction manager	Annual Compliance Report	Completed (reported in 2021 Annual Compliance Report and evidenced by Western Access Road – Inspection and Test Plan (ITP) 017 Road Furniture (CA-5410-QAC-ITP-1017), and reflected in Section 4.14.4.1 of this PEPR)
Tailings beach trials and air quality modelling validation									
Methodology Development	Develop an appropriate tailings beach trial methodology (air quality) to the satisfaction of the Director of Mines (or other authorised officer)	TSF (Figure 4.2)	To establish dust threshold lift off speed for tailings including monitoring of tailings change over time and representation of final landform including modelling input assumptions of moisture content, crust thickness, wind speed, and particle size (OZ Minerals 2017a; MLP Appendix C1 Air Quality Modelling and Assessment of Effects).	Prior to Stage 1 of the TSF	OMC – AQ3 Schedule 6 Condition 15	Environment Lead Tailings Operations Lead	Methodology memo	Methodology to be provided to DEM	Completed

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Tailings Beach Trial Implementation	Implement the tailings beach trial methodology (air quality)	TSF (Figure 4.2)	To establish dust threshold lift off speed for tailings including monitoring of tailings change over time including modelling input assumptions of moisture content, crust thickness, wind speed, and particle size (OZ Minerals 2017a; MLP Appendix C1 Air Quality Modelling and Assessment of Effects).	During Stage 1 of the TSF	OMC – AQ3 Schedule 6 Condition 15	Environment Lead Tailings Operations Lead	Annual status report	Trial status reporting in PEPR Compliance Report	Completed
Air Quality Model Calibration	Calibration of the air quality model (OZ Minerals 2017a; MLP Appendix C1 Air Quality Modelling and Assessment of Effects) with operational monitoring data and dust threshold lift data established in the tailings beach trials	TSF (Figure 4.2)	Validates modelling outputs (Table 9.10).	At years 6/8/10 of the TSF operation	OMC – AQ3 Leading Indicator – AQ5	Environment Lead Tailings Operations Lead	Calibration report	Calibration report provided in Annual Compliance Report Updated closure strategy updated if required PEPR Review	Ongoing – due in 2025
Field Study Data Analysis	Audit by an independent and suitably qualified expert of dust threshold lift data from the tailings beach trials	TSF (Figure 4.2)	Compared to the Air Quality Model (OZ Minerals 2017a; MLP Appendix C1) dust threshold lift speed of 5.4 m/s. Should the threshold lift speed be <5.4 m/s an assessment will be undertaken by an independent and suitably qualified expert to determine if there is a material deviation expected on modelling outputs that triggers a model calibration.	Annual	OMC – AQ3 Leading Indicator – AQ6	Environment Lead Tailings Operations Lead	Audit report	Annual Compliance Report	Ongoing – submission in H1 2024
TSF landform evolution modelling									
Methodology Development	Develop an appropriate erosion field study methodology to the satisfaction of the Director of Mines (or other authorised officer) for the Stage 2 embankment surface and isolated areas of the tailing beach	TSF (Figure 4.2)	To establish runoff and sediment load including modelling input assumptions of embankment geometry, rock armouring, particle sizes, and rainfall intensity (MLP Appendix A7 Closure Strategy (Erosion Modelling)) (OZ Minerals 2017a).	Prior to Stage 1 of the TSF	OMC – TSF7 Schedule 6 Condition 19.5	Environment Lead Tailings Operations Lead	Methodology memo	Methodology to be provided to DEM	Completed – Reported in 2022 Annual Compliance Report as Appendix G
Erosion Field Study Implementation	Implement the erosion field study	TSF (Figure 4.2)	To establish runoff and sediment load including modelling input assumptions of embankment geometry, rock armouring, particle sizes, and rainfall intensity (MLP Appendix A7 Closure Strategy (Erosion Modelling)) (OZ Minerals 2017a).	During Stage 2 of the TSF	OMC – TSF7 Schedule 6 Condition 19.5	Environment Lead Tailings Operations Lead	Annual status report	Trial status reporting in Annual Compliance Report	Ongoing
Landform Evolution Model Calibration	Calibration of the Landform Evolution Model with field study data	TSF (Figure 4.2)	Validates modelling outputs (MLP Appendix A7 Closure Strategy (Erosion Modelling)) (OZ Minerals 2017a).	2 years after completion of Stage 3 embankment and year 8 to 10 of the TSF operation	OMC – TSF7 Leading Indicator – TSF8 Schedule 6 Condition 19.5	Environment Lead Tailings Operations Lead	Calibration report	Calibration report provided in Annual Compliance Report Updated closure strategy updated if required PEPR Review	LEM update has been drafted and will be provided as final in a subsequent PEPR submission

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Field Study Data Analysis	Audit by an independent and suitably qualified expert of laboratory and field data including rainfall intensity, tailings particle sizes, in-channel lateral erosion parameters, 'm' from the tailings beach trials	TSF (Figure 4.2)	Compared to the Landform Evolution Model (MLP Appendix A7 Closure Strategy (Erosion Modelling)) (OZ Minerals 2017a) input assumptions. Should values deviate outside of the sensitivities in Table 9.9 an assessment will be undertaken by an independent and suitably qualified expert to determine if there is a material deviation expected on modelling outputs that model calibration[#].	Annual	OMC – TSF7 Leading Indicator - TSF9 Schedule 6 Condition 19.5	Environment Lead Tailings Operations Lead	Audit Report	Annual Compliance Report	Ongoing
Surface water model calibration									
Methodology Development	Develop an appropriate methodology for the ongoing review and calibration of the surface water model associated with reduced flows in Eliza Creek	SLC subsidence zone and TSF (Figure 4.2)	To address modelling uncertainty including long-term site-specific rainfall and evaporation data (OZ Minerals 2017a; Appendix C2 Surface Water Modelling and Assessment of Effects).	Prior to the commencement of construction activities	Schedule 6 Condition 18	Environment Lead	Methodology memo	Methodology to be provided to DEM	Completed (reported in 2022 Annual Compliance Report as Appendix H, and reflected in Section 6.3.2 of this PEPR)
Long-term site-specific rainfall data and evaporation data collection	Implement the surface water model calibration methodology	SLC subsidence zone and TSF (Figure 4.2)	Collection of long-term site-specific rainfall and evaporation data (OZ Minerals 2017a; MLP Appendix C2 Surface Water Modelling and Assessment of Effects).	From the commencement of construction activities	Schedule 6 Condition 18	Environment Lead Tailings Operations Lead	Annual status report	Data reporting in Annual Compliance Report	Ongoing
Surface Water Model Calibration	Calibration of the surface water mode using site specific rainfall and evaporation data	SLC subsidence zone and TSF (Figure 4.2)	Validates modelling outputs associated with reduced flows in Eliza Creek. Any significant variations in surface water modelling during operations from those must result in a review of the effectiveness of surface water strategies to demonstrate that the outcomes are achievable.	Undertaken two years after commencement of Stage 1 TSF operations	Schedule 6 Condition 18	Environment Lead Tailings Operations Lead	Calibration report	Calibration report provided in Annual Compliance Report	Completed (reported in 2022 Annual Compliance Report as Appendix H, and reflected in Section 6.3.2 of this PEPR)
Groundwater modelling									
Groundwater Modelling Calibration	Calibration of the Groundwater Model (OZ Minerals 2017a; MLP Appendix C3 Groundwater Modelling and Assessment of Effects) with operational monitoring data	Groundwater monitoring sites (Figure 9.8) Groundwater Production and Observation Wells (Figure 9.7)	Validates modelling outputs. If modelling outputs vary an assessment will be undertaken to consider whether strategies are still appropriate.	Undertaken two years after commissioning of the Northern Wellfield	Schedule 6 Condition 16.2	Environment Lead	Calibration report	Calibration report provided in Annual Compliance Report	Completed (reported in 2022 Annual Compliance Report as Appendix I, and reflected in Section 6.4.2 of this PEPR)

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting	Status
Closure methodology verification									
TSF Closure Methodology	Audit (TSF Closure Strategy Verification Report) undertaken by an independent suitably qualified expert approved by the Director of Mines (or other authorised officer)	TSF (Figure 4.2)	Demonstrates# that • Data has been collected for the calibration of the Air Quality Model and Landform Evolution Model as per Leading Indicators AQ5, AQ6, TSF8 and TSF9. • Data collected as per Leading Indicators AQ5, AQ6, TSF8 and TSF9 (and any other relevant data) demonstrates that the TSF closure strategies set out in the PEPR (Section 5.4.8.2), specifically the requirement for no TSF cover system, would be effective in achieving the relevant Environmental Outcomes. # The scope of the audit will be agreed by the Tenement Holder and the Director of Mines (or other authorised officer) at an appropriate time ahead of delivery of the initial report.	The audit will be provided to the Mining Regulator at the following frequencies: an initial report at 6 years after lease grant (allowing for 2 years to reach first tailings deposition, and 4 years to conduct the relevant scientific investigations); and 8 years after lease grant; and 10 years after lease grant; or any other timeframe as agreed between the Tenement Holder and Director of Mines (or other authorised officer)	OMC - AQ3 OMC - TSF7	Environment Lead	Audit Report	Audit report provided in Annual Compliance Report	Ongoing – due in 2025

9.5 Environmental audits, surveys and monitoring

Table 9.6 | Environmental audits, surveys and monitoring

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
Incidents and events								
Traffic	Investigation and corrective actions	Infrastructure locations (Figure 4.2 to Figure 4.7)	• The incident could not have been reasonably prevented. • Any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or authorised officer).	Triggered as a result of an incident associated with mine related traffic	OMC – INC1	Environment Lead	Internal incident reporting	Annual review and reporting in Annual Compliance Report
Public Safety	Investigation and review of incident report records	Infrastructure locations (Figure 4.2 to Figure 4.7)	• The incident could not have been reasonably prevented. • Any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or authorised officer).	Triggered as a result of an incident associated with unauthorised entry	OMC – PS1	Environment Lead	Internal incident reporting	Annual review and reporting in Annual Compliance Report
Accidental Spills – Chemicals	Reporting, investigation and corrective actions	Infrastructure locations (Figure 4.2 to Figure 4.7) Tailings Delivery Infrastructure and TSF	• Spill reported to the Director of Mines (or other authorised officer) as soon as reasonably practicable after becoming aware of the harm or threatened harm. • All risks were minimised so far as is reasonably practicable. • Any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer).	Triggered as a result of an accidental spill that results or threatens to result in material or serious environmental harm (as defined in Section 5(3) of the *Environment Protection Act 1993* (SA)) to native vegetation, native fauna and/or groundwater	OMC – LS1 OMC – GW7 OMC – TSF5	Environment Lead	Internal incident report	Annual review and reporting in Annual Compliance Report. Spill notification to the EPA (SA)
Native Fauna	Investigation and review of incident report records	Infrastructure locations (Figure 4.2 to Figure 4.7)	• The incident could not have been reasonably prevented. • Animal welfare was handled in accordance with the *Animal Welfare Act 1985* (SA). • Any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or authorised officer).	Triggered as a result of serious harm or death of native fauna[#] # serious harm is defined in the *Animal Welfare Act 1985* (SA)	OMC – NF1	Environment Lead	Internal incident reporting	Annual review and reporting in Annual Compliance Report
Radiation	Survey with handheld gamma monitor	Occupied or infrastructure areas (for example crusher chambers, exploration drill sites etc.)	Results are within action levels identified in the Radiation Management Plan separate to this document.	Once off prior to occupation	Radiation Protection and Control Act 1982 (SA)	Health and Safety Lead	Weekly analysis and internal reporting	EPA reporting
Land Use and Third-Party Property	Airstrip clearance and foreign object inspection	Airstrip (Figure 4.3)	Identifies a rising trend in kangaroo, emu and stock assess to the internal permitter of the wildlife and stock control fence surrounding the airstrip.	Prior to the landing and take-off of aircraft	Leading Indicator – NF5 Leading Indicator – LUP6	Environment Lead	Inspection results recorded	Annual review and reporting in Annual Compliance Report
Aboriginal Heritage	Inspection (ground survey, drone flyover or suitable alternative method)	Land clearance at infrastructure locations (Figure 4.2 to Figure 4.7)	Demonstrates land clearing has not been undertaken outside of areas defined in the associated land disturbance permit.	Following completion of land clearance activities	Leading Indicator – AH3	Environment Lead Construction Manager	Audit report	Annual review and reporting in Annual Compliance Report
Weekly								
Radiation	Monitoring of airborne radon decay products using grab samples (Borak method) and personal monitoring	Grab sample locations: • Extraction level • Active development headings • Workshop • Occupied areas (such as lunchroom)	Results are within action levels identified in the Radiation Management Plan separate to this document.	Weekly	Radiation Protection and Control Act 2021 (SA)	Health and Safety Lead	Weekly analysis and internal reporting	EPA reporting

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
		• Personal monitoring: • Selected workers within similar exposure groups						
	Inhalation of airborne dust monitoring via low volume air sampling pumps with inhalable sampling heads	Exposure group: • LHD operator • Development miner • Maintenance personnel • Underground service miner • Mill operator • Flotation operator • Maintenance worker	Results are within action levels identified in the Radiation Management Plan separate to this document.	Weekly	Radiation Protection and Control Act 2021 (SA)	Health and Safety Lead	Weekly analysis and internal reporting	EPA reporting
	Survey with handheld gamma monitor	• Mill area • Flotation area • Maintenance	Results are within action levels identified in the Radiation Management Plan separate to this document.	Monthly	Radiation Protection and Control Act 2021 (SA)	Health and Safety Lead	Weekly analysis and internal reporting	EPA reporting
Monthly								
Public Nuisance – Dust	Continuous dust deposition rate	Figure 9.1; ERML09	Demonstrates exceedances of baseline levels of 1.6 g/m^2/month over three consecutive months.	Monthly collection during construction	Leading Indicator – PN3	Environment Lead	Monthly analysis during construction and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Native Vegetation Aboriginal Heritage	Inspection (ground survey, drone flyover or suitable alternative method)	Land clearance at infrastructure locations (Figure 4.2 to Figure 4.7)	Demonstrates land clearing has not been undertaken outside of areas defined in the associated land disturbance permit.	Following completion of land clearance activities	Leading Indicator – NV2 Leading Indicator – AH3	Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report
Weeds Pests and Pathogens	Inspection (including photographic evidence)	Selected infrastructure locations (Figure 4.2 to Figure 4.7)# Alternative locations must be selected until all locations have been complete. or on a demonstrated risk based approach	Identifies weeds listed as a Priority Weed (Plate 9.1) triggers a review of the effectiveness of management strategies.	Monthly	Leading Indicator – WP3	Environment Lead	Monthly field inspection results recorded in internal weeds database	Annual review and reporting in Annual Compliance Report
	Inspections (including photographic evidence) of selected waste storage areas	Selected infrastructure locations (Figure 4.2 to Figure 4.7)# # Alternative locations must be selected until all locations have been complete. or on a demonstrated risk based approach	Demonstrate that prior to collection food waste containers that service the accommodation village kitchen are closed to prevent feral animal scavenging.	Monthly	Leading Indicator – WP4	Waste Contractor	Monthly field inspection results recorded	Annual review and reporting in Annual Compliance Report
	Inspections (including photographic evidence) of landfill	Landfill	Demonstrate that the tip face has been covered at the end of each day to prevent feral animal scavenging.	Monthly	Leading Indicator – WP5	Environment Lead	Monthly field inspection results recorded	Annual review and reporting in Annual Compliance Report
Native Fauna	Inspection (ground survey)	Wildlife and stock control fence surrounding the airstrip (Figure 4.3)	Integrity of the fence is maintained.	Monthly	OMC – NF4 OMC – LUP5	Environment Lead	Monthly field inspection results recorded	Annual review and reporting in Annual Compliance Report
Land and Soil	Audit of temporary and/or permanent chemical or hydrocarbon storage area	Infrastructure locations (Figure 4.2 to Figure 4.7)# # Alternative locations are to be selected until all locations have been completed or on a demonstrated risk based approach	Constructed and operating in accordance with the EPA Guideline 080/16 Bunding and Spill Management (2016).	Monthly	Leading Indicator – LS3	Environment Lead Construction Manager	Audit report	Reporting in Annual Compliance Report

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
	Audit of a selected chemical storage	Infrastructure locations (Figure 4.2 to Figure 4.7)# # Alternative locations are to be selected until all locations have been completed or on a demonstrated risk based approach	Demonstrates that all chemicals are recorded (including volumes) in the chemical database.	Monthly	Leading Indicator – LS4	Environment Lead Construction Manager	Audit report	Reporting in Annual Compliance Report
Air Quality – CTP	Analysis of scrubber efficiency (continuous data logging)	Concentrate Treatment Plant	Trends indicate decrease in the performance of the scrubbing systems for three consecutive months when compared to previous months.	Continuous data logging via PCS	Leading Indicator – AQ9 Linked to CTP Condition (Schedule 2 Condition 15)	Processing Lead	Monthly analysis of trends and internal reporting	Annual review and reporting in Annual Compliance Report
Radiation	Inhalation of airborne dust monitoring via low volume air sampling pumps with inhalable sampling heads	• Crusher chamber • Underground workshop • Offices • Crib rooms • Mill area • Flotation area	Results are within action levels identified in the Radiation Management Plan separate to this document.	Monthly	Radiation Protection and Control Act 2021 (SA)	Health and Safety Lead	Monthly analysis and internal reporting	EPA Reporting
	Surface contamination probe surveys (ingestion of radionuclide monitoring)	• Underground offices • Workshops • Crib rooms	Results are within action levels identified in the Radiation Management Plan separate to this document.	Monthly	Radiation Protection and Control Act 2021 (SA)	Health and Safety Lead	Monthly analysis and internal reporting	EPA reporting
Weather Station	Weather Data Download	Carrapateena Camp	For future use in air quality and surface water modelling calibration.	Monthly	Air Quality Model Calibration Surface Water Model Calibration	Environment Lead	Monthly analysis	Various inputs in model calibrations
Quarterly								
Public Nuisance	Audit of stakeholder engagement records	Access Roads (Figure 4.2 to Figure 4.7)	All traffic related dust and noise concerns associated with access roads are responded to in accordance with the Local Area Agreement - Operating Protocol within 24 hours upon notification. Any corrective actions are closed out within 14 days or as agreed with the Director of Mines (or authorised officer).	Quarterly	OMC – PN1	Community Lead	Audit report	Annual review and reporting in Annual Compliance Report
Air Quality – Dust	Continuous dust deposition (dust bottle)	ERML1–ERML19 (Figure 9.1)	Dust deposition rates do not exceed 4 g/m^2/month (total).	Quarterly collection and analysis	OMC – PN2 OMC – AQ1	Environment Lead	Quarterly gravimetric analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Air Quality – Metals	Continuous metal concentrations in dust	ERML1–ERML19 (Figure 9.1)	Demonstrates a rising trend in metals over three consecutive years concentrations when compared to previous monitoring results (Table 9.11; ERML1–ERML15).	Quarterly collection Annual laboratory analysis	Leading Indicator – AQ4	Environment Lead	Annual laboratory analysis and internal reporting. Monitoring database updated	Annual review and reporting in Annual Compliance Report
Radiation	Radon and radionuclides data (methods outlined Radioactive Waste Management Plan)	ERML1–ERML19 (Figure 9.1)	Demonstrates total radiation doses do not exceed 1 mSv/annum for members of the public. Demonstrates total radiation doses do not exceed 10 µGy/hour for non-human biota.	Quarterly	OMC – RAD1 OMC – RAD2 Radiation Protection and Control Act 2021 (SA)	Environment Lead	Annual laboratory analysis and internal reporting Monitoring database updated	EPA Reporting
	Gamma irradiation monitoring using optically stimulated	Selected workers within a similar exposure group	Results are within action levels.	Quarterly	Radiation Protection and Control Act 1982 (SA)	Health and Safety Lead	Quarterly analysis and internal reporting	EPA reporting

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
	luminescence dosimetry (OSLD) personal badges						Monitoring database updated	
	Environmental gamma radiation monitoring using passive gamma badges	ERML01–ERML19 (Figure 9.1)	Identifies no significant change from previous readings.	Quarterly	Radiation Protection and Control Act 1982 (SA)	Environment Lead	Annual laboratory analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report EPA reporting
	Audit of inspection records	Infrastructure locations (Figure 4.2 to Figure 4.7)	Vehicles or equipment leaving site that have been used in the active mining operation on the surface or underground will be washed and checked for radioactive contamination by suitably trained personnel and only released when certified clean and uncontaminated. Vehicles or equipment that have only be onsite temporarily such as for plant shutdowns do not require radiation clearances.	Quarterly	Radiation Protection and Control Act 1982 (SA)	Health and Safety Lead	Audit report	EPA reporting
Weeds and Pests	Audit of records maintained at the site by all contractors	Carrapateena Site Gatehouse (Figure 4.2)	Demonstrates that all incoming vehicle, plant and equipment have been subject to weed hygiene procedures ((CA-0000-ENV-PRO-0015 Vehicle Plant and Personnel Hygiene Procedure; and CA-ENV-FRM-1000 Vehicle Weed Inspection Form).	Quarterly	Leading Indicator – WP6	Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report
	Audit of inspection records (including photographic evidence) maintained at the site by the waste contractor	Selected infrastructure locations (Figure 4.2 and Figure 4.3)# # Alternative locations must be selected until all locations have been complete. or on a demonstrated risk based approach	Demonstrate that prior to collection food waste containers that service the accommodation village kitchen are closed to prevent feral animal scavenging.	Quarterly	Leading Indicator – WP4	Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report
	Audit of inspections records (including photographic evidence) maintained at the site by the waste contractor	Landfill (Figure 4.3)	Demonstrate that the tip face has been covered at the end of each day to prevent feral animal scavenging.	Quarterly	Leading Indicator – WP5	Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report
Land Use and Property	Audit of stakeholder engagement records	Arcoona. Pernatty and Bosworth Pastoral Lease or adjacent pastoral leases (Figure 4.2 to Figure 4.7)	Concerns associated with agricultural productivity of Pernatty, Arcoona or Bosworth Pastoral Lease or adjacent pastoral leases as a result of ML or MPL-activities are responded to in accordance with the Local Area Agreement - Operating Protocol within 24 hours any corrective actions are closed out within 14 days or as agreed with the Director of Mines (or other authorised officer).	Quarterly	OMC – LUP1	Community Lead	Audit report	Annual review and reporting in Annual Compliance Report
Concentrate Storage Containers	Audit of inspection records (including photographic evidence) maintained at the site by the transport contractor	Concentrate storage containers	Demonstrates the integrity of containers have been checked prior to departure to ensure no release of concentrate to the environment.	Quarterly	Leading Indicator – AQ10	Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report
TSF Monitoring Wells	Sampling and laboratory analysis for pH, metals and EC	Shallow monitoring wells downstream of the TSF (Figure 9.6; TSFMB1s–TSFMB4s)	Water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (whichever	Quarterly	OMC – TSF1 OMC – GW1	Environment Lead	Quarterly analysis and internal reporting	Annual review and reporting in Annual Compliance Report

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
		Tent Hill Aquifer monitoring wells downstream of the TSF (Figure 9.6; TSFMB1d, TSFMB3d, TSFMB4d)	is greater) for pH, EC and metals (Table 9.22).				Monitoring database updated	
	Monitoring of standing water levels		Standing water levels are trending in accordance with modelled predictions and do not exceed the maximum predicted drawdown at each well (Table 9.19).	Quarterly	OMC – TSF2 OMC – GW2	Environment Lead	Quarterly analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Regional Groundwater Monitoring Wells	Monitoring of standing water levels	Groundwater monitoring wells simulated in the groundwater model (Figure 9.8; Table 9.19 and Table 9.20)	Standing water levels are trending in accordance with modelled predictions and do not exceed the maximum predicted drawdown at each well (Table 9.19).	Quarterly	OMC – GW3 Leading Indicator – GW5 Schedule 6 Condition 16.2	Environment Lead	Quarterly analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
	Monitoring of standing water levels	Groundwater monitoring wells not yet simulated in the groundwater model (Figure 9.8; Table 9.20 and Table 9.19)	No evidence of a trend in standing water levels over three consecutive quarters.	Quarterly	OMC – GW3 Leading Indicator – GW5 Schedule 6 Condition 16.2	Environment Lead	Quarterly analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Production Groundwater Wells	Analysis of groundwater abstraction volumes from flow meter reading records and comparison against the water balance	Flow meters from groundwater production wells (Figure 9.7)	Confirms abstraction is not trending to exceed the predicted water demand (12.9 ML/d). No more than an average of 7 ML/d was abstracted from the Northern Wellfield.	Quarterly	Leading Indicator – GW4	Environment Lead	Quarterly analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Eliza Creek Bed Seepage Inspection	Inspection (including photographic evidence)	Eliza Creek bed (Figure 9.6; IT01–IT03)	Demonstrates visual evidence of shallow lateral seepage surface expressions (salt crystals, salinization or water logging and triggers further investigation (OMC TSF5).	Quarterly	Leading Indicator – TSF10	Environment Lead	Quarterly analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Annual								
Aboriginal Heritage	Audit of land disturbance permits clearly showing approved work areas, cultural heritage survey reports conditions	Infrastructure locations (Figure 4.2 to Figure 4.7)	Infrastructure locations have authorisation in accordance with the *Aboriginal Heritage Act 1988* (SA) prior to any ground disturbance occurring.	Annual	OMC – AH1	Environment Lead	Monthly audit reports during construction	Annual review and reporting in Annual Compliance Report
Native Vegetation	Audit (reconciliation) of the land disturbance register for infrastructure locations	Infrastructure locations (Figure 4.2 to Figure 4.7)	Native vegetation clearance does not exceed the significant environmental benefit approved under the *Native Vegetation Act 1991* (SA) Plains mouse habitat clearance does not exceed that approved under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).	Annual	OMC – NV1	Environment Lead Construction Manager	Audit report	Annual review and reporting in Annual Compliance Report
Weeds Pests and Pathogens	Flora and fauna surveys undertaken by an independent and suitably qualified ecologist	Figure 9.2 Fauna, Figure 9.3 Flora Figure 9.4 Weeds	Demonstrates no introduction of new species of weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals) as a result when compared to previously recorded weed species (Table 9.12) and introduced fauna (Table 9.13).	Annual (spring)	OMC – WP1	Environment Lead	Annual flora and fauna survey report	Reporting in Annual Compliance Report
	Flora and fauna surveys undertaken by suitably qualified and experienced expert	Figure 9.2 Fauna, Figure 9.3 Flora Figure 9.4 Weeds	No increase in the abundance of existing weed or pest species in the Land compared to previous survey records.	Annual (spring)	OMC – WP2	Environment Lead	Annual flora and fauna survey report	Reporting in Annual Compliance Report

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
Cultural Heritage	Audit of cultural heritage survey records	Infrastructure locations (Figure 4.2 to Figure 4.7)	Upon discovery, new Aboriginal heritage sites, objects or remains were treated in accordance with the Cultural Heritage Management Plan until authorisation under the *Aboriginal Heritage Act 1988* (SA) was obtained.	Annual	OMC – AH2	Environment Lead	Audit report	Reporting in Annual Compliance Report
Native Vegetation – Air Quality	Ecological surveys undertaken by a suitably qualified and experienced expert	Figure 9.2 Fauna, Figure 9.3 Flora Figure 9.4 Weeds	No adverse impact on the diversity and abundance of native vegetation at monitoring sites directly attributed to dust deposition from mining operations or mining-related activities when compared to baseline native vegetation conditions (OZ Minerals 2017a; MLP Appendix C4 Ecological Baseline).	Annual	OMC – AQ2	Environment Lead	Annual flora and fauna survey report	Reporting in Annual Compliance Report
Native Vegetation and Water Dependent Ecosystems	Ecological surveys undertaken by a suitably qualified and experienced expert	Figure 9.2 Fauna, Figure 9.3 Flora Figure 9.4 Weeds	No adverse impact on the diversity and abundance of native vegetation or water dependent ecosystems attributed to reduced surface water flows or tailings seepage when compared to baseline conditions (OZ Minerals 2017a; MLP Appendix C4 Ecological Baseline) unless a significant environmental benefit is established and approved in accordance with the relevant legislation.	Annual	OMC – SWRF1 OMC – TSF6 Linked to Native Vegetation Outcome (Schedule 6 Condition 11)	Environment Lead	Annual flora and fauna survey report	Reporting in Annual Compliance Report
Native Fauna	Flora and fauna surveys or verified opportunistic sightings	Figure 9.2 Fauna, Figure 9.3 Flora Figure 9.4 Weeds	Records of the Plains Mouse, Thick-billed Grasswren and *Sclerolaena* sp. Yeltacowie provided to the BDBSA and records of the Night Parrot provided to the Night Parrot Recovery Team.	Annual or opportunistic sighting	OMC – EPBC1 OMC – EPBC2 OMC – EPBC3	Environment Lead	Annual flora and fauna survey report	Reporting in Annual Compliance Report Field records provided to BDBSA or the Night Parrot Recovery Team
Land Use and Property	Rehabilitation trials and LFA monitoring	Areas of disturbed land that has no further mining-related use At least one area per closure domain LFA monitoring sites Figure 9.3; CEF1–CEF7	Demonstrated development of trends and annual improvement of rehabilitation through LFA methodology. Should the data indicate rehabilitation not trending towards sustainability route cause investigations will be undertaken and rectification methods be identified and implemented.	Annual LFA monitoring	Leading Indicator – LUP4	Environment Lead	Annual rehabilitation trials assessment report	Annual review and reporting in Annual Compliance Report
Land and Soil	Audit of waste disposal records	Maintained at the site	Commercial and/or industrial wastes disposed of to an EPA licenced facility.	Annual	Leading Indicator – LS2	Environment Lead	Audit report	Annual review and reporting in Annual Compliance Report
Air Quality – Dust	Laboratory analysis continuous dust deposition collected quarterly	ERML1–ERML19 (Figure 9.1)	Dust deposition rates do not exceed 4 g/m^2/month (total).	Annual	OMC – PN2 OMC – AQ1	Environment Lead	Annual laboratory analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Air Quality – Metals	Laboratory analysis of metal concentrations in dust collected quarterly	ERML1–ERML19 (Figure 9.1)	Demonstrates a rising trend in metals concentrations over three consecutive months when compared to previous reporting periods or when compared to ERML1–ERML15. If an upward trend is identified, an assessment will be undertaken considering whether the TSF final landform capping methodology is still appropriate.	Annual	Leading Indicator – AQ4	Environment Lead	Annual laboratory analysis and internal reporting. Monitoring database updated	Annual review and reporting in Annual Compliance Report

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
Radiation	Audit undertaken by an independent and suitably qualified expert of radon and radionuclides data (methods outlined RWMP)	ERML1–ERML19 (Figure 9.1)	Demonstrates total radiation doses do not exceed 1 mSv/annum for members of the public. Demonstrates total radiation doses do not exceed 10 µGy/hour for non-human biota.	Annual	OMC – RAD1 OMC – RAD2 Radiation Protection and Control Act 2021 (SA)	Environment Lead	Annual laboratory analysis and internal reporting. Monitoring database updated	Annual review and reporting in Annual Compliance Report EPA Reporting
Soil Quality	Soil sampling and laboratory analysis for metals	Monitoring sites adjacent to the TSF ((Figure 9.1; ERML15–ERML19)	Demonstrates a rising trend in metals concentrations over three consecutive years when compared to previous monitoring results (Table 9.11).	Annual IMPORTANT NOTE Radionuclides every five years at ERMLs (Figure 9.1, ERML16–ERML19)	Leading Indicator – AQ7 Linked to Land and Soil Outcome (Schedule 6 Condition 10.1) Radiation Protection and Control Act 2021 (SA)	Environment Lead	Annual analysis and internal reporting Monitoring database updated	Reporting in Annual Compliance Report
Air Quality – CTP	Iso-kinetic sampling	Flash Steam Heat Recovery Stack, Plant Extraction Scrubber Stack and Nonox Vent Scrubber Stack at the Concentrate Treatment Plant	Demonstrates compliance with Schedule 1 of the Environment Protection (Air Quality) Policy 2016 (SA) (Table 9.10).	Annual	Leading Indicator – AQ8 Linked to CTP Condition (Schedule 2 Condition 15)	CTP Lead	Annual analysis and internal reporting Monitoring database updated	Annual review and reporting in Annual Compliance Report
Surface Water – Quality	Surface water sampling and laboratory analysis using rising stage samplers or grab samples	Surface water sampling sites (Figure 9.5; SW01 to SW12, SW-1, SW-6, SW-7, SW-14 to SW-17, Gorge Spring, Euro Spring)	Demonstrates water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (Table 9.16; pH, EC, SS, metals and hydrocarbons) whichever is greater.	Opportunistic Undertaken at least once a year within seven days of a rainfall event required to create flows	OMC – SWES1 OMC – TSF3 OMC – AMD1	Environment Lead	Annual analysis and internal reporting Monitoring database updated	Reporting in Annual Compliance Report
Sediment Sampling	Sediment sampling and laboratory analysis for metals	Eliza Creek (Figure 9.6; IT01–IT03)	Demonstrates sediments meet ANZECC/ARMCANZ (2000) Sediment Quality Guidelines (Table 9.15) or baseline ranges whichever is greater (Table 9.15).	Annual	OMC – TSF4	Environment Lead	Annual analysis and internal reporting Monitoring database updated	Reporting in Annual Compliance Report
Groundwater Radionuclides	Groundwater radionuclide monitoring and laboratory analysis	TSF monitoring wells (Figure 9.6)	Identifies no trend of increase.	Annual	Radiation Protection Control Act 2021 (SA)	Environment Lead	Annual laboratory analysis and internal reporting	Reporting in Annual Compliance Report

9.6 Completion audits, surveys and monitoring

Table 9.7 | Completion audits, surveys and monitoring

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
Public Safety	Audit against the Guideline 'Safety Bund Walls Around Abandoned Open Pit Mines' (Department of Industry and Resources 1997) by a suitably qualified expert approved by the Director of Mines (or other authorised officer), including a review of: • the underground caving system • geotechnical data • other relevant data from the Cave Monitoring Plan	Underground mine SLC subsidence zone and abandonment bund (Figure 4.19)	The underground mine has been operated within design parameters. The predicted vertical and lateral extent of the SLC subsidence zone (Figure 4.19) is validated. The abandonment bund is adequately located outside of the subsidence zone.	Prior to placement of the abandonment bund	OMC – PS2	Mine Lead	Audit report	Application of lease surrender
	Topographical survey of the sub-level cave subsidence zone	SLC subsidence zone (Figure 4.19)	Extent of the surface expression at mine completion is confirmed.	Prior to application of lease surrender	OMC – PS3	Mine Lead	Audit report	Electronic and hard copies of topographical survey provided to the Director of Mines (or other authorised officer) prior to application of lease surrender
	Construct to design audit by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Decline portals and box cut (Figure 4.2) Vent rise plug and vent rises (Figure 4.20) Abandonment bund around the subsidence zone (Figure 4.19) Mine area borrow pit (Figure 4.38)	The decline portals, box cut, vent rise and mine area borrow pit have been closed in accordance with the final design. abandonment bund around the subsidence zone has been constructed in accordance with the Guideline 'Safety Bund Walls Around Abandoned Open Pit Mines' (Department of Industry and Resources 1997).	Prior to application of lease surrender	OMC – PS4 OMC – PS5 OMC – PS6 OMC – PS8	Mine Lead	Audit report	Application of lease surrender
	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Infrastructure locations (Figure 4.2 to Figure 4.7)	All infrastructure is removed or left in-situ as agreed with stakeholders (OMC-LUP2) in a manner that risks to the health and safety of the public so far as it may be affected by mining-related activities are as low as reasonably practicable.	Prior to application of lease surrender	OMC – PS7	Environment Lead	Audit report	Application of lease surrender
Land Use and Property	Audit of infrastructure locations against third-party transfer or Government agreements	Infrastructure locations (Figure 4.2 to Figure 4.7)	All infrastructure has been removed, unless otherwise agreed with Government or signed legal documentation to transfer on going liability of the infrastructure to third parties is provided prior to the relinquishment of the tenement.	Prior to application of lease surrender	OMC – LUP2	Environment Lead	Audit report	Application of lease surrender
	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	LFA monitoring sites (Figure 9.3; CEF01 to CEF07) Infrastructure locations (Figure 4.2 to Figure 4.7)	LFA monitoring results indicate that the LFA curve has moved above, or is likely to move above the critical threshold of sustainability at infrastructure locations.	Prior to application of lease surrender	OMC – LUP3	Environment Lead	Audit report	Application of lease surrender

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
Land and Soil	Internal audit of rehabilitation activities and waste disposal records	Infrastructure locations (Figure 4.2 to Figure 4.7)	Verifies all remaining commercial and/or industrial wastes have been removed from the site and disposed of to an EPA licenced facility. No soil contamination (as defined in the National Environment Protection (Assessment of Site Contamination) Measure 2013) remains in areas used for the handling and storage of hazardous materials as determined by a site contamination audit conducted by an independent and qualified auditor.	Prior to application of lease surrender	OMC – LS5	Environment Lead	Audit report	Application of lease surrender
Air Quality – Dust	Continuous dust deposition (dust bottle)	ERML1–ERML19 (Figure 9.1)	Dust deposition rates do not exceed 4 g/m^2/month (total).	Monthly collection post completion for a period of no less than one year (dry weather cycle and tailings must be of a moisture content and crust thickness as per the air quality model inputs (OZ Minerals 2017a; MLP Appendix C1 Air Quality Modelling and Assessment of Effects)	OMC – AQ11	Environment Lead	Annual laboratory analysis and internal reporting Monitoring database updated	Application of lease surrender
	Gravimetric analysis of continuous dust deposition (dust bottles)	ERML1–ERML19 (Figure 9.1)	Dust deposition rates do not exceed 4 g/m^2/month (total) as per Table 7.1 of Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005).	Monthly analysis post completion for a period of no less than one year (dry weather cycle and tailings must be of a moisture content and crust thickness as per the air quality model inputs (OZ Minerals 2017a; MLP Appendix C1 Air Quality Modelling and Assessment of Effects)	OMC – AQ11	Environment Lead	Annual laboratory analysis and internal reporting Monitoring database updated	Application of lease surrender
Radiation	Continuous radon and radionuclides data collected quarterly	ERML1–ERML19 (Figure 9.1)	Demonstrates total radiation doses do not exceed 1 mSv/annum for members of the public. Demonstrates total radiation doses do not exceed 10 µGy/hour for non-human biota.	Quarterly	OMC – RAD3 OMC – RAD4 Radiation Protection Control Act 2021 (SA)	Environment Lead	Annual laboratory analysis and internal reporting. Monitoring database updated	Application of lease surrender EPA reporting
	Audit undertaken by an independent and suitably qualified expert of radon and radionuclides data collected quarterly	ERML1–ERML19 (Figure 9.1)	Demonstrates total radiation doses do not exceed 1 mSv/annum for members of the public Demonstrates total radiation doses do not exceed 10 µGy/hour for non-human biota.	Post completion for a period of no less than one (1) year (dry weather cycle and tailings must be of a moisture content and crust thickness as per the air quality model inputs)	OMC – RAD3 OMC – RAD4 Radiation Protection Control Act 2021 (SA)	Environment Lead	Annual laboratory analysis and internal reporting Monitoring database updated	Application of lease surrender EPA reporting
Air Quality – Secondary Pathway – Soil	Ecological risk assessment including soil sampling undertaken in accordance with NEPM (Assessment of Site Contamination 1999) by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Monitoring sites adjacent to the TSF (Figure 9.1; ERML16–ERML19)	Verifies concentrations of metals are within the site specific Ecological Investigation Levels (Table 9.11). Ecological Investigation levels to be derived based on the ecological risk assessment framework detailed in Schedule B5a “Guideline on Ecological Risk Assessment (NEPC 2013)”.	Prior to application of lease surrender	OMC – AQ12 Linked to Land and Soil Outcome (Schedule 6 Condition 10.2)	Environment Lead	Annual analysis and internal reporting Monitoring database updated	Application of lease surrender
Surface Water – Infrastructure and Stockpiles	Construct to design audit by a suitably qualified expert approved by the Director of Mines (or other authorised officer)	Subsidence zone abandonment bund (Figure 4.19) and the TSF Final Embankment (Figure 4.2)	Confirms that the abandonment bund around the subsidence zone and the TSF Final Embankment have been rock armoured in accordance with the identification of material types identified in detailed design.	Prior to application of lease surrender	OMC – SWES4	Environment Lead	Audit report	Application of lease surrender

Aspect	Measurement method	Locations	Achievement value(s)	Frequency	Reason for monitoring	Responsibility	Internal reporting	External reporting
	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Culverts, fords, and surface water management infrastructure (Figure 4.22, Figure 4.43, Figure 4.42)	Demonstrates all culverts, fords, and surface water management infrastructure that is not required post completions is removed in a manner to ensure long-term physical stability in consideration of potential erosion and sedimentation and natural flow regimes have been restored.	Prior to application of lease surrender	OMC – SWES5	Environment Lead	Audit report	Application of lease surrender
	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	Waste rock, ore and soil stockpiles (Figure 4.34)	Demonstrates waste rock, ore stockpiles and soil stockpiles have been removed from the ground surface.	Prior to application of lease surrender	OMC – SWES6	Environmental Lead	Audit report	Application of lease surrender
AMD	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) of ore stockpiles	Ore stockpiles (Figure 4.34)	Demonstrates stockpiles have been removed from the ground surface.	Prior to application of lease surrender	OMC – AMD5	Environmental Lead	Audit report	Application of lease surrender
	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) including a review of mine block model records, reconciliation records, geological and sulphur assay data, updates of sulphur cut-off grade and other relevant information	Waste rock and ore stockpiles (Figure 4.34)	Demonstrates that waste rock and ore stockpiles have been managed appropriately to prevent AMD.	Prior to application of lease surrender	OMC – AMD6	Environmental Lead	Audit report	Application of lease surrender
TSF Shallow Groundwater Monitoring Wells	Groundwater sampling and laboratory analysis for pH, metals and EC	Shallow monitoring wells downstream of the TSF (Figure 9.6; TSFMB1s–TSFMB4s)	Demonstrates water quality does not exceed the ANZECC/ARMCANZ (2000) Freshwater Guidelines or baseline ranges (Table 9.22; pH, EC and metals) whichever is greater.	Quarterly At the cessation of tailings discharge for a period of no less than one (1) year	OMC – TSF37	Environment Lead	Quarterly analysis and internal reporting Monitoring database updated	Application of lease surrender
TSF Decommissioning Audits	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) including a review of the operational TSF audit reports and other relevant information	TSF (Figure 4.2)	Demonstrates that the TSF has been operated within design (OZ Minerals 2017a; MLP Appendix A2 TSF Design) or any operational deviations from design parameters have been assessed and addressed appropriately and therefore can be expected function in the long term as per the design. The expert report must address all items as specified in Schedule 2 Condition 10.	After the final discharge of tailings into the TSF and prior to commencement of final rehabilitation, closure and decommissioning	OMC – TSF35 Linked to ML 6471 Schedule 2 Condition 4.5	Tailings Operations Lead	Audit report	Audit report provided to DEM prior to commencement of final rehabilitation, closure and decommissioning
	Audit undertaken by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer)	TSF (Figure 4.2) embankment and spillways	Demonstrates the embankment and spillways have been constructed to design (OZ Minerals 2017a; MLP Appendix A2 TSF Design) to ensure long-term physical stability in consideration of potential erosion and sedimentation of the downstream environment. The expert reports for the audit must address all items as specified in Schedule 2 Condition 11.	After the final TSF and Decant Dam rehabilitation, closure and decommissioning works have been completed	OMC – TSF36 Linked to ML 6471 Schedule 2 Condition 4.6	Tailings Operations Lead	Audit report	Application of lease surrender

9.7 Compliance reporting and PEPR updates

Table 9.8 | Compliance reporting and PEPR updates

Reporting	Frequency	Inputs	Stakeholder
Mid-Year Closure Cost Review (June)	6-monthly	Summary of activities for six-month period and review of current bond.	Internal
PEPR Compliance Report	Annually – 2 months after approval anniversary	Reporting undertaken in accordance with TOR009 (DEM 2020) and MG3 (DEM 2021b). Reporting periods and minimum information required to be provided in a compliance report for a mineral lease and any associated miscellaneous purpose licence.	External – DEM
Full Year Closure Cost Review (December)	Annually	Review of activities conducted throughout year and review of Present Closure Cost Liability, LOM Cost Estimate and Current Security Bond.	External – DEM
PEPR Update – Matters Subsequent	Completed to address matter subsequent including integration of MPL 149 PEPR and future Northern Wellfield PEPR	Updated to address matters raised as matters subsequent and integration of all mining tenements into the one PEPR.	External – DEM
PEPR Update – Project Variations	Triggered for Project Variations (Section 3.6 and Figure 3.4). Provided with annual compliance report to reflect minor variations. Within timeframe specified in the PEPR approval to address matters subsequent	Updated with the annual Compliance report to provide any updated design Strategies, or any change in the impact profile of the project or triggered through the project variation process identified in Section 3.6.	External – DEM
PEPR Update – Validation of Closure Methodologies	Triggered by OMC AQ3 or OMC TSF relating to the verification of TSF Closure Methodologies	If modelling outputs vary an assessment will be undertaken to consider whether the TSF final landform no-capping methodology and embankment final landform design is still appropriate and includes a closure cost liability amendment if required.	External – DEM

9.8 Baseline data, modelling inputs and monitoring locations

9.8.1 Landform evolution modelling

Table 9.9 | Landform evolution model assumptions and sensitivity

Properties	Assumption	Sensitivity
Material properties		
Tailings particle sizes (Unarmoured)	Clayey sandy silt (OZ Minerals 2017a; MLP Appendix A7 Closure Strategy (Erosion Modelling), Figure A-3 Tailings particle size distribution (PSD))	Assumes tailings segregation occurs and finer portions located away from deposition points.
Embankment Particle Size (Unarmoured)	Medium to Couse Gravel with some Sand (OZ Minerals 2017a; MLP Appendix A7 Closure Strategy (Erosion Modelling) Figure A-4 Subsoil PSD)	Assumes the embankment material is as fine as the tailings material of >0.075.
Hydrological properties		
Rainfall intensity	24 hr, 1-in-100 AEP storm	Double the peak storm intensity (OZ Minerals 2017a; MLP Appendix A7 Closure Strategy (Erosion Modelling) Figure A-1 Hyetograph))
In-channel lateral erosion parameter	20	<30 The in-channel lateral erosion parameter is a model parameter which controls how channels erode laterally; 30 is in the upper range of typical values and represents sediment that is readily laterally transported within the channel (resulting in a wider, but shallower erosion channel.
'm' value	0.005	<0.002 0.002 is the upper bound of typical 'm' values representing lower flood peaks and a slower rate of recession of the hydrograph (OZ Minerals 2017a; MLP Appendix A7 Closure Strategy (Erosion Modelling)).
Mannings N value	0.0031	Assumes manning is spatially varies across the catchment: • tailings 0.02 • catchment 0.03 • rock fill 0.04.

9.8.2 Air quality

Table 9.10 | Summary of baseline air quality and air quality modelling outputs

Assessment parameter	Averaging period	Criteria (µg/m^3)	Background (µg/m^3)	Indicative maximum distance to criteria (construction) (km)*			Indicative maximum distance to criteria (operation) (km)*			Indicative maximum distance to criteria (post-completion) (km)*		
				Minimum	Most Likely	Maximum	Minimum	Most Likely	Maximum	Minimum	Most Likely	Maximum
PM_{10}	24-hour	50	3.0 – 23.0	1	3	7	1.5	8	8.5	Not exceeded	1	5
	Annual	25^	13.0	Not exceeded	Not exceeded	Not exceeded	Not exceeded	1.5	2	Not exceeded	Not exceeded	2
$PM_{2.5}$	24-hour	25	1.0 – 7.7	Not exceeded	Not exceeded	0.5	Not exceeded	3.5	4.5	Not exceeded	Not exceeded	Not exceeded
	Annual	8	3.9	Not exceeded	Not exceeded	0.5	Not exceeded	Not exceeded	0.5	Not exceeded	Not exceeded	0.2
TSP	Annual	NA	26	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon monoxide (CO)	1-hour	3,124	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
	8-hour	1,125	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
Nitrogen dioxide (NO_2)	1-hour	250	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
	Annual	60	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
Sulfur dioxide (SO_2)	3-minute	570	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
Formaldehyde (VOC)	3-minute	44	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
Benzene (VOC)	3-minute	58	0	-	Not exceeded	-	-	Not exceeded	-	-	-	-
Polycyclic aromatic hydrocarbons (PAHs)	3-minute	0.008	0	-	Not exceeded	-	-	3.5	-	-	-	-

Assessment parameter	Averaging period	Criteria (µg/m^3)	Background (µg/m^3)	Indicative maximum distance to criteria (construction) (km)*			Indicative maximum distance to criteria (operation) (km)*			Indicative maximum distance to criteria (post-completion) (km)*		
				Minimum	Most Likely	Maximum	Minimum	Most Likely	Maximum	Minimum	Most Likely	Maximum
Carbon disulphide (CS_2)	3-minute	140	0	-	-	-	-	Not exceeded	-	-	-	-
Dust deposition	Annual	4	1.6 g/m^2/month	Not exceeded	Not exceeded	0.5	Not exceeded	Not exceeded	Not exceeded	Not exceeded	Not exceeded	Not exceeded
Radon (Rn-222)	Annual	NA	10 – 23 Bg/m^3	-	-	-	-	NA	-	-	NA	-

Criteria is consistent with Environment Protection (Air Quality) Policy 2016 (SA) except where noted
* Approximate distance from the centre of the source(s), including background pollutant concentrations
^ Criterion is from the National Environment Protection (Ambient Air Quality) Measure (2016)

Table 9.11 | Summary of baseline metals in dust

Metal	Baseline range (mg/g)*
Arsenic	0.001 - 0.1084
Chromium	0.009 - 0.092
Cobalt	0.0018 – 0.1893
Lead	0.024 – 20.0
Molybdenum	0.0012 - 0.1097
Nickel	0.009 – 0.21
Selenium	0.0018 - 0.1596
Thorium	0.0003 – 0.3806
Titanium	0.014 – 2.11
Uranium	0.00019 – 0.00158
Tungsten	0.0003 – 0.24
Lanthanum	0.002 – 0.035
Copper	2 – 98.0

*Baseline ranges taken from 2012 to 2013 and 2015 to 2018 results for ERML01 – ERML15

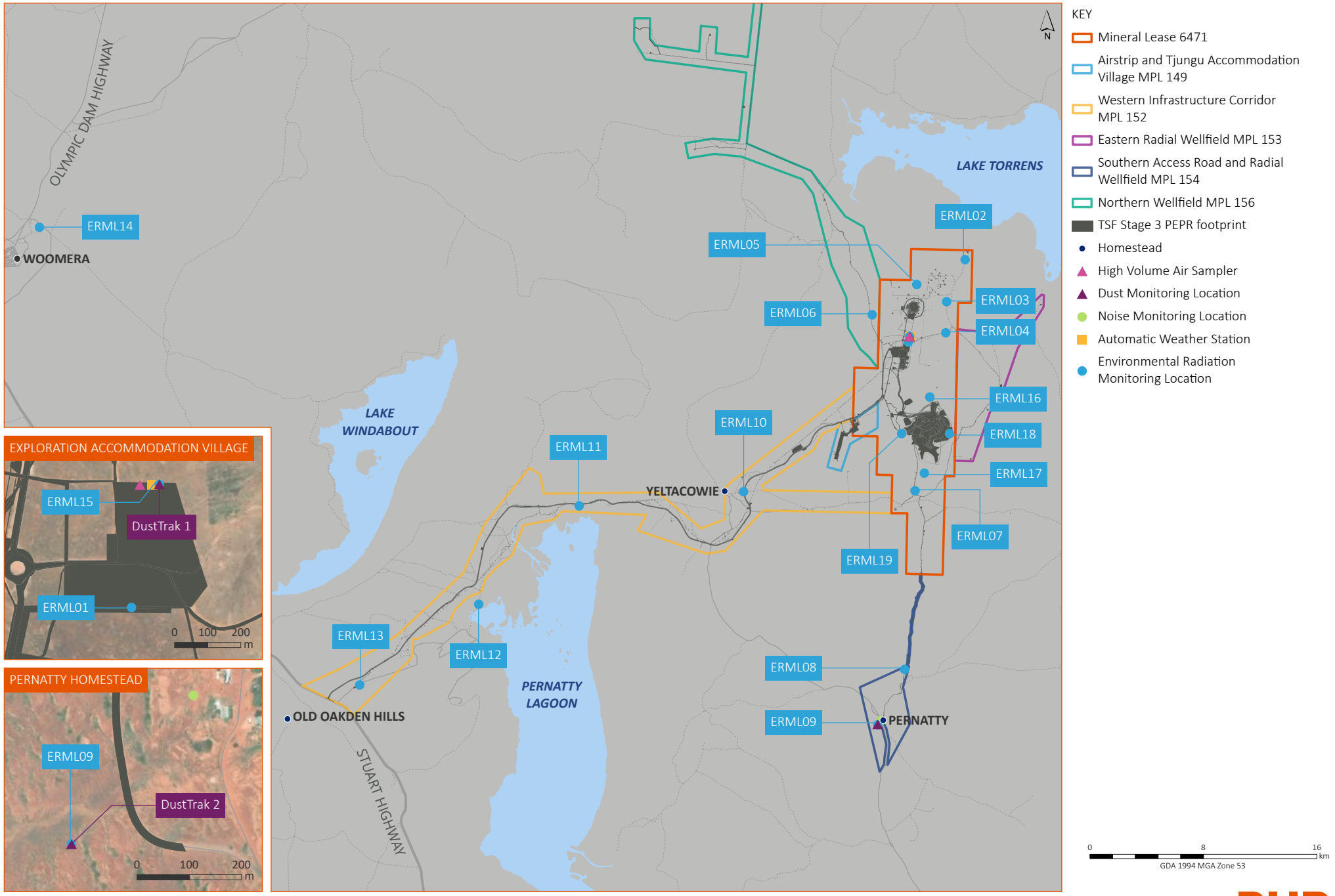


Figure 9.1 | Noise, air quality and environmental radiation monitoring locations

Carrapateena BHP

9.8.3 Flora, fauna, weeds and pests

Table 9.12 | Baseline (recorded) weed species

Species name	Common name
Acetosa vesicaria	Rosy Dock
Bidens pilosa	Cobbler's Pegs
Carthamus lanatus	Malta Thistle
Citrullus lanatus	Bitter Lemon
Flaveria trinervia	Clustered Yellowtops
Heliotropium sp.	Heliotrope
Lepidium africanum	Common Pepper-cress
Malva parvifolium	Mallow
Tribulus terrestris	Caltrop
Mesembryanthemum nodiflorum	Slenderleaf Iceplant
Centaurium melitensis	Cockspur thistle
Nicotiana glauca	Tree tobacco
Schismus barbatus	Arabian Grass
Brassica tournefortii	Wild Turnip
Carrichtera annua	Wards Weed
Sonchus oleraceus	Common Sowthistle
Physalis. sp	Nightshade
Rostraria pumila	Tiny Bristle Grass
Echium plantagineum	Patterson's Curse
*Xanthium spinosum**	Bathurst Burr
Sisymbrium erysimoides	Smooth Mustard

* Declared species under the *Landscape South Australia Act 2019* (SA)

Table 9.13 | Baseline (recorded) introduced fauna species

Species name	Common name
Anas platyrhynchos	Mallard (Northern Mallard)
Columba livia	Feral Pigeon (Rock Dove)
Sturnus vulgaris	Common Starling
Bos taurus	European Cattle
Equus caballus	Horse (Brumby)
Ovis aries	Feral Sheep
Mus musculus	House Mouse
Felis catus	Feral Cat
Vulpes vulpes	Red Fox
Oryctolagus cuniculus	European Rabbit
Passer domesticus	House Sparrow
Canis lupus familiaris	Feral Dog
Capra hircus	Feral Goat

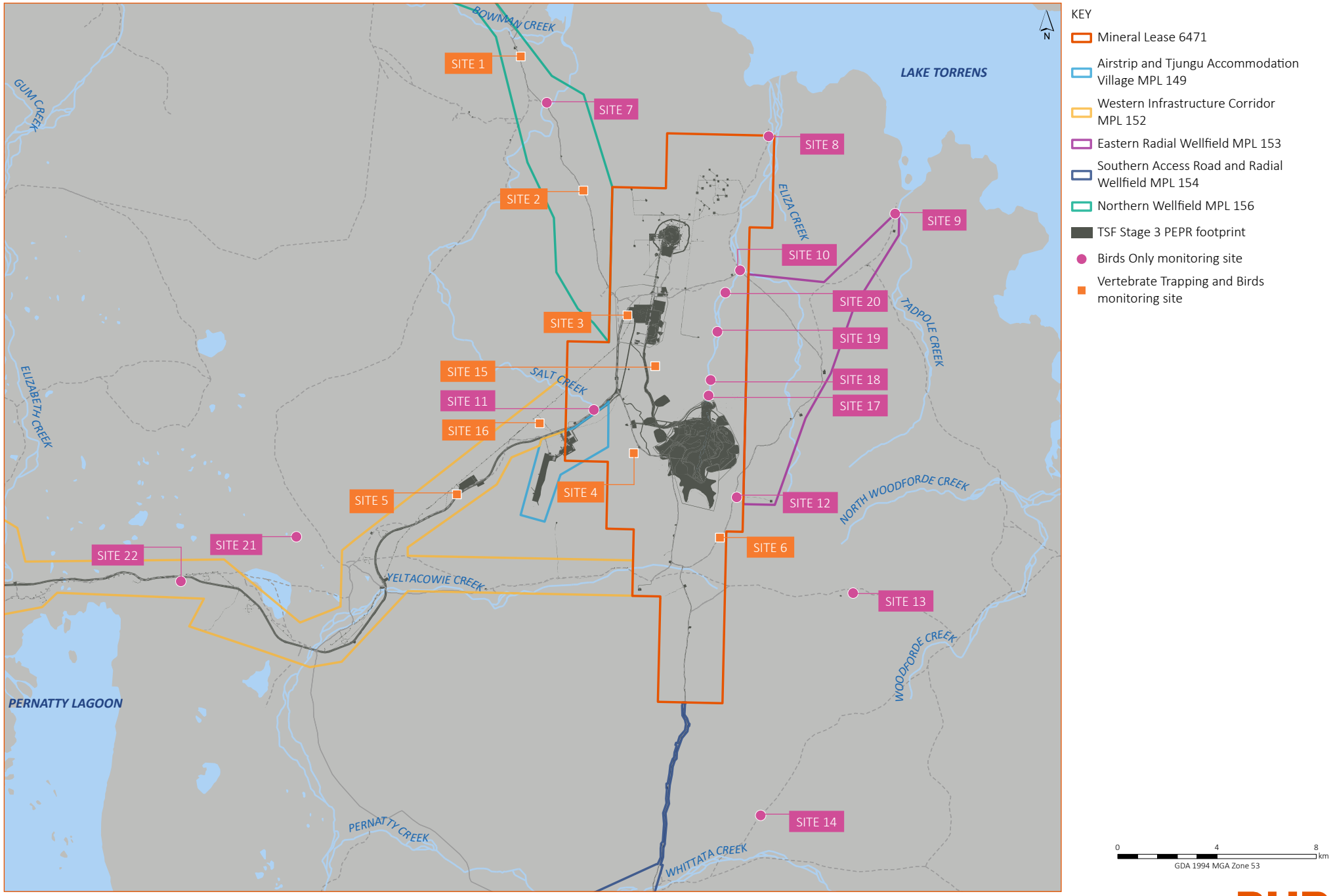


Figure 9.2 | Fauna monitoring locations

Carrapateena BHP

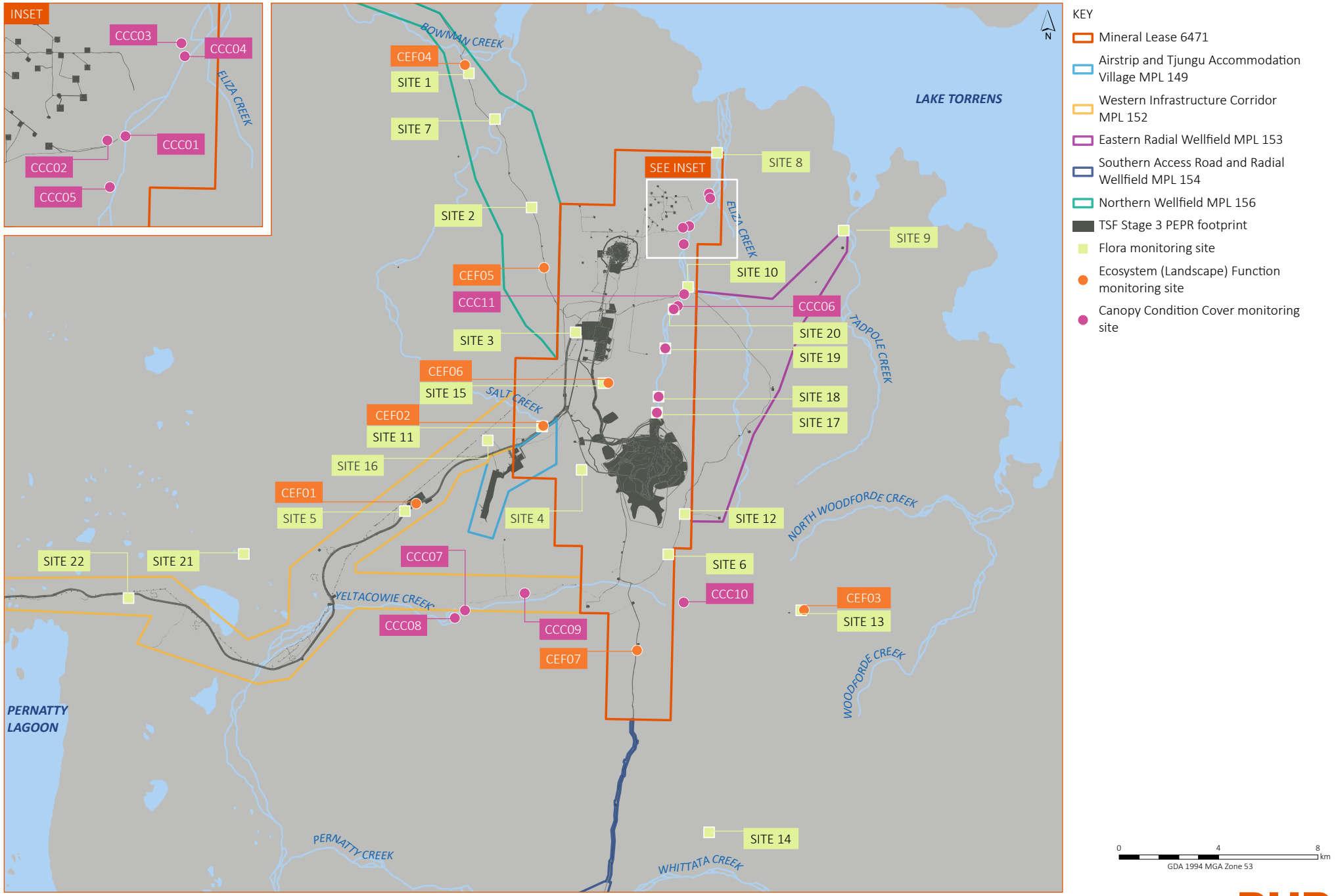


Figure 9.3 | Flora monitoring locations

Carrapateena BHP

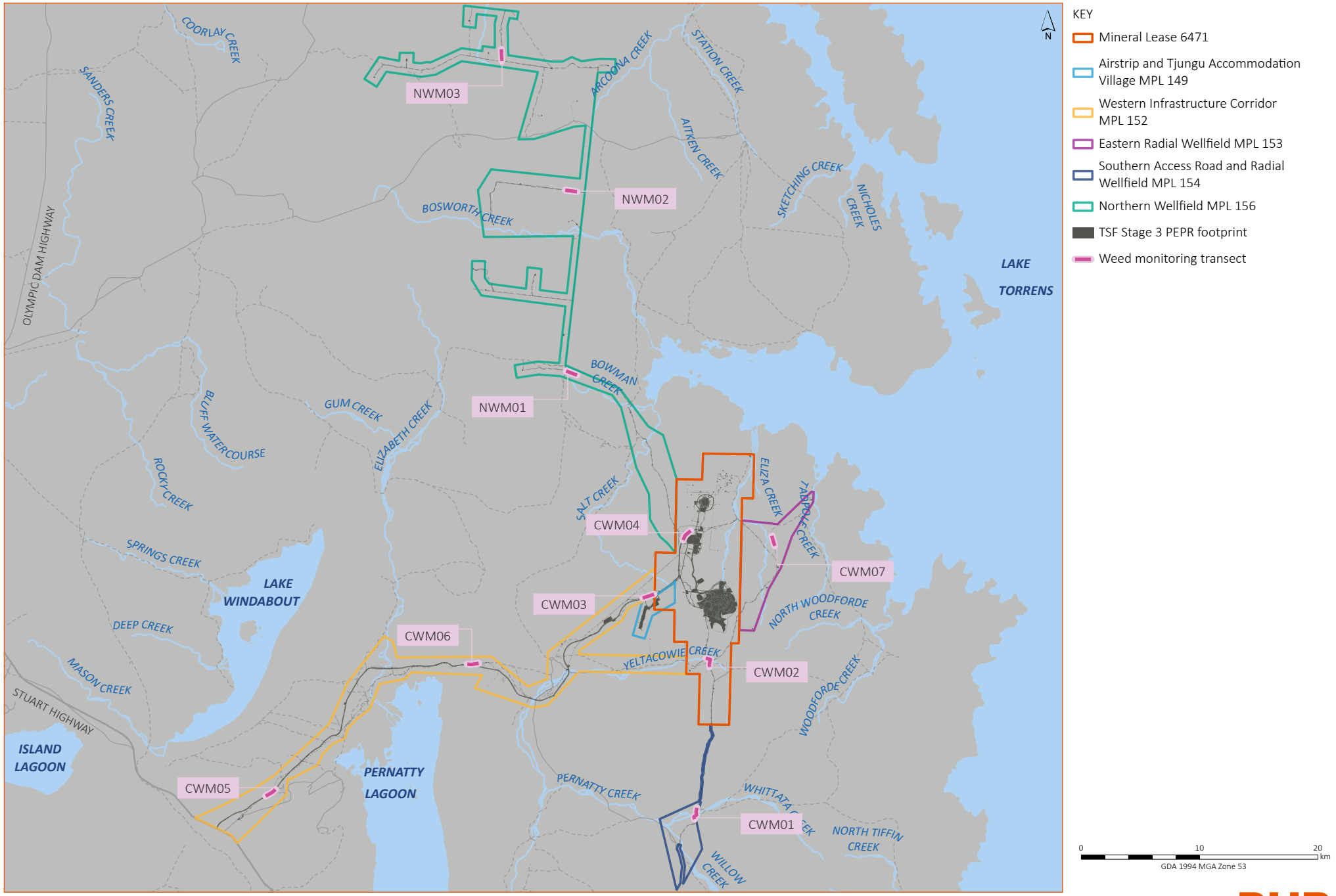


Figure 9.4 | Weed monitoring locations

Carrapateena BHP

AFRICAN RUE *(Peganum harmala)*

ATHEL PINE *(Tamarix aphylla)*

BUFFEL GRASS *(Cenchrus ciliaris)*

MESQUITE *(Prosopis juliflora)*

NEURADA *(Neurada procumbens)*

PARKINSONIA *(Parkinsonia aculeata)*

PRICKLY PEAR *(Opuntia sp.)*

PATTERSON'S CURSE *(Echium plantagineum)*

BATHURST BURR *(Xanthium spinosum)*

Imagery source:
African Rue – sourced online from weeds.nmsu.edu/photos/182.jpg, published by New Mexico State University (no date)
Athel Pine – sourced online from https://www.agric.wa.gov.au/sites/gateway/giles/styles/page_featured_image/public/Athel%20pine %20Tamarix%20aphylla%20flowers_Starr%20Environmental% 202003_0.jpg?itok=zPaBvKAx&c=f9351946d77a44477cabd195475100, published by the Government of Western Australia (no date)
Bathurst Burr – sourced online from https://en.wikipedia.org/wiki/Xanthium_spinosum, published by Wikipedia (2017)
Buffel Grass – sourced online from https://nt.gov.au/_data/assets/image/0004/229732/buffel-grass-habit.jpg (no date), published by the Northern Territory Government (no date)
Mesquite – sourced online from https://alchetron.com/Prosopis-juliflora-4103351-W, published by Alchetron (2017)
Neruada – sourced online from http://saseedbank.com.au/species_information.php?rid=3053, published by the SA Seedbank (2017)
Parkinsonia – sourced online from http://southwestdeserflora.com/WebsiteFolders/Images/Fabaceae/Parkinsonia%20aculeata,%20Jerusalem%20Thorn/9953Parkinsonia-aculeata650x407.jpg, published by South West Desert Flora (2015)
Prickly Pear – sourced online from https://www.greenoptimistic.com/wp-content/uploads/2010/04/prickly-pear-cactus-flowering.jpg, published by Green Optomistic (2017)
Patterson's Curse – sourced online from https://keyserver.lucidcentral.org/weds/data/media/Html/echium_plantagineum.htm, published by the Queensland Government (no date)

9.8.4 Soils and sediments

Table 9.14 | Baseline soil quality and NEPM soil criteria

Parameter	Baseline range (mg/kg)[1]		NEPM Health Investigation Levels (HIL A Soil) (mg/kg)[2]	NEPM Site Specific Ecological Investigation Levels[3]
	0-2 cm depth	15-20 cm depth		
Arsenic (As)	3 – 5	4 - 9	100	TBD
Beryllium (Be)	0.6 – 1.2	0.7 – 1.2	70	NA
Boron (Bo)	NA	NA	5,000	NA
Cadmium (Cd)	<0.1	<0.1	20	NA
Chromium (VI) (Cr)	30 – 40	125 – 175	100	TBD
Cobalt (Co)	6.9 – 10.3	7.9 – 11.5	100	NA
Copper (Cu)	18 – 24	22 – 30	7,000	TBD
Lanthanum (La)	20.8 – 26.0	21.4 – 28.8	NA	NA
Lead (Pb)	11 – 14	11 – 15	300	TBD
Manganese (Mn)	309 – 447	256 – 481	3,000	NA
Methyl Mercury	NA	NA	10	NA
Mercury (inorganic) (Hg)	NA	NA	200	NA
Molybdenum (Mo)	0.6 – 0.7	0.7 – 1.1	NA	NA
Nickel (Ni)	14 – 21	17 – 25	400	TBD
Selenium (Se)	<2	<2	200	NA
Titanium (Ti)	2,160 – 4,450	2,460 – 4,070	NA	NA
Thorium (Th)	6.69 – 9.18	6.76 – 9.16	NA	NA
Tungsten (W)	0.9 – 4.5	1.0 – 1.3	NA	NA
Uranium (U)	0.99 – 1.38	1.04 – 1.30	NA	NA
Zinc (Zn)	46 – 60	48 – 69	8,000	TBD
Cyanide (free)	NA	NA	250	NA

1. Baseline ranges taken from 2019 results for ERML16 to EMRL19
2. Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 2013)
3. Site specific Ecological Investigation Levels to be determined from baseline soil sampling analysis at ERML16 to ERML19

Table 9.15 | Baseline sediment quality and guideline levels

Contaminant	Baseline range (mg/kg dry)[1]	ANZECC/ARMCANZ (2000) Guideline		CSIRO revision of ANZECC/ARMCANZ (2000) Guideline[4]	
		ISQG-Low (Trigger Value)[2]	ISQG-High[3]	Guideline Value	SQG-High
Cadmium	<0.1	1.5	10	1.5	10
Chromium	8.6 – 10.7	80	370	80	370
Copper	5.8 – 7.6	65	270	65	270
Lead	4.6 – 8	50	220	50	220
Silver	<0.1 – 0.1	1	3.7	1	4.0
Zinc	14 – 20.2	200	410	200	410
Uranium	0.1 – 0.2	NA	NA	NA	NA

1. Baseline ranges taken from 2019 results for IT01 to IT03
2. ANZECC/ARMCANZ (2000); interim sediment quality guideline (ISQG) – lowest effect value
3. ANZECC/ARMCANZ (2000); ISQG – median effect value
4. Simpson SL et al (2013); revision of ANZECC/ARMCANZ Sediment Quality Guidelines (SQG)

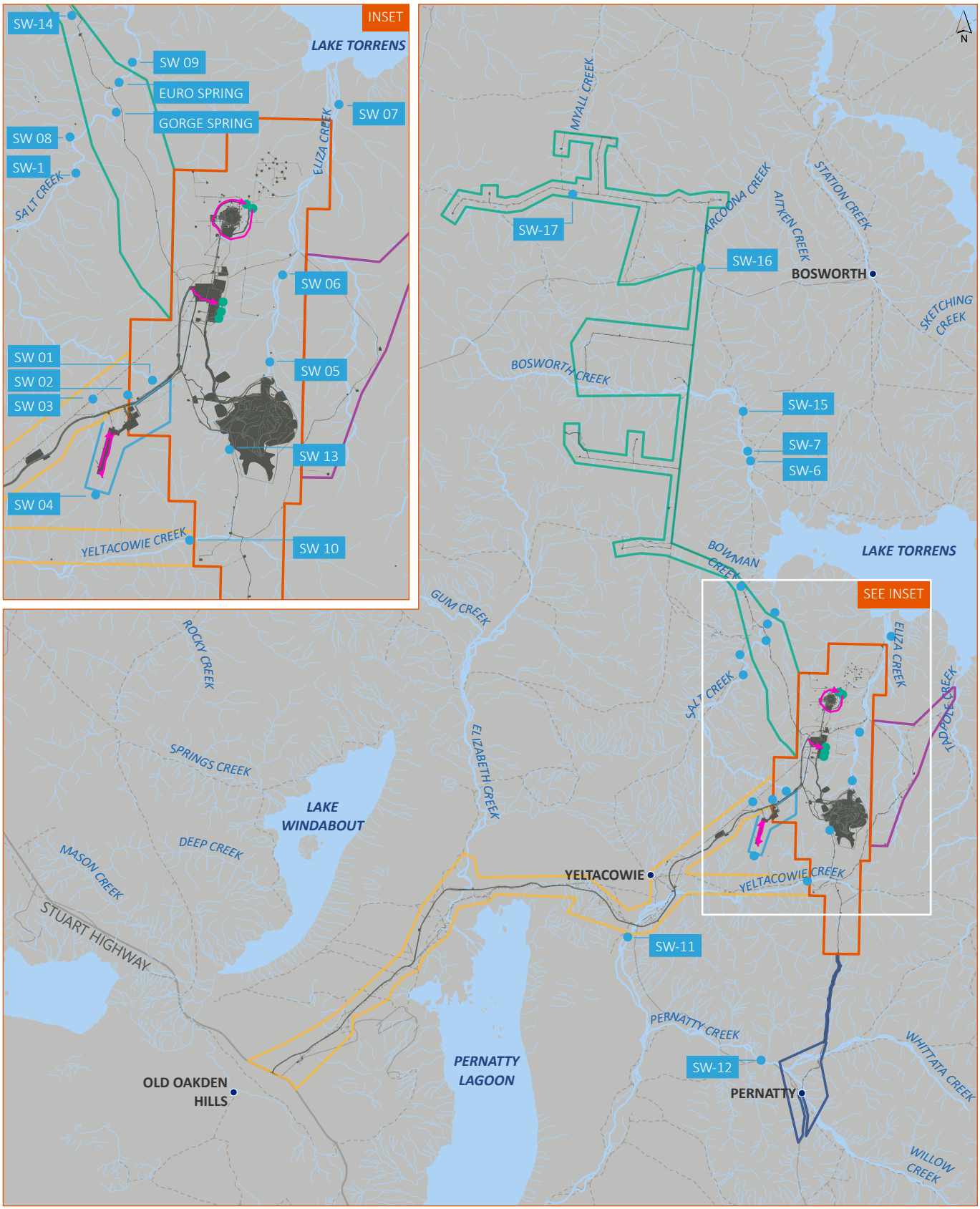
9.8.5 Surface water and tailings

Table 9.16 | Baseline surface water quality and ANZECC/ARMCANZ (2000) Freshwater Guideline Criteria

Monitoring location	Creek	pH	EC (µS/cm)	Hydrocarbons*	Suspended solids (mg/L)	Metals (mg/L)										
						Al	As	Ba	Co	Cu	Fe	Pb	Mn	Se	U	Zn
ANZECC/ARMCANZ (2000) Freshwater Guidelines (95% level of protection)		6.5 – 9	100 – 5,000	0*	No threshold	0.055	0.024	-	0.0028	0.013**	0.3	0.0034	1.9	0.011	-	0.0005
Decant spillway discharge = Mix of ICP Blend and Rainwater (Geochemical Model Inputs)		6.7	2,920	Not tested	-	0.030	0.001	0.165	-	0.001	-	0.001	0.010	-	-	0.001
SW05	Eliza Creek	7.8 – 8.5	397 – 491	Not tested	26 – 164	0.72 – 1.67	0.002 – 0.004	0.095 – 0.11	0.0005	0.006 – 0.009	0.5 – 0.86	0.0005 – 0.002	0.018 – 0.072	0.005	0.12 – 0.157	0.0005
SW06																
SW07																
SW08	Salt Creek	7.6 – 10.3	265 – 24,800	Not tested	8 – 604	0.055 – 2.72	0.001 – 0.002	0.058 – 0.193	0.0005	0.002 – 0.005	0.025 – 1.13	0.0005 – 0.004	0.0005 – 0.951	0.005	0.133 – 1.28	0.0005
SW09																
SW10	Yeltacowie Creek	7.7 – 8.2	281 – 309	Not tested	25 – 350	0.97 – 2.5	0.001 – 0.002	0.075 – 0.107	0.0005	0.004 – 0.007	0.15 – 0.48	0.0005 – 0.001	0.01 – 0.064	0.005	0.142 – 0.21	0.0005
SW11																
SW12																

* ANZECC/ARMCANZ (2000) Guidelines for Primary industries

** ANZECC/ARMCANZ (2000) Freshwater Guidelines criteria for slightly disturbed ecosystems in south central Australia (lowland rivers)



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint
- Major watercourse
- Watercourse
- Diversion drain
- Surface water sampling location
- Surface water management infrastructure
- Homestead

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 9.5 | Surface water management infrastructure and monitoring locations

Carrapateena BHP

Table 9.17 | Composition of spillway (decant) discharge (elements above level of reporting)

Element/compound (mg/L)	Maximum (2018)	Maximum (2018 to 2022)
Antimony (Sb)	-	0.011
Arsenic (As)	-	0.015
Barium (Ba)	-	0.176
Boron (Bo)	-	4.57
Bromine (Br)	-	74.1
Cadmium (Cd)	-	0.0019
Caesium (Cs)	-	0.211
Cobalt (Co)	0.32	0.33
Copper (Cu)	0.15	0.88
Iodine (Io)	-	10.3
Lithium (Li)	-	6.51
Manganese (Mn)	2.6	3.34
Molybdenum (Mo)	0.3	0.43
Nickel (Ni)	0.021	0.052
Silver (Ag)		0.014
Strontium (Sr)		72
Sulfate	1,120	3,480
Uranium (U)	1.3	0.837
Geochemical parameter	**Tailings iron calcium precipitate (ICP) blend**	
pH	6.5	
EC	6,260 µs/cm	
Total-S	1.29 (%S)	
Total-C	0.21 (%C)	
NAPP	-10	
NAG	0	
NAGpH	6.9	
ARD Classification	NAF	

9.8.6 Groundwater

Table 9.18 | Groundwater monitoring frequency – first year of commissioning

Well ID	0 to 12 hours	12 hours to 3 days	3 days to 3 months	3 to 12 months
Radial Wellfield Production Wells				
RP-1	Hourly	Every 6 hours	Daily	Weekly
RP-2	-	-	Daily	
RP-3 to RP-7	Hourly	Every 6 hours	Daily	
Radial Wellfield Observation Wells				
RO-1 to RO-7	-	-	Daily	Weekly
Western Infrastructure Corridor Production Wells				
WAT-3 and WAT-17	Hourly	Every 6 hours	Daily	Weekly
Western Infrastructure Corridor Observation Wells				
DPTI (WAT-3 obs) and WAT-17 obs	-	-	Weekly	Weekly
Northern Wellfield Production Wells				
NT-2P, NT-4P(T) and NT-4P(P), NT-5P, NT-8P, NT-10P and NT-17P	-	-	Weekly	Weekly
Northern Wellfield Observation Wells				
NT-2OB, NT-4OB, NT-5OB, NT-8OB, NT-10OB and NT-17OB	-	-	Daily	Weekly

Table 9.19 | Groundwater compliance well monitoring criteria

Compliance wells							
The standing water levels at compliance wells will be measured quarterly. Compliance wells MS2, MS3, MD3, ENV S2 and ENV W3 are located within the groundwater model predicted drawdown contours and are therefore predicted to exhibit some degree of drawdown (OZ Minerals 2017a; MLP Appendix C3 Groundwater Modelling and Assessment of Effects). Standing water levels at these wells are compared to the predicted head for each year of operations and do not exceed the maximum predicted drawdown at each well. If analysis by an independent and suitably qualified professional found that deviation occurs from the predicted drawdown, to an extent whereby the monitoring data gradient may exceed the maximum predicted drawdown, Carrapateena's conceptual and numerical model may require review in relation to what the trend may mean for compliance. Investigations may be required to assess reason for change (environmental factors, operation of pastoral wells or due to BHP operations).						The standing water levels at compliance wells will be measured quarterly. ENV N4 and ENV N8 were not simulated in the groundwater model. As they are located outside of the predicted drawdown contours they are not predicted to exhibit drawdown. Standing water levels at these wells are compared to previous monitoring results and do not exhibit a trend in water levels over three consecutive quarters. Investigations may be required to assess reason for change (environmental factors, operation of pastoral wells or due to BHP operations).	
Year	MS2	MS3	MD3	ENV S2	ENV W3	ENV N4	ENV N8
Aquifer screened	THA	THA	WSA	Woomera Shale	Woomera Shale	THA	WSA
Reason for monitoring	Effects to the north near the boundary of Lake Torrens			Effects to the south	Effects to the southwest	Effects to the west	
Easting	741607	745680	745672	735692	724745	689809	685847
Northing	654276	6542151	6542157	6514271	6530255	6560753	6562541
Well Unit No.	6435-34	6435-36	6435-35	6335-504	6335-505	6235-145	6235-144
Baseline head (mAHD predicted)	46.05	47.45	47.41	71.78	77.69	NA	NA
Predicted head (mAHD)							
1	45.81	46.92	47.40	71.08	77.27	NA	NA
2	45.54	46.60	47.37	69.68	75.99	NA	NA
3	45.16	46.31	47.33	68.45	74.63	NA	NA
4	44.50	45.99	47.27	67.43	73.28	NA	NA
5	43.92	45.69	47.19	66.59	71.98	NA	NA
6	43.48	45.43	47.10	65.88	70.80	NA	NA
7	43.14	45.22	47.00	65.25	69.77	NA	NA
8	42.83	45.04	46.90	64.70	68.88	NA	NA
9	42.54	44.88	46.78	64.22	68.10	NA	NA
10	42.27	44.73	46.67	63.80	67.41	NA	NA
11	42.01	44.60	46.56	63.42	66.80	NA	NA
12	41.76	44.47	46.45	63.07	66.25	NA	NA
13	41.53	44.36	46.33	62.76	65.76	NA	NA
14	41.31	44.25	46.22	62.48	65.32	NA	NA
15	41.12	44.14	46.11	62.22	64.92	NA	NA
16	40.94	44.04	46.01	61.99	64.55	NA	NA
17	40.77	43.95	45.90	61.77	64.22	NA	NA
18	40.61	43.86	45.80	61.57	63.91	NA	NA
19	40.44	43.77	45.69	61.38	63.62	NA	NA
20	40.27	43.68	45.59	61.21	63.35	NA	NA

Table 9.20 | Groundwater Leading Indicator well monitoring criteria

Leading Indicator wells	
These 15 leading indicator wells were simulated in the groundwater model (OZ Minerals 2017a; MLP Appendix C3 Groundwater Modelling and Assessment of Effects). The standing water levels at leading indicator wells will be measured quarterly. Standing water levels at these wells are compared to the predicted head for each year of operations and do not exceed the maximum predicted drawdown at each well. If analysis by an independent and suitably qualified professional found that deviation occurs from the predicted drawdown, to an extent whereby the monitoring data gradient may exceed the maximum predicted drawdown, Carrapateena's conceptual and numerical model may require review in relation to what the trend may mean for compliance.	These six leading indicator wells were not simulated in the groundwater model. The standing water levels at leading indicator wells will be measured quarterly. Standing water levels at these wells are compared to previous monitoring results and do not exhibit a trend in water levels over three consecutive quarters.

Year	ENV 6	ENV 7	ENV S1	ENV W4	MS4	MD4	PS6	MS6	YC Piezo 1	YC Piezo 2	SC Piezo	PI12	MS1	MD1	PI8-Obs	BI-6 THA	BI-6 PAN	ENV N-10	ENV N-11	Bosworth THA	Bosworth Alluvium
Aquifer screened	THA	Alluvium	Alluvium	Alluvium	THA	WSA	THA	THA	Alluvium	Alluvium	Alluvium	Woomera Shale	THA	WSA	THA	THA	Pandurra	THA	WSA	THA	Alluvium
Reason for monitoring	Leading indicator for subsidence zone drawdown		OZ Minerals owned well to monitor effects at third party receptor		Leading indicator for Pernatty third party receptor wells		Leading indicator for Yeltacowie third party receptor wells		Monitoring groundwater-surface water interactions		GDE monitoring	Leading indicator for effects at Lake Torrens			Cumulative effects	Leading indicator for Bosworth third party receptor wells and Lake Torrens north of the Carrapateena arm		Leading indicator towards Arcoona		BHP-owned wells to monitor effects at third party receptor	
Easting	737941	739534	735667	724661	737405	737405	730277	729003	730777	735970	733585	743935	733353	733345	731480	737900	737887	702014	702041	740069	740619
Northing	6531721	6539616	6514219	6530224	6518834	6518834	6529146	6542894	6528767	6529912	6549389	6537862	6546553	6546551	6550904	6569846	6569845	6567254	6567269	6575779	6574575
Well Unit No.	6435-43	6435-40	6335-489	6335-506	6335-472	6335-510	6335-481	6335-483	6335-497	6335-498	6335-496	6435-49	6335-479	6335-478	6335-515	6336-117	6336-117	6335-571	6335-570	6436-44	6436-43
Baseline head (mAHD predicted)	63.12	56.79	94.10	95.26	77.58	71.36	80.86	73.39	81.78	97.14	39.14	52.41	61.06	69.84	60.67	NA	NA	NA	NA	NA	NA
Predicted head (mAHD)																					
1	62.82	56.39	94.10	95.26	77.58	68.30	80.86	73.39	81.78	97.11	39.14	52.27	61.06	69.97	60.67	NA	NA	NA	NA	NA	NA
2	62.36	55.95	94.10	95.26	77.57	65.28	80.86	73.39	81.78	97.03	39.14	52.00	61.06	69.89	60.67	NA	NA	NA	NA	NA	NA
3	61.95	55.02	94.10	95.26	77.56	63.13	80.86	73.36	81.78	96.93	39.13	51.72	61.05	61.67	60.67	NA	NA	NA	NA	NA	NA
4	61.60	54.04	94.10	95.26	77.54	61.46	80.86	73.19	81.78	96.83	39.13	51.44	61.04	54.35	60.67	NA	NA	NA	NA	NA	NA
5	61.29	53.61	94.10	95.26	77.52	60.09	80.86	72.88	81.78	96.71	39.13	51.16	61.01	49.64	60.66	NA	NA	NA	NA	NA	NA
6	61.02	53.26	94.10	95.26	77.49	58.94	80.86	72.52	81.78	96.60	39.12	50.89	60.98	46.43	60.66	NA	NA	NA	NA	NA	NA
7	60.77	52.99	94.10	95.26	77.47	57.96	80.85	72.14	81.78	96.50	39.12	50.64	60.94	44.01	60.65	NA	NA	NA	NA	NA	NA
8	60.54	52.77	94.10	95.26	77.44	57.11	80.85	71.80	81.78	96.39	39.11	50.40	60.90	42.08	60.65	NA	NA	NA	NA	NA	NA
9	60.32	52.58	94.10	95.26	77.40	56.37	80.85	71.48	81.78	96.30	39.10	50.16	60.86	40.56	60.64	NA	NA	NA	NA	NA	NA
10	60.12	52.38	94.10	95.25	77.37	55.72	80.85	71.20	81.78	96.20	39.09	49.94	60.82	39.22	60.64	NA	NA	NA	NA	NA	NA
11	59.94	52.18	94.10	95.25	77.33	55.15	80.85	70.96	81.78	96.12	39.08	49.73	60.77	37.98	60.63	NA	NA	NA	NA	NA	NA
12	59.76	51.98	94.10	95.25	77.29	54.64	80.85	70.74	81.78	96.03	39.06	49.53	60.73	36.96	60.63	NA	NA	NA	NA	NA	NA
13	59.59	51.77	94.10	95.24	77.25	54.18	80.84	70.55	81.78	95.95	39.05	49.34	60.68	36.05	60.62	NA	NA	NA	NA	NA	NA
14	59.43	51.61	94.10	95.24	77.21	53.77	80.84	70.38	81.78	95.88	39.03	49.16	60.63	35.15	60.61	NA	NA	NA	NA	NA	NA
15	59.28	51.47	94.10	95.23	77.16	53.40	80.84	70.22	81.78	95.81	39.01	48.98	60.57	34.37	60.61	NA	NA	NA	NA	NA	NA
16	59.13	51.34	94.09	95.23	77.12	53.06	80.83	70.09	81.78	95.74	38.99	48.82	60.52	33.68	60.60	NA	NA	NA	NA	NA	NA
17	58.99	51.21	94.09	95.22	77.07	52.75	80.83	69.96	81.78	95.67	38.96	48.65	60.45	33.03	60.60	NA	NA	NA	NA	NA	NA
18	58.84	51.07	94.09	95.21	77.03	52.47	80.83	69.85	81.78	95.61	38.93	48.50	60.39	32.32	60.59	NA	NA	NA	NA	NA	NA

Leading Indicator wells																					
19	58.71	50.90	94.09	95.21	76.98	52.21	80.83	69.75	81.78	95.55	38.90	48.35	60.31	31.63	60.59	NA	NA	NA	NA	NA	NA
20	58.57	50.74	94.09	95.20	76.93	51.97	80.82	69.66	81.78	95.49	38.87	48.21	60.23	31.01	60.58	NA	NA	NA	NA	NA	NA

Table 9.21 | TSF monitoring well monitoring criteria

Compliance wells

These wells were simulated in the groundwater model (OZ Minerals 2017a; MLP Appendix C3 Groundwater Modelling and Assessment of Effects).

The standing water levels at TSF monitoring wells will be measured quarterly.

Standing water levels at these wells are compared to the predicted head for each year of operations and do not exceed the maximum predicted drawdown at each well. If analysis by an independent and suitably qualified professional found that deviation occurs from the predicted drawdown, to an extent whereby the monitoring data gradient may exceed the maximum predicted drawdown, Carrapateena's conceptual and numerical model may require review in relation to what the trend may mean for compliance.

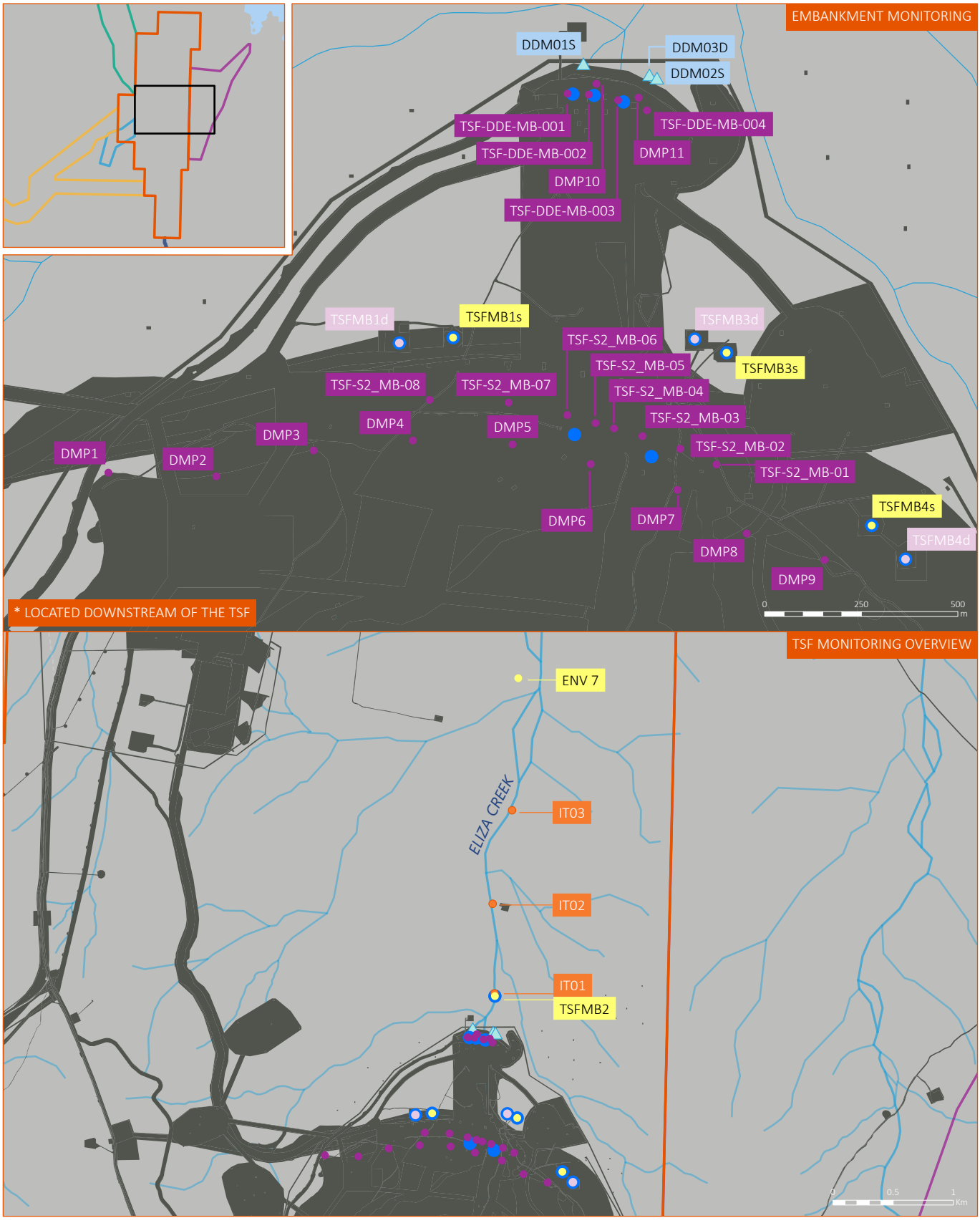
Investigations may be required to assess reason for change (environmental factors, operation of pastoral wells or due to BHP operations).

Year	TSFMB1s (SMW03)	TSFMB3s (SMW04)	TSFMB4s (SMW01)	TSFMB2s (SMW02)	TSFMB1d (THA1)	TSFMB3d (THA2)	TSFMB4d (THA3)
Aquifer screened	Alluvium	Alluvium	Alluvium	Alluvium	THA	THA	THA
Reason for monitoring	Monitor shallow lateral seepage downstream of the TSF			Monitor shallow lateral seepage downstream of the decant dam	Monitor seepage to the regional groundwater table downstream of the TSF		
Easting	738810.6	739517.9	739893.2	7393324	738671.4	739435.6	739980.7
Northing	6535999	6535960	6535513	6536973	6535985	6535995	6535426
Well Unit No.	6435-60	6435-61	6435-58	6435-59	6435-62	6435-63	6435-64
Baseline head (mAHD predicted)	76.72	60.18	60.01	60.16	58.67	57.99	57.90
Predicted head (mAHD)							
1	76.72	60.16	60.00	60.11	58.67	57.89	57.62
2	76.72	60.15	59.99	60.05	58.66	57.85	57.40
3	76.73	60.15	59.98	59.98	58.63	57.81	57.23
4	78.01	60.22	60.02	59.89	58.59	57.77	57.08
5	79.16	60.29	60.05	59.80	58.51	57.72	56.94
6	80.20	60.34	60.09	59.71	58.41	57.67	56.82
7	81.14	60.40	60.13	59.63	58.29	57.60	56.71
8	82.00	60.46	60.17	59.55	58.17	57.53	56.60
9	82.77	60.52	60.21	59.47	58.04	57.44	56.50
10	83.47	60.59	60.26	59.39	57.90	57.33	56.39
11	84.10	60.67	60.31	59.32	57.75	57.20	56.28
12	84.68	60.76	60.36	59.24	57.59	57.03	56.15
13	85.20	60.87	60.41	59.15	57.41	56.81	56.01
14	85.68	60.92	60.46	59.05	57.22	56.60	55.86
15	86.12	60.96	60.50	58.94	57.03	56.42	55.72
16	86.53	60.99	60.52	58.82	56.84	56.26	55.63
17	86.89	61.02	60.53	58.69	56.66	56.11	55.54
18	87.23	61.06	60.52	58.55	56.49	55.97	55.45
19	87.54	61.10	60.52	58.39	56.31	55.82	55.35
20	87.82	61.16	60.50	58.29	56.14	55.68	55.25

Table 9.22 | Baseline groundwater composition

Water Quality Parameters	Stock Water guidelines	Shallow Alluvial and weathered Proterozoic (HSU1)1	THA (HSU3)2	THA (HSU3) downstream of the TSF3	Hypersaline groundwater THA (HSU3)4	Whyalla Sandstone (HSU5)5	Hypersaline Torrens Brine Whyalla Sandstone (HSU5)6
pH[7]	6 – 8.5	7.25 – 7.9	6.31 – 8.05	7.44 – 7.88	6.24 – 7.47	6.7 – 7.69	6.32 – 7.93
TDS (mg/L)[8]	<13,000	2,620 – 11,135	12,900 – 33,500	22,000 – 24,100	35,200 – 361,000	19,300 – 31,000	36,680 – 204,000
Calcium carbonate, $CaCO_3$ (mg/L)	N/A	235 – 502	113 – 334	192 - 216	36 – 196	73 – 224	36 – 196
Sulfate (mg/L)[9]	1,000	444 – 859	2,250 – 3,270	2,450 – 2,610	2,620 – 7,260	1,420 – 2,660	1,280 – 6,260
Chloride (mg/L)[9]	N/A	964 – 1,690	9,080 – 19,400	11,600 – 12,700	18,000 – 198,000	11,800 – 15,200	16,900 – 157,000
Calcium (mg/L)[9]	1,000	59 – 134	1,210 – 1,580	1,380 – 1,400	1,050 – 1,910	600 – 1670	1,580 – 5,490
Magnesium (mg/L)[9]	2,000	32 – 50	416 – 854	640 - 645	842 – 5,910	690 – 835	606 – 3,270
Sodium (mg/L)	N/A	660 – 1,700	4,260 – 1,170	5,590 – 5,870	76,500 – 11,9000	5,020 – 8,750	8,200 – 78,700
Potassium (mg/L)	N/A	4 – 10	27 – 54	39 - 46	54 - 332	46 – 114	50 – 701
Aluminium (mg/L)[9]	5	0.02 – 3.33	0.01 – 0.02	<0.01	0.10 – 0.12	<0.01	0.1 – 1.59
Argon (mg/L)[9]	0.5	0.001 – 0.014	0.001 – 0.005	0.002 – 0.005	0.010 – 0.020	0.001 – 0.007	0.001 – 0.15
Barium (mg/L)	N/A	0.043 – 0.067	0.025 – 0.161	0.002 – 0.005	0.035 – 0.078	0.025 – 0.053	0.033 – 0.209
Cobalt (mg/L)[9]	1	0.001 – 0.003	0.001 – 0.029	<0.001 – 0.001	0.004 – 0.026	0.002 – 0.229	0.01 – 0.046
Copper (mg/L)[9]	0.5	0.005 – 0.016	0.001 – 0.013	<0.001	0.01 – 0.02	0.001 – 0.01	0.009 – 0.023
Lead (mg/L)[9]	0.1	0.001 – 0.004	0.0005 – 0.004	<0.001	0.001 – 0.02	<0.0005 – 0.001	0.001 – 0.02
Manganese (mg/L)[9]	N/A	0.073 – 0.091	0.192 – 1.03	0.629 – 0.69	0.5 – 2.22	0.303 – 4.5	0.721 – 8.16
Selenium (mg/L)[9]	0.02	0.01 – 0.04	0.01 – 0.02	<0.01	0.1 – 0.2	0.01 – 0.1	0.01 – 0.2
Strontium (mg/L)[9]	N/A	1.15 – 1.7	15.6 – 25.7	20.5 – 20.9	22.8 – 51.7	11 – 22.1	22.8 – 104
Thorium (mg/L)[9]	N/A	<0.001	0.001 – 0.005	-	<0.001	0.0005 – 0.001	0.0005 – 0.01
Uranium (mg/L)[9]	0.2	0.014 – 0.026	0.005 – 0.016	<0.001 – 0.006	0.002 – 0.02	0.001 – 0.0016	0.006 – 0.01
Zinc (mg/L)[9]	20	0.046 – 0.69	0.005 – 0.636	<0.005	0.069 – 3.69	0.005 – 1.12	0.005 – 17.6
Iron (mg/L)	N/A	0.05 – 2.22	0.05 – 5.58	<0.05	0.05 – 7.99	2.16 – 7.19	0.23 – 7.7
Silicon (mg/L)	N/A	3.1 – 36.4	6.6 – 11	-	-	11	4.3 – 7.8
Nitrogen (mg/L)	N/A	0.01 – 0.02	0.076 – 0.68	0.2 – 0.6	0.1 – 0.79	0.048 – 0.81	0.01 – 2.46
Fluoride (mg/L)[9]	2	3.1 – 3.5	0.1 – 1.2	0.6 – 0.9	0.1 – 0.7	0.8 – 1.1	0.2 – 1.2
Nitrate as NOx[9]	30	0.34 – 2.62	0.01 – 0.25	<0.01 – 0.02	0.01 – 0.55	0.01 – 0.25	0.01 – 0.25

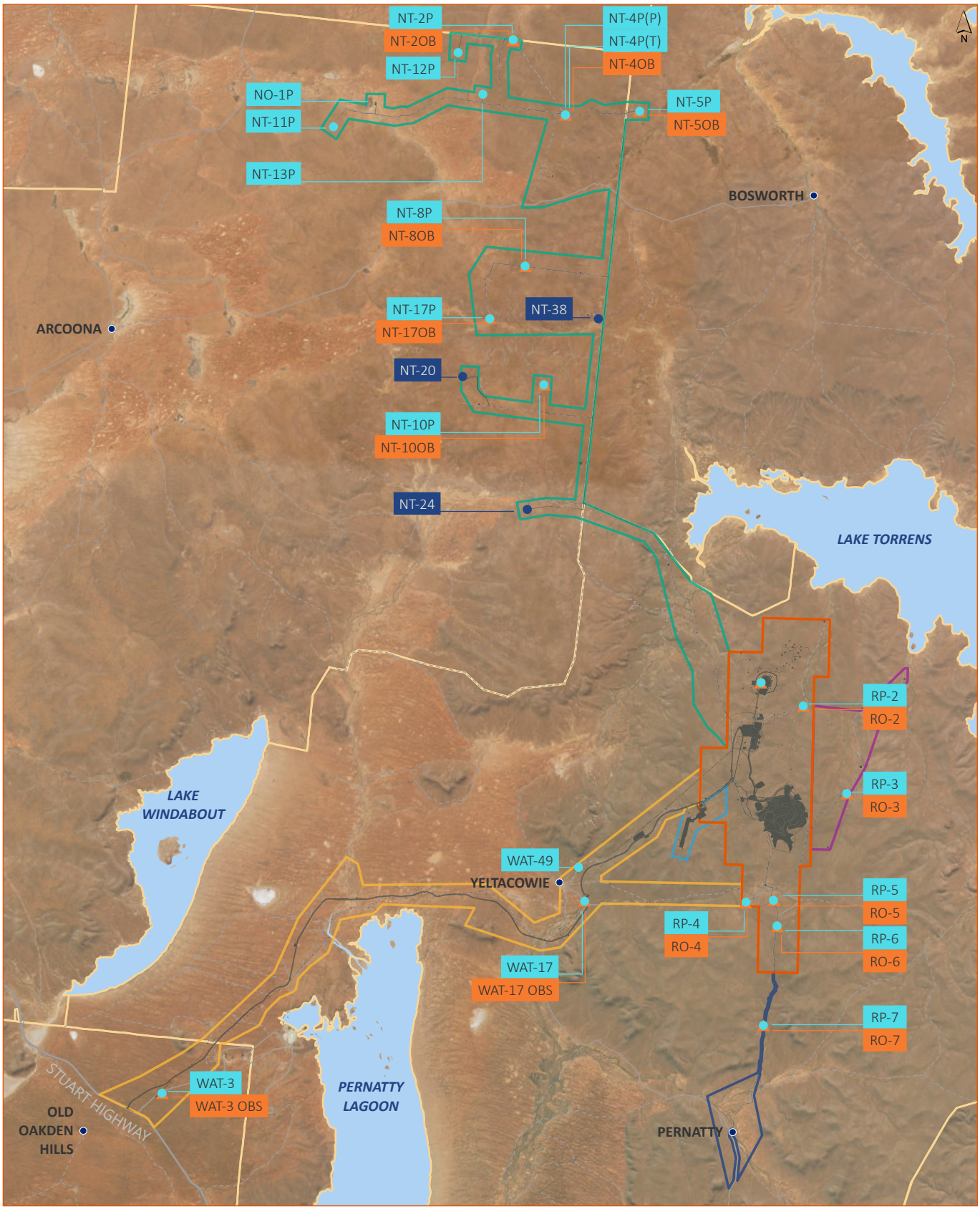
1. Sampled from shallow alluvial sediments and weathered Proterozoic rocks on and surrounding the Mineral Lease (4 wells: ENV7, ENV8, ENV S1 and ENV W4)
2. Sampled from the THA beneath the Mineral Lease (19 wells)
3. One round of sampling from the THA downstream of the TSF (3 wells)
4. Sampled from the THA beneath the Mineral Lease eastern boundary (MS1, MS2 + MS6, ENV N4, PI-9, PI-2, BI-15)
5. Sampled from the Whyalla Sandstone Aquitard beneath the Mineral Lease (PS-15, RP-6, WAT-3)
6. Sampled from the Whyalla Sandstone Aquitard 3.5 km east of the Mineral Lease boundary (MD1, MD3, MD7, RP-6, PS-13, ENV N8, PS-14)
7. ANZECC/ARMCANZ (2000) guidelines: red highlight = exceedances
8. EPA (2015) guidelines: red highlight = exceedances
9. EPA (2003) guidelines: red highlight = exceedances.



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint
- Displacement monitoring beacons
- Shallow monitoring well
- TSF inspection transects (100m)
- TSF Tent Hill Aquifer monitoring wells
- Surface water sampling locations
- Seepage monitoring and dewatering wells

Figure 9.6 | TSF monitoring locations



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- TSF Stage 3 PEPR footprint
- Observation well
- Production well
- Potential / alternate production well

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 9.7 | Groundwater production and observation well locations

Carrapateena BHP

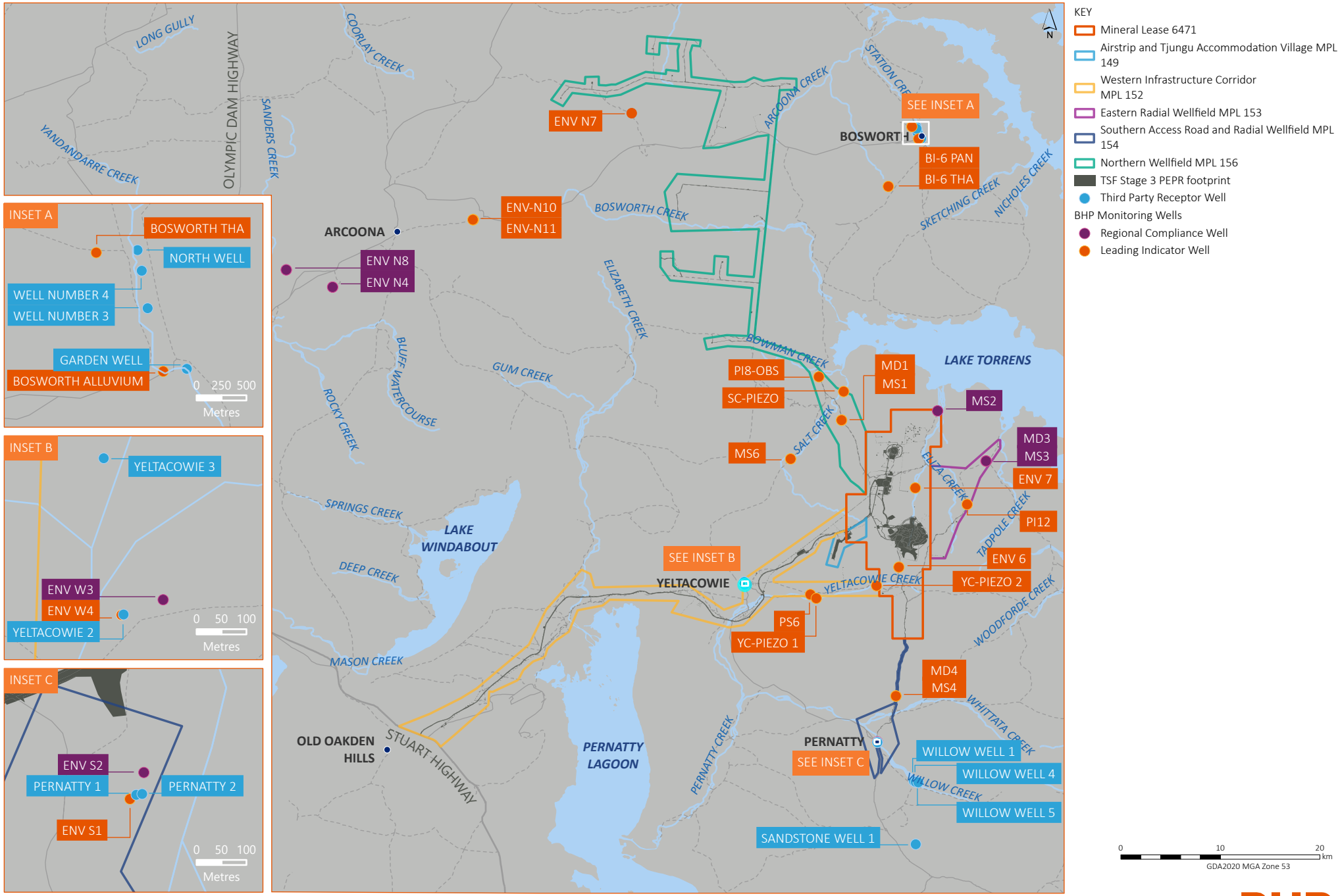


Figure 9.8 | Groundwater monitoring locations

Carrapateena BHP

10. Changes to the approved PEPR

Changes to the current approved PEPR (BHP 2024a) are summarised in Table 10.1.

Table 10.1 | Changes to the current approved PEPR

Location	Description of change(s)
General	
Whole document	General document production improvements and edits
Chapter 1 Introduction	
Section 1.2	Description of changes to approved operations since submission of the previous PEPR
Chapter 2 Proponent details	
No changes	
Chapter 3 Operator capability	
Section 3.3.2	Updates to reflect the outcomes of stakeholder engagement undertaken since submission of the previous PEPR
Chapter 4 Description of the operations	
Section 4.5.2	Update to land disturbance to reflect proposed changes to approved operations
Section 4.6	Update of Mineral Resource and Ore Reserve data to reflect updates presented in the BHP Annual Report (BHP 2024b)
Section 4.9.4.4	Update to processing reagents
Section 4.10	Updates to the description of the TSF operations to reflect the revised life-of-mine TSF design presented in Appendix B1
Section 4.10.3.5	Updates to the geochemical characterisation of tailings reflecting as-deposited tailings solids and liquid compositions and the outcomes of further geochemical studies (Appendix B2)
Section 4.11.5.2	Update to the nominated TSF borrow pit sequencing to reflect revised embankment material requirements
Chapter 5 Closure	
No changes	
Chapter 6 Description of the environment and effects	
Section 6.2.4	Updates to the understanding of the baseline radiation environment reflecting the outcomes of the 2023 Environmental Radiation Impact Assessment: Non-human Biota and Member of Public Doses (RCA 2024)
Section 6.8.3	Updates to the understanding of the baseline ecology environment reflecting the outcomes of the Autumn 2024 ecological survey, included as Appendix C1
Chapter 7 Environmental Outcomes, controls, uncertainty and compliance	
Section 7.3.12	Update to leading indicator TSF8 (LEM and field trials) to reflect TSF Stage 3 timing as a result of the move to a downstream embankment
Chapter 8 Matters of national environmental significance and native vegetation	
Section 8.1.2	Updates to land disturbance areas reflecting the as-built and proposed Carrapateena land disturbance footprint described in Section 4.5 Project footprint

Location	Description of change(s)
Chapter 9 Future works, audits and monitoring	
Table 9.6	Clarified frequency of soil quality aspect to be at ERML16 to ERML19 locations
Figure 9.6	Update to TSF monitoring locations to reflect the revised Stage 3 TSF embankment footprint and the subsequent need to relocate some monitoring points
Section 9.8.5	Updated Table 9.17 to reflect recent sampling outcomes and impact assessment investigations
Chapter 10 Changes to the approved PEPR	
Table 10.1	Updates to this table
Chapter 11 Supporting information	
Chapter 11	Minor updates as required by the changes within this document

11. Supporting information

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11.2 Abbreviated terms

11.2.1 Abbreviations and acronyms

Table 11.1 | Abbreviations and acronyms

Abbreviation	Description
2D	two-dimensional
3D	three-dimensional
ABS	Australian Bureau of Statistics
AEP	annual exceedance probability
ALARA	as low as reasonably achievable
AMD	acid and metalliferous drainage
AN	ammonium nitrate
ANC	acid neutralising capacity
ANCOLD	Australian National Committee on Large Dams
ANE	ammonium nitrate emulsion
ANFO	ammonium nitrate-fuel oil
ARD	acid rock drainage
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS	Australian Standard
BAC	bulk air cooler
BC	block cave
BDBSA	Biological Database of South Australia
BHP	OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd
BOD	biological oxygen demand
BoM	Bureau of Meteorology
BP	borrow pit
C&D	construction and demolition
CASA	Civil Aviation Safety Authority
CCA	copper chromium arsenate
CCTV	closed-circuit television
CDA	Canadian Dam Association
CDL	container deposit legislation
CFS	Country Fire Service
CiDRA	CiDRA Minerals Processing Inc.
CiOP	Change in Operations Proposal
Company	BHP Group Limited
COS	coarse ore stockpile

Abbreviation	Description
CRT	constant rate test
CS	crushing station
CS_2	carbon disulphide
Cth	Commonwealth
CTP	concentrate treatment plant
Cu-Au	copper-gold
DCCEEW	Australian Government Department of Climate Change, Energy, the Environment and Water
DEM	Government of South Australia, Department for Energy and Mining
DEW	Government of South Australia, Department for Environment and Water
DEWNR	Government of South Australia, Department of Environment, Water and Natural Resources (now DEW)
DIDO	drive-in drive-out
DIT	Government of South Australia, Department for Infrastructure and Transport
DoEE	Australian Government Department of the Environment and Energy (now DCCEEW)
DN	nominal diameter
DPC	Government of South Australia, Department of the Premier and Cabinet
DRP	Decommissioning and Rehabilitation Plan
DSD	Government of South Australia, Department of State Development (now DEM)
EC	electrical conductivity
EGL	effective grinding length
EL	Exploration Licence
EML	Extractive Mineral Lease
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	South Australian Environment Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management
ERML	Environmental Radiation Monitoring Location
ERT	Emergency Response Team
ESG	environmental, social and governance
FCR	Forum on Corporate Responsibility
FDC	Fundamental Design Control
FEL	front-end loader
FEP	Features, Events, Processes
FIFO	fly-in fly-out
FoS	factor of safety
GIS	geographical information system

Abbreviation	Description
GISTM	Global Industry Standard on Tailings Management
GAB	Great Artesian Basin
GDE	groundwater dependent ecosystem
GLE	General Limited Equilibrium
GRI	Global Reporting Initiative
GRP	gross regional product
H2H	Hill-to-Hill
HDPE	high-density polyethylene
HE	high explosives
HIL	health investigation level
HMI	human machine interface
HPU	high-pressure unit
HSU	hydrostratigraphic units
HV	heavy vehicle
HVAS	high-volume air sampler
H:V	horizontal:vertical
IAEA	International Atomic Energy Agency
IAF	Impact Assessment Framework
IBC	intermediate bulk container
ICMM	International Council on Mining and Metals
ICOLD	International Committee on Large Dams
ICP	iron calcium precipitate
ICT	information and communication technologies
ID	identification number
IOCG	iron oxide copper gold
IPR	independent peer review
ISO	International Organization for Standardization
ISQG	interim sediment quality guideline
ITP	Inspection and Test Plan
JORC	Joint Ore Reserves Committee
KAC	Kokatha Aboriginal Corporation
LAN	local-area network
LEM	landform evolution modelling
LFA	landscape function analysis
LGA	local government area
LHD	load haul dump

Abbreviation	Description
LOM	life-of-mine
LOPA	Layers of Protection Analysis
LV	light vehicle
MARP	Mining and Rehabilitation Program
MBR	membrane bio-reactor
MCC	motor control centre
MCE	Maximum Credible Event (as related to geotechnical assessment)
MCE	Maximum Credible Earthquake (as related to seismic hazard assessment)
ML	Mineral Lease
MLE	modified Ludzac-Ettinger
MLP	Mining Lease Proposal and MPL Management Plans
MNES	matters of national environmental significance
MPL	Miscellaneous Purposes Licence
MPP	minerals processing plant
MRT	multi-rate test
MSDS	Material Safety Data Sheet
MV	medium voltage
NAF	non-acid forming
NEM	National Electricity Market
NGER	National Greenhouse and Energy Reporting
NGO	non-government organisation
NNTT	National Native Title Tribunal
NORM	naturally occurring radioactive material
NPI	non-process infrastructure
NTMA	Native Title Mining Agreement
NVF	Native Vegetation Fund
OHTL	overhead transmission line
OM&SMP	Operations, Maintenance and Surveillance Manual
OMC	Outcome Measurement Criteria
OMS	Operations, Maintenance and Surveillance
OSA	on-stream analyser
OSLD	optically stimulated luminescence dosimetry
OT	optic transmitters
PAF	potentially acid forming
PAH	polycyclic aromatic hydrocarbon
PC	personal computer

Abbreviation	Description
PCQ	Point Centre Quarter
PCS	process control system (related to mineral processing)
PCS	plastic-clad silica (related to telecommunications)
PDC	polycrystalline diamond compact
PELA	Petroleum Exploration Licence Application
PEPR	Program for Environment Protection and Rehabilitation
PET	polyethylene terephthalate
PFA	Pandurra Formation Aquifer
PGA	peak ground acceleration
PM_{10}	particulate matter less than 10 micrometres in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 micrometres in aerodynamic diameter
PMC	Partnering Management Committee
PMP	probable maximum precipitation (related to surface water assessment)
PMP	Production Management Plan (related to mining operations)
PMST	Protected Matters Search Tool
PSD	particle size distribution
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RAB	rotary air blasting
RAR	return air raise
RCP	reverse circulation percussion
RCPW	representative concentration pathway
RESA	Runway End Safety Area
RL	Retention Lease
RMP	Radiation Management Plan
RnDP	radon decay product
RO	reverse osmosis
RO plant	reverse osmosis desalination plant
ROM	run-of-mine
RRC	Resource Recovery Centre
RTFE	Responsible Tailings Facility Engineer
RWMP	Radioactive Waste Management Plan
SA	South Australia
SABC	SAG mill, ball mill and pebble crusher
SAG	semi-autogenous grinding
SARIG	South Australian Resources Information Gateway (map.sarig.sa.gov.au)

Abbreviation	Description
SCADA	Supervisory Control and Data Acquisition
SEB	significant environmental benefit
SEE	Safety Evaluation Earthquake
SFAIRP	so far as is reasonably practicable
SHA	seismic hazard assessment
SHEC	Safety, Health, Environment and Community
SLA	Statistical Local Area
SLC	sub-level cave
SLOS	sub-level open stoping
SMBS	sodium metabisulfite
SPR	source–pathway–receptor
SPRAT	Species Profile and Threats
SQG	Sediment Quality Guideline
TARP	Trigger Action Response Plan
TCA	Transmission Connection Agreement
TDS	total dissolved solids
THA	Tent Hill Aquifer
TN	total nitrogen
TS	transfer station
TSF	tailings storage facility
TSP	total suspended particulates
TSS	total suspended solids
UHF	ultra-high frequency
USG	Upper Spencer Gulf
WAN	wide-area network
WMC	Western Mining Company
WRD	waste rock dump
WSA	Whyalla Sandstone Aquifer
WWTP	wastewater treatment plant

11.2.2 Units of measure

Table 11.2 | Units of measure

Unit	Description	Unit	Description
°	degree	kV	kilovolt
µg	microgram	kW	kilowatt
µGy	microgray	L	litre
µm	micrometre	m	metre
µS	microsiemen	m^2	metre squared
µSv	microsievert	m^3	metre cubed
%	per cent	mAHD	metres above Australian Height Datum
wt%	weight per cent	mbgl	m below ground level
A$ or $	Australian currency in dollars	mbs	metres below surface
Bq	becquerel	mg	milligram
cfm	cubic feet per minute	ML	megalitre
cfu	colony forming units	mm	millimetre
cm	centimetre	Mm^3	million cubic metres
cm^3	centimetre cubed	mRL	metres relative level
CO_2-e	carbon dioxide equivalent	Mt	million tonnes
d	day	Mtpa	million tonnes per annum
dBA	decibels A	MVA	megavolt-amperes
ft	foot	MW	megawatt
g	gram	NTU	nephelometric turbidity units
GWh	gigawatt hour	ppm	parts per million
h or hr	hour	ppmU	parts per million Uranium
ha	hectare	psi	pounds per square inch
k	permeability	s	second
kg	kilogram	t	tonne(s)
kL	kilolitre	tpa	tonnes per annum
km	kilometre	tpd	tonnes per day
km^2	kilometre squared	tph	tonnes per hour
kN	kilonewton	V	volt
kPa	kilopascal	w/w	weight to weight
kt	kilotonne	y	year
ktpa	kilotonne per annum		

11.3 Glossary

11.3.1 Impact Assessment Framework Terms

Audit: Systematic review undertaken by an expert of performance against design systems, records, standards and/or legislation that is documented in an audit report.

Block cave: The term block cave is used throughout this PEPR to refer to the greater area of mineralisation within the Carrapateena deposit, reflecting the potential for the implementation of a block caving mining methodology for the extraction of this greater resource.

Design Control: An elimination, substitution or engineering control identified and implemented during the project design and/or construction phase with the intent of eliminating, 'so far as is reasonably practicable' (SFAIRP) or otherwise reducing, 'as low as reasonably achievable' (ALARA), potential impacts and/or raw risks associated with Project activities.

Environmental offset: In the context of the EPBC Act the term refers to the measure commensurate for the residual adverse impacts on an action on the environment. Offsets provide environmental benefits to counterbalance impacts that remain after avoidance and mitigation measures have been applied.

Fundamental Design Control: A robust control that prevents an effect to a pathway from occurring, thus preventing an impact.

Impact: Any certain and defined change to a **receptor**, whether adverse or beneficial, wholly or partially resulting from a **source** affecting a **pathway**.

Inspection: Documented collection of visual evidence, including photographs.

Investigation: Documented systematic assessment, undertaken by an expert, to ascertain the root cause behind an incident, including corrective actions if required.

Leading Indicator: Sets out measurable standards which, when monitored, provide an early warning that a control measure is failing and/or that an Outcome is potentially at risk of not being achieved.

Linkage: **Source-pathway-receptor** linkage. A linkage is confirmed where a **source** affects a **pathway** and ultimately leads to an impact on an identified **receptor**. The linkage can be broken by the application of a control strategy or inherent nature of location, e.g. distance to sensitive receptors.

Management Control: An administrative control (e.g. the application of personal protective equipment) or procedural control (e.g. work instructions or standard operating procedures) that may be implemented during operations for the purpose of reducing the consequence and/or likelihood of an identified risk event.

Monitoring/survey: Documented collection of data and analysis using scientific methods.

Monitoring locations: Locations used to demonstrate compliance with the licence conditions, outcomes and operational performance.

Outcome Measurement Criteria (OMC): sets out the measurement methods, location, achievement, frequency and baseline data that are used to measure performance against a stated **Outcome** during construction, operation and closure phases.

Pathway: The pathway, means or route (with consideration of any natural barriers) by which an identified **receptor** can be exposed to, or may reasonably be expected to be impacted by, an identified **source**.

Phase: The time at which a specific source (project element) emerges. The phase is selected to reflect when the source occurs and not when a potential or actual impact is anticipated to occur.

Project Area: Area comprised of ML 6471, MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156.

Receptor: A discrete, identifiable attribute or associated entity that can be measurably impacted by an **effect** to a **pathway**.

Residual impact: In the context of the EPBC Act the term refers to the remaining unavoidable impacts.

Risk: 'The impact of uncertainty on objectives' (ISO 31000:2018) (ISO 2018). It consists of two components – the consequence and its likelihood.

Source: A project element that can interact with the environment.

BHP

BHP

Carrapateena Operation

Program for Environment Protection and Rehabilitation

Volume 2 of 2 Appendices

ML 6471	Carrapateena Mineral Lease
MPL 149	Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure
MPL 152	Western Infrastructure Corridor
MPL 153	Eastern Radial Wellfield
MPL 154	Southern Access Road and Radial Wellfield
MPL 156	Northern Wellfield

June 2025

Volumes and appendices

Volume 1 – Main document

Program for Environment Protection and Rehabilitation

Volume 2 – Appendices

Appendix A Tenement documents
- Appendix A1. ML 6471 Carrapateena Mineral Lease
- Appendix A2. MPL 149 Airstrip, Workers' Accommodation Village and Ancillary Infrastructure
- Appendix A3. MPL 152 Western Infrastructure Corridor
- Appendix A4. MPL 153 Eastern Radial Wellfield
- Appendix A5. MPL 154 Southern Access Road and Radial Wellfield
- Appendix A6. MPL 156 Northern Wellfield
- Appendix A7. Conditions demonstrated commitment

Appendix B Description of operations
- Appendix B1. Tailings storage facility design
- Appendix B2. Tailings geochemical update

Appendix C Baseline, effects and impacts
- Appendix C1. Ecology baseline update

Appendix D Native Vegetation Management Plan

Appendix E Determination Terms of Reference checklist

BHP

Appendix A
Tenement documents

Appendix A1.
ML 6471 Carrapateena Mineral Lease

Government of South Australia

Mining Act 1971

TENEMENT DOCUMENT

MINERAL LEASE

TENEMENT HOLDER	OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255)
CLASS OF LEASE	Mineral Lease (ML)
MINERAL LEASE NUMBER	6471
COMMENCEMENT DATE	3 January 2018
TERM OF LEASE	Twenty-one (21) years
EXPIRY DATE	2 January 2039
MINERAL(S)	Minerals (Copper, Gold and Silver)
AREA OF LEASE	11,633 hectares

DATE BY WHICH THE PROPOSED PEPR MUST BE SUBMITTED: 2 January 2019

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Details of Grant of a Mining Tenement

1. On 3 January 2018, pursuant to Part 6 of the Act, the Minister made a statutory grant of a mineral lease (the Mining Tenement) described in this Tenement Document.

2. The Mining Tenement is granted:

   2.1. To OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255);

   2.2. For the purpose of recovering the Mineral(s) described in the First Schedule of this Tenement Document.

3. The Mining Tenement is numbered ML 6471.

4. The Mining Tenement is:

   4.1. Subject to the Terms and Conditions prescribed by the Act and Regulations and specified in this Tenement Document; and

   4.2. Subject to the Additional Terms and Conditions specified in the First and Second Schedules (respectively) of this Tenement Document.

Terms and conditions required by the Act to be specified in the Tenement Document

Description of the Land

5. The Mining Tenement is granted over an area of 11,633 hectares and is located in the Pernatty area, approximately 62km east of Woomera.

6. The location of the Mining Tenement is more specifically defined in the map and coordinates specified in the Third Schedule of this Tenement Document.

Term, Commencement and Expiration

7. The Mining Tenement is granted for the term of twenty-one (21) years. The term of the Mining Tenement commenced on 3 January 2018, and, unless it is earlier renewed, surrendered or cancelled, the Mining Tenement will cease on 2 January 2039.

Rental

8. The Tenement Holder shall pay, by way of rental, such sums as may be prescribed and in accordance with section 40 of the Act and regulation 42 of the Regulations.

Compensation

9. The Minister may, at any time, require the Tenement Holder to pay to any person an amount of compensation stipulated by the Minister, to which that person is, in the opinion of the Minister, entitled in consequence of mining operations in pursuance of the rights granted and the obligations imposed by the grant of the Mining Tenement.

Suspension and Cancellation: Stipulation of Process

10. Pursuant to subsection 41(1) of the Act, the Minister may suspend or cancel the Mining Tenement if the Tenement Holder contravenes or fails to comply with a term or condition of this Tenement Document or a provision of the Act (which includes the Regulations).

11. Pursuant to subsection 41(2) of the Act, the Minister may stipulate in the tenement document a process for suspension or cancellation that must be followed before the powers in subsection 41(1) may be exercised.

12. The process for suspension of the Mining Tenement shall be as stipulated in the Fourth Schedule of this Tenement Document.

13. The process for cancellation of the Mining Tenement shall be as stipulated in the Fifth Schedule of this Tenement Document.

Environmental outcomes specified pursuant to Regulation 65 of the Regulations

14. The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act.

Explanatory note: The Sixth Schedule may also contain strategies and criteria which the Department of the Premier and Cabinet has formed the view would address the outcomes set out in that Schedule.

Restatement of selected provisions from the Act

Explanation of Restatements

15. All of the restatements in this portion of this Tenement Document are included for guidance only and do not replace the substantive provisions of the Act or the Regulations.

16. If any restatement is inconsistent with the substantive provisions of the Act or the Regulations, the restatement will be invalid and the substantive provision of the Act or the Regulations will prevail and the Tenement Holder is required to comply with the substantive provision of the Act or the Regulations.

17. The Tenement Holder is still required to comply with any provision of the Act or Regulations that is not restated in this Mineral Lease.

Restatement of rights conferred on Tenement Holder

18. The grant of the Mining Tenement confers an exclusive right upon the Tenement Holder including officers, employee(s), contractor(s) or duly authorised agent(s) of the Tenement Holder, to conduct mining operations on the Land, for the Mineral(s), subject to the provisions of the Act and the Regulations, and the terms and conditions of this Tenement Document.

19. The grant of the Mining Tenement authorises the Tenement Holder, including officers, employee(s), contractor(s) or duly authorised agent(s) of the Tenement Holder, to sell, or dispose of, the Mineral(s) recovered in the course of mining operations conducted in pursuance of the grant or to utilise any such mineral(s) for any commercial or industrial purpose, subject to the payment of royalty.

Restatement of rights and powers not conferred on the Tenement Holder

20. The grant of the Mining Tenement does not confer any right on the Tenement Holder:

    20.1. To use the Land for any purpose other than the authorised mining operations.

    20.2. To confer any rights on any other person in relation to the Mining Tenement.

    Explanatory note: For example, the Tenement Holder cannot grant rights to a party under a Joint Venture Agreement (or other agreement however described), to conduct mining operations on the Land in that party's own right. The Tenement Holder may engage employees, contractors or agents to perform work on the tenement on the Tenement Holder's behalf).

Restatement of obligations imposed on Tenement Holder: Program for environment protection and rehabilitation

21. The Tenement Holder must not carry out mining operations unless there is an approved program for environment protection and rehabilitation (an Approved PEPR).

22. A Proposed PEPR will only be approved when it complies with the requirements of Part 10A of the Act and the Regulations.

23. To comply with Part 10 A of the Act, the Proposed PEPR must:

    23.1. Contain the information specified in section 70B(2) of the Act and regulation 65(2), (5), (6) of the Regulations and determinations made by the Minister under regulation 65(7) of the Regulations (if any);

    23.2. Comply with any applicable conditions specified in this Tenement Document (if any);

    23.3. Address any relevant environmental outcomes listed in the Sixth Schedule of this Tenement Document.

    Explanatory note: At the date of grant, the determinations are available at: www.minerals.dpc.sa.gov.au/publications_and_information/ministerial_determinations

24. In accordance with regulation 65(10) of the Regulations, the Tenement Holder must submit to the Department of the Premier and Cabinet for ministerial approval of a Proposed PEPR that fully complies with the Act and Regulations within twelve (12) months after the grant of the Mining Tenement unless the Tenement Holder has been granted an extension of time for such submission.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, GPO Box 320, Adelaide, SA 5001, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Working conditions

25. In accordance with regulation 35 of the Regulations, unless otherwise determined or agreed by the Minister, the Tenement Holder must:

    25.1. Commence mining operations in accordance with the Approved PEPR within twelve (12) months after its approval; and

25.2. Thereafter continue mining operations in accordance with the requirements of the program in the Approved PEPR.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, GPO Box 320, Adelaide, SA 5001, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Other

26. In addition to obligations about the conduct of mining operations and rehabilitation, the Act and Regulations impose other obligations on the Tenement Holder including obligations to:

26.1. Comply with Part 3 of the Act (royalties).

26.2. Comply with the applicable provisions of Part 9 of the Act (entry onto land and use of declared equipment).

26.3. Comply with the applicable provisions of Part 9B of the Act (native title).

26.4. Comply with the provisions of section 76 of the Act (mining returns) to the extent relevant to a mineral lease.

26.5. Comply with section 77 of the Act (records and geological samples) and regulation 84 of the Regulations.

26.6. Comply, as necessary, with section 83 of the Act (ministerial consent for dealings in relation to the Tenement) and regulations 44 and 70 of the Regulations.

26.7. Comply, insofar as applicable to a mineral lease, with regulation 86 of the Regulations (compliance reports).

26.8. Comply with the requirement in regulation 43 of the Regulations to maintain all posts, boundary indicator markers and notices in the positions required by the Regulations as applicable.

26.9. Permit the pastoral lessee (if any) of the Land to have free access and use at all times for domestic purposes, and for the purposes of watering stock from any surface water on the land which shall not have been provided or stored by artificial means by the Tenement Holder.

Restatement of Exempt Land

27. In accordance with section 9 of the Act, the grant of the Mining Tenement does not authorise prospecting, exploring or mining upon any exempt land unless or until the benefit of the exemption is waived under section 9AA.

Restatement of Bond

28. In accordance with section 62 of the Act, the Minister may by written notice require the Tenement Holder to pay a bond in such sum and subject to such terms and conditions as ensure, in the opinion of the Minister, that the following will be satisfied:

    28.1. Any civil or statutory liability likely to be incurred by the Tenement Holder in the course of carrying out mining operations;

    28.2. The present and future obligations of the Tenement Holder in relation to the rehabilitation of land disturbed by mining operations.

    Explanatory note: The terms and conditions referred to in this paragraph will be imposed in the written notice given by the Minister. The Minister may include a term or condition that the bond may be increased if circumstances arise during the term of this Mineral Lease which increases the rehabilitation liability or increases the cost of civil or statutory liability.

Restatement of Fees

29. The Tenement Holder shall pay all fees imposed by the Act and Regulations from time to time.

Restatement of Renewal

30. This Mineral Lease shall be renewed in accordance with the Act.

Restatement of Surrender

31. The Tenement Holder may apply to surrender the Mining Tenement during its term in accordance with the Act and the Regulations.

Restatement of Forfeiture

32. The Mining Tenement is subject to the forfeiture provision of the Act being sections 70 and 85.

Restatement of Notices

33. Notices under the Act will be served in accordance with regulation 106 of the Regulations.

Restatement of Mining Register

34. Section 15A of the Act requires the Mining Registrar to keep a register of, amongst other things, mineral leases. Upon payment of the prescribed fee, the public may inspect the Mining Register.

Restatement of Mining Operations

35. As defined by section 6 of the Act "mining operations" means:

35.1. Operations carried out in the course of prospecting, exploring or mining for minerals; or

35.2. Without limiting paragraph 35.1, any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

35.3. On-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

35.4. Operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

35.5. Operations that are directly related to any operations under a preceding paragraph;

but does not include –

35.6. An investigation or survey under section 15 of the Act; or

35.7. Fossicking; or

35.8. The surface removal of loose rock material disturbed by agricultural operations.

36. This definition applies to operations that occur during all phases of the mine's life.

Restatement of requirement to notify of a change in status

37. The Tenement Holder must comply with regulation 98(1)(c) and 98(2).

    37.1. If the Tenement Holder is a natural person, he or she is required to notify the Mining Registrar of a declaration of bankruptcy within fourteen (14) days of the declaration.

    37.2. If the Tenement Holder is a company, it is required to notify the Mining Registrar of its being placed under official management, or in liquidation or receivership within fourteen (14) days of any of those events.

Restatement of Public Liability Insurance

38. The Tenement Holder must comply with regulation 90, which concerns public liability insurance.

Definitions

39. In this Tenement Document, the following words have the following meanings:

39.1. **"Act"** means the *Mining Act 1971* of South Australia;

39.2. **"Additional Terms and Conditions"** means the Additional Terms and Conditions authorised by section 34(4) of the Act and set out in the First and Second Schedules of this Tenement Document respectively;

39.3. **"AEP"** means Annual Exceedance Probability;

39.4. **"AMD"** means Acid and Metalliferous Drainage;

39.5. **"ANCOLD"** means Australian National Committee on Large Dams;

39.6. **"Approved PEPR"** means the Program for Environment Protection and Rehabilitation under Part 10A of the Act, which has received ministerial approval;

39.7. **"Business Day"** means any day that is not a Saturday, Sunday or a public holiday in South Australia;

39.8. **"Completion"** means the Land has been rehabilitated to an extent that the Minister could approve an application for surrender of the Mining Tenement on the basis that the Tenement Holder has complied with sub-regulation 45(1) of the Regulations and there is no obstacle under sub-regulation 45(3) of the Regulations;

39.9. **"Contamination"** and **"contaminated"** mean the presence of chemical substances in concentrations greater than the background concentrations (if any), where the presence of the chemical substances in the greater concentrations has resulted in:

39.9.1. Actual or potential harm to the health or safety of human beings that is not trivial, or

39.9.2. Actual or potential harm to water that is not trivial, or

39.9.3. Other actual or potential environmental harm that is not trivial;

39.10. **"CTP"** means Concentrate Treatment Plant;

39.11. **"DRP"** means Decommissioning and Rehabilitation Plan;

39.12. **"Environmental Values"** means the environmental values recognised in the South Australian Environment Protection (Water Quality) Policy 2015 and the '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Paper No 4*';

39.13. **"EPA"** means the Environment Protection Authority under the *Environment Protection Act 1993* of South Australia;

39.14. **"ICP"** means Iron Calcium Precipitate, a waste product from the CTP;

39.15. **"mineral lease"** means the Mining Tenement granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

39.16. **"Mineral(s)"** means the Mineral(s) referred to on the front page of this Mineral Lease and in the First Schedule;

39.17. **"Mining Tenement"** or **"Tenement"** means the mineral lease granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

39.18. **"Minister"** means the Minister for Mineral Resources and Energy (or any substituted Minister);

39.19. **"NAF"** means non-acid forming material;

39.20. **"PAF"** means potentially acid forming material;

39.21. **"PEPR"** means Program for Environment Protection and Rehabilitation;

39.22. **"PMP"** means Probable Maximum Precipitation;

39.23. **"Proposed PEPR"** means the document required by regulation 65(10) of the Regulations to be submitted for ministerial approval within twelve (12) months of the date of grant of the Mining Tenement;

39.24. **"QA/QC"** means Quality Assurance and Quality Control

39.25. **"Regulations"** means the Mining Regulations 2011 of South Australia;

39.26. **"Significant Environmental Benefit"** means a benefit provided as a requirement of authorisation to clear native vegetation under the Native Vegetation Regulations 2003.

39.27. **"site"** means the Land;

39.28. **"TDS"** means Total Dissolved Solids;

39.29. **"Tenement Document"** means this document;

39.30. **"Tenement Holder"** means the person, or persons, to whom this Mining Tenement is granted and includes:

39.30.1. If the Tenement Holder is a natural person the executors, administrators and assigns of that person;

39.30.2. If the Tenement Holder is a body corporate the successors, administrators or permitted assigns thereof.

Explanatory note: "The Tenement Holder" has the same meaning as "the mining operator" as defined by section 6 of the Act.

39.31. **"the Land"** means the land over which this Mining Tenement is granted and which is described in paragraphs 5 and 6 of this Tenement Document and in the Third Schedule of this Tenement Document;

39.32. **"the Program"** means the Approved PEPR as defined above;

39.33. **"third party land users"** means the owner of land (as defined by the Act) and any persons lawfully occupying land with the licence of the owner, or the consent of the owner and **"third party land use"** has a corresponding meaning;

39.34. **"TSF"** means Tailing Storage Facility;

39.35. **"Weeds"** means any invasive plant that threatens native vegetation in the local area or any species recognised as invasive in South Australia.

Interpretation

40. For the purposes of interpreting this Tenement Document the following will apply:

40.1. Unless otherwise stated, any term which is used in this Tenement Document which has a specific meaning in the Act or the Regulations, has that same meaning in this Tenement Document;

40.2. The masculine shall include the feminine, words importing persons shall include corporations, and the singular shall include the plural when the context or circumstances require and unless inconsistent with or repugnant to the context the following words shall have the meanings set opposite to them respectively –

40.2.1. "amendment" includes an addition, excision or substitution;

40.2.2. "the Land" includes any part thereof; and

40.2.3. "the term" includes any renewal or extension thereof.

40.3. If the Mining Tenement is granted to more than one person, all of the persons to whom it is granted are all jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document, including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

40.4. If, by virtue of a dealing under section 83 of the Act, the Mining Tenement comes to be held by more than one person, they will all be jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

40.5. If any act pursuant to the Tenement Document would otherwise be required to be done on a day which is not a Business Day, then that act may be done on the next Business Day;

40.6. To the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, the Act or Regulations, the Act or Regulations shall prevail;

40.7. Subject to the transitional provisions in any amendment to the Act or the Regulations, all provisions referred to in this Tenement Document shall be taken to include any such amendment;

40.8. Subject to the transitional provisions in any amendment to the Act or the Regulations, to the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, any amendments to the Act or Regulations, the amended Act or Regulations shall prevail;

40.9. Footnotes and Explanatory notes do not form part of this Tenement Document;

40.10. The contents page does not form part of this Tenement Document;

40.11. The front page and all of the Schedules form part of this Tenement Document.

Executed by the Tenement Holders in accordance with regulation 41

SIGNED by OZM Carrapateena Pty Ltd (ACN 007 756 443))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	MICHELLE POLE.
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18.	05/01/18.
Date	Date

SIGNED by OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole.
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18.	05/01/18.
Date	Date

Entered in the Mining Register on 3 January 2018
In accordance with section 15A(1)(c) of the Act.

Signed by .....
Junesse Martin
Mining Registrar

09/01/2018.
Date

FIRST SCHEDULE

ADDITIONAL TERMS

Explanatory note: A term is a clause that gives a right to a Mining Tenement.

Authorised Mining Operations

1. The grant of the Mining Tenement authorises mining operations (only) for the recovery of Copper, Gold and Silver.

2. The grant of the Mining Tenement authorises mining operations (only) that are consistent with the mining operations described in the Mining Proposal document dated 26 May 2017 and subsequent Response Documents dated 22 September 2017, 6 October 2017, 21 November 2017 and 29 November 2017.

SECOND SCHEDULE

ADDITIONAL CONDITIONS

Explanatory note: A condition is a clause that imposes a restriction on a Mining Tenement.

INDEX TO SECOND SCHEDULE (ADDITIONAL CONDITIONS) **Condition No.**

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Aboriginal Heritage

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Tailings Storage Facility (TSF)

2. The Tenement Holder must ensure that post Completion, all final mine landforms (including the TSF) will be chemically and physically stable in the long term.
3. Following completion of detailed design of the TSF and Decant Dam, the following documentation for the TSF and Decant Dam must be developed and maintained:
   3.1. Construction documentation;

3.2. Design drawings and quantity schedule;

3.3. Technical specifications;

3.4. Construction Quality Assurance (CQA) Manual;

3.5. Operations, Maintenance and Surveillance (OMS) Manual; and

3.6. Dam Safety Emergency Plan (DSEP).

Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Documents.

Tailings Storage Facility (TSF) Audits

4. The TSF and Decant Dam construction, operation and closure must be audited against (i) the design, design criteria and plans that have been adopted for the TSF and Decant Dam construction, operation and closure, (ii) all of the documentation listed in Second Schedule Condition 3 and (iii) the most recent version of the ANCOLD Tailings Dam Guideline:

4.1. for the Stage 1 TSF and Decant Dam embankment foundation preparation and embankment construction; and

4.2. for each subsequent stage of TSF and Decant Dam embankment foundation preparation and embankment construction; and

4.3. on a three (3) monthly basis during Stages 1 and 2 of TSF and Decant Dam operations or at a frequency as the Director of Mines (or other authorised officer) may specify by notice in writing; and

4.4. on a six (6) monthly basis during Stages 3, 4, 5 and 6 (and any subsequent stages) of TSF and Decant Dam operations or at a frequency as the Director of Mines (or other authorised officer) may specify by notice in writing; and

4.5. after the final discharge of tailings into the TSF and prior to commencement of final rehabilitation, closure and decommissioning of the TSF and Decant Dam; and

4.6. after the final TSF and Decant Dam rehabilitation, closure and decommissioning works have been completed.

5. The expert must prepare reports of the findings of each audit.

6. The initial expert report for the audit of the Stage 1 TSF and Decant Dam foundation preparation and embankment construction must be provided to the Director of Mines (or other authorised officer) prior to the placement of tailings and waste into the TSF.

7. The expert report for the audit which occurs after the final discharge of tailings into the TSF must be provided to the Director of Mines (or other authorised officer) prior to the commencement of final rehabilitation of the TSF and Decant Dam.

8. All other expert reports must be provided to the Director of Mines (or other authorised officer) within forty-five (45) days or such longer period approved by the Director of Mines (or other authorised officer) of completion of the audit.

9. All expert reports will be made publically available.

10. The expert reports for the audits of Stage 1 and each subsequent stage of TSF embankment construction must address the following matters (but not limited to):

    10.1. Demonstrate that sufficient freeboard has been achieved to ensure flood storage capacity for a 1-in-100 AEP rainfall event including wave freeboards (1 in 10 AEP winds) and contingency freeboard of 0.5 m;

    10.2. Demonstrate emergency spillways for each stage of the operation have the capacity for flow resulting from a 1-in-1000 AEP critical duration event including wave freeboard;

    10.3. Demonstrate that tailings properties in operations are consistent with the adopted tailings properties, including density and strength as specified in the detailed final design;

        10.3.1. Should the tailings density or strength be inconsistent, undertake an assessment of the potential impact on the TSF (including, but not limited to, TSF storage capacity) and propose any remediation to the design if deemed necessary;

    10.4. Liquefaction assessment based on in-situ test work of the tailings prior to upstream raises;

    10.5. A seismic hazard assessment (SHA) to provide site-specific peak ground acceleration (PGA) parameters for stability assessments;

    10.6. The geometry of upstream raises and foundation treatment has been confirmed prior to each upstream raise;

    10.7. The suitability and compatibility of the various embankment fill materials has been assessed; and

    10.8. Assessment of all of the documentation listed in Second Schedule Condition 3 to ensure that the content of the documents is appropriate for the next stage of TSF embankment construction.

Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.

11. The expert report for the audit which occurs after the final TSF and Decant Dam rehabilitation, closure and decommissioning works have been completed must address the following matters (but not limited to):

    11.1. Spillway designed for the seventy-two (72) hour PMP critical duration event and in accordance with ANCOLD;

    11.2. Decant system is decommissioned in accordance with the design; and

    11.3. Reshaping of the TSF embankment in accordance with the design to provide a profile that is resistant to erosion.

    Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.

12. The audits required by Second Schedule Conditions 4.1, 4.2, 4.5, 4.6 and associated reports required by Second Schedule Condition 5 must be conducted and provided by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer).

13. The audits required by Second Schedule Conditions 4.3, 4.4 and associated reports required by Second Schedule Condition 5 must be conducted and provided by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) at least once for each twelve (12) month period.

14. An audit required by Second Schedule Conditions 4.3, 4.4 and associated reports required by Second Schedule Condition 5 may be conducted and provided by a suitably qualified Tenement Holder employee previously approved by the Director of Mines (or other authorised officer). To apply for approval the Tenement Holder must:

    14.1. Apply in writing; and

    14.2. Provide the employee's Curriculum Vitae showing their academic qualifications, publications (if any) and practical experience.

    Explanatory note: The Department of the Premier and Cabinet is seeking to ensure that if the auditing and reporting person is an employee of the Tenement Holder that they are suitably qualified and that an independent audit is conducted at least once for each twelve (12) month period.

Concentrate Treatment Plant (CTP)

15. The Tenement Holder must during operations ensure that any CTP constructed on the Land is equipped with scrubbers which are designed appropriately to prevent acid mist emissions.

Concentrate Transport

16. The Tenement Holder must during operations ensure that copper concentrate is transported in fit for purpose sealed containers to prevent copper concentrate release to the environment.

Waste

17. The Tenement Holder must ensure that all commercial or industrial waste (which does not include CTP process residue, tailings and waste rock) is disposed of in an EPA licensed facility.

Removal of Infrastructure

18. The Tenement Holder must ensure that all mining related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.

Transparency

19. The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.

Notification of cessation of operations

20. Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 22.

Decommissioning and Rehabilitation Plan (DRP)

21. The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Conditions 22 and 23 when decommissioning or rehabilitating the Mining Tenement.

22. Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 20, and that DRP must:

    22.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;

    22.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).

23. If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:

    23.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 22; and/or

    23.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.

Operating Protocol

24. The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines (or other authorised officer)) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:

    24.1. interaction with landowner operations;

    24.2. emergency procedures;

    24.3. communications and issue management processes;

    24.4. land management;

    24.5. dispute resolution;

24.6. ongoing communication about the Tenement Holder's operations;

24.7. receiving and considering feedback;

24.8. safety procedures;

24.9. access protocols; and

24.10. any matters identified by the Director of Mines (or other authorised officer) in writing.

25. The Tenement Holder must:

25.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and

25.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.

Compliance with regulation 98(1)

26. A notification required by regulation 98(1) must be in writing.

Plains Mouse

27. For the purposes of this Additional Condition:

27.1. 'Plains Mouse' means Pseudomys australis;

27.2. 'existing population' means an area of suitable habitat for the Plains Mouse where the species has been observed/recorded;

27.3. 'existing habitat' means an area of suitable habitat for the Plains Mouse;

27.4. 'suitable habitat' means large open gypseous cracking clay areas associated with minor drainage features, and depressions within gibber stony plains (National Recovery Plan for the Plains Mouse Pseudomys australis 2012).

27.5. To compensate for the residual impact from mining operations on the existing Plains Mouse habitat, the Tenement Holder must provide an environmental offset that:

27.5.1. contains suitable habitat for the Plains Mouse or is known to have an existing population of Plains Mouse;

27.5.2. contains no less than 750ha of suitable habitat to offset the permanent loss of the existing Plains Mouse habitat;

27.5.3. the quality of the suitable habitat must be at least equal to that of the quality of the existing habitat that will be permanently lost;

27.5.4. is connected to existing habitat of Plains Mouse by biodiversity corridors to ensure the Plains Mouse can utilise the environmental offset;

27.5.5. is a direct on-ground offset located on land using an appropriate legal mechanism (to the satisfaction of the Director of Mines (or other authorised officer)) that ensures the environmental offset is secured for conservation purposes for the life of the Mining Tenement or longer;

27.5.6. is located as close as practical to the existing habitat that will be permanently lost;

27.5.7. the implementation of which is commenced either before, or at the same point in time as, the impact to the Plains Mouse habitat arising from the mining operations; and

27.5.8. is managed for the life of the Mining Tenement or longer to maintain or improve the existing suitable habitat quality.

28. To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:

28.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;

28.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;

28.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and

28.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions.

Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.

Other Legislation

29. The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the:

29.1. *Environment Protection and Biodiversity Conservation Act 1999;*

29.2. *Development Act 1993;*

29.3. *Planning, Development and Infrastructure Act 2016;*

29.4. *Dangerous Substances Act 1979;*

29.5. *National Parks and Wildlife Act 1972;*

29.6. *Natural Resources Management Act 2004;*

29.7. *Public and Environmental Health Act 1987;*

29.8. *Aboriginal Heritage Act 1988;*

29.9. *Heritage Places Act 1993;*

29.10. *Work Health and Safety Act 2012;*

29.11. *Environment Protection Act 1993;*

29.12. *Radiation Protection and Control Act 1982;*

29.13. *Native Vegetation Act 1991;*

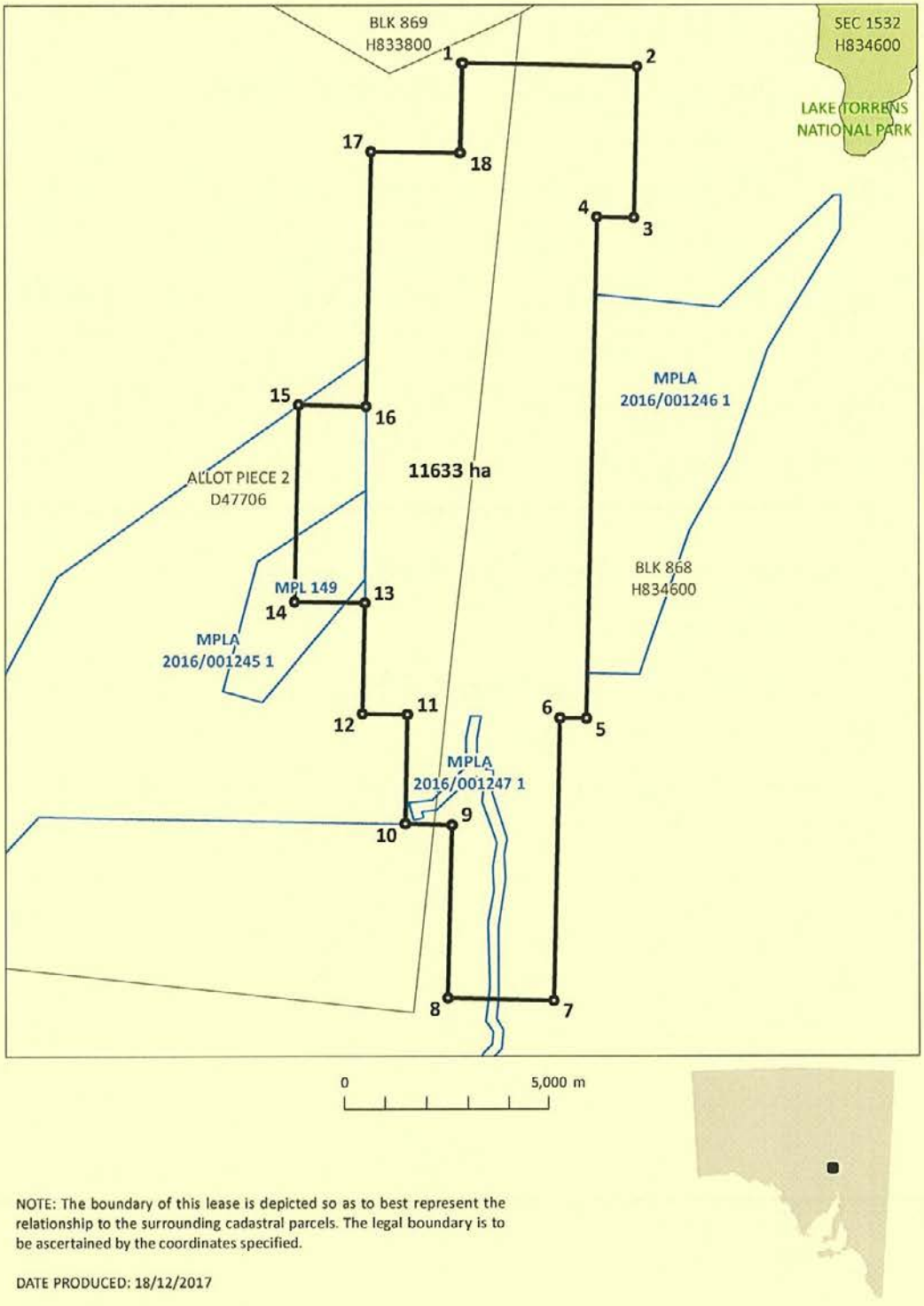
29.14. *Mines and Works Inspection Act 1920;*

29.15. *Road Traffic Act 1961; and*

29.16. *Wilderness Protection Act 1992.*

THIRD SCHEDULE

MAP



NOTE: The boundary of this lease is depicted so as to best represent the relationship to the surrounding cadastral parcels. The legal boundary is to be ascertained by the coordinates specified.

DATE PRODUCED: 18/12/2017

THIRD SCHEDULE

DESCRIPTION OF AREAS

All that part of the State of South Australia, bounded by a line joining the points of coordinates set out in the following table:

Map Grid of Australia 1994 Zone 53

Point	Easting		Northing	
1	737605.63	mE	6547494.97	mN
2	741925.70	mE	6547396.68	mN
3	741840.45	mE	6543684.64	mN
4	740924.39	mE	6543705.65	mN
5	740643.15	mE	6531439.16	mN
6	739989.59	mE	6531454.15	mN
7	739830.87	mE	6524530.05	mN
8	737231.01	mE	6524589.38	mN
9	737327.26	mE	6528832.87	mN
10	736197.27	mE	6528858.43	mN
11	736257.73	mE	6531538.95	mN
12	735153.27	mE	6531563.79	mN
13	735213.82	mE	6534263.10	mN
14	733481.47	mE	6534301.80	mN
15	733588.58	mE	6539116.70	mN
16	735256.32	mE	6539079.49	mN
17	735396.14	mE	6545329.14	mN
18	737555.69	mE	6545280.65	mN

Area: 11,633 ha

Based on information provided by the applicant.

FOURTH SCHEDULE

PROCESS FOR SUSPENSION

Issuance of Suspension Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to suspend the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder thirty (30) Business Days from the date of the written notice to show cause why the grant of the Mining Tenement should not be suspended ("the Suspension Show Cause Notice").

Minister's action if Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister may suspend the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if Tenement Holder does respond

3. If the Tenement Holder responds to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to suspend the grant of the Mining Tenement (in accordance with the process outlined below).

Written Notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the Minister's decision;

   4.1. if the decision is to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Suspended".

   4.2. if the decision is to not to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Not Suspended".

5. A Notice of Decision: Not Suspended, may contain any information that the Minister considers relevant.

6. A Notice of Decision: Suspended, shall:

6.1. Specify the reason for suspension;

6.2. specify the period of suspension;

6.3. specify the action (if any) the Tenement Holder may be required to take for the Minister to consider revoking the suspension, and the time frame for taking that action; and

6.4. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 41(3) of the Act.

Minister's action if Tenement Holder takes action as specified in Notice of Decision

7. If the Tenement Holder takes the action specified by the Minister under paragraph 6.3, the Minister will consider revoking the suspension.

8. If the Minister revokes the suspension, the Minister will, within a reasonable time write to the Tenement Holder informing the Tenement Holder of the revocation.

Minister's action if Tenement Holder appeals

9. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising the discretion under section 41(4) of the Act, to stay the operation of the suspension until the appeal is finally disposed of.

10. If the Environment, Resources and Development Court, or a court of further appeal finally determines that it is satisfied that there is no proper ground for the suspension, and so orders, the Minister will reinstate the grant of the Mining Tenement in accordance with section 41(5) of the Act.

The Mining Register

11. All of the stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

11.1. A memorandum Notice of Decision: Suspended;

11.2. A memorandum Notice of Decision: Not Suspended;

11.3. A memorandum of Minister's Decision to Revoke the Suspension;

11.4. A memorandum of Appeal;

11.5. A memorandum of Stay of Suspension by the Minister;

11.6. Memoranda of all of the courts' orders (whether the Environment Resources and Development Court or subsequent appeal courts).

FIFTH SCHEDULE

PROCESS FOR CANCELLATION

Issuance of Cancellation Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to cancel the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. give the Tenement Holder sixty (60) Business Days from the date of written notice to show cause why the grant of the Mining Tenement should not be cancelled ("the Cancellation Show Cause Notice").

Minister's action if the Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister may cancel the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if the Tenement Holder does respond

3. If the Tenement Holder responds to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to cancel the grant of the Mining Tenement (in accordance with the process outlined below).

Written notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the decision.

   4.1. If the decision is to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Cancelled".

   4.2. If the decision is not to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Not Cancelled".

5. A Notice of Decision: Not Cancelled may contain any information that the Minister considers relevant.

6. A Notice of Decision: Cancelled shall:

   6.1. Specify the reason for cancellation;

   6.2. specify the date from which cancellation is effective; and

   6.3. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 41(3) of the Act.

Minister's action if Tenement Holder appeals

7. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising his discretion under section 41(4) of the Act, to stay the operation of the cancellation until the appeal is finally disposed of.

8. If the Environment, Resources and Development Court, or a court of further appeal finally determines that it is satisfied that there is no proper ground for the cancellation, and so orders, and the cancellation has not been stayed by the Minister under section 41(4) of the Act, or by order of the Environment, resources and Development Court, the Minister will reinstate the grant of the Mining Tenement in accordance with section 41(5) of the Act.

The Mining Register

9. All stages in the cancellation process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

   9.1. A memorandum Notice of Decision: Cancelled;

   9.2. A memorandum of Notice of Decision: Not Cancelled;

   9.3. A memorandum of Minister's Decision to Revoke the Cancellation;

   9.4. A memorandum of Appeal;

   9.5. A memorandum of Stay of Cancellation by the Minister;

   9.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

SIXTH SCHEDULE

ENVIRONMENTAL OUTCOMES

AND ASSOCIATED CRITERIA AND STRATEGIES PURSUANT TO REGULATION 65 OF THE MINING REGULATIONS 2011

Explanatory note: The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act. The Sixth Schedule may also specify requirements for strategies and criteria relevant to the outcomes set out in that Schedule.

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Aboriginal Heritage Outcome

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Public Safety Outcomes

2. The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.
3. The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining related activities are as low as reasonably practicable.

Public Nuisance Outcome

4. The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining related traffic.

Traffic Outcomes

5. The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.

Weeds and Pests Outcome

6. The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities.

Land Use and Property Outcomes

7. The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).
8. Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.
9. The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.

Land and Soil Outcome

10. The Tenement Holder must, ensure that:
    10.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining related activities; and
    10.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining related activities.

Native Vegetation Outcome

11. The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation.

Native Vegetation Criteria

12. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Native Vegetation Outcome in Sixth Schedule Clause 11:
    12.1. Where baseline native vegetation condition (abundance and diversity) is required as a component of the measurement criteria, baseline native vegetation surveys must be undertaken prior to the impact of mining operations or mining related activities on the existing environment.

Native Fauna Outcome

13. The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.

Air Quality Outcome

14. The Tenement Holder must during construction, operation and post Completion ensure no adverse change to the air quality environment as a result of particulate emissions and/or dust generated by mining operations or mining related activities.

Air Quality Strategies

15. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Air Quality Outcome in Sixth Schedule Clause 14:

    15.1. Develop and implement a future works program that investigates the requirement (or otherwise) for a cover system for the TSF surface.

    15.2. The future works program must ensure that the investigation into the requirement (or otherwise) for a cover system is completed in a timely manner.

Radiation Outcome

16. The Tenement Holder, must during construction, operation and post Completion ensure no public health or environmental impacts from radionuclides (including radon) as a result of mining operations or mining related activities.

Surface Water Outcome

17. The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining related activities.

Surface Water Strategies – Model

18. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:

    18.1. Establish a program for the ongoing review and calibration of the surface water model using data obtained from ongoing monitoring to address any assumptions and uncertainty within the model. Any significant variations in surface water flow measured during operations from those predicted by the models must result in a review of the effectiveness of surface water strategies to demonstrate that the outcomes are achievable.

Surface Water Strategies – Contamination, Erosion and Sediments

19. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:

    19.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining related activities leaves the Land.

    19.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining related activities is effectively managed and controlled.

    19.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining related activities is effectively managed and controlled.

    19.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.

    19.5. Develop a program to undertake erosion field studies, including detailed surveys of the embankment size and shape, together with measurement of runoff and sediment load from the downstream embankment surface and isolated areas of tailings beach, to validate outputs of the landform evolution modelling (OZ Minerals Response Document dated 22 September 2017 page 75).

    19.6. Adopt effective strategies to prevent the exposure, puncturing and/or tearing of any geotextile liners used to contain tailings at the TSF embankment, for example, ensure that the design of the TSF embankment includes a protective layer between the geotextile liner and the rock armouring layer.

19.7. Adopt an effective thickness and construction methodology for rock armour which is used for erosion control for rehabilitation and closure. The thickness and construction methodology should be validated through testwork and trials.

19.8. The design of the final landform of the TSF embankment must ensure that re-profiling of the embankment does not adversely impact on the effectiveness of any geotextile liners which are required for the achievement of the outcome.

19.9. A program for determining the erodibility of waste rock to ensure that waste rock of an appropriate erodibility is used on the external batters of final landforms. The results of the program are to inform the material selection and design of the final landforms.

Surface Water Strategies – TSF

20. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:

20.1. All future works listed in Section 7 of Appendix F2 of the Mining Proposal ("Independent Tailings Storage Facility Design Review" (ATC Williams)).

20.2. All future works listed in Section 14 of Appendix B of the Response Document dated 22 September 2017 ("TSF Design Report for the Mining Lease Proposal", Updated September 2017, (Golders)).

20.3. The recommendation in Section 7 of Appendix C of the Response Document dated 22 September 2017 (ATC Williams) which states, optimising the thickness and extent of the clay liner and depth of the interception trench downstream of the TSF embankment will need to be provided as part of detailed design.

20.4. The conclusions and recommendations in Section 6 of Appendix D of the Response Document dated 22 September 2017 (SRK), including (but not limited to):

20.4.1. The Landform Evolution Model should be calibrated with measured parameters to improve model predictions; and

20.4.2. If mining operations are suspended prior to completion of the TSF, the TSF will need to be upgraded to prevent the embankment overtopping during large storm events. The effect of this strategy on the maximum rehabilitation liability must be considered.

20.5. Review the input concentrations for elements and metals used in the solute transport geochemistry model (Mining Proposal Appendix C4 – Table 4-1). Based on the review, provide an updated or revised solute transport geochemistry model. If required, adopt revised strategies.

20.6. Undertake the following works to demonstrate that the upstream methodology for the construction of the Stage 3 TSF upstream embankment will be effective in achieving all relevant environmental outcomes:

20.6.1. Conduct settling tests on a representative sample of the fine fraction of the tailings material (particle size less than 30 microns);

20.6.2. Conduct drying tests to determine whether the expected maximum required drying time of twenty-six (26) days is appropriate or not. Such drying tests must ensure the sample tested is thick enough so that it does not unrealistically estimate the required drying time; and

20.6.3. Based on the results of the test work, demonstrate that the upstream construction methodology for TSF embankment lifts will be effective.

20.7. Clarify the design details of the geomembrane liner on the upstream face of the Stage 1 embankment, and demonstrate that appropriate stability calculations have been done. Ensure that the geomembrane liner will be protected during installation of the decant facility.

20.8. Demonstrate that the TSF decant water outfall pipe will be stable under the likely maximum vertical stress resulting from being buried by tailings material.

20.9. Develop a process to ensure that the inclined decant tower is appropriately decommissioned prior to Stage 3 of the TSF in order to ensure that it does not leak or become structurally unsound.

20.10. Review the conclusion (from the Mining Proposal and Response Documents) that the decant pond will take up to three years to recede after an extreme rainfall event (i.e. a seventy-two (72) hour, PMP rainfall event occurring at the end of the 95% wet season). Evaluate whether the absorption capacity of the tailings has been reasonably accounted for. Based on the review, if it is confirmed that the decant pond will take a number of years to recede following an extreme rainfall event, (i) assess if the TSF freeboard will remain acceptable should another high intensity rainfall event occur during the three (3) year period, and (ii) assess the potential impact on stability of an elevated phreatic surface resulting from a temporarily large decant pond.

20.11. Demonstrate that the drainage and decant system would function as designed following an extreme rainfall event should it occur early in the life of the TSF operation (e.g. in the first year).

20.12. Review the TSF dam break study with consideration of whether the initial release (and thus initial hydrograph) could be water-only, followed by release of non-Newtonian tailings.

20.13. Adopt appropriate strategies to ensure effective operations of the tailings pipelines (as committed to in the Mining Proposal and Response Documents) including (but not limited to):

20.13.1. Tailings pipelines are to be inspected for condition, integrity, signs of wear and leaks at an appropriate frequency;

20.13.2. Alarmed pressure indicators are to be installed on the tailings pipelines and monitored continuously; and

20.13.3. Remote isolation valves are to be installed on the tailings pipelines to isolate sections of the pipelines if required.

20.14. The minimum freeboard height and maximum supernatant pond dimensions for the TSF and Decant Dam must be specified.

20.15. The maximum dimensions of the supernatant pond must be consistent with the subaerial method of tailings deposition.

20.16. Cease deposition of tailings to the TSF if the specified limits for freeboard height or supernatant pond dimensions are exceeded and report this exceedance to the Director of Mines (or other authorised officer) within twenty-four (24) hours. Freeboard is defined as the difference in height between the level of the supernatant pond and the lowest point of the tailings dam embankment or spillway.

20.17. Ensure that the TSF final landforms will be chemically and physically stable post Completion.

20.18. Provide strategies to ensure that the installed drainage (toe drain) on the upstream side of the TSF embankment is protected from blinding and/or clogging during initial deposition of tailings.

20.19. Develop strategies to ensure that the compacted clay liner proposed for watercourses within the TSF footprint is effective in mitigating seepage. Consider strategies to ensure compacted clay seals do not dry out and crack prior to being covered with tails, such as inspections and a protective layer to be applied over the compacted clay seals.

20.20. Review the size of the lined decant cell in the Decant Dam to ensure that the lined area is of an appropriate size to manage seepage.

20.21. Review the seepage assessment and modelling for the Decant Dam. As a result of the review update the strategies for the management of seepage (if required).

Surface Water Strategies – Acid and Metalliferous Drainage

21. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:

21.1. The recommendations in Section 7 of Appendix E of the Response Document dated 22 September 2017 ("Geochemical Characterisation of Tailings and ICP" (EGI)).

21.2. Ensure that no stockpiles that include PAF material are left on the surface of the Land post Completion.

21.3. Strategies to ensure that stockpiles that include PAF material are appropriately managed should the operation enter a phase of care and maintenance.

21.4. Develop and implement an AMD management plan that includes the following, but not limited to:

21.4.1. Develop a program for confirming the NAF classification and long-term leach (kinetic) testing results of the tailings under field conditions;

21.4.2. Develop a program to investigate the potential for metalliferous drainage to be generated by NAF material which contains sulphides;

21.4.3. Refine the sulphur cut-off grade for PAF material through further testing of waste units;

21.4.4. Develop an ore, waste rock and sulphur block model;

21.4.5. Develop the block model to include the sulphur distribution of all waste and ore to be mined for the purpose of determining the distribution and estimating the volume of NAF and PAF using the sulphur cut-off grade;

21.4.6. Regular updating of the block model with new geological and sulfur assay data in the course of operations and aligning to the materials handling program;

21.4.7. Develop a QA/QC process for validation of Acid Base Accounting (ABA) characteristics;

21.4.8. Develop a QA/QC process for the waste rock block model and testing to ensure the correct rock is placed in the correct destination;

21.4.9. Segregation of PAF waste rock, NAF waste rock, and waste rock with the potential for metalliferous drainage (based on a classification process) and a mining schedule for each;

21.4.10. Ensure stockpiles containing PAF material are appropriately located;

21.4.11. Develop appropriate stockpile management strategies;

21.4.12. Confirm final end uses for waste rock and marginal ore based on geochemical classification; and

21.4.13. Develop strategies that prevent AMD from being generated from the TSF embankment and decant causeway, such as avoiding the use of PAF material and marginal ore for construction of the TSF embankment and decant causeway.

Surface Water Leading Indicator Criteria – TSF

22. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(e) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:

22.1. Leading indicator criteria in relation to the outcomes relevant to the TSF must include, as a minimum, the measurement of appropriate process solutions and tailings supernatant solutions.

Groundwater Outcomes

23. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to the Environmental Values of the groundwater within the shallow perched aquifer within the Land as a result of chemicals or hydrocarbons from mining operations or mining related activities.

24. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quality within aquifers outside of the TSF seepage zone of influence area delineated by the groundwater model as a result of mining operations or mining related activities.

25. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining related activities.

Groundwater Strategies

26. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Ground Water Outcomes in Sixth Schedule Clauses 23, 24 and 25:

    26.1. Provide a groundwater solute transport, geochemistry and hydrogeological model that delineates the predicted TSF seepage zone of influence area within the groundwater aquifers.

    26.2. Establish a program for the ongoing calibration of the groundwater solute transport, geochemistry and hydrogeological models using data obtained from ongoing monitoring to address any assumptions and uncertainty within the models.

    26.3. Provide a transient groundwater model that delineates the predicted extent of groundwater drawdown within the groundwater aquifers.

    26.4. Establish a program for the ongoing calibration of the transient groundwater model using data obtained from ongoing groundwater monitoring.

    26.5. Provide a calibrated transient groundwater model within an appropriate time frame.

Groundwater Criteria

27. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Groundwater Quality Outcome in Sixth Schedule Clause 24:

    27.1. Establish compliance groundwater monitoring bores that are at appropriate locations and of sufficient density and depth to measure the movement of TSF seepage and groundwater.

    27.2. Establish compliance groundwater monitoring bores that are at appropriate locations and of sufficient density and depth to measure the groundwater quality within and outside of the TSF seepage zone of influence area delineated by the groundwater model.

Appendix A2.
MPL 149 Airstrip, Workers' Accommodation Village and Ancillary Infrastructure

Government of South Australia

Mining Act 1971

TENEMENT DOCUMENT

MISCELLANEOUS PURPOSES LICENCE

TENEMENT HOLDER	OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255)
MISCELLANEOUS PURPOSES LICENCE NUMBER	149
PURPOSE	Airstrip, workers' accommodation village, access road and ancillary infrastructure.
COMMENCEMENT DATE	5 July 2017
TERM OF MINING TENEMENT	Twenty-one (21) Years
EXPIRY DATE	4 July 2038
AREA OF MINING TENEMENT	910 hectares

DATE BY WHICH THE PROPOSED PEPR MUST BE SUBMITTED: 4 July 2018

RevenueSA - Stamp Duty - ABN 19 040 349 865 ©
RevNetID/PRA Bundle No.: EX1379654 43
Orig/~~Copy~~ 1 of/~~with~~ 1 copies
Consideration/Value/Security: $ 0
SA Proportion (if applicable): $ 0
SD: $ 0 LTO Fees: $ 0
Int: $ 0 Pen/Add Tax: $ 0
Signature: Date: 20/7/17

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Details of Grant of a Mining Tenement

1. On 5 July 2017, pursuant to Part 8 of the Act, the Minister made a statutory grant of a miscellaneous purposes licence (the Mining Tenement) described in this Tenement Document.

2. The Mining Tenement is granted:

   2.1. To OZM Minerals Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255);

   2.2. For the purpose of constructing an airstrip, accommodation village, access road and ancillary infrastructure.

3. The Mining Tenement is numbered MPL149.

4. The Mining Tenement is:

   4.1. Subject to the Terms and Conditions prescribed by the Act and Regulations and specified in this Tenement Document; and

   4.2. Subject to the Additional Terms and Conditions specified in the First and Second Schedules (respectively) of this Tenement Document.

Terms and conditions required by the Act to be specified in the Tenement Document

Description of the Land

5. The Mining Tenement is granted over an area of 910 hectares and is located in the Pernatty area approximately 62 km east-south-east of Woomera.

6. The location of the Mining Tenement is more specifically defined in the map and coordinates specified in the Third Schedule of this Tenement Document.

Term, Commencement and Expiration

7. The Mining Tenement is granted for the term of 21 years. The term of the Mining Tenement commenced on 5 July 2017, and, unless it is earlier renewed, surrendered or cancelled, the Mining Tenement will cease on 4 July 2038.

Rental

8. The Tenement Holder shall pay, by way of rental, such sums as may be prescribed and in accordance with section 52(6), (7), (8) and (9) of the Act and regulation 54 of the Regulations.

Compensation

9. The Minister may, at any time, require the Tenement Holder to pay to any person an amount of compensation stipulated by the Minister, to which that person is, in the opinion of the Minister, entitled in consequence of mining operations in pursuance of the rights granted and the obligations imposed by the grant of the Mining Tenement.

Suspension and Cancellation: Stipulation of Process

10. Pursuant to subsection 56(1) of the Act, the Minister may suspend or cancel the Mining Tenement if the Tenement Holder contravenes or fails to comply with a term or condition of this Tenement Document or a provision of the Act (which includes the Regulations).

11. Pursuant to subsection 56(2) of the Act, the Minister may stipulate in the tenement document a process for suspension or cancellation that must be followed before the powers in subsection 56(1) may be exercised.

12. The process for suspension of the Mining Tenement shall be as stipulated in the Fourth Schedule of this Tenement Document.

13. The process for cancellation of the Mining Tenement shall be as stipulated in the Fifth Schedule of this Tenement Document.

Environmental outcomes specified pursuant to Regulation 65 of the Regulations

14. The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act.

Explanatory note: The Sixth Schedule may also contain strategies and criteria which the Department has formed the view would address the outcomes set out in that Schedule.

Restatement of selected provisions from the Act

Explanation of Restatements

15. All of the restatements in this portion of this Tenement Document are included for guidance only and do not replace the substantive provisions of the Act or the Regulations.

16. If any restatement is inconsistent with the substantive provisions of the Act or the Regulations, the restatement will be invalid and the substantive provision of the Act or the Regulations will prevail and the Tenement Holder is required to comply with the substantive provision of the Act or the Regulations.

17. The Tenement Holder is still required to comply with any provision of the Act or Regulations that is not restated in this Tenement Document.

Restatement of obligations imposed on Tenement Holder: Program for environment protection and rehabilitation

18. The Tenement Holder must not carry out mining operations unless there is an approved program for environment protection and rehabilitation (an Approved PEPR).

19. A Proposed PEPR will only be approved when it complies with the requirements of Part 10A of the Act and the Regulations.

20. To comply with Part 10A of the Act, the Proposed PEPR must:

    20.1. Contain the information specified in section 70B(2) of the Act and regulation 65(2), (5), (6) of the Regulations and determinations made by the Minister under regulation 65(7) of the Regulations (if any);

    20.2. Comply with any applicable conditions specified in this Tenement Document (if any);

    20.3. Address any relevant environmental outcomes listed in the Sixth Schedule of this Tenement Document.

    Explanatory note: At the date of grant, the determinations are available at: www.minerals.statedevelopment.sa.gov.au/publications_and_information/ministerial_determinations

21. In accordance with regulation 65(10) of the Regulations, the Tenement Holder must submit to the Department of the Premier and Cabinet for ministerial approval a Proposed PEPR that fully complies with the Act and Regulations within twelve (12) months after the grant of the Mining Tenement unless the Tenement Holder has been granted an extension of time for such submission.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, Level 7, 101 Grenfell Street, Adelaide, SA 5000, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Other

22. In addition to obligations about the conduct of mining operations and rehabilitation, the Act and Regulations impose other obligations on the Tenement Holder including obligations to:

22.1. Comply with the applicable provisions of Part 9 of the Act (entry onto land and use of declared equipment).

22.2. Comply with the applicable provisions of Part 9B of the Act (native title).

22.3. Comply with the provisions of section 76 of the Act (mining returns) to the extent relevant to a miscellaneous purposes licence.

22.4. Comply with section 77 of the Act (records and geological samples) and regulation 84 of the Regulations.

22.5. Comply, as necessary, with section 83 of the Act (ministerial consent for dealings in relation to the Tenement) and regulations 44 and 70 of the Regulations.

22.6. Comply, insofar as applicable to a miscellaneous purposes licence, with regulation 86 of the Regulations (compliance reports).

22.7. Comply with the requirement in regulation 55 of the Regulations to maintain all posts, boundary indicator markers and notices in the positions required by the Regulations as applicable.

22.8. Permit the pastoral lessee (if any) of the Land to have free access and use at all times for domestic purposes, and for the purposes of watering stock from any surface water on the land which shall not have been provided or stored by artificial means by the Tenement Holder.

Restatement of Exempt Land

23. In accordance with section 9 of the Act, the grant of the Mining Tenement does not authorise prospecting, exploring or mining upon any exempt land unless or until the benefit of the exemption is waived under section 9AA.

Restatement of Bond

24. In accordance with section 62 of the Act, the Minister may by written notice require the Tenement Holder to pay a bond in such sum and subject to such terms and conditions as ensure, in the opinion of the Minister, that the following will be satisfied:

    24.1. Any civil or statutory liability likely to be incurred by the Tenement Holder in the course of carrying out mining operations;

    24.2. The present and future obligations of the Tenement Holder in relation to the rehabilitation of land disturbed by mining operations.

    Explanatory note: The terms and conditions referred to in this paragraph will be imposed in the written notice given by the Minister. The Minister may include a term or condition that the bond may be increased if circumstances arise during the term of this Miscellaneous Purposes Licence which increases the rehabilitation liability or increases the cost of civil or statutory liability.

Restatement of Fees

25. The Tenement Holder shall pay all fees imposed by the Act and Regulations from time to time.

Restatement of Renewal

26. This mining Tenement shall be renewed in accordance with the Act.

Restatement of Surrender

27. The Tenement Holder may apply to surrender the Mining Tenement during its term in accordance with the Act and the Regulations.

Restatement of Forfeiture

28. The Mining Tenement is subject to the forfeiture provision of the Act being section 85.

Restatement of Notices

29. Notices under the Act will be served in accordance with regulation 106 of the Regulations.

Restatement of Mining Register

30. Section 15A of the Act requires the Mining Registrar to keep a register of, amongst other things, miscellaneous purposes licences. Upon payment of the prescribed fee, the public may inspect the Mining Register.

Restatement of Mining Operations

31. As defined by section 6 of the Act "mining operations" means:

    31.1. Operations carried out in the course of prospecting, exploring or mining for minerals; or

    31.2. Without limiting paragraph 28.1, any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

    31.3. On-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

    31.4. Operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

    31.5. Operations that are directly related to any operations under a preceding paragraph;

    but does not include –

    31.6. An investigation or survey under section 15 of the Act ; or

    31.7. Fossicking; or

    31.8. The surface removal of loose rock material disturbed by agricultural operations.

32. This definition applies to operations that occur during all phases of the Mining Tenement's life.

Restatement of requirement to notify of a change in status

33. The Tenement Holder must comply with regulation 98(1)(c) and 98(2).

33.1. If the Tenement Holder is a natural person, he or she is required to notify the Mining Registrar of a declaration of bankruptcy within 14 days of the declaration.

33.2. If the Tenement Holder is a company, it is required to notify the Mining Registrar of its being placed under official management, or in liquidation or receivership within 14 days of any of those events.

Restatement of Public Liability Insurance

34. Comply with regulation 90, which concerns public liability insurance.

Definitions

35. In this Tenement Document, the following words have the following meanings:

35.1. "**Act**" means the *Mining Act 1971* of South Australia;

35.2. "**Additional Terms and Conditions**" means the Additional Terms and Conditions authorised by section 52(3) of the Act and set out in the First and Second Schedule of this Tenement Document respectively;

35.3. "**Applicant**" means the person or persons who applied for the Mining Tenement;

35.4. "**Approved PEPR**" means the program for environment protection and rehabilitation under Part 10A of the Act, which has received ministerial approval;

35.5. "**Business Day**" means any day that is not a Saturday, Sunday or a public holiday in South Australia;

35.6. "**Contamination**" and "**contaminated**" mean the presence of chemical substances in concentrations greater than the background concentrations (if any), where the presence of the chemical substances in the greater concentrations has resulted in

35.6.1. Actual or potential harm to the health or safety of human beings that is not trivial, or

35.6.2. Actual or potential harm to water that is not trivial, or

35.6.3. Other actual or potential environmental harm that is not trivial;

35.7. "**DPC**" and "**Department**" means the Department of the Premier and Cabinet and includes any substituted Department;

35.8. "**DRP**" means the Decommissioning and Rehabilitation Plan;

35.9. "**EPA**" means the Environment Protection Authority under the *Environment Protection Act 1993* of South Australia;

35.10. "**the Land**" means the land over which the Mining Tenement is granted and which is described in paragraphs 5 and 6 and in the Third Schedule of this Tenement Document;

35.11. "**Mine Completion**" and "**completion**" means the Land has been rehabilitated to an extent that the Minister could approve an application for surrender of the Mining Tenement on the basis that the Tenement Holder has complied with sub-regulation 59(1) of the Regulations and there is no obstacle under sub-regulation 59(3) of the Regulations;

35.12. "**Mining related activities**" means activities authorized by the Miscellaneous Purposes Licence;

35.13. "**Mining Tenement**" means the Miscellaneous Purposes Licence granted to the Tenement Holder, as referred to in paragraphs 1 and 2 of this Tenement Document and all of the rights and obligations encompassed in the grant;

35.14. "**the Minister**" means the Minister for Mineral Resources and Energy (or any substituted Minister);

35.15. "**Miscellaneous Purposes Licence**" means the Mining Tenement granted to the Tenement Holder as referred to in paragraph 1 and 2 of this Tenement Document.

35.16. "**PEPR**" means Program for Environment Protection and Rehabilitation;

35.17. "**Proposed PEPR**" means the document required by regulation 65(10) to be submitted for ministerial approval within twelve (12) months of the date of grant of the Mining Tenement;

35.18. "**Regulations**" means the Mining Regulations 2011 of South Australia;

35.19. "**site**" means the Land;

35.20. "**Tenement Document**" means this document;

35.21. "**Tenement Holder**" means the person, or persons, to whom this the Mining Tenement is granted and includes;

35.21.1. If the Tenement Holder is a natural person the executors, administrators and assigns of that person;

35.21.2. If the Tenement Holder is a body corporate the successors, administrators or permitted assigns thereof.

Explanatory Note: "The Tenement Holder" has the same meaning as "the mining operator" as defined by section 6 of the Act.

35.22. "**third party land users**" means the owner of land as defined by the Act (which includes native title holders and any persons lawfully occupying land with the licence of the owner, or the consent of the owner) and "**third party land use**" has a corresponding meaning;

35.23. "**Weeds**" means any invasive plant that threatens native vegetation in the local area or any species recognized as invasive in South Australia.

Interpretation

36. For the purposes of interpreting this Tenement Document the following will apply:

36.1. Unless otherwise stated, any term which is used in this Tenement Document which has a specific meaning in the Act or the Regulations, has that same meaning in this Tenement Document;

36.2. The masculine shall include the feminine, words importing persons shall include corporations, and the singular shall include the plural when the context or circumstances require and unless inconsistent with or repugnant to the context the following words shall have the meanings set opposite to them respectively –

36.2.1. "amendment" includes an addition, excision or substitution;

36.2.2. "the Land" includes any part thereof; and

36.2.3. "the term" includes any renewal or extension thereof.

36.3. If the Mining Tenement is granted to more than one person, all of the persons to whom it is granted are all jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document, including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.4. If, by virtue of a dealing under section 83 of the Act, the Mining Tenement comes to be held by more than one person, they will all be jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.5. If any act pursuant to Tenement Document would otherwise be required to be done on a day which is not a Business Day then that act may be done on the next Business Day;

36.6. To the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, the Act or Regulations, the Act or Regulations shall prevail;

36.7. Subject to the transitional provisions in any amendment to the Act or the Regulations, all provisions referred to in this Tenement Document shall be taken to include any such amendment;

36.8. Subject to the transitional provisions in any amendment to the Act or the Regulations, to the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or

Condition, and, on the other hand, any amendments to the Act or Regulations, the amended Act or Regulations shall prevail;

36.9. Footnotes and Explanatory notes do not form part of this Tenement Document;

36.10. The contents page does not form part of this Tenement Document;

36.11. The front page and all of the Schedules form part of this Tenement Document.

Executed by the Tenement Holder(s) in accordance with regulation 57

SIGNED by OZM Carrapateena Pty Ltd (ACN 007 756 443) and)
OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Luke Anderson	Robert Mancini
Chief Financial Officer	Head of Legal and Company Secretary
.....	.....
Print Name of Director	Print Name of ~~Director~~/Secretary
17/7/2017	17/07/2017
Date	Date

Entered in the Mining Register on 5 July 2017
In accordance with section 15A(1)(c) of the Act.

DIRECTOR OF MINES Adelaide

Signed by .....
Junesse Martin
Mining Registrar

20/7/2017
Date

FIRST SCHEDULE

ADDITIONAL TERMS

Explanaory Note: A term is a clause that gives a right to a Mining Tenement

Authorised Mining Related Activities

Miscellaneous Purposes Licence

1. The Mining Tenement is granted for the purpose of the construction, operation and rehabilitation of an:
   1.1. Airstrip;
   1.2. Accommodation village;
   1.3. Access road and;
   1.4. Ancillary infrastructure

   directly related to the conduct of mining operations authorised under mining tenement Retention Lease 127 and any Mineral Lease granted over all or part of Retention Lease 127.

2. Mining related activities on the Land must be consistent with the activities described in the Miscellaneous Purposes Licence Management Plan dated 2 December 2016 and subsequent Response Document dated 16 March 2017.

SECOND SCHEDULE

ADDITIONAL CONDITIONS

Explanatory Note: A condition is a clause that imposes a restriction on a Mining Tenement.

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Operating Protocol 6

Other Legislation 7

Waste 8

Refuelling (soil strategy) 9

Transparency

1. The Tenement Holder agrees to the Approved PEPR and any Compliance Reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.

Notification of cessation of operations

2. Within 30 days of becoming aware of any event or decision which is likely to give rise to the cessation of mining related activities for a period of more than 7 days and prior to the cessation of mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under **Condition 4**.

Decommissioning and Rehabilitation Plan (DRP)

3. The Tenement Holder must comply with a DRP approved in accordance with **Condition 4 and 5** when decommissioning or rehabilitating the Mining Tenement.

4. Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within 60

days of any notification provided to the Director of Mines in relation to the notification of cessation of operations under **Condition 2**, and that DRP must:

4.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;

4.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).

5. If, in the opinion of the Director of Mines (or other authorised officer), mining related activities on the Mining Tenement have substantially ceased for two years or more, the Director of Mines (or other authorised officer) may:

5.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Condition 4; and/or

5.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.

Operating Protocol

6. The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol between itself and owners of land adjacent to and on the Land prior to the commencement of mining related activities that includes the following matters:

6.1. Interaction with landowner operations;

6.2. emergency procedures;

6.3. communications and issue management processes;

6.4. land management;

6.5. dispute resolution;

6.6. ongoing communication about the Tenement Holder's operations;

6.7. receiving and considering feedback;

6.8. safety procedures;

6.9. access protocols; and

6.10. any matters identified by the Director of Mines (or other authorized officer) in writing.

7. The Tenement Holder must maintain and adhere to the protocol to the satisfaction of the Director of Mines for the term of the Mining Tenement

Other Legislation

8. The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the:
    8.1. *Environment Protection and Biodiversity Conservation Act 1999;*
    8.2. *Development Act 1993;*
    8.3. *Dangerous Substances Act 1979;*
    8.4. *National Parks and Wildlife Act 1972;*
    8.5. *Natural Resources Management Act 2004;*
    8.6. *Public and Environmental Health Act 1987;*
    8.7. *Aboriginal Heritage Act 1988;*
    8.8. *Heritage Places Act 1993*
    8.9. *Work Health and Safety Act 2012;*
    8.10. *Environment Protection Act 1993;*
    8.11. *Native Vegetation Act 1991;*
    8.12. *Mines and Works Inspection Act 1920;* and
    8.13. *Road Traffic Act 1961.*

Waste

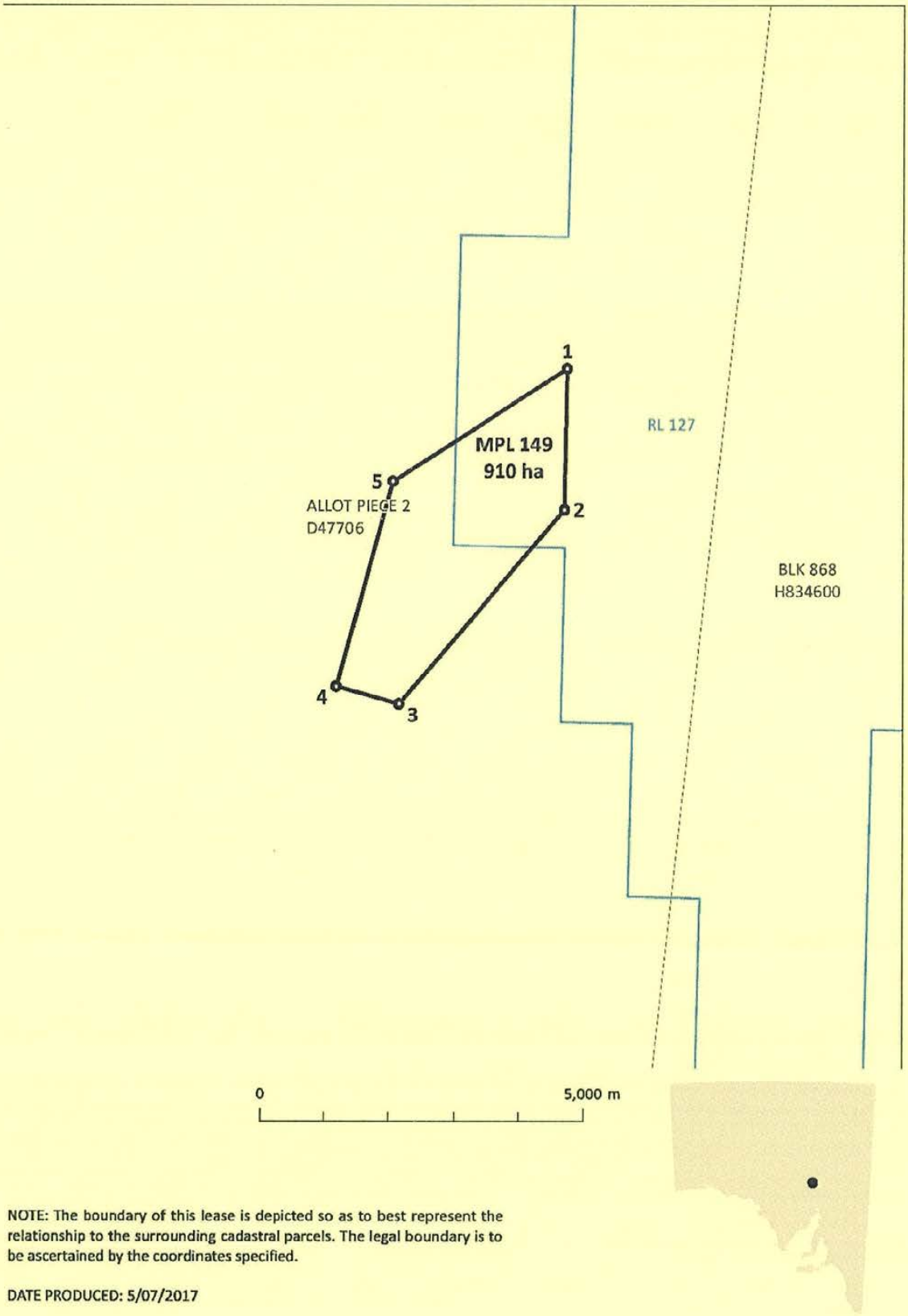
9. The Tenement Holder must ensure that all commercial or industrial waste is disposed of in an EPA licensed facility.

Refuelling (soil strategy)

10. The Tenement Holder must ensure that fuel storage is bunded in accordance with Environment Protection Authority requirements.

THIRD SCHEDULE

MAP



NOTE: The boundary of this lease is depicted so as to best represent the relationship to the surrounding cadastral parcels. The legal boundary is to be ascertained by the coordinates specified.

DATE PRODUCED: 5/07/2017

THIRD SCHEDULE

DESCRIPTION OF AREAS

All that part of the State of South Australia, bounded by a line joining the points of coordinates set out in the following table:

Map Grid of Australia 1994 Zone 53

Point	Easting		Northing	
1	735250	mE	6537039	mN
2	735211	mE	6534849	mN
3	732664	mE	6531842	mN
4	731695	mE	6532116	mN
5	732566	mE	6535290	mN

Area: 910 ha

Based on information provided by the applicant.

FOURTH SCHEDULE

PROCESS FOR SUSPENSION

Issuance of Suspension Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to suspend the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder thirty (30) Business Days from the date of the written notice to show cause why the grant of the Mining Tenement should not be suspended ("the Suspension Show Cause Notice").

Minister's action if Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister may suspend the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if Tenement Holder does respond

3. If the Tenement Holder responds to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to suspend the grant of the Mining Tenement (in accordance with the process outlined below).

Written Notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the Minister's decision;

   4.1. If the decision is to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Suspended".

   4.2. If the decision is to not to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Not Suspended".

5. A Notice of Decision: Not Suspended, may contain any information that the Minister considers relevant.

6. A Notice of Decision: Suspended, shall:

   6.1. Specify the reason for suspension;

   6.2. Specify the period of suspension;

   6.3. Specify the action (if any) the Tenement Holder may be required to take for the Minister to consider revoking the suspension, and the time frame for taking that action;

   6.4. Inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder takes action as specified in Notice of Decision

7. If the Tenement Holder takes the action specified by the Minister under paragraph 6.3, the Minister will consider revoking the suspension.

8. If the Minister revokes the suspension, the Minister will, within a reasonable time write to the Tenement Holder informing the Tenement Holder of the revocation.

Minister's action if Tenement Holder appeals

9. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising the discretion under section 56(4) of the Act, to stay the operation of the suspension until the appeal is finally disposed of.

10. If the Environment, Resources and Development Court, or a court of further appeal finally determines it is satisfied that there is no proper ground for the suspension, and so orders, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

11. All of the stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

    11.1. A memorandum Notice of Decision: Suspended;

    11.2. A memorandum Notice of Decision: Not Suspended;

    11.3. A memorandum of Minister's Decision to Revoke the Suspension;

    11.4. A memorandum of Appeal;

    11.5. A memorandum of Stay of Suspension by the Minister;

11.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

FIFTH SCHEDULE

PROCESS FOR CANCELLATION

Issuance of Cancellation Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to cancel the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder sixty (60) Business Days from the date of written notice to show cause why the grant of the Mining Tenement should not be cancelled ("the Cancellation Show Cause Notice").

Minister's action if the Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister may cancel the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if the Tenement Holder does respond

3. If the Tenement Holder responds to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to cancel the grant of the Mining Tenement (in accordance with the process outlined below).

Written notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the decision.

   4.1. If the decision is to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Cancelled".

   4.2. If the decision is not to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Not Cancelled".

5. A Notice of Decision: Not Cancelled may contain any information that the Minister considers relevant.

6. A Notice of Decision: Cancelled shall:

   6.1. Specify the reason for cancellation;

   6.2. Specify the date from which cancellation is effective; and

   6.3. Inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder appeals

7. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising his discretion under section 56(4) of the Act, to stay the operation of the cancellation until the appeal is finally disposed of.

8. If the Environment, Resources and Development Court or a court of further appeal finally determines that it is satisfied that there is no proper ground for the cancellation, and so orders, and the cancellation has not been stayed by the Minister under section 56(4) of the Act, or by order of the Environment, Resources and Development Court, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

9. All stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

   9.1. A memorandum Notice of Decision: Cancelled;

   9.2. A memorandum of Notice of Decision: Not Cancelled;

   9.3. A memorandum of Minister's Decision to Revoke the Cancellation;

   9.4. A memorandum of Appeal;

   9.5. A memorandum of Stay of Cancellation by the Minister;

   9.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

SIXTH SCHEDULE

ENVIRONMENTAL OUTCOMES

AND ASSOCIATED CRITERIA AND STRATEGIES PURSUANT TO REGULATION 65 OF THE MINING REGULATIONS 2011

Explanatory Note: The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act. The Sixth Schedule may also specify requirements for strategies and criteria relevant to the outcomes set out in that Schedule.

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Soil and Land Disturbance Outcomes

1. Before mine completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-mining land use can be recommenced post completion.
2. The Tenement Holder must, ensure that:
   2.1. There is no contamination of land and soils either on or off the Land as a result of mining related activities ; and
   2.2. No contamination of land and soils either on or off the Land post completion occurs as a result of mining related activities.

Public Safety Outcomes

3. The Tenement Holder must during construction and operation ensure that unauthorised entry to the site does not result in public injuries and or deaths that could have been reasonably prevented.
4. The Tenement Holder must demonstrate that post completion, the risks to the health and safety of the public so far as it may be affected by mining related activities are as low as reasonably practicable.

Traffic Outcome

5. The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining related traffic.

Adjacent Land Use and Third Party Property Outcome

6. The Tenement Holder must during construction and operation ensure no impacts to agricultural productivity for third party land users on or off the Land as a result of mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).

Aboriginal Heritage Outcome

7. The Tenement Holder must during construction and operation ensure that there is no disturbance to Aboriginal heritage sites, objects or remains unless it is authorized under relevant legislation.

Native Fauna Outcome

8. The Tenement Holder must ensure during construction, operation and post completion that there are no native fauna injuries or deaths due to mining related activities that could reasonably have been prevented.

Native Vegetation Outcome

9. The Tenement Holder must during construction and operation ensure no loss of abundance or diversity of native vegetation on or off the Land unless unless a significant environmental benefit has been approved in accordance with the relevant legislation.

Weeds, Pests and Pathogens Outcome

10. The Tenement Holder must, during construction and operation ensure no introduction of new species of weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining related activities.

Groundwater and Surface Water Outcomes

11. The Tenement Holder must ensure that during construction, operation and post completion there is no adverse change to the environmental values of the groundwater within the shallow perched aquifer within the Land as a result of chemicals or hydrocarbons from mining related activities.
12. The Tenement Holder must ensure that during construction, operation and post completion no surface water contaminated (including sedimentation) as a result of mining related activities leaves the Land.

Appendix A3.
MPL 152 Western Infrastructure Corridor

Government of South Australia

Mining Act 1971

TENEMENT DOCUMENT

MISCELLANEOUS PURPOSES LICENCE

TENEMENT HOLDER	OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255)
MISCELLANEOUS PURPOSES LICENCE NUMBER	152
PURPOSE	Western Infrastructure Corridor: Authorised mining related activities as specified in the First Schedule.
COMMENCEMENT DATE	3 January 2018
TERM OF MINING TENEMENT	Twenty-one (21) years
EXPIRY DATE	2 January 2039
AREA OF MINING TENEMENT	20,126 hectares

DATE BY WHICH THE PROPOSED PEPR MUST BE SUBMITTED: 2 January 2019

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Details of Grant of a Mining Tenement

1. On 3 January 2018, pursuant to Part 8 of the Act, the Minister made a statutory grant of a miscellaneous purposes licence (the Mining Tenement) described in this Tenement Document.

2. The Mining Tenement is granted:

   2.1. To OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255);

   2.2. For the purpose of authorised mining related activities as specified in the First Schedule.

3. The Mining Tenement is numbered 152.

4. The Mining Tenement is:

   4.1. Subject to the Terms and Conditions prescribed by the Act and Regulations and specified in this Tenement Document; and

   4.2. Subject to the Additional Terms and Conditions specified in the First and Second Schedules (respectively) of this Tenement Document.

Terms and conditions required by the Act to be specified in the Tenement Document

Description of the Land

5. The Mining Tenement is granted over an area of 20,126 hectares and is located in the Pernatty area, approximately 46km east southeast of Woomera.

6. The location of the Mining Tenement is more specifically defined in the map and coordinates specified in the Third Schedule of this Tenement Document.

Term, Commencement and Expiration

7. The Mining Tenement is granted for the term of twenty-one (21) years. The term of the Mining Tenement commenced on 3 January 2018, and, unless it is earlier renewed, surrendered or cancelled, the Mining Tenement will cease on 2 January 2039.

Rental

8. The Tenement Holder shall pay, by way of rental, such sums as may be prescribed and in accordance with section 52(6), (7), (8) and (9) of the Act and regulation 54 of the Regulations.

Compensation

9. The Minister may, at any time, require the Tenement Holder to pay to any person an amount of compensation stipulated by the Minister, to which that person is, in the opinion of the Minister, entitled in consequence of mining operations in pursuance of the rights granted and the obligations imposed by the grant of the Mining Tenement.

Suspension and Cancellation: Stipulation of Process

10. Pursuant to subsection 56(1) of the Act, the Minister may suspend or cancel the Mining Tenement if the Tenement Holder contravenes or fails to comply with a term or condition of this Tenement Document or a provision of the Act (which includes the Regulations).

11. Pursuant to subsection 56(2) of the Act, the Minister may stipulate in the tenement document a process for suspension or cancellation that must be followed before the powers in subsection 56(1) may be exercised.

12. The process for suspension of the Mining Tenement shall be as stipulated in the Fourth Schedule of this Tenement Document.

13. The process for cancellation of the Mining Tenement shall be as stipulated in the Fifth Schedule of this Tenement Document.

Environmental outcomes specified pursuant to Regulation 65 of the Regulations

14. The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act.

Explanatory note: The Sixth Schedule may also contain strategies and criteria which the Department has formed the view would address the outcomes set out in that Schedule.

Restatement of selected provisions from the Act

Explanation of Restatements

15. All of the restatements in this portion of this Tenement Document are included for guidance only and do not replace the substantive provisions of the Act or the Regulations.

16. If any restatement is inconsistent with the substantive provisions of the Act or the Regulations, the restatement will be invalid and the substantive provision of the Act or the Regulations will prevail and the Tenement Holder is required to comply with the substantive provision of the Act or the Regulations.

17. The Tenement Holder is still required to comply with any provision of the Act or Regulations that is not restated in this Tenement Document.

Restatement of obligations imposed on Tenement Holder: Program for environment protection and rehabilitation

18. The Tenement Holder must not carry out mining operations unless there is an approved program for environment protection and rehabilitation (an Approved PEPR).

19. A Proposed PEPR will only be approved when it complies with the requirements of Part 10A of the Act and the Regulations.

20. To comply with Part 10A of the Act, the Proposed PEPR must:

    20.1. Contain the information specified in section 70B(2) of the Act and regulation 65(2), (5), (6) of the Regulations and determinations made by the Minister under regulation 65(7) of the Regulations (if any);

    20.2. Comply with any applicable conditions specified in this Tenement Document (if any);

    20.3. Address any relevant environmental outcomes listed in the Sixth Schedule of this Tenement Document.

    Explanatory note: At the date of grant, the determinations are available at: www.minerals.dpc.sa.gov.au/publications_and_information/ministerial_determinations

21. In accordance with regulation 65(10) of the Regulations, the Tenement Holder must submit to the Department of the Premier and Cabinet for ministerial approval a Proposed PEPR that fully complies with the Act and Regulations within twelve (12) months after the grant of the Mining Tenement unless the Tenement Holder has been granted an extension of time for such submission.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, GPO Box 320, Adelaide, SA 5001, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Other

22. In addition to obligations about the conduct of mining operations and rehabilitation, the Act and Regulations impose other obligations on the Tenement Holder including obligations to:

    22.1. Comply with the applicable provisions of Part 9 of the Act (entry onto land and use of declared equipment).

    22.2. Comply with the applicable provisions of Part 9B of the Act (native title).

    22.3. Comply with the provisions of section 76 of the Act (mining returns) to the extent relevant to a miscellaneous purposes licence.

    22.4. Comply with section 77 of the Act (records and geological samples) and regulation 84 of the Regulations.

    22.5. Comply, as necessary, with section 83 of the Act (ministerial consent for dealings in relation to the Tenement) and regulations 44 and 70 of the Regulations.

    22.6. Comply, insofar as applicable to a miscellaneous purposes licence, with regulation 86 of the Regulations (compliance reports).

    22.7. Comply with the requirement in regulation 55 of the Regulations to maintain all posts, boundary indicator markers and notices in the positions required by the Regulations as applicable.

    22.8. Permit the pastoral lessee (if any) of the Land to have free access and use at all times for domestic purposes, and for the purposes of watering stock from any surface water on the land which shall not have been provided or stored by artificial means by the Tenement Holder.

Restatement of Exempt Land

23. In accordance with section 9 of the Act, the grant of the Mining Tenement does not authorise prospecting, exploring or mining upon any exempt land unless or until the benefit of the exemption is waived under section 9AA.

Restatement of Bond

24. In accordance with section 62 of the Act, the Minister may by written notice require the Tenement Holder to pay a bond in such sum and subject to such terms and conditions as ensure, in the opinion of the Minister, that the following will be satisfied:

    24.1. Any civil or statutory liability likely to be incurred by the Tenement Holder in the course of carrying out mining operations;

    24.2. The present and future obligations of the Tenement Holder in relation to the rehabilitation of land disturbed by mining operations.

    Explanatory note: The terms and conditions referred to in this paragraph will be imposed in the written notice given by the Minister. The Minister may include a term or condition that the bond may be increased if circumstances arise during the term of this Miscellaneous Purposes Licence which increases the rehabilitation liability or increases the cost of civil or statutory liability.

Restatement of Fees

25. The Tenement Holder shall pay all fees imposed by the Act and Regulations from time to time.

Restatement of Renewal

26. This mining Tenement shall be renewed in accordance with the Act.

Restatement of Surrender

27. The Tenement Holder may apply to surrender the Mining Tenement during its term in accordance with the Act and the Regulations.

Restatement of Forfeiture

28. The Mining Tenement is subject to the forfeiture provision of the Act being section 85.

Restatement of Notices

29. Notices under the Act will be served in accordance with regulation 106 of the Regulations.

Restatement of Mining Register

30. Section 15A of the Act requires the Mining Registrar to keep a register of, amongst other things, miscellaneous purposes licences. Upon payment of the prescribed fee, the public may inspect the Mining Register.

Restatement of Mining Operations

31. As defined by section 6 of the Act "mining operations" means:

    31.1. Operations carried out in the course of prospecting, exploring or mining for minerals; or

    31.2. Without limiting paragraph 28.1, any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

    31.3. On-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

    31.4. Operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

    31.5. Operations that are directly related to any operations under a preceding paragraph;

    but does not include –

    31.6. An investigation or survey under section 15 of the Act; or

    31.7. Fossicking; or

    31.8. The surface removal of loose rock material disturbed by agricultural operations.

32. This definition applies to operations that occur during all phases of the Mining Tenement's life.

Restatement of requirement to notify of a change in status

33. The Tenement Holder must comply with regulation 98(1)(c) and 98(2).

33.1. If the Tenement Holder is a natural person, he or she is required to notify the Mining Registrar of a declaration of bankruptcy within fourteen (14) days of the declaration.

33.2. If the Tenement Holder is a company, it is required to notify the Mining Registrar of its being placed under official management, or in liquidation or receivership within fourteen (14) days of any of those events.

Restatement of Public Liability Insurance

34. The tenement holder must comply with regulation 90, which concerns public liability insurance.

Definitions

35. In this Tenement Document, the following words have the following meanings:

35.1. **"Act"** means the *Mining Act 1971* of South Australia;

35.2. **"Additional Terms and Conditions"** means the Additional Terms and Conditions authorised by section 52(3) of the Act and set out in the First and Second Schedules of this Tenement Document respectively;

35.3. **"Approved PEPR"** means the Program for Environment Protection and Rehabilitation under Part 10A of the Act, which has received ministerial approval;

35.4. **"Business Day"** means any day that is not a Saturday, Sunday or a public holiday in South Australia;

35.5. **"Completion"** means the Land has been rehabilitated to an extent that the Minister could approve an application for surrender of the Mining Tenement on the basis that the Tenement holder has complied with sub-regulation 59(1) of the Regulations and there is no obstacle under sub-regulation 59(3) of the Regulations;

35.6. **"Contamination"** and **"contaminated"** mean the presence of chemical substances in concentrations greater than the background concentrations (if any), where the presence of the chemical substances in the greater concentrations has resulted in

35.6.1. Actual or potential harm to the health or safety of human beings that is not trivial, or

35.6.2. Actual or potential harm to water that is not trivial, or

35.6.3. Other actual or potential environmental harm that is not trivial;

35.7. **"DRP"** means Decommissioning and Rehabilitation Plan;

35.8. **"Environmental Values"** means the environmental values recognised in the South Australian Environment Protection (Water Quality) Policy 2015 and the *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Paper No 4'*;

35.9. **"EPA"** means the Environment Protection Authority under the *Environment Protection Act 1993* of South Australia;

35.10. **"miscellaneous purposes licence"** means the Mining Tenement granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.11. **"mining operations"** means the mining operations authorised by Mineral Lease 6471;

35.12. **"Mining Tenement"** or **"Tenement"** means the miscellaneous purposes licence granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.13. **"Minister"** means the Minister for Mineral Resources and Energy (or any substituted Minister);

35.14. **"PEPR"** means Program for Environment Protection and Rehabilitation;

35.15. **"Proposed PEPR"** means the document required by regulation 65(10) of the Regulations to be submitted for ministerial approval within twelve (12) months of the date of grant of the Mining Tenement;

35.16. **"Regulations"** means the Mining Regulations 2011 of South Australia;

35.17. **"Significant Environmental Benefit"** means a benefit provided as a requirement of authorisation to clear native vegetation under the Native Vegetation Regulations 2003.

35.18. **"site"** means the Land;

35.19. **"Tenement Document"** means this document;

35.20. **"Tenement Holder"** means the person, or persons, to whom this Mining Tenement is granted and includes;

35.20.1. If the Tenement Holder is a natural person the executors, administrators and assigns of that person;

35.20.2. If the Tenement Holder is a body corporate the successors, administrators or permitted assigns thereof.

Explanatory note: "The Tenement Holder" has the same meaning as "the mining operator" as defined by section 6 of the Act.

35.21. **"the Land"** means the land over which this Mining Tenement is granted and which is described in paragraphs 5 and 6 of this Tenement Document and in the Third Schedule of this Tenement Document;

35.22. **"the Program"** means the Approved PEPR as defined above;

35.23. **"third party land users"** means the owner of land (as defined by the Act) and any persons lawfully occupying land with the licence of the owner, or the consent of the owner and **"third party land use"** has a corresponding meaning;

35.24. **"Weeds"** means any invasive plant that threatens native vegetation in the local area or any species recognised as invasive in South Australia.

Interpretation

36. For the purposes of interpreting this Tenement Document the following will apply:

36.1. Unless otherwise stated, any term which is used in this Tenement Document which has a specific meaning in the Act or the Regulations, has that same meaning in this Tenement Document;

36.2. The masculine shall include the feminine, words importing persons shall include corporations, and the singular shall include the plural when the context or circumstances require and unless inconsistent with or repugnant to the context the following words shall have the meanings set opposite to them respectively –

36.2.1. "amendment" includes an addition, excision or substitution;

36.2.2. "the Land" includes any part thereof; and

36.2.3. "the term" includes any renewal or extension thereof.

36.3. If the Mining Tenement is granted to more than one person, all of the persons to whom it is granted are all jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document, including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.4. If, by virtue of a dealing under section 83 of the Act, the Mining Tenement comes to be held by more than one person, they will all be jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.5. If any act pursuant to Tenement Document would otherwise be required to be done on a day which is not a Business Day, then that act may be done on the next Business Day;

36.6. To the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, the Act or Regulations, the Act or Regulations shall prevail;

36.7. Subject to the transitional provisions in any amendment to the Act or the Regulations, all provisions referred to in this Tenement Document shall be taken to include any such amendment;

36.8. Subject to the transitional provisions in any amendment to the Act or the Regulations, to the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, any amendments to the Act or Regulations, the amended Act or Regulations shall prevail;

36.9. Footnotes and Explanatory notes do not form part of this Tenement Document;

36.10. The contents page does not form part of this Tenement Document;

36.11. The front page and all of the Schedules form part of this Tenement Document.

Executed by the Tenement Holder(s) in accordance with regulation 57

SIGNED by OZM Carrapateena Pty Ltd (ACN 007 756 443))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18.	05/01/18.
Date	Date

SIGNED by OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18	05/01/18
Date	Date

Entered in the Mining Register on 3 January 2018
In accordance with section 15A(1)(c) of the Act.

Signed by .....
Junesse Martin
Mining Registrar

DIRECTOR OF MINES Adelaide

08/01/2018
Date

FIRST SCHEDULE

ADDITIONAL TERMS

Explanatory note: A term is a clause that gives a right to a Mining Tenement.

Authorised Mining Related Activities

1. The Mining Tenement is granted for the purpose of the construction, operation and rehabilitation of a:

    1.1. Network of local (radial) wells;

    1.2. Water-holding and distribution network including:

        1.2.1. ponds/dams;

        1.2.2. piping; and

        1.2.3. pumps;

    1.3. Independent power supply;

    1.4. Power transmission line;

    1.5. Site access road; and

    1.6. Ancillary infrastructure;

    directly related to the conduct of mining operations authorised under mining tenement ML 6471.

2. Mining related activities on the Land must be consistent with the activities described in the Miscellaneous Purposes Licence Management Plan dated 26 May 2017 and subsequent Response Documents dated 22 September 2017, 6 October 2017, 21 November 2017 and 29 November 2017.

SECOND SCHEDULE

ADDITIONAL CONDITIONS

Explanatory note: A condition is a clause that imposes a restriction on a Mining Tenement.

INDEX TO SECOND SCHEDULE (ADDITIONAL CONDITIONS) **Condition No.**

Aboriginal Heritage 1

Concentrate Transport 2

Waste 3

Removal of Infrastructure 4

Transparency 5

Notification of Cessation of Operations 6

Decommissioning and Rehabilitation Plan (DRP) 7-9

Operating Protocol 10-11

Compliance with Regulation 98(1) 12

Matters of National Environmental Significance 13

Other Legislation 14

Aboriginal Heritage

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Concentrate Transport

2. The Tenement Holder must during operations ensure that copper concentrate is transported in fit for purpose sealed containers to prevent copper concentrate release to the environment.

Waste

3. The Tenement Holder must ensure that all commercial or industrial waste (which does not include tailings and waste rock) is disposed of in an EPA licensed facility.

Removal of Infrastructure

4. The Tenement Holder must ensure that all mining related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.

Transparency

5. The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.

Notification of Cessation of Operations

6. Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 8.

Decommissioning and Rehabilitation Plan (DRP)

7. The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 8 and 9 when decommissioning or rehabilitating the Mining Tenement.

8. Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 6, and that DRP must:

    8.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;

    8.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).

9. If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:

   9.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 8; and/or

   9.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.

Operating Protocol

10. The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:

   10.1. interaction with landowner operations;

   10.2. emergency procedures;

   10.3. communications and issue management processes;

   10.4. land management;

   10.5. dispute resolution;

   10.6. ongoing communication about the Tenement Holder's operations;

   10.7. receiving and considering feedback;

   10.8. safety procedures;

   10.9. access protocols; and

   10.10. any matters identified by the Director of Mines (or other authorised officer) in writing.

11. The Tenement Holder must:

   11.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and

   11.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.

Compliance with Regulation 98(1)

12. A notification required by regulation 98(1) must be in writing.

Matters of National Environmental Significance

13. To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:

    13.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;

    13.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;

    13.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and

    13.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions.

    Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.

Other Legislation

14. The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the:

    14.1. *Environment Protection and Biodiversity Conservation Act 1999;*

    14.2. *Development Act 1993;*

    14.3. *Planning, Development and Infrastructure Act 2016;*

    14.4. *Dangerous Substances Act 1979;*

    14.5. *National Parks and Wildlife Act 1972;*

    14.6. *Natural Resources Management Act 2004;*

    14.7. *Public and Environmental Health Act 1987;*

    14.8. *Aboriginal Heritage Act 1988;*

    14.9. *Heritage Places Act 1993;*

    14.10. *Work Health and Safety Act 2012;*

14.11. *Environment Protection Act 1993;*

14.12. *Radiation Protection and Control Act 1982;*

14.13. *Native Vegetation Act 1991;*

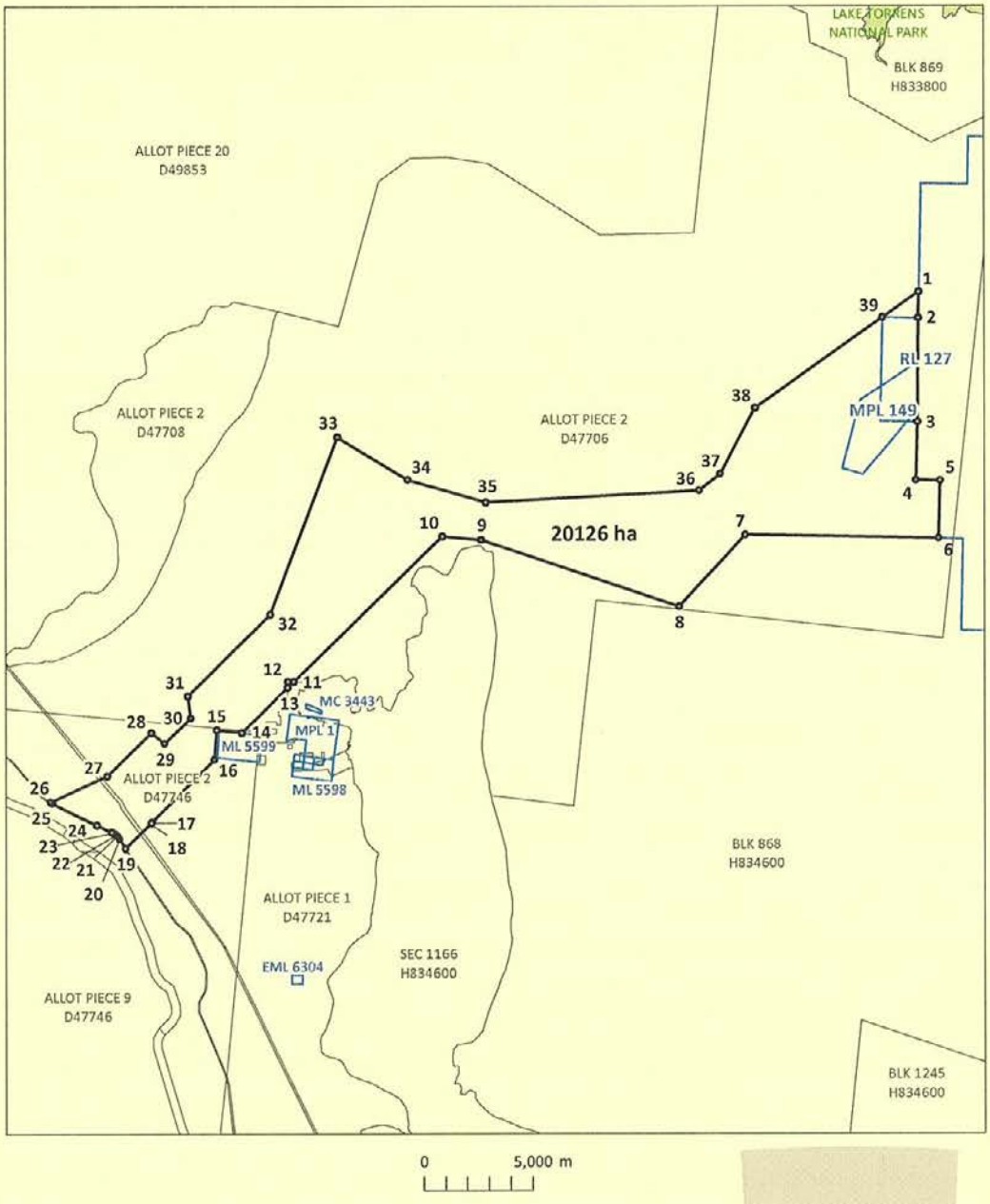
14.14. *Mines and Works Inspection Act 1920;*

14.15. *Road Traffic Act 1961; and*

14.16. *Wilderness Protection Act 1992.*

THIRD SCHEDULE

MAP



NOTE: The boundary of this lease is depicted so as to best represent the relationship to the surrounding cadastral parcels. The legal boundary is to be ascertained by the coordinates specified.

DATE PRODUCED: 18/12/2017

THIRD SCHEDULE

DESCRIPTION OF AREAS

All that part of the State of South Australia, bounded by a line joining the points of coordinates set out in the following table:

Map Grid of Australia 1994 Zone 53				
Point	Easting		Northing	
1	735283.37	mE	6540287.68	mN
2	735256.32	mE	6539079.49	mN
3	735213.82	mE	6534263.10	mN
4	735153.27	mE	6531563.79	mN
5	736257.73	mE	6531538.95	mN
6	736197.27	mE	6528858.43	mN
7	727159.20	mE	6529047.05	mN
8	724029.53	mE	6525713.83	mN
9	714807.41	mE	6528810.71	mN
10	713015.94	mE	6528984.85	mN
11	706104.13	mE	6522246.52	mN
12	705839.44	mE	6522254.13	mN
13	705831.56	mE	6521980.53	mN
14	703682.87	mE	6519883.01	mN
15	702508.57	mE	6520007.79	mN
16	702392.43	mE	6518642.47	mN
17	699450.76	mE	6515738.09	mN
18	699425.77	mE	6515714.24	mN
19	698231.59	mE	6514547.80	mN
20	697946.55	mE	6514964.22	mN
21	697846.10	mE	6515087.31	mN
22	697719.31	mE	6515197.02	mN
23	697575.13	mE	6515282.58	mN
24	696890.24	mE	6515610.67	mN
25	694794.51	mE	6516621.90	mN
26	694693.16	mE	6516679.38	mN
27	697354.84	mE	6517884.51	mN
28	699423.80	mE	6519891.50	mN
29	700057.50	mE	6519391.43	mN
30	701301.04	mE	6520555.60	mN
31	701143.57	mE	6521586.06	mN
32	705018.43	mE	6525374.95	mN
33	708155.12	mE	6533570.23	mN
34	711414.31	mE	6531591.18	mN
35	715027.93	mE	6530553.17	mN
36	724980.85	mE	6531090.44	mN
37	725960.23	mE	6531845.24	mN
38	727621.75	mE	6534916.29	mN
39	733588.58	mE	6539116.70	mN

Area: 20,126 ha

Based on information provided by the applicant.

FOURTH SCHEDULE

PROCESS FOR SUSPENSION

Issuance of Suspension Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to suspend the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder thirty (30) Business Days from the date of the written notice to show cause why the grant of the Mining Tenement should not be suspended ("the Suspension Show Cause Notice").

Minister's action if Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister may suspend the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if Tenement Holder does respond

3. If the Tenement Holder responds to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to suspend the grant of the Mining Tenement (in accordance with the process outlined below).

Written Notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the Minister's decision;

   4.1. if the decision is to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Suspended".

   4.2. if the decision is to not to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Not Suspended".

5. A Notice of Decision: Not Suspended, may contain any information that the Minister considers relevant.

6. A Notice of Decision: Suspended, shall:

6.1. Specify the reason for suspension;

6.2. specify the period of suspension;

6.3. specify the action (if any) the Tenement Holder may be required to take for the Minister to consider revoking the suspension, and the time frame for taking that action;

6.4. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder takes action as specified in Notice of Decision

7. If the Tenement Holder takes the action specified by the Minister under paragraph 6.3, the Minister will consider revoking the suspension.

8. If the Minister revokes the suspension, the Minister will, within a reasonable time write to the Tenement Holder informing the Tenement Holder of the revocation.

Minister's action if Tenement Holder appeals

9. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising the discretion under section 56(4) of the Act, to stay the operation of the suspension until the appeal is finally disposed of.

10. If the Environment, Resources and Development Court, or a court of further appeal finally determines it is satisfied that there is no proper ground for the suspension, and so orders, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

11. All of the stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

11.1. A memorandum Notice of Decision: Suspended;

11.2. A memorandum Notice of Decision: Not Suspended;

11.3. A memorandum of Minister's Decision to Revoke the Suspension;

11.4. A memorandum of Appeal;

11.5. A memorandum of Stay of Suspension by the Minister;

11.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

FIFTH SCHEDULE

PROCESS FOR CANCELLATION

Issuance of Cancellation Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to cancel the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder sixty (60) Business Days from the date of written notice to show cause why the grant of the Mining Tenement should not be cancelled ("the Cancellation Show Cause Notice").

Minister's action if the Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister may cancel the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if the Tenement Holder does respond

3. If the Tenement Holder responds to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to cancel the grant of the Mining Tenement (in accordance with the process outlined below).

Written notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the decision.

   4.1. If the decision is to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Cancelled".

   4.2. If the decision is not to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Not Cancelled".

5. A Notice of Decision: Not Cancelled may contain any information that the Minister considers relevant.

6. A Notice of Decision: Cancelled shall:

   6.1. Specify the reason for cancellation;

   6.2. specify the date from which cancellation is effective; and

   6.3. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder appeals

7. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising his discretion under section 56(4) of the Act, to stay the operation of the cancellation until the appeal is finally disposed of.

8. If the Environment, Resources and Development Court or a court of further appeal finally determines that it is satisfied that there is no proper ground for the cancellation, and so orders, and the cancellation has not been stayed by the Minister under section 56(4) of the Act, or by order of the Environment, Resources and Development Court, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

9. All stages in the cancellation process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

   9.1. A memorandum Notice of Decision: Cancelled;

   9.2. A memorandum of Notice of Decision: Not Cancelled;

   9.3. A memorandum of Minister's Decision to Revoke the Cancellation;

   9.4. A memorandum of Appeal;

   9.5. A memorandum of Stay of Cancellation by the Minister;

   9.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

SIXTH SCHEDULE

ENVIRONMENTAL OUTCOMES

AND ASSOCIATED CRITERIA AND STRATEGIES PURSUANT TO REGULATION 65 OF THE MINING REGULATIONS 2011

Explanatory note: The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act. The Sixth Schedule may also specify requirements for strategies and criteria relevant to the outcomes set out in that Schedule.

INDEX TO SIXTH SCHEDULE **Clause No.**

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Weeds and Pests Outcome 6

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Land and Soil Outcome 10

Native Vegetation Outcome 11

Native Fauna Outcome 12

Surface Water Outcome 13

Surface Water Strategies – Contamination, Erosion and Sediments 14

Groundwater Outcome 15

Aboriginal Heritage Outcome

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Public Safety Outcomes

2. The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.

3. The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining related activities are as low as reasonably practicable.

Public Nuisance Outcome

4. The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining related traffic.

Traffic Outcome

5. The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.

Weeds and Pests Outcome

6. The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities.

Land Use and Property Outcomes

7. The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).
8. Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.
9. The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.

Land and Soil Outcome

10. The Tenement Holder must, ensure that:

    10.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining related activities; and

    10.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining related activities.

Native Vegetation Outcome

11. The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation.

Native Fauna Outcome

12. The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.

Surface Water Outcome

13. The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining related activities.

Surface Water Strategies – Contamination, Erosion and Sediments

14. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 13:

    14.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining related activities leaves the Land.

14.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining related activities is effectively managed and controlled.

14.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining related activities is effectively managed and controlled.

14.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.

Groundwater Outcome

15. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining related activities.

Appendix A4.
MPL 153 Eastern Radial Wellfield

Government of South Australia

Mining Act 1971

TENEMENT DOCUMENT

MISCELLANEOUS PURPOSES LICENCE

TENEMENT HOLDER	OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255)
MISCELLANEOUS PURPOSES LICENCE NUMBER	153
PURPOSE	Eastern Radial Wellfield: Authorised mining related activities as specified in the First Schedule.
COMMENCEMENT DATE	3 January 2018
TERM OF MINING TENEMENT	Twenty-one (21) years
EXPIRY DATE	2 January 2039
AREA OF MINING TENEMENT	3,029 hectares

DATE BY WHICH THE PROPOSED PEPR MUST BE SUBMITTED: 2 January 2019

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Details of Grant of a Mining Tenement

1. On 3 January 2018, pursuant to Part 8 of the Act, the Minister made a statutory grant of a miscellaneous purposes licence (the Mining Tenement) described in this Tenement Document.

2. The Mining Tenement is granted:

   2.1. To OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255);

   2.2. For the purpose of authorised mining related activities as specified in the First Schedule.

3. The Mining Tenement is numbered MPL 153.

4. The Mining Tenement is:

   4.1. Subject to the Terms and Conditions prescribed by the Act and Regulations and specified in this Tenement Document; and

   4.2. Subject to the Additional Terms and Conditions specified in the First and Second Schedules (respectively) of this Tenement Document.

Terms and conditions required by the Act to be specified in the Tenement Document

Description of the Land

5. The Mining Tenement is granted over an area of 3,029 hectares and is located in the Pernatty area, approximately 67km east of Woomera.

6. The location of the Mining Tenement is more specifically defined in the map and coordinates specified in the Third Schedule of this Tenement Document.

Term, Commencement and Expiration

7. The Mining Tenement is granted for the term of twenty-one (21) years. The term of the Mining Tenement commenced on 3 January 2018, and, unless it is earlier renewed, surrendered or cancelled, the Mining Tenement will cease on 2 January 2039.

Rental

8. The Tenement Holder shall pay, by way of rental, such sums as may be prescribed and in accordance with section 52(6), (7), (8) and (9) of the Act and regulation 54 of the Regulations.

Compensation

9. The Minister may, at any time, require the Tenement Holder to pay to any person an amount of compensation stipulated by the Minister, to which that person is, in the opinion of the Minister, entitled in consequence of mining operations in pursuance of the rights granted and the obligations imposed by the grant of the Mining Tenement.

Suspension and Cancellation: Stipulation of Process

10. Pursuant to subsection 56(1) of the Act, the Minister may suspend or cancel the Mining Tenement if the Tenement Holder contravenes or fails to comply with a term or condition of this Tenement Document or a provision of the Act (which includes the Regulations).

11. Pursuant to subsection 56(2) of the Act, the Minister may stipulate in the tenement document a process for suspension or cancellation that must be followed before the powers in subsection 56(1) may be exercised.

12. The process for suspension of the Mining Tenement shall be as stipulated in the Fourth Schedule of this Tenement Document.

13. The process for cancellation of the Mining Tenement shall be as stipulated in the Fifth Schedule of this Tenement Document.

Environmental outcomes specified pursuant to Regulation 65 of the Regulations

14. The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act.

Explanatory note: The Sixth Schedule may also contain strategies and criteria which the Department has formed the view would address the outcomes set out in that Schedule.

Restatement of selected provisions from the Act

Explanation of Restatements

15. All of the restatements in this portion of this Tenement Document are included for guidance only and do not replace the substantive provisions of the Act or the Regulations.

16. If any restatement is inconsistent with the substantive provisions of the Act or the Regulations, the restatement will be invalid and the substantive provision of the Act or the Regulations will prevail and the Tenement Holder is required to comply with the substantive provision of the Act or the Regulations.

17. The Tenement Holder is still required to comply with any provision of the Act or Regulations that is not restated in this Tenement Document.

Restatement of obligations imposed on Tenement Holder: Program for environment protection and rehabilitation

18. The Tenement Holder must not carry out mining operations unless there is an approved program for environment protection and rehabilitation (an Approved PEPR).

19. A Proposed PEPR will only be approved when it complies with the requirements of Part 10A of the Act and the Regulations.

20. To comply with Part 10A of the Act, the Proposed PEPR must:

    20.1. Contain the information specified in section 70B(2) of the Act and regulation 65(2), (5), (6) of the Regulations and determinations made by the Minister under regulation 65(7) of the Regulations (if any);

    20.2. Comply with any applicable conditions specified in this Tenement Document (if any);

    20.3. Address any relevant environmental outcomes listed in the Sixth Schedule of this Tenement Document.

    Explanatory note: At the date of grant, the determinations are available at: www.minerals.dpc.sa.gov.au/publications_and_information/ministerial_determinations

21. In accordance with regulation 65(10) of the Regulations, the Tenement Holder must submit to the Department of the Premier and Cabinet for ministerial approval a Proposed

PEPR that fully complies with the Act and Regulations within twelve (12) months after the grant of the Mining Tenement unless the Tenement Holder has been granted an extension of time for such submission.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, GPO Box 320, Adelaide, SA 5001, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Other

22. In addition to obligations about the conduct of mining operations and rehabilitation, the Act and Regulations impose other obligations on the Tenement Holder including obligations to:

    22.1. Comply with the applicable provisions of Part 9 of the Act (entry onto land and use of declared equipment).

    22.2. Comply with the applicable provisions of Part 9B of the Act (native title).

    22.3. Comply with the provisions of section 76 of the Act (mining returns) to the extent relevant to a miscellaneous purposes licence.

    22.4. Comply with section 77 of the Act (records and geological samples) and regulation 84 of the Regulations.

    22.5. Comply, as necessary, with section 83 of the Act (ministerial consent for dealings in relation to the Tenement) and regulations 44 and 70 of the Regulations.

    22.6. Comply, insofar as applicable to a miscellaneous purposes licence, with regulation 86 of the Regulations (compliance reports).

    22.7. Comply with the requirement in regulation 55 of the Regulations to maintain all posts, boundary indicator markers and notices in the positions required by the Regulations as applicable.

    22.8. Permit the pastoral lessee (if any) of the Land to have free access and use at all times for domestic purposes, and for the purposes of watering stock from any surface water on the land which shall not have been provided or stored by artificial means by the Tenement Holder.

Restatement of Exempt Land

23. In accordance with section 9 of the Act, the grant of the Mining Tenement does not authorise prospecting, exploring or mining upon any exempt land unless or until the benefit of the exemption is waived under section 9AA.

Restatement of Bond

24. In accordance with section 62 of the Act, the Minister may by written notice require the Tenement Holder to pay a bond in such sum and subject to such terms and conditions as ensure, in the opinion of the Minister, that the following will be satisfied:

    24.1. Any civil or statutory liability likely to be incurred by the Tenement Holder in the course of carrying out mining operations;

    24.2. The present and future obligations of the Tenement Holder in relation to the rehabilitation of land disturbed by mining operations.

    Explanatory note: The terms and conditions referred to in this paragraph will be imposed in the written notice given by the Minister. The Minister may include a term or condition that the bond may be increased if circumstances arise during the term of this Miscellaneous Purposes Licence which increases the rehabilitation liability or increases the cost of civil or statutory liability.

Restatement of Fees

25. The Tenement Holder shall pay all fees imposed by the Act and Regulations from time to time.

Restatement of Renewal

26. This mining Tenement shall be renewed in accordance with the Act.

Restatement of Surrender

27. The Tenement Holder may apply to surrender the Mining Tenement during its term in accordance with the Act and the Regulations.

Restatement of Forfeiture

28. The Mining Tenement is subject to the forfeiture provision of the Act being section 85.

Restatement of Notices

29. Notices under the Act will be served in accordance with regulation 106 of the Regulations.

Restatement of Mining Register

30. Section 15A of the Act requires the Mining Registrar to keep a register of, amongst other things, miscellaneous purposes licences. Upon payment of the prescribed fee, the public may inspect the Mining Register.

Restatement of Mining Operations

31. As defined by section 6 of the Act "mining operations" means:

    31.1. Operations carried out in the course of prospecting, exploring or mining for minerals; or

    31.2. Without limiting paragraph 28.1, any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

    31.3. On-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

    31.4. Operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

    31.5. Operations that are directly related to any operations under a preceding paragraph;

    but does not include –

    31.6. An investigation or survey under section 15 of the Act; or

    31.7. Fossicking; or

    31.8. The surface removal of loose rock material disturbed by agricultural operations.

32. This definition applies to operations that occur during all phases of the Mining Tenement's life.

Restatement of requirement to notify of a change in status

33. The Tenement Holder must comply with regulation 98(1)(c) and 98(2).

33.1. If the Tenement Holder is a natural person, he or she is required to notify the Mining Registrar of a declaration of bankruptcy within fourteen (14) days of the declaration.

33.2. If the Tenement Holder is a company, it is required to notify the Mining Registrar of its being placed under official management, or in liquidation or receivership within fourteen (14) days of any of those events.

Restatement of Public Liability Insurance

34. The Tenement Holder must comply with regulation 90, which concerns public liability insurance.

Definitions

35. In this Tenement Document, the following words have the following meanings:

35.1. **"Act"** means the *Mining Act 1971* of South Australia;

35.2. **"Additional Terms and Conditions"** means the Additional Terms and Conditions authorised by section 52(3) of the Act and set out in the First and Second Schedules of this Tenement Document respectively;

35.3. **"Approved PEPR"** means the Program for Environment Protection and Rehabilitation under Part 10A of the Act, which has received ministerial approval;

35.4. **"Business Day"** means any day that is not a Saturday, Sunday or a public holiday in South Australia;

35.5. **"Completion"** means the Land has been rehabilitated to an extent that the Minister could approve an application for surrender of the Mining Tenement on the basis that the Tenement holder has complied with sub-regulation 59(1) of the Regulations and there is no obstacle under sub-regulation 59(3) of the Regulations;

35.6. **"Contamination"** and **"contaminated"** mean the presence of chemical substances in concentrations greater than the background concentrations (if any), where the presence of the chemical substances in the greater concentrations has resulted in

35.6.1. Actual or potential harm to the health or safety of human beings that is not trivial, or

35.6.2. Actual or potential harm to water that is not trivial, or

35.6.3. Other actual or potential environmental harm that is not trivial;

35.7. **"DRP"** means Decommissioning and Rehabilitation Plan;

35.8. **"Environmental Values"** means the environmental values recognised in the South Australian Environment Protection (Water Quality) Policy 2015 and the *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Paper No 4'*;

35.9. **"EPA"** means the Environment Protection Authority under the *Environment Protection Act 1993* of South Australia;

35.10. **"miscellaneous purposes licence"** means the Mining Tenement granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.11. **"mining operations"** means the mining operations authorised by Mineral Lease 6471;

35.12. **"Mining Tenement"** or **"Tenement"** means the miscellaneous purposes licence granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.13. **"Minister"** means the Minister for Mineral Resources and Energy (or any substituted Minister);

35.14. **"PEPR"** means Program for Environment Protection and Rehabilitation;

35.15. **"Proposed PEPR"** means the document required by regulation 65(10) of the Regulations to be submitted for ministerial approval within twelve (12) months of the date of grant of the Mining Tenement;

35.16. **"Regulations"** means the Mining Regulations 2011 of South Australia;

35.17. **"Significant Environmental Benefit"** means a benefit provided as a requirement of authorisation to clear native vegetation under the Native Vegetation Regulations 2003.

35.18. **"site"** means the Land;

35.19. **"Tenement Document"** means this document;

35.20. **"Tenement Holder"** means the person, or persons, to whom this Mining Tenement is granted and includes;

35.20.1. If the Tenement Holder is a natural person the executors, administrators and assigns of that person;

35.20.2. If the Tenement Holder is a body corporate the successors, administrators or permitted assigns thereof.

Explanatory note: "The Tenement Holder" has the same meaning as "the mining operator" as defined by section 6 of the Act.

35.21. **"the Land"** means the land over which this Mining Tenement is granted and which is described in paragraphs 5 and 6 of this Tenement Document and in the Third Schedule of this Tenement Document;

35.22. **"the Program"** means the Approved PEPR as defined above;

35.23. **"third party land users"** means the owner of land (as defined by the Act) and any persons lawfully occupying land with the licence of the owner, or the consent of the owner and **"third party land use"**has a corresponding meaning;

35.24. **"Weeds"** means any invasive plant that threatens native vegetation in the local area or any species recognised as invasive in South Australia.

Interpretation

36. For the purposes of interpreting this Tenement Document the following will apply:

36.1. Unless otherwise stated, any term which is used in this Tenement Document which has a specific meaning in the Act or the Regulations, has that same meaning in this Tenement Document;

36.2. The masculine shall include the feminine, words importing persons shall include corporations, and the singular shall include the plural when the context or circumstances require and unless inconsistent with or repugnant to the context the following words shall have the meanings set opposite to them respectively –

36.2.1. "amendment" includes an addition, excision or substitution;

36.2.2. "the Land" includes any part thereof; and

36.2.3. "the term" includes any renewal or extension thereof.

36.3. If the Mining Tenement is granted to more than one person, all of the persons to whom it is granted are all jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document, including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.4. If, by virtue of a dealing under section 83 of the Act, the Mining Tenement comes to be held by more than one person, they will all be jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.5. If any act pursuant to Tenement Document would otherwise be required to be done on a day which is not a Business Day then that act may be done on the next Business Day;

36.6. To the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, the Act or Regulations, the Act or Regulations shall prevail;

36.7. Subject to the transitional provisions in any amendment to the Act or the Regulations, all provisions referred to in this Tenement Document shall be taken to include any such amendment;

36.8. Subject to the transitional provisions in any amendment to the Act or the Regulations, to the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, any amendments to the Act or Regulations, the amended Act or Regulations shall prevail;

36.9. Footnotes and Explanatory notes do not form part of this Tenement Document;

36.10. The contents page does not form part of this Tenement Document;

36.11. The front page and all of the Schedules form part of this Tenement Document.

Executed by the Tenement Holder(s) in accordance with regulation 57

SIGNED by OZM Carrapateena Pty Ltd (ACN 007 756 443))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18.	05/01/18
Date	Date

SIGNED by OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18.	05/01/18
Date	Date

Entered in the Mining Register on 3 January 2018
In accordance with section 15A(1)(c) of the Act.

Signed by .....
Junesse Martin
Mining Registrar

08/01/2018
Date

FIRST SCHEDULE

ADDITIONAL TERMS

Explanatory note: A term is a clause that gives a right to a Mining Tenement.

Authorised Mining Related Activities

1. The Mining Tenement is granted for the purpose of the construction, operation and rehabilitation of a:

   1.1. Network of local (radial) wells;

   1.2. Water-holding and distribution network including:

      1.2.1. ponds/dams;

      1.2.2. piping; and

      1.2.3. pumps;

   1.3. Independent power supply; and

   1.4. Ancillary infrastructure;

   directly related to the conduct of mining operations authorised under mining tenement ML 6471.

2. Mining related activities on the Land must be consistent with the activities described in the Miscellaneous Purposes Licence Management Plan dated 26 May 2017 and subsequent Response Documents dated 22 September 2017, 6 October 2017, 21 November 2017 and 29 November 2017.

SECOND SCHEDULE

ADDITIONAL CONDITIONS

Explanatory note: A condition is a clause that imposes a restriction on a Mining Tenement.

INDEX TO SECOND SCHEDULE (ADDITIONAL CONDITIONS) **Condition No.**

Aboriginal Heritage 1

Waste 2

Removal of Infrastructure 3

Transparency 4

Notification of Cessation of Operations 5

Decommissioning and Rehabilitation Plan (DRP) 6-8

Operating Protocol 9-10

Compliance with Regulation 98(1) 11

Matters of National Environmental Significance 12

Other Legislation 13

Aboriginal Heritage

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Waste

2. The Tenement Holder must ensure that all commercial or industrial waste (which does not include tailings and waste rock) is disposed of in an EPA licensed facility.

Removal of Infrastructure

3. The Tenement Holder must ensure that all mining related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.

Transparency

4. The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.

Notification of Cessation of Operations

5. Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 7.

Decommissioning and Rehabilitation Plan (DRP)

6. The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 7 and 8 when decommissioning or rehabilitating the Mining Tenement.

7. Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 5, and that DRP must:

    7.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;

    7.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).

8. If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:

    8.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 7; and/or

8.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.

Operating Protocol

9. The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:

9.1. interaction with landowner operations;

9.2. emergency procedures;

9.3. communications and issue management processes;

9.4. land management;

9.5. dispute resolution;

9.6. ongoing communication about the Tenement Holder's operations;

9.7. receiving and considering feedback;

9.8. safety procedures;

9.9. access protocols; and

9.10. any matters identified by the Director of Mines (or other authorised officer) in writing.

10. The Tenement Holder must:

10.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and

10.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.

Compliance with Regulation 98(1)

11. A notification required by regulation 98(1) must be in writing.

Matters of National Environmental Significance

12. To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:

12.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;

12.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;

12.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and

12.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions.

Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.

Other Legislation

13. The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the:

13.1. *Environment Protection and Biodiversity Conservation Act 1999;*

13.2. *Development Act 1993;*

13.3. *Planning, Development and Infrastructure Act 2016;*

13.4. *Dangerous Substances Act 1979;*

13.5. *National Parks and Wildlife Act 1972;*

13.6. *Natural Resources Management Act 2004;*

13.7. *Public and Environmental Health Act 1987;*

13.8. *Aboriginal Heritage Act 1988;*

13.9. *Heritage Places Act 1993;*

13.10. *Work Health and Safety Act 2012;*

13.11. *Environment Protection Act 1993;*

13.12. *Radiation Protection and Control Act 1982;*

13.13. *Native Vegetation Act 1991;*

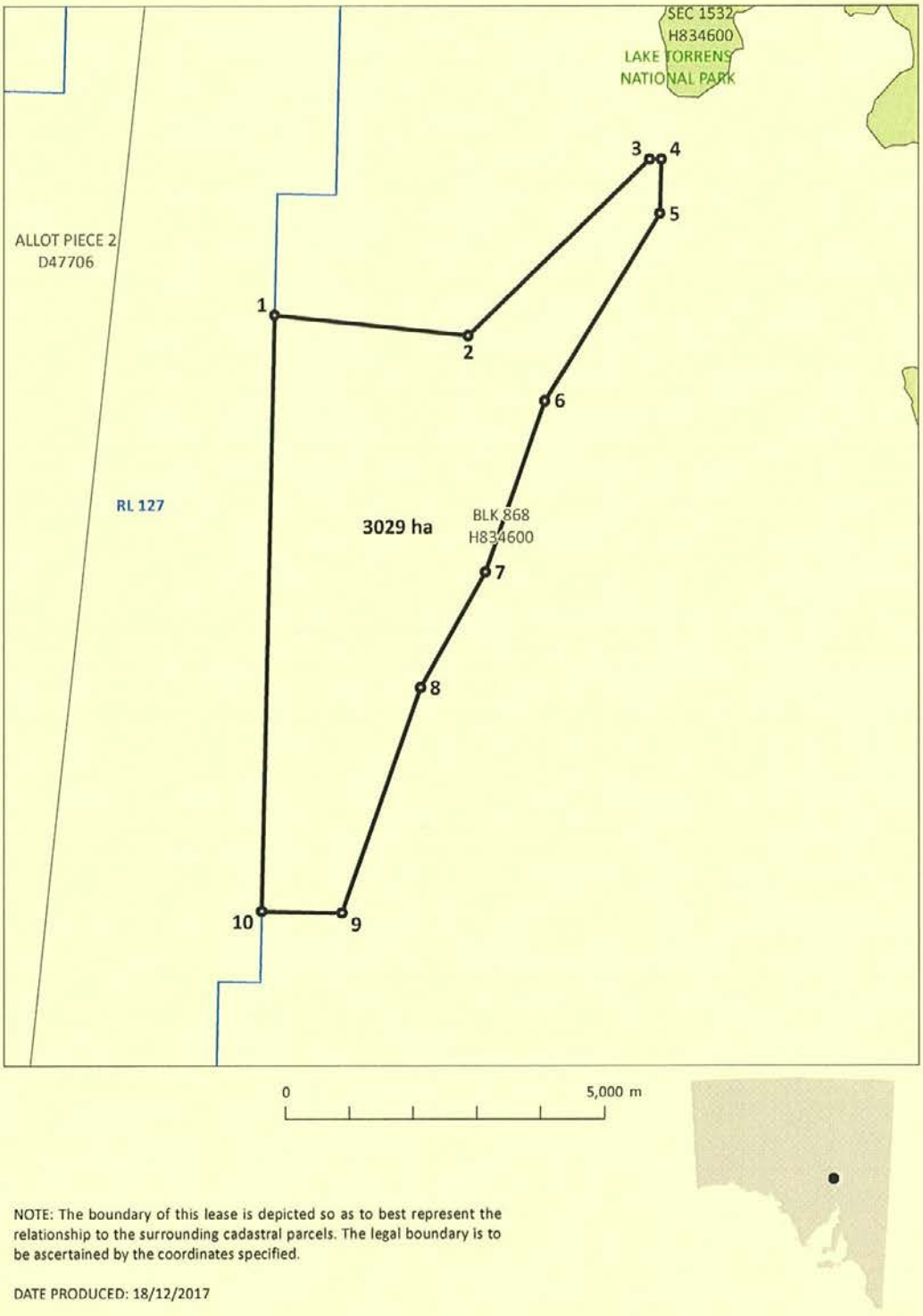
13.14. *Mines and Works Inspection Act 1920;*

13.15. *Road Traffic Act 1961; and*

13.16. *Wilderness Protection Act 1992.*

THIRD SCHEDULE

MAP



NOTE: The boundary of this lease is depicted so as to best represent the relationship to the surrounding cadastral parcels. The legal boundary is to be ascertained by the coordinates specified.

DATE PRODUCED: 18/12/2017

THIRD SCHEDULE

DESCRIPTION OF AREAS

All that part of the State of South Australia, bounded by a line joining the points of coordinates set out in the following table:

Map Grid of Australia 1994 Zone 53

Point	Easting		Northing	
1	740881.11	mE	6541815.54	mN
2	743924.76	mE	6541496.30	mN
3	746770.43	mE	6544240.16	mN
4	746954.57	mE	6544235.84	mN
5	746934.77	mE	6543391.80	mN
6	745131.01	mE	6540484.80	mN
7	744199.43	mE	6537821.59	mN
8	743174.84	mE	6536026.76	mN
9	741937.59	mE	6532520.07	mN
10	740668.63	mE	6532548.92	mN

Area: 3,029 ha

Based on information provided by the applicant.

FOURTH SCHEDULE

PROCESS FOR SUSPENSION

Issuance of Suspension Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to suspend the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder thirty (30) Business Days from the date of the written notice to show cause why the grant of the Mining Tenement should not be suspended ("the Suspension Show Cause Notice").

Minister's action if Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister may suspend the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if Tenement Holder does respond

3. If the Tenement Holder responds to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to suspend the grant of the Mining Tenement (in accordance with the process outlined below).

Written Notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the Minister's decision;

   4.1. if the decision is to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Suspended".

   4.2. if the decision is to not to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Not Suspended".

5. A Notice of Decision: Not Suspended, may contain any information that the Minister considers relevant.

6. A Notice of Decision: Suspended, shall:

6.1. Specify the reason for suspension;

6.2. specify the period of suspension;

6.3. specify the action (if any) the Tenement Holder may be required to take for the Minister to consider revoking the suspension, and the time frame for taking that action;

6.4. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder takes action as specified in Notice of Decision

7. If the Tenement Holder takes the action specified by the Minister under paragraph 6.3, the Minister will consider revoking the suspension.

8. If the Minister revokes the suspension, the Minister will, within a reasonable time write to the Tenement Holder informing the Tenement Holder of the revocation.

Minister's action if Tenement Holder appeals

9. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising the discretion under section 56(4) of the Act, to stay the operation of the suspension until the appeal is finally disposed of.

10. If the Environment, Resources and Development Court, or a court of further appeal finally determines it is satisfied that there is no proper ground for the suspension, and so orders, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

11. All of the stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

11.1. A memorandum Notice of Decision: Suspended;

11.2. A memorandum Notice of Decision: Not Suspended;

11.3. A memorandum of Minister's Decision to Revoke the Suspension;

11.4. A memorandum of Appeal;

11.5. A memorandum of Stay of Suspension by the Minister;

11.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

FIFTH SCHEDULE

PROCESS FOR CANCELLATION

Issuance of Cancellation Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to cancel the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

    1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

    1.2. Give the Tenement Holder sixty (60) Business Days from the date of written notice to show cause why the grant of the Mining Tenement should not be cancelled ("the Cancellation Show Cause Notice").

Minister's action if the Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister may cancel the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if the Tenement Holder does respond

3. If the Tenement Holder responds to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to cancel the grant of the Mining Tenement (in accordance with the process outlined below).

Written notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the decision.

    4.1. If the decision is to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Cancelled".

    4.2. If the decision is not to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Not Cancelled".

5. A Notice of Decision: Not Cancelled may contain any information that the Minister considers relevant.

6. A Notice of Decision: Cancelled shall:

   6.1. Specify the reason for cancellation;

   6.2. specify the date from which cancellation is effective; and

   6.3. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder appeals

7. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising his discretion under section 56(4) of the Act, to stay the operation of the cancellation until the appeal is finally disposed of.

8. If the Environment, Resources and Development Court or a court of further appeal finally determines that it is satisfied that there is no proper ground for the cancellation, and so orders, and the cancellation has not been stayed by the Minister under section 56(4) of the Act, or by order of the Environment, Resources and Development Court, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

9. All stages in the cancellation process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

   9.1. A memorandum Notice of Decision: Cancelled;

   9.2. A memorandum of Notice of Decision: Not Cancelled;

   9.3. A memorandum of Minister's Decision to Revoke the Cancellation;

   9.4. A memorandum of Appeal;

   9.5. A memorandum of Stay of Cancellation by the Minister;

   9.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

SIXTH SCHEDULE

ENVIRONMENTAL OUTCOMES

AND ASSOCIATED CRITERIA AND STRATEGIES PURSUANT TO REGULATION 65 OF THE MINING REGULATIONS 2011

Explanatory note: The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act. The Sixth Schedule may also specify requirements for strategies and criteria relevant to the outcomes set out in that Schedule.

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Groundwater Outcome 15

Aboriginal Heritage Outcome

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Public Safety Outcomes

2. The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.

3. The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining related activities are as low as reasonably practicable.

Public Nuisance Outcome

4. The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining related traffic.

Traffic Outcome

5. The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.

Weeds and Pests Outcome

6. The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities.

Land Use and Property Outcomes

7. The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).
8. Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.
9. The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.

Land and Soil Outcome

10. The Tenement Holder must, ensure that:

    10.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining related activities; and

    10.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining related activities.

Native Vegetation Outcome

11. The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a Significant Environmental Benefit has been approved in accordance with the relevant legislation.

Native Fauna Outcome

12. The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.

Surface Water Outcome

13. The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining related activities.

Surface Water Strategies – Contamination, Erosion and Sediments

14. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 13:

    14.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining related activities leaves the Land.

14.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining related activities is effectively managed and controlled.

14.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining related activities is effectively managed and controlled.

14.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.

Groundwater Outcomes

15. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining related activities.

Appendix A5.
MPL 154 Southern Access Road and Radial Wellfield

Government of South Australia

Mining Act 1971

TENEMENT DOCUMENT

MISCELLANEOUS PURPOSES LICENCE

TENEMENT HOLDER	OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255)
MISCELLANEOUS PURPOSES LICENCE NUMBER	154
PURPOSE	Southern Access Road and Radial Wellfield: Authorised mining related activities as specified in the First Schedule.
COMMENCEMENT DATE	3 January 2018
TERM OF MINING TENEMENT	Twenty-one (21) years
EXPIRY DATE	2 January 2039
AREA OF MINING TENEMENT	1,867 hectares

DATE BY WHICH THE PROPOSED PEPR MUST BE SUBMITTED: 2 January 2019

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Details of Grant of a Mining Tenement

1. On 3 January 2018, pursuant to Part 8 of the Act, the Minister made a statutory grant of a miscellaneous purposes licence (the Mining Tenement) described in this Tenement Document.

2. The Mining Tenement is granted:

   2.1. To OZM Carrapateena Pty Ltd (ACN 007 756 443) and OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255);

   2.2. For the purpose of authorised mining related activities as specified in the First Schedule.

3. The Mining Tenement is numbered MPL 154.

4. The Mining Tenement is:

   4.1. Subject to the Terms and Conditions prescribed by the Act and Regulations and specified in this Tenement Document; and

   4.2. Subject to the Additional Terms and Conditions specified in the First and Second Schedules (respectively) of this Tenement Document.

Terms and conditions required by the Act to be specified in the Tenement Document

Description of the Land

5. The Mining Tenement is granted over an area of 1,867 hectares and is located in the Pernatty area, approximately 67km southeast of Woomera.

6. The location of the Mining Tenement is more specifically defined in the map and coordinates specified in the Third Schedule of this Tenement Document.

Term, Commencement and Expiration

7. The Mining Tenement is granted for the term of twenty-one (21) years. The term of the Mining Tenement commenced on 3 January 2018, and, unless it is earlier renewed, surrendered or cancelled, the Mining Tenement will cease on 2 January 2039.

Rental

8. The Tenement Holder shall pay, by way of rental, such sums as may be prescribed and in accordance with section 52(6), (7), (8) and (9) of the Act and regulation 54 of the Regulations.

Compensation

9. The Minister may, at any time, require the Tenement Holder to pay to any person an amount of compensation stipulated by the Minister, to which that person is, in the opinion of the Minister, entitled in consequence of mining operations in pursuance of the rights granted and the obligations imposed by the grant of the Mining Tenement.

Suspension and Cancellation: Stipulation of Process

10. Pursuant to subsection 56(1) of the Act, the Minister may suspend or cancel the Mining Tenement if the Tenement Holder contravenes or fails to comply with a term or condition of this Tenement Document or a provision of the Act (which includes the Regulations).

11. Pursuant to subsection 56(2) of the Act, the Minister may stipulate in the tenement document a process for suspension or cancellation that must be followed before the powers in subsection 56(1) may be exercised.

12. The process for suspension of the Mining Tenement shall be as stipulated in the Fourth Schedule of this Tenement Document.

13. The process for cancellation of the Mining Tenement shall be as stipulated in the Fifth Schedule of this Tenement Document.

Environmental outcomes specified pursuant to Regulation 65 of the Regulations

14. The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act.

Explanatory note: The Sixth Schedule may also contain strategies and criteria which the Department has formed the view would address the outcomes set out in that Schedule.

Restatement of selected provisions from the Act

Explanation of Restatements

15. All of the restatements in this portion of this Tenement Document are included for guidance only and do not replace the substantive provisions of the Act or the Regulations.

16. If any restatement is inconsistent with the substantive provisions of the Act or the Regulations, the restatement will be invalid and the substantive provision of the Act or the Regulations will prevail and the Tenement Holder is required to comply with the substantive provision of the Act or the Regulations.

17. The Tenement Holder is still required to comply with any provision of the Act or Regulations that is not restated in this Tenement Document.

Restatement of obligations imposed on Tenement Holder: Program for environment protection and rehabilitation

18. The Tenement Holder must not carry out mining operations unless there is an approved program for environment protection and rehabilitation (an Approved PEPR).

19. A Proposed PEPR will only be approved when it complies with the requirements of Part 10A of the Act and the Regulations.

20. To comply with Part 10A of the Act, the Proposed PEPR must:

    20.1. Contain the information specified in section 70B(2) of the Act and regulation 65(2),(5),(6) of the Regulations and determinations made by the Minister under regulation 65(7) of the Regulations (if any);

    20.2. Comply with any applicable conditions specified in this Tenement Document (if any);

    20.3. Address any relevant environmental outcomes listed in the Sixth Schedule of this Tenement Document.

    Explanatory note: At the date of grant, the determinations are available at: www.minerals.dpc.sa.gov.au/publications_and_information/ministerial_determinations

21. In accordance with regulation 65(10) of the Regulations, the Tenement Holder must submit to the Department of the Premier and Cabinet for ministerial approval a Proposed PEPR that fully complies with the Act and Regulations within twelve (12) months after the grant of the Mining Tenement unless the Tenement Holder has been granted an extension of time for such submission.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, GPO Box 320, Adelaide, SA 5001, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Other

22. In addition to obligations about the conduct of mining operations and rehabilitation, the Act and Regulations impose other obligations on the Tenement Holder including obligations to:

22.1. Comply with the applicable provisions of Part 9 of the Act (entry onto land and use of declared equipment).

22.2. Comply with the applicable provisions of Part 9B of the Act (native title).

22.3. Comply with the provisions of section 76 of the Act (mining returns) to the extent relevant to a miscellaneous purposes licence.

22.4. Comply with section 77 of the Act (records and geological samples) and regulation 84 of the Regulations.

22.5. Comply, as necessary, with section 83 of the Act (ministerial consent for dealings in relation to the Tenement) and regulations 44 and 70 of the Regulations.

22.6. Comply, insofar as applicable to a miscellaneous purposes licence, with regulation 86 of the Regulations (compliance reports).

22.7. Comply with the requirement in regulation 55 of the Regulations to maintain all posts, boundary indicator markers and notices in the positions required by the Regulations as applicable.

22.8. Permit the pastoral lessee (if any) of the Land to have free access and use at all times for domestic purposes, and for the purposes of watering stock from any surface water on the land which shall not have been provided or stored by artificial means by the Tenement Holder.

Restatement of Exempt Land

23. In accordance with section 9 of the Act, the grant of the Mining Tenement does not authorise prospecting, exploring or mining upon any exempt land unless or until the benefit of the exemption is waived under section 9AA.

Restatement of Bond

24. In accordance with section 62 of the Act, the Minister may by written notice require the Tenement Holder to pay a bond in such sum and subject to such terms and conditions as ensure, in the opinion of the Minister, that the following will be satisfied:

    24.1. Any civil or statutory liability likely to be incurred by the Tenement Holder in the course of carrying out mining operations;

    24.2. The present and future obligations of the Tenement Holder in relation to the rehabilitation of land disturbed by mining operations.

    Explanatory note: The terms and conditions referred to in this paragraph will be imposed in the written notice given by the Minister. The Minister may include a term or condition that the bond may be increased if circumstances arise during the term of this Miscellaneous Purposes Licence which increases the rehabilitation liability or increases the cost of civil or statutory liability.

Restatement of Fees

25. The Tenement Holder shall pay all fees imposed by the Act and Regulations from time to time.

Restatement of Renewal

26. This mining Tenement shall be renewed in accordance with the Act.

Restatement of Surrender

27. The Tenement Holder may apply to surrender the Mining Tenement during its term in accordance with the Act and the Regulations.

Restatement of Forfeiture

28. The Mining Tenement is subject to the forfeiture provision of the Act being section 85.

Restatement of Notices

29. Notices under the Act will be served in accordance with regulation 106 of the Regulations.

Restatement of Mining Register

30. Section 15A of the Act requires the Mining Registrar to keep a register of, amongst other things, miscellaneous purposes licences. Upon payment of the prescribed fee, the public may inspect the Mining Register.

Restatement of Mining Operations

31. As defined by section 6 of the Act "mining operations" means:

    31.1. Operations carried out in the course of prospecting, exploring or mining for minerals; or

    31.2. Without limiting paragraph 28.1, any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

    31.3. On-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

    31.4. Operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

    31.5. Operations that are directly related to any operations under a preceding paragraph;

    but does not include –

    31.6. An investigation or survey under section 15 of the Act; or

    31.7. Fossicking; or

    31.8. The surface removal of loose rock material disturbed by agricultural operations.

32. This definition applies to operations that occur during all phases of the Mining Tenement's life.

Restatement of requirement to notify of a change in status

33. The Tenement Holder must comply with regulation 98(1)(c) and 98(2).

33.1. If the Tenement Holder is a natural person, he or she is required to notify the Mining Registrar of a declaration of bankruptcy within fourteen (14) days of the declaration.

33.2. If the Tenement Holder is a company, it is required to notify the Mining Registrar of its being placed under official management, or in liquidation or receivership within fourteen (14) days of any of those events.

Restatement of Public Liability Insurance

34. The Tenement Holder must comply with regulation 90, which concerns public liability insurance.

Definitions

35. In this Tenement Document, the following words have the following meanings:

35.1. **"Act"** means the *Mining Act 1971* of South Australia;

35.2. **"Additional Terms and Conditions"** means the Additional Terms and Conditions authorised by section 52(3) of the Act and set out in the First and Second Schedules of this Tenement Document respectively;

35.3. **"Approved PEPR"** means the Program for Environment Protection and Rehabilitation under Part 10A of the Act, which has received ministerial approval;

35.4. **"Business Day"** means any day that is not a Saturday, Sunday or a public holiday in South Australia;

35.5. **"Completion"** means the Land has been rehabilitated to an extent that the Minister could approve an application for surrender of the Mining Tenement on the basis that the Tenement holder has complied with sub-regulation 59(1) of the Regulations and there is no obstacle under sub-regulation 59(3) of the Regulations;

35.6. **"Contamination"** and **"contaminated"** mean the presence of chemical substances in concentrations greater than the background concentrations (if any), where the presence of the chemical substances in the greater concentrations has resulted in

35.6.1. Actual or potential harm to the health or safety of human beings that is not trivial, or

35.6.2. Actual or potential harm to water that is not trivial, or

35.6.3. Other actual or potential environmental harm that is not trivial;

35.7. **"DRP"** means Decommissioning and Rehabilitation Plan;

35.8. **"Environmental Values"** means the environmental values recognised in the South Australian Environment Protection (Water Quality) Policy 2015 and the 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Paper No 4';

35.9. **"EPA"** means the Environment Protection Authority under the *Environment Protection Act 1993* of South Australia;

35.10. **"miscellaneous purposes licence"** means the Mining Tenement granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.11. **"mining operations"** means the mining operations authorised by Mineral Lease 6471;

35.12. **"Mining Tenement"** or **"Tenement"** means the miscellaneous purposes licence granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.13. **"Minister"** means the Minister for Mineral Resources and Energy (or any substituted Minister);

35.14. **"PEPR"** means Program for Environment Protection and Rehabilitation;

35.15. **"Proposed PEPR"** means the document required by regulation 65(10) of the Regulations to be submitted for ministerial approval within twelve (12) months of the date of grant of the Mining Tenement;

35.16. **"Regulations"** means the Mining Regulations 2011 of South Australia;

35.17. **"Significant Environmental Benefit"** means a benefit provided as a requirement of authorisation to clear native vegetation under the Native Vegetation Regulations 2003.

35.18. **"site"** means the Land;

35.19. **"Tenement Document"** means this document;

35.20. **"Tenement Holder"** means the person, or persons, to whom this Mining Tenement is granted and includes;

35.20.1. If the Tenement Holder is a natural person the executors, administrators and assigns of that person;

35.20.2. If the Tenement Holder is a body corporate the successors, administrators or permitted assigns thereof.

Explanatory Note: "The Tenement Holder" has the same meaning as "the mining operator" as defined by section 6 of the Act.

35.21. **"the Land"** means the land over which this Mining Tenement is granted and which is described in paragraphs 5 and 6 of this Tenement Document and in the Third Schedule of this Tenement Document;

35.22. **"the Program"** means the Approved PEPR as defined above;

35.23. **"third party land users"** means the owner of land (as defined by the Act) and any persons lawfully occupying land with the licence of the owner, or the consent of the owner and **"third party land use"** has a corresponding meaning;

35.24. **"Weeds"** means any invasive plant that threatens native vegetation in the local area or any species recognised as invasive in South Australia.

Interpretation

36. For the purposes of interpreting this Tenement Document the following will apply:

36.1. Unless otherwise stated, any term which is used in this Tenement Document which has a specific meaning in the Act or the Regulations, has that same meaning in this Tenement Document;

36.2. The masculine shall include the feminine, words importing persons shall include corporations, and the singular shall include the plural when the context or circumstances require and unless inconsistent with or repugnant to the context the following words shall have the meanings set opposite to them respectively –

36.2.1. "amendment" includes an addition, excision or substitution;

36.2.2. "the Land" includes any part thereof; and

36.2.3. "the term" includes any renewal or extension thereof.

36.3. If the Mining Tenement is granted to more than one person, all of the persons to whom it is granted are all jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document, including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.4. If, by virtue of a dealing under section 83 of the Act, the Mining Tenement comes to be held by more than one person, they will all be jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.5. If any act pursuant to Tenement Document would otherwise be required to be done on a day which is not a Business Day then that act may be done on the next Business Day;

36.6. To the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, the Act or Regulations, the Act or Regulations shall prevail;

36.7. Subject to the transitional provisions in any amendment to the Act or the Regulations, all provisions referred to in this Tenement Document shall be taken to include any such amendment;

36.8. Subject to the transitional provisions in any amendment to the Act or the Regulations, to the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, any amendments to the Act or Regulations, the amended Act or Regulations shall prevail;

36.9. Footnotes and Explanatory notes do not form part of this Tenement Document;

36.10. The contents page does not form part of this Tenement Document;

36.11. The front page and all of the Schedules form part of this Tenement Document.

MISCELLANEOUS PURPOSES LICENCE 154

Executed by the Tenement Holder(s) in accordance with regulation 57

SIGNED by OZM Carrapateena Pty Ltd (ACN 007 756 443))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18	05/01/18
Date	Date

SIGNED by OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of ~~Director~~/Secretary
Andrew Cole Managing Director & CEO	Michelle Pole
Print Name of Director	Print Name of ~~Director~~/Secretary
05/01/18	05/01/18
Date	Date

Entered in the Mining Register on 3 January 2018
In accordance with section 15A(1)(c) of the Act.

Signed by .....
Junesse Martin
Mining Registrar

08/01/2018
Date

FIRST SCHEDULE

ADDITIONAL TERMS

Explanatory note: A term is a clause that gives a right to a Mining Tenement

Authorised Mining Related Activities

1. The Mining Tenement is granted for the purpose of the construction, operation and rehabilitation of a:

    1.1. Network of local (radial) wells;

    1.2. Water-holding and distribution network including:

        1.2.1. ponds/dams;

        1.2.2. piping; and

        1.2.3. pumps;

    1.3. Independent power supply;

    1.4. Southern Access Road to the site; and

    1.5. Ancillary infrastructure;

    directly related to the conduct of mining operations authorised under mining tenement ML 6471.

2. Mining related activities on the Land must be consistent with the activities described in the Miscellaneous Purposes Licence Management Plan dated 26 May 2017 and subsequent Response Documents dated 22 September 2017, 6 October 2017, 21 November 2017 and 29 November 2017.

SECOND SCHEDULE

ADDITIONAL CONDITIONS

Explanatory note: A condition is a clause that imposes a restriction on a Mining Tenement.

INDEX TO SECOND SCHEDULE (ADDITIONAL CONDITIONS) **Condition No.**

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Concentrate Transport 2

Waste 3

Removal of Infrastructure 4

Transparency 5

Notification of Cessation of Operations 6

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Matters of National Environmental Significance 13

Other Legislation 14

Aboriginal Heritage

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Concentrate Transport

2. The Tenement Holder must during operations ensure that copper concentrate is transported in fit for purpose sealed containers to prevent copper concentrate release to the environment.

Waste

3. The Tenement Holder must ensure that all commercial or industrial waste (which does not include tailings and waste rock) is disposed of in an EPA licensed facility.

Removal of Infrastructure

4. The Tenement Holder must ensure that all mining related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.

Transparency

5. The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.

Notification of Cessation of Operations

6. Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 8.

Decommissioning and Rehabilitation Plan (DRP)

7. The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 8 and 9 when decommissioning or rehabilitating the Mining Tenement.

8. Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 6, and that DRP must:

    8.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;

    8.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).

9. If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:

   9.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 8; and/or

   9.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.

Operating Protocol

10. The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:

    10.1. interaction with landowner operations;

    10.2. emergency procedures;

    10.3. communications and issue management processes;

    10.4. land management;

    10.5. dispute resolution;

    10.6. ongoing communication about the Tenement Holder's operations;

    10.7. receiving and considering feedback;

    10.8. safety procedures;

    10.9. access protocols; and

    10.10. any matters identified by the Director of Mines (or other authorised officer) in writing.

11. The Tenement Holder must:

    11.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and

    11.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.

Compliance with Regulation 98(1)

12. A notification required by regulation 98(1) must be in writing.

Matters of National Environmental Significance

13. To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:

    13.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;

    13.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;

    13.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and

    13.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions.

Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.

Other Legislation

14. The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the:

    14.1. *Environment Protection and Biodiversity Conservation Act 1999;*

    14.2. *Development Act 1993;*

    14.3. *Planning, Development and Infrastructure Act 2016;*

    14.4. *Dangerous Substances Act 1979;*

    14.5. *National Parks and Wildlife Act 1972;*

    14.6. *Natural Resources Management Act 2004;*

    14.7. *Public and Environmental Health Act 1987;*

    14.8. *Aboriginal Heritage Act 1988;*

    14.9. *Heritage Places Act 1993;*

    14.10. *Work Health and Safety Act 2012;*

14.11. *Environment Protection Act 1993;*

14.12. *Radiation Protection and Control Act 1982;*

14.13. *Native Vegetation Act 1991;*

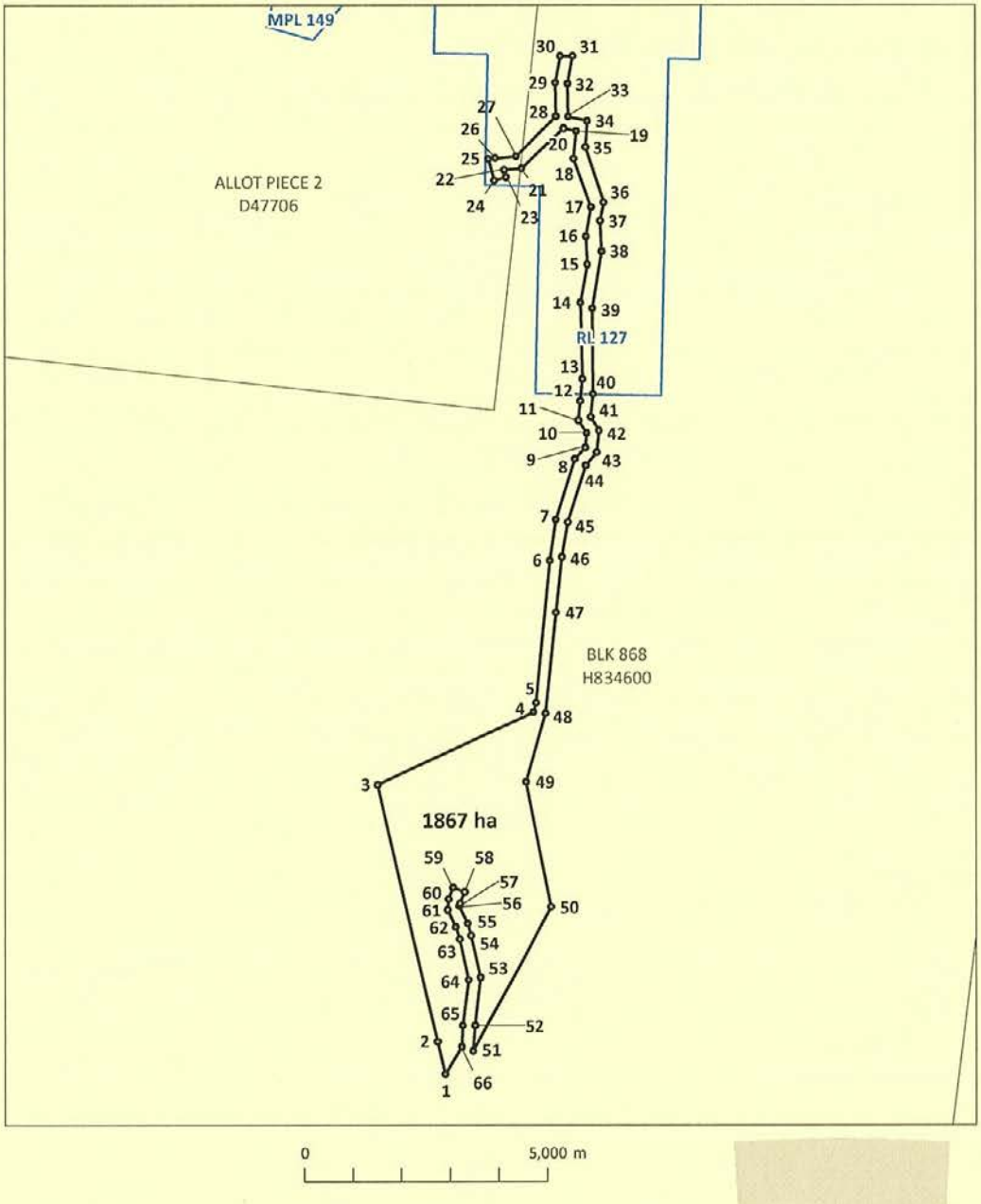
14.14. *Mines and Works Inspection Act 1920;*

14.15. *Road Traffic Act 1961; and*

14.16. *Wilderness Protection Act 1992.*

THIRD SCHEDULE

MAP



NOTE: The boundary of this lease is depicted so as to best represent the relationship to the surrounding cadastral parcels. The legal boundary is to be ascertained by the coordinates specified.

DATE PRODUCED: 18/12/2017

THIRD SCHEDULE

DESCRIPTION OF AREAS

All that part of the State of South Australia, bounded by a line joining the points of coordinates set out in the following table:

Map Grid of Australia 1994 Zone 53			Map Grid of Australia 1994 Zone 53		
Point	Easting	Northing	Point	Easting	Northing
1	735364.0 m	6510616. m	34	738310.0 m	6530171. m
2	735202.9 m	6511285. m	35	738269.8 m	6529629. m
3	733972.5 m	6516567. m	36	738649.7 m	6528496. m
4	737178.3 m	6518041. m	37	738575.6 m	6528124. m
5	737236.9 m	6518239. m	38	738606.3 m	6527494. m
6	737529.2 m	6521148. m	39	738419.4 m	6526322. m
7	737648.0 m	6521990. m	40	738421.9 m	6524562. m
8	738049.4 m	6523231. m	41	738376.2 m	6524093. m
9	738263.0 m	6523472. m	42	738548.9 m	6523822. m
10	738291.5 m	6523761. m	43	738503.8 m	6523367. m
11	738119.0 m	6524031. m	44	738271.2 m	6523105. m
12	738157.2 m	6524423. m	45	737893.8 m	6521938. m
13	738210.4 m	6524878. m	46	737773.4 m	6521222. m
14	738165.6 m	6526446. m	47	737650.2 m	6520086. m
15	738311.2 m	6527227. m	48	737431.7 m	6518013. m
16	738280.4 m	6527803. m	49	737017.5 m	6516618. m
17	738387.6 m	6528394. m	50	737544.0 m	6514050. m
18	738025.8 m	6529396. m	51	735941.4 m	6511101. m
19	738080.4 m	6529966. m	52	735976.8 m	6511621. m
20	737825.4 m	6530024. m	53	736092.9 m	6512610. m
21	736945.1 m	6529200. m	54	735892.5 m	6513469. m
22	736584.4 m	6529169. m	55	735830.9 m	6513713. m
23	736623.5 m	6529018. m	56	735648.4 m	6514073. m
24	736389.8 m	6528955. m	57	735666.3 m	6514125. m
25	736271.0 m	6529388. m	58	735759.8 m	6514362. m
26	736409.8 m	6529405. m	59	735527.2 m	6514454. m
27	736832.2 m	6529441. m	60	735433.7 m	6514217. m
28	737662.6 m	6530266. m	61	735411.3 m	6513994. m
29	737653.9 m	6530956. m	62	735584.6 m	6513650. m
30	737758.4 m	6531504. m	63	735655.8 m	6513389. m
31	738011.8 m	6531499. m	64	735845.2 m	6512557. m
32	737904.2 m	6530934. m	65	735726.1 m	6511622. m
33	737912.6 m	6530260. m	66	735707.0 m	6511189. m

Area: 1,867 ha

Based on information provided by the applicant.

FOURTH SCHEDULE

PROCESS FOR SUSPENSION

Issuance of Suspension Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to suspend the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder thirty (30) Business Days from the date of the written notice to show cause why the grant of the Mining Tenement should not be suspended ("the Suspension Show Cause Notice").

Minister's action if Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister may suspend the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if Tenement Holder does respond

3. If the Tenement Holder responds to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to suspend the grant of the Mining Tenement (in accordance with the process outlined below).

Written Notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the Minister's decision;

   4.1. if the decision is to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Suspended".

   4.2. if the decision is to not to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Not Suspended".

5. A Notice of Decision: Not Suspended, may contain any information that the Minister considers relevant.

6. A Notice of Decision: Suspended, shall:

6.1. Specify the reason for suspension;

6.2. specify the period of suspension;

6.3. specify the action (if any) the Tenement Holder may be required to take for the Minister to consider revoking the suspension, and the time frame for taking that action;

6.4. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder takes action as specified in Notice of Decision

7. If the Tenement Holder takes the action specified by the Minister under paragraph 6.3, the Minister will consider revoking the suspension.

8. If the Minister revokes the suspension, the Minister will, within a reasonable time write to the Tenement Holder informing the Tenement Holder of the revocation.

Minister's action if Tenement Holder appeals

9. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising the discretion under section 56(4) of the Act, to stay the operation of the suspension until the appeal is finally disposed of.

10. If the Environment, Resources and Development Court, or a court of further appeal finally determines it is satisfied that there is no proper ground for the suspension, and so orders, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

11. All of the stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

11.1. A memorandum Notice of Decision: Suspended;

11.2. A memorandum Notice of Decision: Not Suspended;

11.3. A memorandum of Minister's Decision to Revoke the Suspension;

11.4. A memorandum of Appeal;

11.5. A memorandum of Stay of Suspension by the Minister;

11.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

FIFTH SCHEDULE

PROCESS FOR CANCELLATION

Issuance of Cancellation Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to cancel the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

    1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

    1.2. Give the Tenement Holder sixty (60) Business Days from the date of written notice to show cause why the grant of the Mining Tenement should not be cancelled ("the Cancellation Show Cause Notice").

Minister's action if the Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister may cancel the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if the Tenement Holder does respond

3. If the Tenement Holder responds to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to cancel the grant of the Mining Tenement (in accordance with the process outlined below).

Written notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the decision.

    4.1. If the decision is to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Cancelled".

    4.2. If the decision is not to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Not Cancelled".

5. A Notice of Decision: Not Cancelled may contain any information that the Minister considers relevant.

6. A Notice of Decision: Cancelled shall:

   6.1. Specify the reason for cancellation;

   6.2. specify the date from which cancellation is effective; and

   6.3. inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder appeals

7. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising his discretion under section 56(4) of the Act, to stay the operation of the cancellation until the appeal is finally disposed of.

8. If the Environment, Resources and Development Court or a court of further appeal finally determines that it is satisfied that there is no proper ground for the cancellation, and so orders, and the cancellation has not been stayed by the Minister under section 56(4) of the Act, or by order of the Environment, Resources and Development Court, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

9. All stages in the cancellation suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

   9.1. A memorandum Notice of Decision: Cancelled;

   9.2. A memorandum of Notice of Decision: Not Cancelled;

   9.3. A memorandum of Minister's Decision to Revoke the Cancellation;

   9.4. A memorandum of Appeal;

   9.5. A memorandum of Stay of Cancellation by the Minister;

   9.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

SIXTH SCHEDULE

ENVIRONMENTAL OUTCOMES

AND ASSOCIATED CRITERIA AND STRATEGIES PURSUANT TO REGULATION 65 OF THE MINING REGULATIONS 2011

Explanatory note: The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act. The Sixth Schedule may also specify requirements for strategies and criteria relevant to the outcomes set out in that Schedule.

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Native Fauna Outcome 12

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Groundwater Outcome 15

Aboriginal Heritage Outcome

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Public Safety Outcomes

2. The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.

3. The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining related activities are as low as reasonably practicable.

Public Nuisance Outcome

4. The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining related traffic.

Traffic Outcome

5. The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.

Weeds and Pests Outcome

6. The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities.

Land Use and Property Outcomes

7. The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).
8. Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.
9. The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.

Land and Soil Outcome

10. The Tenement Holder must, ensure that:

    10.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining related activities; and

    10.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining related activities.

Native Vegetation Outcome

11. The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation.

Native Fauna Outcome

12. The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.

Surface Water Outcome

13. The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining related activities.

Surface Water Strategies – Contamination, Erosion and Sediments

14. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 13:

    14.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining related activities leaves the Land.

14.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining related activities is effectively managed and controlled.

14.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining related activities is effectively managed and controlled.

14.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.

Groundwater Outcome

15. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining related activities.

Appendix A6.
MPL 156 Northern Wellfield

Government of South Australia

Mining Act 1971

TENEMENT DOCUMENT

MISCELLANEOUS PURPOSES LICENCE

TENEMENT HOLDER	OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255) OZM Carrapateena Pty Ltd (ACN 007 756 443)
MISCELLANEOUS PURPOSES LICENCE NUMBER	156
PURPOSE	Establishment of a Northern Wellfield including bore fields, pipelines and access roads and associated infrastructure.
COMMENCEMENT DATE	11 December 2018
TERM OF MINING TENEMENT	Twenty (20) years and twenty-three (23) days
EXPIRY DATE	2 January 2039
AREA OF MINING TENEMENT	16,413 hectares

DATE BY WHICH THE PROPOSED PEPR MUST BE SUBMITTED: 10 December 2019

MISCELLANEOUS PURPOSES LICENCE 156

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MISCELLANEOUS PURPOSES LICENCE 156

Details of Grant of a Mining Tenement

1. On 11 December 2018, pursuant to Part 8 of the Act, the Minister made a statutory grant of a miscellaneous purposes licence (the Mining Tenement) described in this Tenement Document.

2. The Mining Tenement is granted:

   2.1. To OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255) and OZM Carrapateena Pty Ltd (ACN 007 756 443);

   2.2. For the purpose of establishing a Northern Wellfield including bore fields, pipelines and access roads and associated infrastructure.

3. The Mining Tenement is numbered 156.

4. The Mining Tenement is:

   4.1. Subject to the Terms and Conditions prescribed by the Act and Regulations and specified in this Tenement Document; and

   4.2. Subject to the Additional Terms and Conditions specified in the First and Second Schedules (respectively) of this Tenement Document.

Terms and conditions required by the Act to be specified in the Tenement Document

Description of the Land

5. The Mining Tenement is granted over an area of 16,413 hectares and is located in the Arcoona area, approximately 45 km east-northeast of Woomera.

6. The location of the Mining Tenement is more specifically defined in the map and coordinates specified in the Third Schedule of this Tenement Document.

Term, Commencement and Expiration

7. The Mining Tenement is granted for the term of twenty (20) years and twenty-three (23) days. The term of the Mining Tenement commenced on 11 December 2018, and, unless it is earlier renewed, surrendered or cancelled, the Mining Tenement will cease on 2 January 2039.

Rental

8. The Tenement Holder shall pay, by way of rental, such sums as may be prescribed and in accordance with section 52(6),(7),(8) and (9) of the Act and regulation 54 of the Regulations.

Compensation

9. The Minister may, at any time, require the Tenement Holder to pay to any person an amount of compensation stipulated by the Minister, to which that person is, in the opinion of the Minister, entitled in consequence of mining operations in pursuance of the rights granted and the obligations imposed by the grant of the Mining Tenement.

Suspension and Cancellation: Stipulation of Process

10. Pursuant to subsection 56(1) of the Act, the Minister may suspend or cancel the Mining Tenement if the Tenement Holder contravenes or fails to comply with a term or condition of this Tenement Document or a provision of the Act (which includes the Regulations).

11. Pursuant to subsection 56(2) of the Act, the Minister may stipulate in the tenement document a process for suspension or cancellation that must be followed before the powers in subsection 56(1) may be exercised.

12. The process for suspension of the Mining Tenement shall be as stipulated in the Fourth Schedule of this Tenement Document.

13. The process for cancellation of the Mining Tenement shall be as stipulated in the Fifth Schedule of this Tenement Document.

Environmental outcomes specified pursuant to Regulation 65 of the Regulations

14. The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act.

Explanatory note: The Sixth Schedule may also contain strategies and criteria which the Department has formed the view would address the outcomes set out in that Schedule.

MISCELLANEOUS PURPOSES LICENCE 156

Restatement of selected provisions from the Act

Explanation of Restatements

15. All of the restatements in this portion of this Tenement Document are included for guidance only and do not replace the substantive provisions of the Act or the Regulations.

16. If any restatement is inconsistent with the substantive provisions of the Act or the Regulations, the restatement will be invalid and the substantive provision of the Act or the Regulations will prevail and the Tenement Holder is required to comply with the substantive provision of the Act or the Regulations.

17. The Tenement Holder is still required to comply with any provision of the Act or Regulations that is not restated in this Tenement Document.

Restatement of obligations imposed on Tenement Holder: Program for environment protection and rehabilitation

18. The Tenement Holder must not carry out mining operations unless there is an approved program for environment protection and rehabilitation (an Approved PEPR).

19. A Proposed PEPR will only be approved when it complies with the requirements of Part 10A of the Act and the Regulations.

20. To comply with Part 10A of the Act, the Proposed PEPR must:

    20.1. Contain the information specified in section 70B(2) of the Act and regulation 65(2),(5),(6) of the Regulations and determinations made by the Minister under regulation 65(7) of the Regulations (if any);

    20.2. Comply with any applicable conditions specified in this Tenement Document (if any);

    20.3. Address any relevant environmental outcomes listed in the Sixth Schedule of this Tenement Document.

    Explanatory note: At the date of grant, the determinations are available at: www.minerals.dpc.sa.gov.au/publications_and_information/ministerial_determinations

21. In accordance with regulation 65(10) of the Regulations, the Tenement Holder must submit to the Department of the Premier and Cabinet for ministerial approval a Proposed

PEPR that fully complies with the Act and Regulations within twelve (12) months after the grant of the Mining Tenement unless the Tenement Holder has been granted an extension of time for such submission.

Explanatory note: Until otherwise notified, the Tenement Holder may apply for an extension of time in writing to the Director of Mines, GPO Box 320, Adelaide, SA 5001, setting out the reasons why the Tenement Holder seeks an extension and the date when the Tenement Holder estimates that the document will be ready for submission to the Minister.

Restatement of obligations imposed on Tenement Holder: Other

22. In addition to obligations about the conduct of mining operations and rehabilitation, the Act and Regulations impose other obligations on the Tenement Holder including obligations to:

22.1. Comply with the applicable provisions of Part 9 of the Act (entry onto land and use of declared equipment).

22.2. Comply with the applicable provisions of Part 9B of the Act (native title).

22.3. Comply with the provisions of section 76 of the Act (mining returns) to the extent relevant to a miscellaneous purposes licence.

22.4. Comply with section 77 of the Act (records and geological samples) and regulation 84 of the Regulations.

22.5. Comply, as necessary, with section 83 of the Act (ministerial consent for dealings in relation to the Tenement) and regulations 44 and 70 of the Regulations.

22.6. Comply, insofar as applicable to a miscellaneous purposes licence, with regulation 86 of the Regulations (compliance reports).

22.7. Comply with the requirement in regulation 55 of the Regulations to maintain all posts, boundary indicator markers and notices in the positions required by the Regulations as applicable.

22.8. Permit the pastoral lessee (if any) of the Land to have free access and use at all times for domestic purposes, and for the purposes of watering stock from any surface water on the land which shall not have been provided or stored by artificial means by the Tenement Holder.

Restatement of Exempt Land

23. In accordance with section 9 of the Act, the grant of the Mining Tenement does not authorise prospecting, exploring or mining upon any exempt land unless or until the benefit of the exemption is waived under section 9AA.

Restatement of Bond

24. In accordance with section 62 of the Act, the Minister may by written notice require the Tenement Holder to pay a bond in such sum and subject to such terms and conditions as ensure, in the opinion of the Minister, that the following will be satisfied:

    24.1. Any civil or statutory liability likely to be incurred by the Tenement Holder in the course of carrying out mining operations;

    24.2. The present and future obligations of the Tenement Holder in relation to the rehabilitation of land disturbed by mining operations.

    Explanatory note: The terms and conditions referred to in this paragraph will be imposed in the written notice given by the Minister. The Minister may include a term or condition that the bond may be increased if circumstances arise during the term of this Miscellaneous Purposes Licence which increases the rehabilitation liability or increases the cost of civil or statutory liability.

Restatement of Fees

25. The Tenement Holder shall pay all fees imposed by the Act and Regulations from time to time.

Restatement of Renewal

26. This mining Tenement shall be renewed in accordance with the Act.

Restatement of Surrender

27. The Tenement Holder may apply to surrender the Mining Tenement during its term in accordance with the Act and the Regulations.

Restatement of Forfeiture

28. The Mining Tenement is subject to the forfeiture provision of the Act being section 85.

Restatement of Notices

29. Notices under the Act will be served in accordance with regulation 106 of the Regulations.

Restatement of Mining Register

30. Section 15A of the Act requires the Mining Registrar to keep a register of, amongst other things, miscellaneous purposes licences. Upon payment of the prescribed fee, the public may inspect the Mining Register.

Restatement of Mining Operations

31. As defined by section 6 of the Act "mining operations" means:

    31.1. Operations carried out in the course of prospecting, exploring or mining for minerals; or

    31.2. Without limiting paragraph 28.1, any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

    31.3. On-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

    31.4. Operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

    31.5. Operations that are directly related to any operations under a preceding paragraph;

    but does not include –

    31.6. An investigation or survey under section 15 of the Act ; or

    31.7. Fossicking; or

    31.8. The surface removal of loose rock material disturbed by agricultural operations.

32. This definition applies to operations that occur during all phases of the Mining Tenement's life.

Restatement of requirement to notify of a change in status

33. The Tenement Holder must comply with regulation 98(1)(c) and 98(2).

    33.1. If the Tenement Holder is a natural person, he or she is required to notify the Mining Registrar of a declaration of bankruptcy within fourteen (14) days of the declaration.

33.2. If the Tenement Holder is a company, it is required to notify the Mining Registrar of its being placed under official management, or in liquidation or receivership within fourteen (14) days of any of those events.

Restatement of Public Liability Insurance

34. Comply with regulation 90, which concerns public liability insurance.

Definitions

35. In this Tenement Document, the following words have the following meanings:

35.1. "**Act**" means the *Mining Act 1971* of South Australia;

35.2. "**Additional Terms and Conditions**" means the Additional Terms and Conditions authorised by section 52(3) of the Act and set out in the First and Second Schedule of this Tenement Document respectively;

35.3. "**Approved PEPR**" means the program for environment protection and rehabilitation under Part 10A of the Act, which has received ministerial approval;

35.4. "**Business Day**" means any day that is not a Saturday, Sunday or a public holiday in South Australia;

35.5. **"Completion"** means the Land has been rehabilitated to an extent that the Minister could approve an application for surrender of the Mining Tenement on the basis that the Tenement Holder has complied with sub-regulation 59(1) of the Regulations and there is no obstacle under sub-regulation 59(3) of the Regulations;

35.6. "**Contamination**" and "**contaminated**" mean the presence of chemical substances in concentrations greater than the background concentrations (if any), where the presence of the chemical substances in the greater concentrations has resulted in:

35.6.1. Actual or potential harm to the health or safety of human beings that is not trivial, or

35.6.2. Actual or potential harm to water that is not trivial, or

35.6.3. Other actual or potential environmental harm that is not trivial;

35.7. "**DRP**" means the Decommissioning and Rehabilitation Plan;

35.8. **"Environmental Values"** means the environmental values recognised in the South Australian Environment Protection (Water Quality) Policy 2015 and *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Paper No 4';*

35.9. **"EPA"** means the Environment Protection Authority under the *Environment Protection Act 1993* of South Australia;

35.10. **"mining operations"** means the mining operations authorised by Mineral Lease 6471;

35.11. "**Mining Tenement**" or "**Tenement**" means the Mining Tenement granted to the Tenement Holder, as referred to in paragraphs 1 of this Tenement Document;

35.12. "**Minister**" means the Minister for Energy and Mining (or any substituted Minister);

35.13. "**Miscellaneous Purposes Licence**" means the Mining Tenement granted to the Tenement Holder as referred to in paragraph 1 of this Tenement Document;

35.14. "**PEPR**" means Program for Environment Protection and Rehabilitation;

35.15. "**Proposed PEPR**" means the document required by regulation 65(10) of the Regulations to be submitted for ministerial approval within twelve (12) months of the date of grant of the Mining Tenement;

35.16. "**Regulations**" means the Mining Regulations 2011 of South Australia;

35.17. **"Significant Environmental Benefit"** means a benefit provided as a requirement of authorisation to clear native vegetation under the Native Vegetation Regulations 2003;

35.18. "**site**" means the Land;

35.19. "**Tenement Document**" means this document;

35.20. "**Tenement Holder**" means the person, or persons, to whom this Mining Tenement is granted and includes;

35.20.1. If the Tenement Holder is a natural person the executors, administrators and assigns of that person;

35.20.2. If the Tenement Holder is a body corporate the successors, administrators or permitted assigns thereof;

Explanatory Note: "The Tenement Holder" has the same meaning as "the mining operator" as defined by section 6 of the Act.

35.21. **"the Land"** means the land over which this Mining Tenement is granted and which is described in paragraphs 5 and 6 of this Tenement Document and in the Third Schedule of this Tenement Document;

35.22. **"the Program"** means the Approved PEPR as defined above;

35.23. "**third party land users**" means the owner of land (as defined by the Act) and any persons lawfully occupying land with the licence of the owner, or the consent of the owner and "**third party land use**" has a corresponding meaning;

35.24. "**Weeds**" means any invasive plant that threatens native vegetation in the local area or any species recognised as invasive in South Australia.

Interpretation

36. For the purposes of interpreting this Tenement Document the following will apply:

36.1. Unless otherwise stated, any term which is used in this Tenement Document which has a specific meaning in the Act or the Regulations, has that same meaning in this Tenement Document;

36.2. The masculine shall include the feminine, words importing persons shall include corporations, and the singular shall include the plural when the context or circumstances require and unless inconsistent with or repugnant to the context the following words shall have the meanings set opposite to them respectively –

36.2.1. "amendment" includes an addition, excision or substitution;

36.2.2. "the Land" includes any part thereof; and

36.2.3. "the term" includes any renewal or extension thereof.

36.3. If the Mining Tenement is granted to more than one person, all of the persons to whom it is granted are all jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document, including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.4. If, by virtue of a dealing under section 83 of the Act, the Mining Tenement comes to be held by more than one person, they will all be jointly and severally liable for compliance with the Act, the Regulations and this Tenement Document including the Additional Terms and Conditions in the First and Second Schedules of this Tenement Document respectively;

36.5. If any act pursuant to Tenement Document would otherwise be required to be done on a day which is not a Business Day then that act may be done on the next Business Day;

36.6. To the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or Condition, and, on the other hand, the Act or Regulations, the Act or Regulations shall prevail;

36.7. Subject to the transitional provisions in any amendment to the Act or the Regulations, all provisions referred to in this Tenement Document shall be taken to include any such amendment;

36.8. Subject to the transitional provisions in any amendment to the Act or the Regulations, to the extent that there is any inconsistency, on the one hand, between a term of this Tenement Document or any Additional Term or

Condition, and, on the other hand, any amendments to the Act or Regulations, the amended Act or Regulations shall prevail;

36.9. Footnotes and Explanatory notes do not form part of this Tenement Document;

36.10. The contents page does not form part of this Tenement Document;

36.11. The front page and all of the Schedules form part of this Tenement Document.

Executed by the Tenement Holder(s) in accordance with regulation 57

SIGNED by OZ Minerals Carrapateena Pty Ltd (ACN 149 626 255)) and
OZM Carrapateena Pty Ltd (ACN 007 756 443))
in accordance with section 127 of the)
Corporations Act 2001 and its Constitution)

.....	.....
Signature of Director	Signature of Director/~~Secretary~~
ANDREW COLE.	MRS RANSON.
Print Name of Director	Print Name of Director/Secretary
14/1/19	14/1/19
Date	Date

Entered in the Mining Register on 11 December 2018
In accordance with section 15A(1)(c) of the Act.

Signed by .....
Junesse Martin
Mining Registrar

17/1/2019
Date

FIRST SCHEDULE

ADDITIONAL TERMS

Explanatory Note: A term is a clause that gives a right to a Mining Tenement

Authorised Mining Related Activities

1. Construction, operation and rehabilitation of:
   - 1.1. A network of wells;
   - 1.2. Water holding and distribution network including:
     - 1.2.1. ponds/dams;
     - 1.2.2. piping; and
     - 1.2.3. pumps;
   - 1.3. independent power supply; and
   - 1.4. ancillary infrastructure;

   directly related to the conduct of mining operations authorized under mining tenement ML6471.

2. Mining related activities on the Land must be consistent with the activities described in the Miscellaneous Purposes Licence Management Plan dated June 2018 and subsequent Response Document dated 11 October 2018.

SECOND SCHEDULE

ADDITIONAL CONDITIONS

Explanatory Note: A condition is a clause that imposes a restriction on a Mining Tenement.

INDEX TO SECOND SCHEDULE (ADDITIONAL CONDITIONS) Condition No.

Aboriginal Heritage 1

Waste 2

Removal of Infrastructure 3

Transparency 4

Notification of Cessation of Operations 5

Decommissioning and Rehabilitation Plan (DRP) 6-8

Operating Protocol 9-10

Compliance with Regulation 98(1) 11

Other Legislation 12

Aboriginal Heritage

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Waste

2. The Tenement Holder must ensure that all commercial or industrial waste (which does not include CTP process residue, tailings and waste rock) is disposed of in an EPA licensed facility.

Removal of Infrastructure

3. The Tenement Holder must ensure that all mining related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain

Transparency

4. The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.

Notification of Cessation of Operations

5. Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 7

Decommissioning and Rehabilitation Plan (DRP)

6. The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 7 and 8 when decommissioning or rehabilitating the Mining Tenement.
7. Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 5, and that DRP must:
    7.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;
    7.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).
8. If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:

8.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 7; and/or

8.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.

Operating Protocol

9. The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:

    9.1. interaction with landowner operations;

    9.2. emergency procedures;

    9.3. communications and issue management processes;

    9.4. land management;

    9.5. dispute resolution;

    9.6. ongoing communication about the Tenement Holder's operations;

    9.7. receiving and considering feedback;

    9.8. safety procedures;

    9.9. access protocols; and

    9.10. any matters identified by the Director of Mines (or other authorised officer) in writing.

10. The Tenement Holder must:

    10.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and

    10.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.

Compliance with Regulation 98(1)

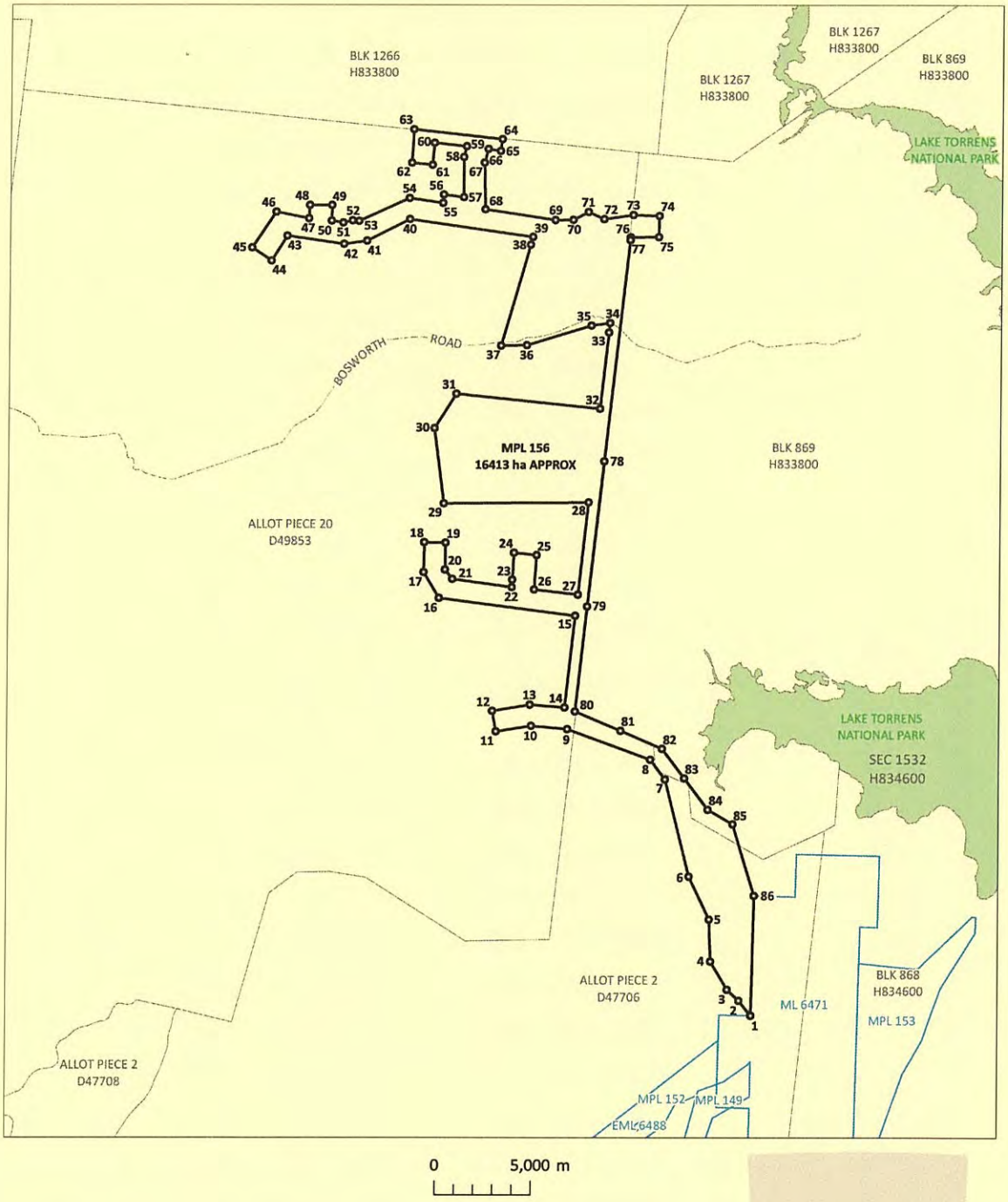
11. A notification required by regulation 98(1) must be in writing.

Other Legislation

12. The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the:
    - 12.1. *Environment Protection and Biodiversity Conservation Act 1999;*
    - 12.2. *Development Act 1993;*
    - 12.3. *Planning, Development and Infrastructure Act 2016;*
    - 12.4. *Dangerous Substances Act 1979;*
    - 12.5. *National Parks and Wildlife Act 1972;*
    - 12.6. *Natural Resources Management Act 2004;*
    - 12.7. *Public and Environmental Health Act 1987;*
    - 12.8. *Aboriginal Heritage Act 1988;*
    - 12.9. *Heritage Places Act 1993;*
    - 12.10. *Work Health and Safety Act 2012;*
    - 12.11. *Environment Protection Act 1993*
    - 12.12. *Radiation Protection and Control Act 1982;*
    - 12.13. *Native Vegetation Act 1991;*
    - *12.14. Mines and Works Inspection Act 1920;*
    - *12.15. Road Traffic Act 1961; and*
    - *12.16. Wilderness Protection Act 1992.*

THIRD SCHEDULE

MAP



NOTE: The boundary of this lease is depicted so as to best represent the relationship to the surrounding cadastral parcels. The legal boundary is to be ascertained by the coordinates specified.

DATE PRODUCED: 3/01/2019

THIRD SCHEDULE

DESCRIPTION OF AREAS

All that part of the State of South Australia, bounded by a line joining the points of coordinates set out in the following table:

Map Grid of Australia 1994 Zone 53

Point	Easting		Northing	
1	735256.32	mE	6539079.49	mN
2	734631.99	mE	6539855.37	mN
3	734008.29	mE	6540423.91	mN
4	733134.17	mE	6541904.59	mN
5	733042.31	mE	6544082.04	mN
6	731978.07	mE	6546320.42	mN
7	730698.49	mE	6551390.59	mN
8	729921.30	mE	6552417.37	mN
9	725607.68	mE	6554004.41	mN
10	723714.31	mE	6554173.53	mN
11	721883.22	mE	6553885.13	mN
12	721690.30	mE	6554958.85	mN
13	723649.23	mE	6555282.16	mN
14	725460.44	mE	6555138.81	mN
15	725982.36	mE	6559925.37	mN
16	718871.04	mE	6560846.04	mN
17	718070.47	mE	6562196.36	mN
18	718097.91	mE	6563764.57	mN
19	719199.35	mE	6563741.62	mN
20	719178.58	mE	6562327.72	mN
21	719571.35	mE	6561842.06	mN
22	722665.56	mE	6561419.46	mN
23	722684.39	mE	6561809.24	mN
24	722774.78	mE	6563216.18	mN
25	723946.24	mE	6563098.62	mN
26	723824.21	mE	6561295.74	mN
27	726109.86	mE	6561027.37	mN
28	726632.02	mE	6565846.62	mN
29	719092.18	mE	6565787.81	mN
30	718587.75	mE	6569726.03	mN

31	719712.23	mE	6571518.59	mN
32	727198.84	mE	6570741.06	mN
33	727625.35	mE	6574730.49	mN
34	727681.36	mE	6575221.28	mN
35	726717.71	mE	6575092.75	mN
36	723358.30	mE	6574062.53	mN
37	722018.38	mE	6574033.26	mN
38	723524.43	mE	6579320.39	mN
39	723636.10	mE	6579724.80	mN
40	717220.09	mE	6580639.60	mN
41	714991.44	mE	6579511.75	mN
42	713787.65	mE	6579339.11	mN
43	710825.39	mE	6579769.97	mN
44	710009.21	mE	6578475.67	mN
45	708990.18	mE	6579154.12	mN
46	710235.33	mE	6581020.98	mN
47	711939.51	mE	6580686.40	mN
48	711980.76	mE	6581371.65	mN
49	713141.28	mE	6581369.60	mN
50	713128.78	mE	6580554.64	mN
51	713738.52	mE	6580462.56	mN
52	714216.27	mE	6580569.21	mN
53	714567.18	mE	6580551.16	mN
54	717196.40	mE	6581754.95	mN
55	718934.87	mE	6581493.16	mN
56	718969.61	mE	6581931.28	mN
57	720015.55	mE	6581793.65	mN
58	720007.09	mE	6583900.52	mN
59	720153.94	mE	6584462.85	mN
60	718478.41	mE	6584642.13	mN
61	718380.47	mE	6583480.41	mN
62	717305.03	mE	6583592.61	mN
63	717401.95	mE	6585346.94	mN
64	722007.80	mE	6584837.76	mN
65	721918.64	mE	6584214.65	mN
66	721275.46	mE	6584324.72	mN
67	721085.29	mE	6583606.91	mN

68	721146.84	mE	6581165.09	mN
69	724803.84	mE	6580609.11	mN
70	725735.46	mE	6580620.56	mN
71	726527.71	mE	6581026.81	mN
72	727340.19	mE	6580659.00	mN
73	728840.78	mE	6580878.95	mN
74	730209.71	mE	6580825.87	mN
75	730182.14	mE	6579723.03	mN
76	728712.60	mE	6579711.08	mN
77	728696.80	mE	6579566.40	mN
78	727434.58	mE	6568006.23	mN
79	726603.47	mE	6560408.15	mN
80	726006.31	mE	6554930.92	mN
81	728365.51	mE	6553918.01	mN
82	730535.56	mE	6552993.86	mN
83	731709.28	mE	6551448.76	mN
84	732953.76	mE	6549807.37	mN
85	734245.37	mE	6549058.16	mN
86	735396.14	mE	6545329.14	mN

Area: 16,413 ha

Based on information provided by the applicant.

FOURTH SCHEDULE

PROCESS FOR SUSPENSION

Issuance of Suspension Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to suspend the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder thirty (30) Business Days from the date of the written notice to show cause why the grant of the Mining Tenement should not be suspended ("the Suspension Show Cause Notice").

Minister's action if Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister may suspend the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if Tenement Holder does respond

3. If the Tenement Holder responds to the Suspension Show Cause Notice within thirty (30) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to suspend the grant of the Mining Tenement (in accordance with the process outlined below).

Written Notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the Minister's decision;

   4.1. If the decision is to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Suspended".

   4.2. If the decision is to not to suspend the grant of the Mining Tenement, the written notice shall be called "Notice of Decision: Not Suspended".

5. A Notice of Decision: Not Suspended, may contain any information that the Minister considers relevant.

6. A Notice of Decision: Suspended, shall:

   6.1. Specify the reason for suspension;

   6.2. Specify the period of suspension;

   6.3. Specify the action (if any) the Tenement Holder may be required to take for the Minister to consider revoking the suspension, and the time frame for taking that action;

   6.4. Inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder takes action as specified in Notice of Decision

7. If the Tenement Holder takes the action specified by the Minister under paragraph 6.3, the Minister will consider revoking the suspension.
8. If the Minister revokes the suspension, the Minister will, within a reasonable time write to the Tenement Holder informing the Tenement Holder of the revocation.

Minister's action if Tenement Holder appeals

9. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising the discretion under section 56(4) of the Act, to stay the operation of the suspension until the appeal is finally disposed of.
10. If the Environment, Resources and Development Court, or a court of further appeal finally determines it is satisfied that there is no proper ground for the suspension, and so orders, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

11. All of the stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

    11.1. A memorandum Notice of Decision: Suspended;

    11.2. A memorandum Notice of Decision: Not Suspended;

    11.3. A memorandum of Minister's Decision to Revoke the Suspension;

    11.4. A memorandum of Appeal;

    11.5. A memorandum of Stay of Suspension by the Minister;

11.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

FIFTH SCHEDULE

PROCESS FOR CANCELLATION

Issuance of Cancellation Show Cause Notice

1. Where the Minister is of the view that there may be grounds to consider whether to cancel the grant of the Mining Tenement, the Minister shall give written notice to the Tenement Holder, which shall:

   1.1. Specify the provision of the Act or the Regulations, or the term or condition of the grant of the Mining Tenement, that the Minister believes the Tenement Holder has contravened or failed to comply with; and

   1.2. Give the Tenement Holder sixty (60) Business Days from the date of written notice to show cause why the grant of the Mining Tenement should not be cancelled ("the Cancellation Show Cause Notice").

Minister's action if the Tenement Holder does not respond

2. If the Tenement Holder does not respond to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister may cancel the grant of the Mining Tenement without further notice (in accordance with the process outlined below).

Minister's action if the Tenement Holder does respond

3. If the Tenement Holder responds to the Cancellation Show Cause Notice within sixty (60) Business Days, the Minister will consider the Tenement Holder's submission and decide whether to cancel the grant of the Mining Tenement (in accordance with the process outlined below).

Written notice of Minister's decision

4. The Minister shall give written notice to the Tenement Holder of the decision.

   4.1. If the decision is to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Cancelled".

   4.2. If the decision is not to cancel the grant of the Mining Tenement, the written notice shall be called "the Notice of Decision: Not Cancelled".

5. A Notice of Decision: Not Cancelled may contain any information that the Minister considers relevant.

6. A Notice of Decision: Cancelled shall:

   6.1. Specify the reason for cancellation;

   6.2. Specify the date from which cancellation is effective; and

   6.3. Inform the Tenement Holder of their right of appeal to the Environment, Resources and Development Court in accordance with subsection 56(3) of the Act.

Minister's action if Tenement Holder appeals

7. If the Tenement Holder appeals to the Environment, Resources and Development Court the Minister will consider exercising his discretion under section 56(4) of the Act, to stay the operation of the cancellation until the appeal is finally disposed of.

8. If the Environment, Resources and Development Court or a court of further appeal finally determines that it is satisfied that there is no proper ground for the cancellation, and so orders, and the cancellation has not been stayed by the Minister under section 56(4) of the Act, or by order of the Environment, Resources and Development Court, the Minister will reinstate the grant of the Mining Tenement in accordance with section 56(5) of the Act.

The Mining Register

9. All stages in the suspension process shall be recorded on the Mining Register by way of appropriate memoranda, for example:

   9.1. A memorandum Notice of Decision: Cancelled;

   9.2. A memorandum of Notice of Decision: Not Cancelled;

   9.3. A memorandum of Minister's Decision to Revoke the Cancellation;

   9.4. A memorandum of Appeal;

   9.5. A memorandum of Stay of Cancellation by the Minister;

   9.6. Memoranda of all of the courts' orders (whether the Environment, Resources and Development Court or subsequent appeal courts).

SIXTH SCHEDULE

ENVIRONMENTAL OUTCOMES

AND ASSOCIATED CRITERIA AND STRATEGIES PURSUANT TO REGULATION 65 OF THE MINING REGULATIONS 2011

Explanatory Note: The Sixth Schedule of this Tenement Document sets out outcomes contemplated in regulation 65(2) of the Regulations, that the Tenement Holder is required to address in any program submitted in accordance with Part 10A of the Act. The Sixth Schedule may also specify requirements for strategies and criteria relevant to the outcomes set out in that Schedule.

INDEX TO SIXTH SCHEDULE Clause No.

Aboriginal Heritage Outcome 1

Traffic Outcome 2

Weeds and Pests Outcome 3

Land Use and Property Outcomes 4-6

Land and Soil Outcome 7

Native Vegetation Outcome 8

Native Vegetation Strategies 9

Native Fauna Outcome 10

Surface Water Outcome 11

Surface Water Strategies – Contamination, Erosion and Sediments 12

Surface Water Fauna Strategies 13

Groundwater Outcomes 14-15

Groundwater Quality Strategies 16

Aboriginal Heritage Outcome

1. The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.

Traffic Outcome

2. The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.

Weeds and Pests Outcome

3. The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities.

Land Use and Property Outcomes

4. The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).
5. Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.
6. The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.

Land and Soil Outcome

7. The Tenement Holder must, ensure that:
    7.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining related activities; and
    7.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining related activities.

Native Vegetation Outcome

8. The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a Significant Environmental Benefit has been approved in accordance with the relevant legislation.

Native Vegetation Strategies

9. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Native Vegetation Outcome in Sixth Schedule Clause 8;

   9.1. Where baseline native vegetation condition (abundance and diversity) is required as a component of the measurement criteria, baseline native vegetation surveys must be undertaken prior to the influence of mining operations or mining related activities on the existing environment.

Native Fauna Outcome

10. The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.

Surface Water Outcome

11. The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining related activities.

Surface Water Strategies – Contamination, Erosion and Sediments

12. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 11:

12.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining related activities leaves the Land.

12.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining related activities is effectively managed and controlled.

12.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining related activities is effectively managed and controlled.

12.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.

Surface Water Fauna Strategies

13. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Native Fauna Outcome in Sixth Schedule Clause 10;

13.1. Where baseline fauna condition (abundance and diversity) is required as a component of the measurement criteria, baseline fauna surveys must be undertaken prior to the influence of mining operations or mining related activities on the existing environment.

Groundwater Outcomes

14. The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model (Appendix B. of the Miscellaneous Purposes Licence Management Plan for the Northern Wellfield June 2018), as a result of mining operations or mining related activities.

15. The Tenement Holder must during construction, operation and post completion ensure that there is no adverse change to the environmental values of the groundwater within the shallow perched aquifer within the Land as a result of chemicals or hydrocarbons from mining operations or mining related activities.

Groundwater Quantity Strategies

16. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Groundwater Outcome in Sixth Schedule Clause 14;

16.1. Provide a transient groundwater model that delineates the predicted extent of groundwater drawdown within the groundwater aquifers.

16.2. Establish a program for the ongoing calibration of the transient groundwater model using data obtained from ongoing groundwater monitoring.

Appendix A7.
Conditions demonstrated commitment

A7.1 | ML 6471 Mineral Lease – Tenement Conditions Demonstrated Commitment

No.	Condition	Demonstrated Commitment
FIRST SCHEDULE ADDITIONAL TERMS		
Acknowledged		
SECOND SCHEDULE ADDITIONAL CONDITIONS		
Aboriginal Heritage		
1.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Chapter 7.3.1 Aboriginal heritage; Outcome Measurement Criteria - AH1, Outcome Measurement Criteria - AH2 and Leading Indicator - AH3
Tailings Storage Facility (TSF)		
2.	The Tenement Holder must ensure that post Completion, all final mine landforms (including the TSF) will be chemically and physically stable in the long term.	Section 5.4.8.2 Tailings storage facility and decant dam, Section 7.3.12.1 Erosion and sedimentation, Section 7.3.12.3 Tailings storage facility and Section 7.3.13.1 Tailings storage facility
3.	Following completion of detailed design of the TSF and Decant Dam, the following documentation for the TSF and Decant Dam must be developed and maintained: 3.1. Construction documentation; 3.2. Design drawings and quantity schedule; 3.3. Technical specifications; 3.4. Construction Quality Assurance (CQA) Manual; 3.5. Operations, Maintenance and Surveillance (OMS) Manual; and 3.6. Dam Safety Emergency Plan (DSEP). *Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Documents.*	The documentation will be subject to the ongoing auditing requirements in Section 7.3.12.3 Tailings storage facility and Section 9.1 Tailings storage facility design, audits, monitoring and test work. Section 4.10 details the construction and operation of the TSF, with Section 5.4.8.2 detailing the closure of the TSF. BHP maintains the TSF DSEP (current version Document No. 20144293-056-R-Rev0 dated 16 March 2023), the TSF CQA (current version Document No. 20144293-013-S-Rev3 dated 25 October 2021) and the OMS (current version Document No. CA-3630-CIV-MNL-1003 dated 16 March 2023)
Tailings Storage Facility (TSF) Audits		
4.	The TSF and Decant Dam construction, operation and closure must be audited against (i) the design, design criteria and plans that have been adopted for the TSF and Decant Dam construction, operation and closure, (ii) all of the documentation listed in Second Schedule Condition 3 and (iii) the most recent version of the ANCOLD Tailings Dam Guideline: 4.1. for the Stage 1 TSF and Decant Dam embankment foundation preparation and embankment construction; and 4.2. for each subsequent stage of TSF and Decant Dam embankment foundation preparation and embankment construction; and 4.3. on a three (3) monthly basis during Stages 1 and 2 of TSF and Decant Dam operations or at a frequency as the Director of Mines (or other authorised officer) may specify by notice in writing; and 4.4. on a six (6) monthly basis during Stages 3, 4, 5 and 6 (and any subsequent stages) of TSF and Decant Dam operations or at a frequency as the Director of Mines (or other authorised officer) may specify by notice in writing; and 4.5. after the final discharge of tailings into the TSF and prior to commencement of final rehabilitation, closure and decommissioning of the TSF and Decant Dam; and 4.6. after the final TSF and Decant Dam rehabilitation, closure and decommissioning works have been completed.	Auditing requirements and commitments detailed in Section 7.3.12.3 Tailings storage facility, Leading Indicator – TSF11, Leading Indicator – TSF15, Leading Indicator – TSF16, Section 7.3.13.1 Tailings storage facility and Section 9.1 Tailings storage facility design, audits, monitoring and test work
5.	The expert must prepare reports of the findings of each audit.	Auditing requirements and commitments detailed in Section 7.3.12.3 Tailings storage facility and Section 9.1 Tailings storage facility design, audits, monitoring and test work
6.	The initial expert report for the audit of the Stage 1 TSF and Decant Dam foundation preparation and embankment construction must be provided to the Director of Mines (or other authorised officer) prior to the placement of tailings and waste into the TSF.	Chapter 7.7.12.3 Tailings storage facility; Leading Indicator TSF11, section 9.1 Tailings storage facility design, audits, monitoring and test work
7.	The expert report for the audit which occurs after the final discharge of tailings into the TSF must be provided to the Director of Mines (or other authorised officer) prior to the commencement of final rehabilitation of the TSF and Decant Dam.	Chapter 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria TSF35
8.	All other expert reports must be provided to the Director of Mines (or other authorised officer) within forty-five (45) days or such longer period approved by the Director of Mines (or other authorised officer) of completion of the audit.	Commitment acknowledged
9.	All expert reports will be made publically available.	Commitment acknowledged
10.	The expert reports for the audits of Stage 1 and each subsequent stage of TSF embankment construction must address the following matters (but not limited to): 10.1. Demonstrate that sufficient freeboard has been achieved to ensure flood storage capacity for a 1-in-100 AEP rainfall event including wave freeboards (1 in 10 AEP winds) and contingency freeboard of 0.5 m; 10.2. Demonstrate emergency spillways for each stage of the operation have the capacity for flow resulting from a 1-in-1000 AEP critical duration event including wave freeboard;	Chapter 7.3.12.3 Tailings storage facility; Leading Indicator – TSF11 and Leading Indicator - TSF15, Section 9.1 Tailings storage facility design, audits, monitoring and test work

No.	Condition	Demonstrated Commitment
	10.3. Demonstrate that tailings properties in operations are consistent with the adopted tailings properties, including density and strength as specified in the detailed final design;	
	10.3.1. Should the tailings density or strength be inconsistent, undertake an assessment of the potential impact on the TSF (including, but not limited to, TSF storage capacity) and propose any remediation to the design if deemed necessary;	
	10.4. Liquefaction assessment based on in-situ test work of the tailings prior to upstream raises;	
	10.5. A seismic hazard assessment (SHA) to provide site-specific peak ground acceleration (PGA) parameters for stability assessments;	
	10.6. The geometry of upstream raises and foundation treatment has been confirmed prior to each upstream raise;	
	10.7. The suitability and compatibility of the various embankment fill materials has been assessed; and	
	10.8. Assessment of all of the documentation listed in Second Schedule Condition 3 to ensure that the content of the documents is appropriate for the next stage of TSF embankment construction.	
11.	The expert report for the audit which occurs after the final TSF and Decant Dam rehabilitation, closure and decommissioning works have been completed must address the following matters (but not limited to):	Chapter 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria - TSF36, Section 9.6 Completion audits, surveys and monitoring
	11.1. Spillway designed for the seventy-two (72) hour PMP critical duration event and in accordance with ANCOLD;	
	11.2. Decant system is decommissioned in accordance with the design; and	
	11.3. Reshaping of the TSF embankment in accordance with the design to provide a profile that is resistant to erosion.	
	Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.	
12.	The audits required by Second Schedule Conditions 4.1, 4.2, 4.5, 4.6 and associated reports required by Second Schedule Condition 5 must be conducted and provided by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer).	Chapter 7.3.12.3 Tailings storage facility; Leading Indicator – TSF11, Leading Indicator - TSF15, Outcome Measurement Criteria - TSF35 and Outcome Measurement Criteria - TSF36, Section 9.1 Tailings storage facility design, audits, monitoring and test work, Section 9.6 Completion audits, surveys and monitoring
13.	The audits required by Second Schedule Conditions 4.3, 4.4 and associated reports required by Second Schedule Condition 5 must be conducted and provided by an independent and suitably qualified expert approved by the Director of Mines (or other authorised officer) at least once for each twelve (12) month period.	Chapter 7.3.12.3 Tailings storage facility; Leading Indicator - TSF16, Section 9.1 Tailings storage facility design, audits, monitoring and test work
14.	An audit required by Second Schedule Conditions 4.3, 4.4 and associated reports required by Second Schedule Condition 5 may be conducted and provided by a suitably qualified Tenement Holder employee previously approved by the Director of Mines (or other authorised officer). To apply for approval the Tenement Holder must:	Acknowledged
	14.1. Apply in writing; and	
	14.2. Provide the employee's Curriculum Vitae showing their academic qualifications, publications (if any) and practical experience.	
	Explanatory note: The Department of the Premier and Cabinet is seeking to ensure that if the auditing and reporting person is an employee of the Tenement Holder that they are suitably qualified and that an independent audit is conducted at least once for each twelve (12) month period.	
Concentrate Treatment Plant (CTP)		
15.	The Tenement Holder must during operations ensure that any CTP constructed on the Land is equipped with scrubbers that are designed appropriately to prevent acid mist emissions.	Design strategy acknowledged and committed to in Section 7.3.10 Air quality
Concentrate Transport		
16.	The Tenement Holder must during operations ensure that copper concentrate is transported in fit-for-purpose sealed containers to prevent copper concentrate release to the environment.	Design strategy acknowledged and committed to in Section 4.9.1 Key elements
Waste		
17.	The Tenement Holder must ensure that all commercial or industrial waste (which does not include CTP process residue, tailings and waste rock) is disposed of in an EPA licensed facility.	Management strategy acknowledged and committed to in Section 7.3.9 Land and soil; Outcome Measurement Criteria LS5
Removal of Infrastructure		
18.	The Tenement Holder must ensure that all mining-related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.	Management strategy acknowledged and committed to in Section 7.3.8 Land use and property; Outcome Measurement Criteria LUP2
Transparency		
19.	The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.	Acknowledged. As stated in Section 3.1 Management capability, BHP is committed to transparency, and will make available to the public the approved PEPR and associated compliance reports.
Notification of cessation of operations		
20.	Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining-related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining-related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining-related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 22.	Acknowledged
Decommissioning and Rehabilitation Plan (DRP)		

No.	Condition	Demonstrated Commitment
21.	The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Conditions 22 and 23 when decommissioning or rehabilitating the Mining Tenement.	Acknowledged
22.	Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 20, and that DRP must:	Acknowledged
	22.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;	
	22.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).	
23.	If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining-related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:	Acknowledged
	23.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 22; and/or	
	23.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.	
Operating Protocol		
24.	The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines (or other authorised officer)) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining-related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:	Management strategy acknowledged and committed to in Section 3.3.1 Approach, Section 7.3.8 Land use and property and Section 7.3.2 Public nuisance
	24.1. interaction with landowner operations;	
	24.2. emergency procedures;	
	24.3. communications and issue management processes;	
	24.4. land management;	
	24.5. dispute resolution;	
	24.6. ongoing communication about the Tenement Holder's operations;	
	24.7. receiving and considering feedback;	
	24.8. safety procedures;	
	24.9. access protocols; and	
	24.10. any matters identified by the Director of Mines (or other authorised officer) in writing.	
25.	The Tenement Holder must:	Timeframes committed to in Section 4.4 Operations schedule and planning and Section 7.3.2 Public nuisance, Section 7.3.8 Land use and property
	25.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and	
	25.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.	
Compliance with regulation 98(1)		
26.	A notification required by regulation 98(1) must be in writing.	Acknowledged
Plains Mouse		
27.	For the purposes of this Additional Condition:	
	27.1. ‘Plains Mouse’ means Pseudomys australis;	Acknowledged
	27.2. ‘existing population’ means an area of suitable habitat for the Plains Mouse where the species has been observed/recorded; Acknowledged.	Acknowledged
	27.3. ‘existing habitat’ means an area of suitable habitat for the Plains Mouse;	Acknowledged
	27.4. ‘suitable habitat’ means large open gypseous cracking clay areas associated with minor drainage features, and depressions within gibber stony plains (National Recovery Plan for the Plains Mouse Pseudomys australis 2012).	Acknowledged
	27.5. To compensate for the residual impact from mining operations on the existing Plains Mouse habitat, the Tenement Holder must provide an environmental offset that:	Acknowledged and established on South Gap Station. Committed made to an Offset Strategy for Plains Mouse Habitat to address total disturbance to Plains Mouse habitat
	27.5.1. contains suitable habitat for the Plains Mouse or is known to have an existing population of Plains Mouse;	
	27.5.2. contains no less than 750 ha of suitable habitat to offset the permanent loss of the existing Plains Mouse habitat;	
	27.5.3. the quality of the suitable habitat must be at least equal to that of the quality of the existing habitat that will be permanently lost;	
	27.5.4. is connected to existing habitat of Plains Mouse by biodiversity corridors to ensure the Plains Mouse can utilise the environmental offset;	
	27.5.5. is a direct on-ground offset located on land using an appropriate legal mechanism (to the satisfaction of the Director of Mines (or other authorised officer)) that ensures the environmental offset is secured for conservation purposes for the life of the Mining Tenement or longer;	
	27.5.6. is located as close as practical to the existing habitat that will be permanently lost;	
	27.5.7. the implementation of which is commenced either before, or at the same point in time as, the impact to the Plains Mouse habitat arising from the mining operations; and	
	27.5.8. is managed for the life of the Mining Tenement or longer to maintain or improve the existing suitable habitat quality.	
28.	To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:	

No.	Condition	Demonstrated Commitment
	28.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;	Management strategy acknowledged and committed to in Section 7.3.6 Weeds and pests, and in the associated Offset Strategy for Plains Mouse
	28.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;	Acknowledged and committed to in Section 7.3.7 Native fauna; Outcome Measurement Criteria EPBC1, and in the associated Offset Strategy for Plains Mouse
	28.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and	Acknowledged and committed to in Section 7.3.7 Native fauna; Outcome Measurement Criteria EPBC3, and in the associated Offset Strategy for Plains Mouse
	28.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. *Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.*	Acknowledged and committed to in Section 7.3.7; Outcome Measurement Criteria EPBC2, and in the associated Offset Strategy for Plains Mouse
Other Legislation		
29.	The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the: 29.1. Environment Protection and Biodiversity Conservation Act 1999 (Cth) 29.2. Development Act 1993 (SA) 29.3. Planning, Development and Infrastructure Act 2016 (SA) 29.4. Dangerous Substances Act 1979 (SA) 29.5. National Parks and Wildlife Act 1972 (SA) 29.6. Natural Resources Management Act 2004 (SA) 29.7. Public and Environmental Health Act 1987 (SA) 29.8. Aboriginal Heritage Act 1988 (SA) 29.9. Heritage Places Act 1993 (SA) 29.10. Work Health and Safety Act 2012 (SA) 29.11. Environment Protection Act 1993 (SA) 29.12. Radiation Protection and Control Act 1982 (SA) 29.13. Native Vegetation Act 1991 (SA) 29.14. Mines and Works Inspection Act 1920 (SA) 29.15. Road Traffic Act 1961 (SA) 29.16. Wilderness Protection Act 1992 (SA)	Acknowledged As demonstrated in Section 3.4 Legislative requirements, the legislative framework for the Project is well understood and takes into consideration secondary permitting that will be required at various phases of the Project. Commitments and responsibilities under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), *Native Vegetation Act 1991* (SA) and *Radiation Protection and Control Act 2021* (SA) are outlined in Section 8 Matters of national environmental significance and native vegetation. BHP will comply with all applicable State and Commonwealth legislation and regulations. Note: *Natural Resources Management Act 2004* (SA) now repealed and replaced with *Landscape South Australia Act 2019* (SA) and the *Radiation Protection and Control Act 1982* (SA) has been updated to the *Radiation Protection and Control Act 2021* (SA)
THIRD SCHEDULE MAP AND DESCRIPTION OF AREAS		
Acknowledged		
FOURTH SCHEDULE PROCESS FOR SUSPENSION		
Acknowledged		
FIFTH SCHEDULE PROCESS FOR CANCELLATION		
Acknowledged		
SIXTH SCHEDULE ENVIRONMENTAL OUTCOMES		
Aboriginal Heritage Outcome		
1.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Section 7.3.1 Aboriginal heritage; Outcome Measurement Criteria – AH1, Outcome Measurement Criteria – AH2 and Leading Indicator – AH3
Public Safety Outcomes		
2.	The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.	Section 7.3.4 Public safety; Outcome Measurement Criteria – PS1
3.	The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining-related activities are as low as reasonably practicable.	Section 7.3.4 Public safety; Outcome Measurement Criteria – PS2 to Outcome Measurement Criteria – PS8
Public Nuisance Outcome		
4.	The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining-related traffic.	Section 7.3.2 Public nuisance; Outcome Measurement Criteria – PN1, Outcome Measurement Criteria – PN2 and Leading Indicator – PN3
Traffic Outcomes		
5.	The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.	Chapter 7.3.3 Traffic; Outcome Measurement Criteria – INC1

No.	Condition	Demonstrated Commitment
Weeds and Pests Outcome		
6.	The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining-related activities.	Section 7.3.6 Weeds and pests; Outcome Measurement Criteria – WP1, Outcome Measurement Criteria – WP2, Leading Indicator – WP3 to Leading Indicator – WP6
Land Use and Property Outcomes		
7.	The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP1
8.	Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4
9.	The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4
Land and Soil Outcome		
10.	The Tenement Holder must, ensure that: 10.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining-related activities; and	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS1, Leading Indicator – LS2, Leading Indicator – LS3 and Leading Indicator – LS4
	10.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining-related activities.	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS5
Native Vegetation Outcome		
11.	The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – NV1 and, Leading Indicator – NV2
Native Vegetation Criteria		
12.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Native Vegetation Outcome in Sixth Schedule Clause 11: 12.1. Where baseline native vegetation condition (abundance and diversity) is required as a component of the measurement criteria, baseline native vegetation surveys must be undertaken prior to the impact of mining operations or mining-related activities on the existing environment.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – ECO1
Native Fauna Outcome		
13.	The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining-related activities that could have been reasonably prevented	Section 7.3.7 Native fauna; Outcome Measurement Criteria – NF1, Leading Indicator – NF2 and Leading Indicator – NF3
Air Quality Outcome		
14.	The Tenement Holder must during construction, operation and post Completion ensure no adverse change to the air quality environment as a result of particulate emissions and/or dust generated by mining operations or mining-related activities.	Section 7.3.10 Air quality; Outcome Measurement Criteria – AQ1, Outcome Measurement Criteria – AQ2, Outcome Measurement Criteria – AQ3, Leading Indicator – AQ4, Leading Indicator – AQ5, Leading Indicator – AQ6, Leading Indicator – AQ7, Leading Indicator – AQ8, Leading Indicator – AQ9, Leading Indicator – AQ10, Outcome Measurement Criteria – AQ11 and Outcome Measurement Criteria – AQ12
Air Quality Strategies		
15.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Air Quality Outcome in Sixth Schedule Clause 14: 15.1. Develop and implement a future works program that investigates the requirement (or otherwise) for a cover system for the TSF surface.	Section 1.2.2 Verification of assumptions and uncertainties, Section 7.3.10 Air quality; Outcome Measurement Criteria – AQ3, Leading Indicator – AQ5, Leading Indicator AQ6, and Section 9.4 Baseline information, agreements, well commissioning, field trails and modelling calibration
	15.2. The future works program must ensure that the investigation into the requirement (or otherwise) for a cover system is completed in a timely manner.	Section 1.2.2 Verifications of assumptions and uncertainties, Section 7.3.10; Outcome Measurement Criteria – AQ3, Leading Indicator – AQ5, Leading Indicator AQ6 and Section 9.4 Baseline information, agreements, well commissioning, field trails and modelling calibration
Radiation Outcome		
16.	The Tenement Holder, must during construction, operation and post Completion ensure no public health or environmental impacts from radionuclides (including radon) as a result of mining operations or mining-related activities.	Section 7.3.11 Radiation; Outcome Measurement Criteria – RAD1, Outcome Measurement Criteria – RAD2, Outcome Measurement Criteria – RAD3 and Outcome Measurement Criteria – RAD4
Surface Water Outcome		

No.	Condition	Demonstrated Commitment
17.	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Section 7.3.12.1 Erosion and sedimentation: Outcome Measurement Criteria – SWES1, Leading Indicator – SWES2, Leading Indicator – SWES3, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5 and Outcome Measurement Criteria – SWES6 Section 7.3.12.2 Reduced flow; Outcome Measurement Criteria – SWRF1 Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF1, Outcome Measurement Criteria – TSF2, Outcome Measurement Criteria – TSF3, Outcome Measurement Criteria – TSF4, Outcome Measurement Criteria – TSF5, Outcome Measurement Criteria – TSF6, Outcome Measurement Criteria – TSF7, Leading Indicator – TSF8, Leading Indicator – TSF9, Leading Indicator – TSF10, Leading Indicator – TSF11, Leading Indicator – TSF12, Leading Indicator – TSF13, Leading Indicator – TSF14, Leading Indicator – TSF15, Leading Indicator – TSF16, Leading Indicator – TSF17, Leading Indicator – TSF18, Leading Indicator – TSF19, Leading Indicator – TSF20, Leading Indicator – TSF21, Leading Indicator – TSF22, Leading Indicator – TSF23, Leading Indicator – TSF24, Leading Indicator – TSF25, Leading Indicator – TSF26,Leading Indicator – TSF26, Leading Indicator – TSF27, Leading Indicator – TSF28,, Outcome Measurement Criteria – TSF35, Outcome Measurement Criteria – TSF36 and Outcome Measurement Criteria – TSF37 Section 7.3.12.4 Acid and metalliferous drainage; Outcome Measurement Criteria – AMD6, Leading Indicator – AMD2, Leading Indicator – AMD3, Leading Indicator – AMD4, Outcome Measurement Criteria – AMD5 and Outcome Measurement Criteria – AMD1
Surface Water Strategies – Model		
18.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17: 18.1. Establish a program for the ongoing review and calibration of the surface water model using data obtained from ongoing monitoring to address any assumptions and uncertainty within the model. Any significant variations in surface water flow measured during operations from those predicted by the models must result in a review of the effectiveness of surface water strategies to demonstrate that the outcomes are achievable.	Section 7.3.12 Surface water and Section 9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration
Surface Water Strategies – Contamination, Erosion and Sediments		
19.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:	
	19.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining-related activities leaves the Land.	Section 1.2.2 Verification of assumptions and uncertainties and Section 7.3.12.1
	19.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of assumptions and uncertainties and Section 7.3.12.1 Erosion and sedimentation; Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	19.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of assumptions and uncertainties and Section 7.3.12.1 Erosion and sedimentation; Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	19.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.	Section 1.2.2 Verification of assumptions and uncertainties, Section 7.3.12.1 Erosion and sedimentation; Outcome Measurement Criteria SEWS6
	19.5. Develop a program to undertake erosion field studies, including detailed surveys of the embankment size and shape, together with measurement of runoff and sediment load from the downstream embankment surface and isolated areas of tailings beach, to validate outputs of the landform evolution modelling (OZ Minerals Response Document dated 22 September 2017 page 75).	Section 1.2.2 Verification of assumptions and uncertainties, Section 7.3.12.1, Section 7.3.12.3 Outcome Measurement Criteria – TSF7, Leading Indicator – TSF8 and Leading Indicator – TSF9
	19.6. Adopt effective strategies to prevent the exposure, puncturing and/or tearing of any geotextile liners used to contain tailings at the TSF embankment, for example, ensure that the design of the TSF embankment includes a protective layer between the geotextile liner and the rock armouring layer.	Section 1.2.2 Verification of assumptions and uncertainties
	19.7. Adopt an effective thickness and construction methodology for rock armour, which is used for erosion control for rehabilitation and closure. The thickness and construction methodology should be validated through testwork and trials.	Section 1.2.2 Verification of assumptions and uncertainties Section 9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration, and 9.6 Completion audits, surveys and monitoring
	19.8. The design of the final landform of the TSF embankment must ensure that re-profiling of the embankment does not adversely impact on the effectiveness of any geotextile liners which are required for the achievement of the outcome.	Section 1.2.2 Verification of assumptions and uncertainties
	19.9. A program for determining the erodibility of waste rock to ensure that waste rock of an appropriate erodibility is used on the external batters of final landforms. The results of the program are to inform the material selection and design of the final landforms.	Section 1.2.2 Verification of assumptions and uncertainties
Surface Water Strategies – TSF		
20.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:	

No.	Condition	Demonstrated Commitment
	20.1. All future works listed in Section 7 of Appendix F2 of the Mining Proposal ("Independent Tailings Storage Facility Design Review" (ATC Williams)).	Section 1.2.2 Verification of assumptions and uncertainties
	20.2. All future works listed in Section 14 of Appendix B of the Response Document dated 22 September 2017 ("TSF Design Report for the Mining Lease Proposal", Updated September 2017, (Golders)).	Section 1.2.2 Verification of assumptions and uncertainties
	20.3. The recommendation in Section 7 of Appendix C of the Response Document dated 22 September 2017 (ATC Williams) which states, optimising the thickness and extent of the clay liner and depth of the interception trench downstream of the TSF embankment will need to be provided as part of detailed design.	Section 1.2.2 Verification of assumptions and uncertainties
	20.4. The conclusions and recommendations in Section 6 of Appendix D of the Response Document dated 22 September 2017 (SRK), including (but not limited to):	Section7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF7
	20.4.1. The Landform Evolution Model should be calibrated with measured parameters to improve model predictions; and	Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF7, Leading Indicator - TSF8 and Leading Indicator - TSF9
	20.4.2. If mining operations are suspended prior to completion of the TSF, the TSF will need to be upgraded to prevent the embankment overtopping during large storm events. The effect of this strategy on the maximum rehabilitation liability must be considered.	Section 5.1.2.2 Care and maintenance plan
	20.5. Review the input concentrations for elements and metals used in the solute transport geochemistry model (Mining Proposal Appendix C4 – Table 4-1). Based on the review, provide an updated or revised solute transport geochemistry model. If required, adopt revised strategies.	Section 1.2.2 Verification of assumptions and uncertainties, Complete. Updated geochemical model provided to DEM on 5 July 2018. Section 4.10.3.4 Geochemical properties
	20.6. Undertake the following works to demonstrate that the upstream methodology for the construction of the Stage 3 TSF upstream embankment will be effective in achieving all relevant environmental outcomes:	Alternative (downstream) Stage 3 construction methodologies proposed. Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF29
	20.6.1. Conduct settling tests on a representative sample of the fine fraction of the tailings material (particle size less than 30 microns);	Alternative (downstream) Stage 3 construction methodologies proposed Section 4.10.3.2 Particle density and particle size distribution, Section 4.10.5.4 Embankment stability Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF29
	20.6.2. Conduct drying tests to determine whether the expected maximum required drying time of twenty-six (26) days is appropriate or not. Such drying tests must ensure the sample tested is thick enough so that it does not unrealistically estimate the required drying time; and	Alternative (downstream) Stage 3 construction methodologies proposed Section 4.10.3.3 Average dry density Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF29
	20.6.3. Based on the results of the test work, demonstrate that the upstream construction methodology for TSF embankment lifts will be effective.	Alternative (downstream) Stage 3 construction methodologies proposed Section 4.10.3.9 Rate of rise, Section 4.10.5 Tailings storage facility and decant dam embankments Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF29
	20.7. Clarify the design details of the geomembrane liner on the upstream face of the Stage 1 embankment, and demonstrate that appropriate stability calculations have been done. Ensure that the geomembrane liner will be protected during installation of the decant facility.	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.7.1 Stages 1 and 2 as-built operations
	20.8. Demonstrate that the TSF decant water outfall pipe will be stable under the likely maximum vertical stress resulting from being buried by tailings material.	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.4.5 Decant and decant dam
	20.9. Develop a process to ensure that the inclined decant tower is appropriately decommissioned prior to Stage 3 of the TSF in order to ensure that it does not leak or become structurally unsound.	Section 1.2.2 Verification of assumptions and uncertainties, Section 7.3.12.3 Tailings storage facility; Leading Indicator TSF26
	20.10. Review the conclusion (from the Mining Proposal and Response Documents) that the decant pond will take up to three years to recede after an extreme rainfall event (i.e. a seventy-two (72) hour, PMP rainfall event occurring at the end of the 95% wet season). Evaluate whether the absorption capacity of the tailings has been reasonably accounted for. Based on the review, if it is confirmed that the decant pond will take a number of years to recede following an extreme rainfall event, (i) assess if the TSF freeboard will remain acceptable should another high intensity rainfall event occur during the three (3) year period, and (ii) assess the potential impact on stability of an elevated phreatic surface resulting from a temporarily large decant pond.	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.4.3 Freeboard
	20.11. Demonstrate that the drainage and decant system would function as designed following an extreme rainfall event should it occur early in the life of the TSF operation (e.g. in the first year).	Section 4.10.4 Water management
	20.12. Review the TSF dam break study with consideration of whether the initial release (and thus initial hydrograph) could be water-only, followed by release of non-Newtonian tailings.	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.5.3 Embankment stability
	20.13. Adopt appropriate strategies to ensure effective operations of the tailings pipelines (as committed to in the Mining Proposal and Response Documents) including (but not limited to):	
	20.13.1. Tailings pipelines are to be inspected for condition, integrity, signs of wear and leaks at an appropriate frequency;	Section 4.10.6 Tailings delivery and return water infrastructure and Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF13
	20.13.2. Alarmed pressure indicators are to be installed on the tailings pipelines and monitored continuously; and	Section 4.10.6 Tailings delivery and return water infrastructure and Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF12
	20.13.3. Remote isolation valves are to be installed on the tailings pipelines to isolate sections of the pipelines if required.	Section 4.10.6 Tailings delivery and return water infrastructure and Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF12
	20.14. The minimum freeboard height and maximum supernatant pond dimensions for the TSF and Decant Dam must be specified.	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.4.3 Freeboard
	20.15. The maximum dimensions of the supernatant pond must be consistent with the subaerial method of tailings deposition.	Section 1.2.2 Verification of assumptions and uncertainties

No.	Condition	Demonstrated Commitment
	20.16. Cease deposition of tailings to the TSF if the specified limits for freeboard height or supernatant pond dimensions are exceeded and report this exceedance to the Director of Mines (or other authorised officer) within twenty-four (24) hours. Freeboard is defined as the difference in height between the level of the supernatant pond and the lowest point of the tailings dam embankment or spillway.	Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF22
	20.17. Ensure that the TSF final landforms will be chemically and physically stable post Completion.	Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF35, Outcome Measurement Criteria – TSF36 and Outcome Measurement Criteria – TSF37
	20.18. Provide strategies to ensure that the installed drainage (toe drain) on the upstream side of the TSF embankment is protected from blinding and/or clogging during initial deposition of tailings.	Section 1.2.2 Verification of assumptions and uncertainties, Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF27, Section 4.10.4.6 Seepage management
	20.19. Develop strategies to ensure that the compacted clay liner proposed for watercourses within the TSF footprint is effective in mitigating seepage. Consider strategies to ensure compacted clay seals do not dry out and crack prior to being covered with tails, such as inspections and a protective layer to be applied over the compacted clay seals.	Section 1.2.2 Verification of assumptions and uncertainties, Section 7.3.12.3 Tailings storage facility; Leading Indicator – TSF28, Section 4.10.4.6 Seepage management
	20.20. Review the size of the lined decant cell in the Decant Dam to ensure that the lined area is of an appropriate size to manage seepage.	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.4.6 Seepage management
	20.21. Review the seepage assessment and modelling for the Decant Dam. As a result of the review update the strategies for the management of seepage (if required).	Section 1.2.2 Verification of assumptions and uncertainties, Section 4.10.4.6 Seepage management
Surface Water Strategies – Acid and Metalliferous Drainage		
	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 17:	
	21.1. The recommendations in Section 7 of Appendix E of the Response Document dated 22 September 2017 (“Geochemical Characterisation of Tailings and ICP” (EGI)).	Section 1.2.2 Verifications of assumptions and uncertainties, Section 4.10.3.5 Geochemical properties
	21.2. Ensure that no stockpiles that include PAF material are left on the surface of the Land post Completion.	Section 7.3.12.4 Acid and metalliferous drainage, Outcome Measurement Criteria – AMD5 and Outcome Measurement Criteria – AMD6
	21.3. Strategies to ensure that stockpiles that include PAF material are appropriately managed should the operation enter a phase of care and maintenance.	Section 5.1.2.2 Care and maintenance plan, Section 5.2 Closure strategy, Section 5.4.4.2 Stockpiles
21.	21.4. Develop and implement an AMD management plan that includes the following, but not limited to: 21.4.1. Develop a program for confirming the NAF classification and long-term leach (kinetic) testing results of the tailings under field conditions; 21.4.2. Develop a program to investigate the potential for metalliferous drainage to be generated by NAF material which contains sulphides; 21.4.3. Refine the sulphur cut-off grade for PAF material through further testing of waste units; 21.4.4. Develop an ore, waste rock and sulphur block model; 21.4.5. Develop the block model to include the sulphur distribution of all waste and ore to be mined for the purpose of determining the distribution and estimating the volume of NAF and PAF using the sulphur cut-off grade; 21.4.6. Regular updating of the block model with new geological and sulfur assay data in the course of operations and aligning to the materials handling program; 21.4.7. Develop a QA/QC process for validation of Acid Base Accounting (ABA) characteristics; 21.4.8. Develop a QA/QC process for the waste rock block model and testing to ensure the correct rock is placed in the correct destination; 21.4.9. Segregation of PAF waste rock, NAF waste rock, and waste rock with the potential for metalliferous drainage (based on a classification process) and a mining schedule for each; 21.4.10. Ensure stockpiles containing PAF material are appropriately located; 21.4.11. Develop appropriate stockpile management strategies; 21.4.12. Confirm final end uses for waste rock and marginal ore based on geochemical classification; and 21.4.13. Develop strategies that prevent AMD from being generated from the TSF embankment and decant causeway, such as avoiding the use of PAF material and marginal ore for construction of the TSF embankment and decant causeway.	Section 1.2.2 Verifications of assumptions and uncertainties, Section 4.10.3.5 Geochemical properties, Section 4.11.3.3 Potentially acid forming waste material, Section 7.3.12.4 Acid and metalliferous drainage, Section 9.2 Ore stockpiles design, audits, monitoring and test work
Surface Water Leading Indicator Criteria – TSF		
22.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(e) in relation to the Surface Water Outcome in Sixth Schedule Clause 17: 22.1. Leading indicator criteria in relation to the outcomes relevant to the TSF must include, as a minimum, the measurement of appropriate process solutions and tailings supernatant solutions.	Section 7.3.12.3 Tailings storage facility, Leading Indicator – TSF21
Groundwater Outcomes		
23.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to the Environmental Values of the groundwater within the shallow perched aquifer within the Land as a result of chemicals or hydrocarbons from mining operations or mining-related activities.	Section 7.3.13.3 Quality, Outcome Measurement Criteria – GW7
24.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quality within aquifers outside of the TSF seepage zone of influence area delineated by the groundwater model as a result of mining operations or mining-related activities.	Section 7.3.13.1 Tailings storage facility, Outcome Measurement Criteria – GW1 and Outcome Measurement Criteria – GW2
25.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining-related activities.	Section 7.3.13.2 Quantity, Outcome Measurement Criteria – GW3, Leading Indicator – GW4 and Leading Indicator – GW5

No.	Condition		Demonstrated Commitment
Groundwater Strategies			
26.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Groundwater Outcomes in Sixth Schedule Clauses 23, 24 and 25:		
	26.1.	Provide a groundwater solute transport, geochemistry and hydrogeological model that delineates the predicted TSF seepage zone of influence area within the groundwater aquifers.	Provided in the following documents: Appendix C3 of the Mineral Lease Proposal Groundwater Modelling and Assessment of Effects (CDM Smith, 2016) Carrapateena Response Document Appendix F Tailings Discharge and Seepage Geochemical Model (OZ Minerals, 2017)
	26.2.	Establish a program for the ongoing calibration of the groundwater solute transport, geochemistry and hydrogeological models using data obtained from ongoing monitoring to address any assumptions and uncertainty within the models.	Section 1.2.2 Verifications of assumptions and uncertainties, Section 4.10.3.5 Geochemical properties, Section 7.3.13.1 Tailings storage facility, Strategy – GW6, Section 7.3.12.3 Tailings storage facility, Leading Indicator – TSF21, Leading Indicator – TSF24
	26.3.	Provide a transient groundwater model that delineates the predicted extent of groundwater drawdown within the groundwater aquifers.	Provided in the following documents: Appendix C3 of the Mineral Lease Proposal Groundwater Modelling and Assessment of Effects (CDM Smith, 2016)
	26.4.	Establish a program for the ongoing calibration of the transient groundwater model using data obtained from ongoing groundwater monitoring.	Section 1.2.2 Verifications of assumptions and uncertainties, Section 7.3.13.1 Tailings storage facility, Section 7.3.13.2 Quantity
	26.5.	Provide a calibrated transient groundwater model within an appropriate timeframe.	Section 1.2.2 Verifications of assumptions and uncertainties, Section 7.3.13.1 Tailings storage facility, Section 7.3.13.2 Quantity
Groundwater Criteria			
27.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Groundwater Quality Outcome in Sixth Schedule Clause 24:		Section 7.3.13.1 Tailings storage facility, Outcome Measurement Criteria – GW1 and Outcome Measurement Criteria – GW2
	27.1.	Establish compliance groundwater monitoring bores that are at appropriate locations and of sufficient density and depth to measure the movement of TSF seepage and groundwater.	
	27.2.	Establish compliance groundwater monitoring bores that are at appropriate locations and of sufficient density and depth to measure the groundwater quality within and outside of the TSF seepage zone of influence area delineated by the groundwater model.	

A7.2 | MPL 149 Airstrip, Workers' Accommodation Village and Ancillary Infrastructure – Tenement Conditions Demonstrated Commitment

No.	Condition	Demonstrated Commitment
FIRST SCHEDULE ADDITIONAL TERMS		
1.	The Mining Tenement is granted for the purpose of the construction, operation and rehabilitation of an: 1.1. Airstrip 1.2. Accommodation village 1.3. Access road 1.4. Ancillary infrastructure directly related to the conduct of mining operations authorised under mining tenement Retention Lease 127 and any Mineral Lease granted over all or part of Retention Lease 127.	Activities described in Chapter 4 Description of the operations, are limited to these activities whilst maintaining future optionality in detailed design.
2.	Mining related activities on the land must be consistent with the activities described in the Miscellaneous Purposes Licence Management Plan dated 2 December 2016 and subsequent Response Document dated 16 March 2017.	Activities described in Chapter 4 Description of the operations, are within the defined Project scope whilst maintaining future optionality in detailed design. Minor infrastructure location amendments do not affect the ability of the operations to achieve the stated Outcomes.
SECOND SCHEDULE ADDITIONAL CONDITIONS		
Transparency		
1.	The Tenement Holder agrees to the Approved PEPR and any Compliance Reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.	Acknowledged. As stated in Section 3.1 Management capability, BHP is committed to transparency, and will make available to the public the approved PEPR and associated compliance reports.
Notification of Cessation of Operations		
2.	Within 30 days of becoming aware of any event or decision that is likely to give rise to the cessation of mining-related activities for a period of more than seven days and prior to the cessation of mining-related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining-related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required Decommissioning and Rehabilitation Plan under Condition 4.	As stated in Section 5.1.2.1 Unplanned closure management, BHP will provide notification to the Department of Energy and Mining (SA) in the event that operations at Carrapateena are likely to be interrupted for a period of greater than seven days.
Decommissioning and Rehabilitation (DRP) Plan		
3.	The Tenement Holder must comply with a DRP approved in accordance with Condition 4 and 5 when decommissioning or rehabilitating the Mining Tenement.	As stated in Section 5.1.1 Planned mine closure, BHP will comply with the DRP that allows the Project to comply with the tenement schedules and PEPR commitments.
4.	Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within 60 days of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Condition 2, and that DRP must: 4.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR 4.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).	As stated in Section 5.1.1 Planned mine closure, in the event of unplanned or temporary closure, BHP would develop a DRP that sets out the activities and scheduling required for carrying out rehabilitation of the tenements within specified timeframes.
5.	If, in the opinion of the Director of Mines (or other authorised officer), mining-related activities on the Mining Tenement have substantially ceased for two years or more, the Director of Mines (or other authorised officer) may: 5.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Condition 4; and/or 5.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.	As stated in Section 5.1.2.2 Care and maintenance plan, in the event activities have substantially ceased for two years or more, BHP would develop a DRP that sets out the activities and scheduling required for carrying out rehabilitation of the tenements within specified timeframes.
Operating Protocol		
6.	The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol between itself and owners of land adjacent to and on the land prior to the commencement of mining-related activities that includes the following matters: 6.1. Interaction with landowner operations 6.2. Emergency procedures 6.3. Communications and issue management processes 6.4. Land management 6.5. Dispute resolution 6.6. Ongoing communication about the Tenement Holder's operations 6.7. Receiving and considering feedback 6.8. Safety procedures 6.9. Access protocols 6.10. Any matters identified by the Director of Mines (or other authorised officer) in writing	Management strategy acknowledged and committed to in Section 7.3.2 Public nuisance and Section 7.3.8 Land use and property
7.	The Tenement Holder must maintain and adhere to the protocol to the satisfaction of the Director of Mines for the term of the Mining Tenement.	As stated in Section 3.3 Stakeholder engagement, it is important to BHP that engagement is maintained with stakeholders who may have raised specific concerns and/or have a specific

No.	Condition	Demonstrated Commitment
		interest in potential Outcomes. This stakeholder engagement forms part of the ongoing management capability and informs how engagement is approached across the Project life.
Other Legislation		
8.	The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the: 8.1. Environment Protection and Biodiversity Conservation Act 1999 (Cth) 8.2. Development Act 1993 (SA) 8.3. Dangerous Substances Act 1979 (SA) 8.4. National Parks and Wildlife Act 1972 (SA) 8.5. Natural Resources Management Act 2004 (SA) 8.6. Public and Environmental Health Act 1987 (SA) 8.7. Aboriginal Heritage Act 1988 (SA) 8.8. Heritage Places Act 1993 (SA) 8.9. Work Health and Safety Act 2012 (SA) 8.10. Environment Protection Act 1993 (SA) 8.11. Native Vegetation Act 1991 (SA) 8.12. Mines and Works Inspection Act 1920 (SA) 8.13. Road Traffic Act 1961 (SA)	As demonstrated in Section 3.4 Legislative requirements, the legislative framework for the Project is well understood and takes into consideration secondary permitting that will be required at various phases of the Project. Commitments and responsibilities under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), *Native Vegetation Act 1991* (SA) and *Radiation Protection and Control Act 2021* (SA) are outlined in Section 8. BHP will comply with all applicable State and Commonwealth legislation and regulations. Note: *Natural Resources Management Act 2004* (SA) now repealed and replaced with *Landscape South Australia Act 2019* (SA) and the *Radiation Protection and Control Act 1982* (SA) has been updated to the *Radiation Protection and Control Act 2021* (SA)
9.	The Tenement Holder must ensure that all commercial or industrial waste is disposed of in an EPA licensed facility.	As stated in Section 4.15.4 Waste management facilities and infrastructure, any future landfill will be a prescribed activity under the *Environment Protection Act 1993* (SA) and will require an Environmental Protection Licence. The landfill will be designed, constructed, operated and closed in accordance with the SA EPA guideline Environmental Management of Landfill Facilities (SA EPA, 2007)
Refuelling (Soil Strategy)		
10.	The Tenement Holder must ensure that fuel storage is bunded in accordance with Environment Protection Authority requirements.	As stated in Section 4.15.1 Key elements, hydrocarbon and fuel storage facilities will be designed in accordance with Australian Standards. Storages will be bunded in accordance with EPA bunding guidelines and/or relevant Australian standards.
THIRD SCHEDULE DESCRIPTION OF AREAS		
Map	To be attached	Figure 1.1: Project Location Figure 4.3: MPL 149 tenement and key project elements
FOURTH SCHEDULE PROCESS FOR SUSPENSION		
1.	Issuance of Suspension Show Cause Notice	Acknowledged. Specific requirements detailed in Appendix A will be adhered to.
2.	Minister’s action if Tenement Holder does not respond	
3.	Minister’s action if Tenement Holder does respond	
4.	Written Notice of Minister’s decision to suspend or not to suspend the grant of Mining Tenement	
5.	Written Notice of Minister’s decision: Not Suspended	
6.	Written Notice of Minister’s decision: Suspended	
7.	Minister’s action if Tenement Holder takes action as specified in Notice of Decision	
8.	Minister’s action if Tenement Holder takes action as specified in Notice of Decision: Revoked suspension	
9.	Minister’s action if Tenement Holder appeals	
10.	Minister’s action if Tenement Holder appeals: no ground for the suspension	
11.	The Mining Registrar	
FIFTH SCHEDULE PROCESS FOR CANCELLATION		
1.	Issuance of Cancellation Show Cause Notice	Acknowledged. Specific requirements detailed in Appendix A will be adhered to.
2.	Minister’s action if the Tenement Holder does not respond	
3.	Minister’s action if the Tenement Holder does respond	
4.	Written notice of Minister’s decision	

No.	Condition	Demonstrated Commitment
5.	Written notice of Minister's decision: Not Cancelled	
6.	Written notice of Minister's decision: Cancelled	
7.	Minister's action if Tenement Holder appeals	
8.	Minister's action if Tenement Holder appeals: no ground for cancellation	
9.	The Mining Registrar	

A7.3 | MPL 152 Western Infrastructure Corridor – Tenement Conditions Demonstrated Commitment

No.	Condition	Demonstrated Commitment
FIRST SCHEDULE ADDITIONAL TERMS		
Acknowledged		
SECOND SCHEDULE ADDITIONAL CONDITIONS		
Aboriginal Heritage		
28.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Chapter 7.3.1 Aboriginal heritage; Outcome Measurement Criteria - AH1, Outcome Measurement Criteria - AH2 and Leading Indicator - AH3
Concentrate Transport		
29.	The Tenement Holder must during operations ensure that copper concentrate is transported in fit-for-purpose sealed containers to prevent copper concentrate release to the environment.	Design strategy acknowledged and committed to in Section 4.9.1 Key elements
Waste		
30.	The Tenement Holder must ensure that all commercial or industrial waste (which does not include tailings and waste rock) is disposed of in an EPA licensed facility.	Management strategy acknowledged and committed to in Section 7.3.9 Land and soil and Outcome Measurement Criteria – LS5
Removal of Infrastructure		
31.	The Tenement Holder must ensure that all mining-related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.	Management strategy acknowledged and committed to in Section 7.3.8 Land use and property and Outcome Measurement Criteria - LUP2
Transparency		
32.	The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.	Acknowledged. As stated in Section 3.1 Management capability, BHP is committed to transparency, and will make available to the public the approved PEPR and associated compliance reports.
Notification of cessation of operations		
33.	Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining-related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining-related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining-related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 8.	Acknowledged
Decommissioning and Rehabilitation Plan (DRP)		
34.	The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 8 and 9 when decommissioning or rehabilitating the Mining Tenement.	Acknowledged
35.	Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 6, and that DRP must:	Acknowledged
	35.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;	
	35.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).	
36.	If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining-related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:	Acknowledged
	36.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 8; and/or	
	36.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.	
Operating Protocol		
37.	The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining-related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:	Management strategy acknowledged and committed to in Section 3.3.1 Approach, Section 7.3.2 Public nuisance and Section 7.3.8 Land use and property
	37.1. interaction with landowner operations;	
	37.2. emergency procedures;	
	37.3. communications and issue management processes;	
	37.4. land management;	
	37.5. dispute resolution;	
	37.6. ongoing communication about the Tenement Holder's operations;	
	37.7. receiving and considering feedback;	

No.	Condition	Demonstrated Commitment
	37.8. safety procedures; 37.9. access protocols; and 37.10. any matters identified by the Director of Mines (or other authorised officer) in writing.	
38.	The Tenement Holder must: 38.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and 38.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.	Timeframes committed to in Section 4.4 Operations schedule and planning and Section 9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration
Compliance with regulation 98(1)		
39.	A notification required by regulation 98(1) must be in writing.	Acknowledged
Matters of National Environmental Significance		
40.	To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:	
	40.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;	Management strategy acknowledged and committed to in Section 7.3.6 Weeds and pests, and in the associated Offset Strategy for Plains Mouse.
	40.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC1, and in the associated Offset Strategy for Plains Mouse.
	40.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC3, and in the associated Offset Strategy for Plains Mouse.
	40.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. *Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.*	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC2, and in the associated Offset Strategy for Plains Mouse.
Other Legislation		
41.	The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the: 41.1. Environment Protection and Biodiversity Conservation Act 1999 (Cth) 41.2. Development Act 1993 (SA) 41.3. Planning, Development and Infrastructure Act 2016 (SA) 41.4. Dangerous Substances Act 1979 (SA) 41.5. National Parks and Wildlife Act 1972 (SA) 41.6. Natural Resources Management Act 2004 (SA) 41.7. Public and Environmental Health Act 1987 (SA) 41.8. Aboriginal Heritage Act 1988 (SA) 41.9. Heritage Places Act 1993 (SA) 41.10. Work Health and Safety Act 2012 (SA) 41.11. Environment Protection Act 1993 (SA) 41.12. Radiation Protection and Control Act 1982 (SA) 41.13. Native Vegetation Act 1991 (SA) 41.14. Mines and Works Inspection Act 1920 (SA) 41.15. Road Traffic Act 1961 (SA) 41.16. Wilderness Protection Act 1992 (SA)	As demonstrated in Section 3.4 Legislative requirements, the legislative framework for the Project is well understood and takes into consideration secondary permitting that will be required at various phases of the Project. Commitments and responsibilities under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), *Native Vegetation Act 1991* (SA) and *Radiation Protection and Control Act 2021* (SA) are outlined in Section 8. BHP will comply with all applicable State and Commonwealth legislation and regulations. Note: *Natural Resources Management Act 2004* (SA) now repealed and replaced with *Landscape South Australia Act 2019* (SA) and *the Radiation Protection and Control Act 1982* (SA) has been updated to the *Radiation Protection and Control Act 2021* (SA)
THIRD SCHEDULE MAP AND DESCRIPTION OF AREAS		
Acknowledged		
FOURTH SCHEDULE PROCESS FOR SUSPENSION		
Acknowledged		
FIFTH SCHEDULE PROCESS FOR CANCELLATION		
Acknowledged		
SIXTH SCHEDULE ENVIRONMENTAL OUTCOMES		
Aboriginal Heritage Outcome		
42.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Section 7.3.1 Aboriginal heritage; Outcome Measurement Criteria – AH1, Outcome Measurement Criteria – AH2 and Leading Indicator – AH3

No.	Condition	Demonstrated Commitment
Public Safety Outcomes		
43.	The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.	Section 7.3.4 Public safety; Outcome Measurement Criteria – PS1
44.	The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining-related activities are as low as reasonably practicable.	Section 7.3.4 Public safety; Outcome Measurement Criteria – PS2 to Outcome Measurement Criteria – PS8
Public Nuisance Outcome		
45.	The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining-related traffic.	Section 7.3.2 Public nuisance; Outcome Measurement Criteria – PN1, Outcome Measurement Criteria – PN2 and Leading Indicator – PN3
Traffic Outcomes		
46.	The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.	Section 7.3.3 Traffic; Outcome Measurement Criteria – INC1
Weeds and Pests Outcome		
47.	The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining-related activities.	Section 7.3.6 Weeds and pests; Outcome Measurement Criteria – WP1, Outcome Measurement Criteria – WP2, Leading Indicator – WP3 to Leading Indicator – WP6
Land Use and Property Outcomes		
48.	The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP1
49.	Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4
50.	The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4
Land and Soil Outcome		
51.	The Tenement Holder must, ensure that: 51.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining-related activities; and	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS1, Leading Indicator – LS2 Leading Indicator – LS3 and Leading Indicator – LS4
	51.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining-related activities.	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS5
Native Vegetation Outcome		
52.	The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – NV1 and Leading Indicator – NV2
Native Fauna Outcome		
53.	The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining-related activities that could have been reasonably prevented.	Section 7.3.7 Native fauna; Outcome Measurement Criteria – NF1, Leading Indicator – NV2 and Leading Indicator – NV3
Surface Water Outcome		
54.	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Section 7.3.12.1 Erosion and sedimentation: Outcome Measurement Criteria – SWES1, Leading Indicator – SWES2, Leading Indicator – SWES3, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5 and Outcome Measurement Criteria – SWES6 Section 7.3.12.2 Reduced flow; Outcome Measurement Criteria – SWRF1 Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF1, Outcome Measurement Criteria – TSF2, Outcome Measurement Criteria – TSF3, Outcome Measurement Criteria – TSF4, Outcome Measurement Criteria – TSF5, Outcome Measurement Criteria – TSF6, Outcome Measurement Criteria – TSF7, Leading Indicator – TSF8, Leading Indicator – TSF9, Leading Indicator – TSF10, Leading Indicator – TSF11, , Leading Indicator – TSF15, Leading Indicator – TSF16, Leading Indicator – TSF21, Leading Indicator – TSF23, Leading Indicator – TSF24, Outcome Measurement Criteria – TSF35, Outcome Measurement Criteria – TSF36 and Outcome Measurement Criteria – TSF37

No.	Condition	Demonstrated Commitment
		Section 7.3.12.4 Acid and metalliferous drainage; Outcome Measurement Criteria – AMD6, Leading Indicator – AMD2, Leading Indicator – AMD3, Leading Indicator – AMD4, Outcome Measurement Criteria – AMD5 and Outcome Measurement Criteria – AMD1
Surface Water Strategies – Contamination, Erosion and Sediments		
55.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 13:	
	55.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining-related activities leaves the Land.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	55.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	55.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	55.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Outcome Measurement Criteria – SWES6
Groundwater Outcomes		
56.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining-related activities.	Section 7.3.13.2 Quantity; Outcome Measurement Criteria – GW3, Leading Indicator – GW4 and Leading Indicator – GW5

A7.4 | MPL 153 Eastern Radial Wellfield – Tenement Conditions Demonstrated Commitment

No.	Condition	Demonstrated Commitment
FIRST SCHEDULE ADDITIONAL TERMS		
Acknowledged		
SECOND SCHEDULE ADDITIONAL CONDITIONS		
Aboriginal Heritage		
57.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Chapter 7.3.1 Aboriginal heritage; Outcome Measurement Criteria - AH1, Outcome Measurement Criteria - AH2 and Leading Indicator - AH3
Waste		
58.	The Tenement Holder must ensure that all commercial or industrial waste (which does not include tailings and waste rock) is disposed of in an EPA licensed facility.	Management strategy acknowledged and committed to in Section 7.3.9 Land and soil and Outcome Measurement Criteria – LS5
Removal of Infrastructure		
59.	The Tenement Holder must ensure that all mining-related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.	Management strategy acknowledged and committed to in Section 7.3.8 Land use and property and Outcome Measurement Criteria - LUP2
Transparency		
60.	The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.	Acknowledged. As stated in Section 3.1 Management capability, BHP is committed to transparency, and will make available to the public the approved PEPR and associated compliance reports.
Notification of cessation of operations		
61.	Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining-related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining-related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining-related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 7.	Acknowledged
Decommissioning and Rehabilitation Plan (DRP)		
62.	The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 7 and 8 when decommissioning or rehabilitating the Mining Tenement.	Acknowledged
63.	Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 5, and that DRP must:	Acknowledged
	63.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;	
	63.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).	
64.	If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining-related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:	Acknowledged
	64.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 7; and/or	
	64.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.	
Operating Protocol		
65.	The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining-related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:	Management strategy acknowledged and committed to in Section 3.3.1 Approach, Section 7.3.2 Public nuisance and Section 7.3.8 Land use and property
	65.1. interaction with landowner operations;	
	65.2. emergency procedures;	
	65.3. communications and issue management processes;	

No.	Condition	Demonstrated Commitment
	65.4. land management;	
	65.5. dispute resolution;	
	65.6. ongoing communication about the Tenement Holder's operations;	
	65.7. receiving and considering feedback;	
	65.8. safety procedures;	
	65.9. access protocols; and	
	65.10. any matters identified by the Director of Mines (or other authorised officer) in writing.	
66.	The Tenement Holder must: 66.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and	Timeframes committed to in Section 4.4 Operations schedule and planning and Section 9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration
	66.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.	
Compliance with regulation 98(1)		
67.	A notification required by regulation 98(1) must be in writing.	Acknowledged
Matters of National Environmental Significance		
68.	To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:	
	68.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;	Management strategy acknowledged and committed to in Section 7.3.6 Weeds and pests, and in the associated Offset Strategy for Plains Mouse.
	68.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC1, and in the associated Offset Strategy for Plains Mouse.
	68.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC3, and in the associated Offset Strategy for Plains Mouse.
	68.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. *Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.*	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC2, and in the associated Offset Strategy for Plains Mouse.
Other Legislation		
69.	The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the: 69.1. Environment Protection and Biodiversity Conservation Act 1999 (Cth) 69.2. Development Act 1993 (SA) 69.3. Planning, Development and Infrastructure Act 2016 (SA) 69.4. Dangerous Substances Act 1979 (SA) 69.5. National Parks and Wildlife Act 1972 (SA) 69.6. Natural Resources Management Act 2004 (SA) 69.7. Public and Environmental Health Act 1987 (SA) 69.8. Aboriginal Heritage Act 1988 (SA) 69.9. Heritage Places Act 1993 (SA) 69.10. Work Health and Safety Act 2012 (SA) 69.11. Environment Protection Act 1993 (SA) 69.12. Radiation Protection and Control Act 1982 (SA) 69.13. Native Vegetation Act 1991 (SA) 69.14. Mines and Works Inspection Act 1920 (SA) 69.15. Road Traffic Act 1961 (SA) 69.16. Wilderness Protection Act 1992 (SA)	Acknowledged. As demonstrated in Section 3.4 Legislative requirements, the legislative framework for the Project is well understood and takes into consideration secondary permitting that will be required at various phases of the Project. Commitments and responsibilities under the Environment Protection and Biodiversity Conservation Act 1999 (Cth), Native Vegetation Act 1991 (SA) and Radiation Protection and Control Act 1982 (SA) are outlined in Section 8. BHP will comply with all applicable State and Commonwealth legislation and regulations. Note: *Natural Resources Management Act 2004* (SA) now repealed and replaced with *Landscape South Australia Act 2019* (SA) and the *Radiation Protection and Control Act 1982* (SA) has been updated to the *Radiation Protection and Control Act 2021* (SA)
THIRD SCHEDULE MAP AND DESCRIPTION OF AREAS		
Acknowledged		
FOURTH SCHEDULE PROCESS FOR SUSPENSION		
Acknowledged		

No.	Condition	Demonstrated Commitment
FIFTH SCHEDULE PROCESS FOR CANCELLATION		
Acknowledged		
SIXTH SCHEDULE ENVIRONMENTAL OUTCOMES		
Aboriginal Heritage Outcome		
70.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Section 7.3.1 Aboriginal heritage; Outcome Measurement Criteria – AH1, Outcome Measurement Criteria – AH2 and Leading Indicator – AH3
Public Safety Outcomes		
71.	The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.	Section 7.3.4 Public Safety; Outcome Measurement Criteria – PS1
72.	The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining-related activities are as low as reasonably practicable.	Section 7.3.4 Public Safety; Outcome Measurement Criteria – PS2 to Outcome Measurement Criteria - PS8
Public Nuisance Outcome		
73.	The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining-related traffic.	Section 7.3.2 Public nuisance; Outcome Measurement Criteria – PN1, Outcome Measurement Criteria – PN2 and Leading Indicator – PN3
Traffic Outcomes		
74.	The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.	Section 7.3.3 Traffic; Outcome Measurement Criteria – INC1
Weeds and Pests Outcome		
75.	The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining-related activities.	Section 7.3.6 Weeds and pests; Outcome Measurement Criteria – WP1, Outcome Measurement Criteria – WP2, Leading Indicator – WP3 to Leading Indicator – WP6
Land Use and Property Outcomes		
76.	The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP1
77.	Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4
78.	The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator - LUP4
Land and Soil Outcome		
79.	The Tenement Holder must, ensure that: 79.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining-related activities; and	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS1, Leading Indicator – LS2 Leading Indicator – LS3 and Leading Indicator – LS4
	79.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining-related activities.	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS5
Native Vegetation Outcome		
80.	The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a Significant Environmental Benefit has been approved in accordance with the relevant legislation.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – NV1, Leading Indicator – NV2
Native Fauna Outcome		
81.	The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining-related activities that could have been reasonably prevented.	Section 7.3.7 Native Fauna; Outcome Measurement Criteria – NF1, Leading Indicator – NF2 and Leading Indicator – NF3
Surface Water Outcome		
82.	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Section 7.3.12.1 Erosion and sedimentation: Outcome Measurement Criteria – SWES1, Leading Indicator – SWES2, Leading Indicator – SWES3, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5 and Outcome Measurement Criteria – SWES6 Section 7.3.12.2 Reduced flow; Outcome Measurement Criteria – SWRF1

No.	Condition	Demonstrated Commitment
		Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF1, Outcome Measurement Criteria – TSF2, Outcome Measurement Criteria – TSF3, Outcome Measurement Criteria – TSF4, Outcome Measurement Criteria – TSF5, Outcome Measurement Criteria – TSF6, Outcome Measurement Criteria – TSF7, Leading Indicator – TSF8, Leading Indicator – TSF9, Leading Indicator – TSF10, Leading Indicator – TSF11, , Leading Indicator – TSF15, Leading Indicator – TSF16, Leading Indicator – TSF21, Leading Indicator – TSF23, Leading Indicator – TSF24, Outcome Measurement Criteria – TSF35, Outcome Measurement Criteria – TSF36 and Outcome Measurement Criteria – TSF37 Section 7.3.12.4 Acid and metalliferous drainage; Outcome Measurement Criteria – AMD6, Leading Indicator – AMD2, Leading Indicator – AMD3, Leading Indicator – AMD4, Outcome Measurement Criteria – AMD5 and Outcome Measurement Criteria – AMD1
Surface Water Strategies – Contamination, Erosion and Sediments		
83.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 13:	
	83.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining-related activities leaves the Land.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	83.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	83.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	83.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES6
Groundwater Outcomes		
84.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining-related activities.	Section 7.3.13.2 Quantity; Outcome Measurement Criteria – GW3, Leading Indicator – GW4 and Leading Indicator – GW5

A7.5 | MPL 154 Southern Access Road and Radial Wellfield – Tenement Conditions Demonstrated Commitment |

No.	Condition	Demonstrated Commitment
FIRST SCHEDULE ADDITIONAL TERMS		
Acknowledged		
SECOND SCHEDULE ADDITIONAL CONDITIONS		
Aboriginal Heritage		
85.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Chapter 7.3.1 Aboriginal heritage, Outcome Measurement Criteria - AH1, Outcome Measurement Criteria - AH2 and Leading Indicator - AH3
Concentrate Transport		
86.	The Tenement Holder must during operations ensure that copper concentrate is transported in fit-for-purpose sealed containers to prevent copper concentrate release to the environment.	Management strategy acknowledged and committed to in Section 4.9.1 Key elements
Waste		
87.	The Tenement Holder must ensure that all commercial or industrial waste (which does not include tailings and waste rock) is disposed of in an EPA licensed facility.	Management strategy acknowledged and committed to in Section 7.3.9 Land and soil and Outcome Measurement Criteria – LS5
Removal of Infrastructure		
88.	The Tenement Holder must ensure that all mining-related infrastructure is decommissioned and removed from the Land at Completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.	Management strategy acknowledged and committed to in Section 7.3.8 Land use and property and Outcome Measurement Criteria – LUP2
Transparency		
89.	The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.	Acknowledged. As stated in Section 3.1 Management capability, BHP is committed to transparency, and will make available to the public the approved PEPR and associated compliance reports.
Notification of cessation of operations		
90.	Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining-related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining-related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining-related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 8.	Acknowledged
Decommissioning and Rehabilitation Plan (DRP)		
91.	The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 8 and 9 when decommissioning or rehabilitating the Mining Tenement.	Acknowledged
92.	Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 6, and that DRP must:	
	92.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;	
	92.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).	
93.	If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining-related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:	
	93.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 8; and/or	
	93.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.	
Operating Protocol		
94.	The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the Land prior to the commencement of mining operations and mining-related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:	Management strategy acknowledged and committed to in Section 3.3.1 Approach, Section 7.3.2 Public nuisance and Section 7.3.8 Land use and property
	94.1. interaction with landowner operations;	
	94.2. emergency procedures;	
	94.3. communications and issue management processes;	
	94.4. land management;	
	94.5. dispute resolution;	
	94.6. ongoing communication about the Tenement Holder's operations;	
	94.7. receiving and considering feedback;	

No.	Condition	Demonstrated Commitment
	94.8. safety procedures; 94.9. access protocols; and 94.10. any matters identified by the Director of Mines (or other authorised officer) in writing.	
95.	The Tenement Holder must: 95.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and 95.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.	Timeframes committed to in Section 4.4 Operations schedule and planning and Section 9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration
Compliance with regulation 98(1)		
96.	A notification required by regulation 98(1) must be in writing.	Acknowledged
Matters of National Environmental Significance		
97.	To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must:	
	97.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes;	Management strategy acknowledged and committed to in Section 7.3.6 Weeds and pests, and in the associated Offset Strategy for Plains Mouse.
	97.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions;	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC1, and in the associated Offset Strategy for Plains Mouse.
	97.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC3, and in the associated Offset Strategy for Plains Mouse.
	97.4. Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. *Explanatory note: This condition reflects a commitment made in the Mining Proposal and Response Document.*	Acknowledged and committed to in Section 7.3.7 Native fauna and Outcome Measurement Criteria EPBC2, and in the associated Offset Strategy for Plains Mouse.
Other Legislation		
98.	The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the: 98.1. Environment Protection and Biodiversity Conservation Act 1999 (Cth) 98.2. Development Act 1993 (SA) 98.3. Planning, Development and Infrastructure Act 2016 (SA) 98.4. Dangerous Substances Act 1979 (SA) 98.5. National Parks and Wildlife Act 1972 (SA) 98.6. Natural Resources Management Act 2004 (SA) 98.7. Public and Environmental Health Act 1987 (SA) 98.8. Aboriginal Heritage Act 1988 (SA) 98.9. Heritage Places Act 1993 (SA) 98.10. Work Health and Safety Act 2012 (SA) 98.11. Environment Protection Act 1993 (SA) 98.12. Radiation Protection and Control Act 1982 (SA) 98.13. Native Vegetation Act 1991 (SA) 98.14. Mines and Works Inspection Act 1920 (SA) 98.15. Road Traffic Act 1961 (SA) 98.16. Wilderness Protection Act 1992 (SA)	Acknowledged. As demonstrated in Section 3.4 Legislative requirements, the legislative framework for the Project is well understood and takes into consideration secondary permitting that will be required at various phases of the Project. Commitments and responsibilities under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), *Native Vegetation Act 1991* (SA) and *Radiation Protection and Control Act 2021* (SA) are outlined in Section 8. BHP will comply with all applicable State and Commonwealth legislation and regulations. Note: *Natural Resources Management Act 2004* (SA) now repealed and replaced with *Landscape South Australia Act 2019* (SA) and the *Radiation Protection and Control Act 1982* (SA) has been updated to the *Radiation Protection and Control Act 2021* (SA)
THIRD SCHEDULE MAP AND DESCRIPTION OF AREAS		
Acknowledged		
FOURTH SCHEDULE PROCESS FOR SUSPENSION		
Acknowledged		
FIFTH SCHEDULE PROCESS FOR CANCELLATION		
Acknowledged		
SIXTH SCHEDULE ENVIRONMENTAL OUTCOMES		
Aboriginal Heritage Outcome		
1.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Section 7.3.1 Aboriginal heritage; Outcome Measurement Criteria – AH1, Outcome Measurement Criteria – AH2 and Leading Indicator – AH3
Public Safety Outcomes		

No.	Condition	Demonstrated Commitment
99.	The Tenement Holder must during construction and operation ensure that unauthorised entry to the Land does not result in public injuries and or deaths that could have been reasonably prevented.	Section 7.3.4 Public Safety; Outcome Measurement Criteria – PS1
100.	The Tenement Holder must demonstrate that post Completion, the risks to the health and safety of the public so far as it may be affected by mining operations or mining-related activities are as low as reasonably practicable.	Section 7.3.4 Public Safety; Outcome Measurement Criteria – PS2 to Outcome Measurement Criteria - PS8
Public Nuisance Outcome		
101.	The Tenement Holder must during construction and operation ensure that there are no public nuisance impacts from dust and noise generated by mining operations or mining-related traffic.	Section 7.3.2 Public nuisance; Outcome Measurement Criteria – PN1, Outcome Measurement Criteria - PN2 and Leading Indicator – PN3
Traffic Outcomes		
102.	The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mining-related traffic that could have been reasonably prevented by the Tenement Holder.	Section 7.3.3 Traffic; Outcome Measurement Criteria – INC1
Weeds and Pests Outcome		
103.	The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining-related activities.	Section 7.3.6 Weeds and pests; Outcome Measurement Criteria – WP1, Outcome Measurement Criteria – WP2, Leading Indicator – WP3 to Leading Indicator – WP6
Land Use and Property Outcomes		
104.	The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP1
105.	Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator - LUP4
106.	The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4
Land and Soil Outcome		
107.	The Tenement Holder must, ensure that: 107.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining-related activities; and	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS1, Leading Indicator – LS2 Leading Indicator – LS3 and Leading Indicator – LS4
	107.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining-related activities.	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS5
Native Vegetation Outcome		
108.	The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – NV1 and Leading Indicator – NV2
Native Fauna Outcome		
109.	The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining-related activities that could have been reasonably prevented.	Section 7.3.7 Native fauna; Outcome Measurement Criteria – NF1, Leading Indicator – NF2 and Leading Indicator – NF3
Surface Water Outcome		
110.	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Section 7.3.12.1 Erosion and sedimentation: Outcome Measurement Criteria – SWES1, Leading Indicator – SWES2, Leading Indicator – SWES3, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5 and Outcome Measurement Criteria – SWES6 Section 7.3.12.2 Reduced flow; Outcome Measurement Criteria – SWRF1 Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF1, Outcome Measurement Criteria – TSF2, Outcome Measurement Criteria – TSF3, Outcome Measurement Criteria – TSF4, Outcome Measurement Criteria – TSF5, Outcome Measurement Criteria – TSF6, Outcome Measurement Criteria – TSF7, Leading Indicator – TSF8, Leading Indicator – TSF9, Leading Indicator – TSF10, Leading Indicator – TSF11, , Leading Indicator – TSF15, Leading Indicator – TSF16, Leading Indicator – TSF21, Leading Indicator – TSF23, Leading Indicator – TSF24, Outcome Measurement Criteria – TSF35, Outcome Measurement Criteria – TSF36 and Outcome Measurement Criteria – TSF37 Section 7.3.12.4 Acid and metalliferous drainage; Outcome Measurement Criteria – AMD6, Leading Indicator – AMD2, Leading Indicator – AMD3, Leading Indicator – AMD4, Outcome Measurement Criteria – AMD5 and Outcome Measurement Criteria – AMD1

No.	Condition	Demonstrated Commitment
Surface Water Strategies – Contamination, Erosion and Sediments		
111.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 13:	
	111.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining-related activities leaves the Land.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	111.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	111.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining-related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	111.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.	Section 1.2.2 Verification of uncertainties, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES6
Groundwater Outcomes		
112.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model as a result of mining operations or mining-related activities.	Section 7.3.13.2 Quantity; Outcome Measurement Criteria – GW3, Leading Indicator – GW4 and Leading Indicator – GW5

A7.6 | MPL 156 Northern Wellfield – Tenement Conditions Demonstrated Commitment

No.	Condition	Demonstrated Commitment
FIRST SCHEDULE ADDITIONAL TERMS		
Acknowledged		
SECOND SCHEDULE ADDITIONAL CONDITIONS		
Aboriginal Heritage		
113.	The Tenement Holder must, during construction, operation and post completion, ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Chapter 7.3.1 Aboriginal heritage; Outcome Measurement Criteria - AH1, Outcome Measurement Criteria - AH2 and Leading Indicator - AH3
Waste		
114.	The Tenement Holder must ensure that all commercial or industrial waste (which does not include CTP process residue, tailings and waste rock) is disposed of in an EPA-licensed facility.	Management strategy acknowledged and committed to in Section 4.15.1 Key elements, Section 7.3.9, Outcome Measurement Criteria – LS5
Removal of Infrastructure		
115.	The Tenement Holder must ensure that all mining-related infrastructure is decommissioned and removed from the land at completion unless the Director of Mines (or other authorised officer) has approved, in writing, for the infrastructure to remain.	Management strategy acknowledged and committed to in Section 7.3.8 Land use and property and Outcome Measurement Criteria - LUP2
Transparency		
116.	The Tenement Holder agrees to the Approved PEPR and any compliance reports and reportable incident reports, submitted in accordance with the Regulations, being made available for public inspection.	Acknowledged. As stated in Section 3.1 Management capability, BHP is committed to transparency, and will make available to the public the approved PEPR and associated compliance reports.
Notification of cessation of operations		
117.	Within thirty (30) days of becoming aware of any event or decision which is likely to give rise to the cessation of mining operations or mining-related activities for a period of more than seven (7) days and where possible prior to the cessation of mining operations or mining related activities, the Tenement Holder must notify the Director of Mines in writing of the event or decision. The notice must specify the date upon which the mining operations or mining-related activities are expected to cease or have ceased, an estimate of the period of cessation and an outline of the steps to develop any required DRP under Second Schedule Condition 7.	Acknowledged
Decommissioning and Rehabilitation Plan (DRP)		
118.	The Tenement Holder must comply with a DRP approved in accordance with Second Schedule Condition 7 and 8 when decommissioning or rehabilitating the Mining Tenement.	Acknowledged
119.	Unless the Director of Mines (or other authorised officer) otherwise directs, a DRP must be submitted to the Director of Mines (or other authorised officer) for approval within sixty (60) days or such longer period which is approved by the Director of Mines (or other authorised officer) of any notification provided to the Director of Mines in relation to the notification of cessation of operations under Second Schedule Condition 5, and that DRP must:	Acknowledged
	119.1. set out the activities and scheduling required for the carrying out of the rehabilitation works specified in the Approved PEPR;	
	119.2. be prepared in accordance with any guidelines provided by the Director of Mines (or other authorised officer).	
120.	If, in the opinion of the Director of Mines (or other authorised officer), mining operations or mining-related activities on the Mining Tenement have substantially ceased for two (2) consecutive years or more, the Director of Mines (or other authorised officer) may:	Acknowledged
	120.1. require that the Tenement Holder submits a DRP for approval dealing with the requirements set out in Second Schedule Condition 7; and/or	
	120.2. direct the Tenement Holder to rehabilitate the Mining Tenement in accordance with the Approved PEPR and/or any DRP.	
Operating Protocol		
121.	The Tenement Holder must develop (in consultation with the owners of land and to the satisfaction of the Director of Mines) a communication and operating protocol, or an agreement incorporating such a protocol, between itself and owners of land adjacent to and on the land prior to the commencement of mining operations and mining-related activities that includes, unless the Director of Mines (or other authorised officer) is otherwise satisfied, the following matters:	Management strategy acknowledged and committed to in Section 3.3.1 Approach, Section 7.3.2 Public nuisance and Section 7.3.8 Land use and property
	121.1. interaction with landowner operations;	
	121.2. emergency procedures;	
	121.3. communications and issue management processes;	
	121.4. land management;	
	121.5. dispute resolution;	
	121.6. ongoing communication about the Tenement Holder's operations;	
	121.7. receiving and considering feedback;	
	121.8. safety procedures;	
	121.9. access protocols; and	
	121.10. any matters identified by the Director of Mines (or other authorised officer) in writing.	

No.	Condition	Demonstrated Commitment
122.	The Tenement Holder must: 122.1. provide the protocol(s) to the Director of Mines (or other authorised officer) within six (6) months of the grant of the Mining Tenement or such longer period that the Director of Mines (or other authorised officer) may allow; and 122.2. maintain and adhere to the protocol(s) to the satisfaction of the Director of Mines (or other authorised officer) for the term of the Mining Tenement.	Timeframes committed to in Section 4.4 Operations schedule and planning and Section 9.4 Baseline information, agreements, well commissioning, field trials and modelling calibration
Compliance with regulation 98(1)		
123.	A notification required by regulation 98(1) must be in writing.	Acknowledged
Other Legislation		
124.	The Tenement Holder must comply with all State and Commonwealth legislation and regulations applicable to the activities undertaken pursuant to this Mining Tenement including (but not limited to) the: 124.1. Environment Protection and Biodiversity Conservation Act 1999 (Cth) 124.2. Development Act 1993 (SA) 124.3. Planning, Development and Infrastructure Act 2016 (SA) 124.4. Dangerous Substances Act 1979 (SA) 124.5. National Parks and Wildlife Act 1972 (SA) 124.6. Natural Resources Management Act 2004 (SA) 124.7. Public and Environmental Health Act 1987 (SA) 124.8. Aboriginal Heritage Act 1988 (SA) 124.9. Heritage Places Act 1993 (SA) 124.10. Work Health and Safety Act 2012 (SA) 124.11. Environment Protection Act 1993 (SA) 124.12. Radiation Protection and Control Act 1982 (SA) 124.13. Native Vegetation Act 1991 (SA) 124.14. Mines and Works Inspection Act 1920 (SA) 124.15. Road Traffic Act 1961 (SA) 124.16. Wilderness Protection Act 1992 (SA)	Acknowledged. As demonstrated in Section 3.4 Legislative requirements, the legislative framework for the Project is well understood and takes into consideration secondary permitting that will be required at various phases of the Project. Commitments and responsibilities under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), *Native Vegetation Act 1991* (SA) and *Radiation Protection and Control Act 2021* (SA) are outlined in Section 8. BHP will comply with all applicable State and Commonwealth legislation and regulations. Note: *Natural Resources Management Act 2004* (SA) now repealed and replaced with *Landscape South Australia Act 2019* (SA) and the *Radiation Protection and Control Act 1982* (SA) has been updated to the *Radiation Protection and Control Act 2021* (SA)
THIRD SCHEDULE MAP AND DESCRIPTION OF AREAS		
Acknowledged		
FOURTH SCHEDULE PROCESS FOR SUSPENSION		
Acknowledged		
FIFTH SCHEDULE PROCESS FOR CANCELLATION		
Acknowledged		
SIXTH SCHEDULE ENVIRONMENTAL OUTCOMES		
Aboriginal Heritage Outcome		
125.	The Tenement Holder must during construction, operation and post Completion ensure that there is no damage, disturbance or interference to Aboriginal heritage sites, objects or remains unless it is authorised under the relevant legislation.	Section 7.3.1 Aboriginal heritage; Outcome Measurement Criteria – AH1, Outcome Measurement Criteria – AH2 and Leading Indicator – AH3
Traffic Outcome		
126.	The Tenement Holder must during construction and operation, ensure that there are no traffic accidents involving members of the public and mine related traffic that could have been reasonably prevented by the Tenement Holder.	Section 7.3.3 Traffic; Outcome Measurement Criteria – INC1
Weeds and Pests Outcome		
127.	The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities.	Section 7.3.6 Weeds and pests; Outcome Measurement Criteria – WP1, Outcome Measurement Criteria – WP2, Leading Indicator – WP3 to Leading Indicator – WP6
Land Use and Property Outcomes		
128.	The Tenement Holder must during construction, operation and post Completion ensure there are no impacts to third-party land use or property on or off the Land as a result of mining operations or mining related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register).	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP1
129.	Before Completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-Tenement land use of the Land can be recommenced post Completion.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator LUP4

No.	Condition	Demonstrated Commitment
130.	The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.	Section 7.3.8 Land use and property; Outcome Measurement Criteria – LUP2, Outcome Measurement Criteria – LUP3 and Leading Indicator - LUP4
Land and Soil Outcome		
131.	The Tenement Holder must, ensure that: 131.1. There is no contamination of land and soils either on or off the Land as a result of mining operations or mining related activities; and	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS1, Leading Indicator – LS2 Leading Indicator – LS3 and Leading Indicator – LS4
	131.2. No contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining related activities.	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS5
Native Vegetation Outcome		
132.	The Tenement Holder must during construction, operation and post Completion ensure that there is no loss of abundance and/or diversity of native vegetation on or off the Land unless a Significant Environmental Benefit has been approved in accordance with the relevant legislation.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – NV1, Leading Indicator – NV2
Native Vegetation Strategies		
133.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Native Vegetation Outcome in Sixth Schedule Clause 8; 133.1. Where baseline native vegetation condition (abundance and diversity) is required as a component of the measurement criteria, baseline native vegetation surveys must be undertaken prior to the influence of mining operations or mining related activities on the existing environment.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – ECO1
Native Fauna Outcome		
134.	The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.	Section 7.3.7 Native fauna; Outcome Measurement Criteria – NF1
Surface Water Outcome		
135.	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining related activities.	Section 7.3.12.1 Erosion and sedimentation: Outcome Measurement Criteria – SWES1, Leading Indicator – SWES2, Leading Indicator – SWES3, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5 and Outcome Measurement Criteria – SWES6 Section 7.3.12.2 Reduced flow; Outcome Measurement Criteria – SWRF1 Section 7.3.12.3 Tailings storage facility; Outcome Measurement Criteria – TSF1, Outcome Measurement Criteria – TSF2, Outcome Measurement Criteria – TSF3, Outcome Measurement Criteria – TSF4, Outcome Measurement Criteria – TSF5, Outcome Measurement Criteria – TSF6, Outcome Measurement Criteria – TSF7, Leading Indicator – TSF8, Leading Indicator – TSF9, Leading Indicator – TSF10, Leading Indicator – TSF11, , Leading Indicator – TSF15, Leading Indicator – TSF16, Leading Indicator – TSF21, Leading Indicator – TSF23, Leading Indicator – TSF24, Outcome Measurement Criteria – TSF35, Outcome Measurement Criteria – TSF36 and Outcome Measurement Criteria – TSF37 Section 7.3.12.4 Acid and metalliferous drainage; Outcome Measurement Criteria – AMD6, Leading Indicator – AMD2, Leading Indicator – AMD3, Leading Indicator – AMD4, Outcome Measurement Criteria – AMD5 and Outcome Measurement Criteria – AMD1
Surface Water Strategies – Contamination, Erosion and Sediments		
136.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Surface Water Outcome in Sixth Schedule Clause 11:	
	136.1. Ensure that during construction, operation and post Completion no surface water contaminated (including by sedimentation) as a result of mining operations or mining related activities leaves the Land.	Section 1.2.2 Verification of uncertainties Strategy SWES7, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	136.2. Develop and implement appropriate strategies to ensure erosion caused by mining operations and mining related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties Strategy SWES7, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	136.3. Develop and implement appropriate strategies to ensure sediment caused by mining operations and mining related activities is effectively managed and controlled.	Section 1.2.2 Verification of uncertainties Strategy SWES7, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES1, Outcome Measurement Criteria – SWES4, Outcome Measurement Criteria – SWES5
	136.4. Ensure that topsoil and subsoil can be used for rehabilitation where appropriate.	Section 1.2.2 Verification of uncertainties Strategy SWES8, Section 4.12.6 Surface water management, Section 7.3.12.1 Erosion and sedimentation, Outcome Measurement Criteria SWES6

No.	Condition	Demonstrated Commitment
Surface Water Fauna Strategies		
137.	137.1. The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(d) in relation to the Native Fauna Outcome in Sixth Schedule Clause 10; 137.2. Where baseline fauna condition (abundance and diversity) is required as a component of the measurement criteria, baseline fauna surveys must be undertaken prior to the influence of mining operations or mining related activities on the existing environment.	Section 7.3.5 Native vegetation; Outcome Measurement Criteria – ECO1
Groundwater Outcomes		
138.	The Tenement Holder must during construction, operation and post Completion ensure that there is no adverse change to groundwater quantity within aquifers outside of the predicted extent of groundwater drawdown delineated by the groundwater model (Appendix B. of the Miscellaneous Purposes Licence Management Plan for the Northern Wellfield June 2018), as a result of mining operations or mining related activities.	Section 7.3.13.2 Quantity; Outcome Measurement Criteria – GW3, Leading Indicator – GW4, Leading Indicator – GW5, Strategy – GW6 as cited in Section 1.2.2 Verification of assumptions and uncertainties
139.	The Tenement Holder must during construction, operation and post completion ensure that there is no adverse change to the environmental values of the groundwater within the shallow perched aquifer within the Land as a result of chemicals or hydrocarbons from mining operations or mining related activities.	Section 7.3.9 Land and soil; Outcome Measurement Criteria – LS1. Section 7.3.13.3 Quality; Outcome Measurement Criteria – GW7.
Groundwater Quantity Strategies		
140.	The Tenement Holder is required to address the following matters for the purposes of Regulation 65(2)(c) in relation to the Groundwater Outcome in Sixth Schedule Clause 14; 140.1. Provide a transient groundwater model that delineates the predicted extent of groundwater drawdown within the groundwater aquifers. 140.2. Establish a program for the ongoing calibration of the transient groundwater model using data obtained from ongoing groundwater monitoring.	Section 7.3.13.2 Quantity; Leading Indicator – GW5 and Section 1.2.2 Verification of uncertainties.

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Appendix B
Description of operations

Appendix B1.
Tailings storage facility design

BHP, owner of OZ Minerals Carrapateena Pty Ltd

Tailings Storage Facility - Life of Mine Concept Design Update for 224 Mdt

Carrapateena, South Australia
CA-3630-CIV-REP-1109

January 2025

Question today
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Tailings Storage Facility - Life of Mine Concept Design Update for 224 Mdt Carrapateena, South Australia
CA-3630-CIV-REP-1109

BHP, owner of OZ Minerals Carrapateena Pty Ltd

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1	17 January 2025	Updated to address BHP comments

	Name	Date	Signature
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WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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1 Introduction

This report presents a concept design for the updated Life of Mine layout for tailings deposition for Stages 3 to 6 of the Carrapateena Tailings Storage Facility (TSF).

The revised Life of Mine concept design is to support BHPs plan to ramp up the ore production rate, with forecast tailings generation of about 5.3 million dry tonnes (Mdt) per annum in 2024 to about 12.4 Mdt per annum by 2038, as part of the transition to block-caving mining. The total of actual and forecast tailings from Stage 1 commissioning to the end of mine life is expected to reach about 224 Mdt.

2 Background

2.1 Approved TSF design

The Carrapateena TSF was approved as a component of the Mining Lease Proposal in May 2017 and Program for Environmental Protection and Rehabilitation (PEPR) in early 2018. The mine plan was for a sub-level caving (SLC) operation and an assumed ore production rate during full operation of about 4.5 Mdt per annum of which, about 4.3 Mdt was expected to be tailings.

A TSF siting assessment[1] for Life of Mine for Carrapateena was updated in September 2017 to review the suitability of sites within the Mining Lease and a site at the head of the Eliza Creek ephemeral valley was confirmed for design. A TSF design prepared in July 2018 and was approved for storage of up to 145 Mdt of tailings solids over a 34-year life of the Carrapateena operation[2]. The TSF was designed to be constructed in six stages: a starter embankment, one downstream raise and four upstream raises. As noted in Section 2.4, Stage 3 will now be a downstream raise.

The permitted design comprises a cross-valley embankment TSF near the head of the Eliza Creek valley, designed to about 48 m above the valley floor with an ultimate tailings storage area of about 540 ha. The permitted design was based on deposition of thickened tailings slurry with a solids concentration of about 62% w/w (weight of solids over total weight of solids and water).

2.2 Existing TSF layout

The TSF comprises a Decant Dam and a tailings storage area, with both storages formed by cross valley embankments. Construction of the Stage 1 starter layout occurred between November 2018 and August 2019. For Stage 1 operation, thickened tailings was deposited down-valley towards the Stage 1 embankment by a series of pipe outlets in the valley reaches, referred to as the Stage 1 deposition strategy. Stage 1 deposition occurred between December 2019 and March 2023.

Construction of the Stage 2 layout including installation of new outlet pipes for tailings deposition occurred between November 2021 and December 2022, and operation of the Stage 2 layout commenced in March 2023 with up-valley deposition from the embankment, referred to as the Stage 2A deposition strategy. A plan showing the as-constructed Stage 2 layout is presented in Figure 2.1. The future Stage 2B deposition strategy comprises down-valley deposition of tailings towards (but not reaching) the embankment through a series of pipe outlets in the valley reaches.

The intent of the Stage 2A and Stage 2B deposition strategy is to move the supernatant pond away from the embankment towards the gravity decant tower causeway (the Decant Causeway) and maintain the pond adjacent to the Decant Causeway. It was also to allow for improved conditions for tailings consolidation adjacent to the embankment for a Stage 3 upstream embankment raise, however, a downstream raise will now be constructed due to the increased rate of tailings generation and raise height considerations. Maintaining the pond away from the embankment also provides for better management of dam breach failure risks associated with water. Under Stage 2A operation, the pond reached the Decant Causeway in June 2023.

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1 Carrapateena Project – Tailings Storage Facility Siting Assessment. Carrapateena ref. not available. Golder (now WSP) report ref. 1648044-002-M-Rev3, 6 September 2017.

2 *Tailings Storage Facility Design Report for the Program for Environmental Protection and Rehabilitation, Carrapateena Project*. Golder (now WSP) report ref. 1660055-045-R-Rev2, July 2018.

For Stage 1 operation, the average solids concentration of tailings slurry was about 60% w/w and beach slopes varied between about 2.4% near the slurry outlets and about 0.6% adjacent to the supernatant pond, i.e., at the toe of the beach. The Stage 1 tailings beach model was updated during Stage 1 operation to reflect the beach slope performance. Two tailings beach models[3] were also developed for the Stage 2 layout to reflect the expected beach slope range for Stage 2 operation. Concave beach profiles were adopted for each model, one with beach slope gradients varying between 1% and 0.6% (referred to as the 'flatter beach') and the other with gradients between 2% and 0.8% (referred to as the 'steeper beach'), based on measured Stage 1 performance between different valley reaches and expected performance and changes to tailings properties during Stage 2 operation.

A tailings beach survey of 26 September 2023, taken after about six months of Stage 2A tailings deposition, showed a continuous tailings beach from the embankment to Decant Tower 1 (northern end of the Decant Causeway), and indicated beach slope gradients of between about 1.1% and 0.6%. A survey of June 2024 shows a maximum beach slope gradient of about 1.3% in the western area of the beach, where deposition has been from pairs of outlets. In the eastern area, where deposition has been from a single outlet, the maximum beach slope gradient is about 0.9%. The Stage 2 beach initially approximated the 'flatter' profile, however, there has been some recent steepening. As noted in Section 3.1, there is a possibility that the beach may become steeper once deposition of coarser tailings commences.

The TSF layout as of June 2024 is shown in Figure 2.2.

[3] *Stage 2 Raise Design, Tailings Storage Facility, Carrapateena Project*. Carrapateena ref. CA-3630-CIV-REP-1023, Golder (now WSP) report ref. 20144293-016-R-Rev0, December 2021

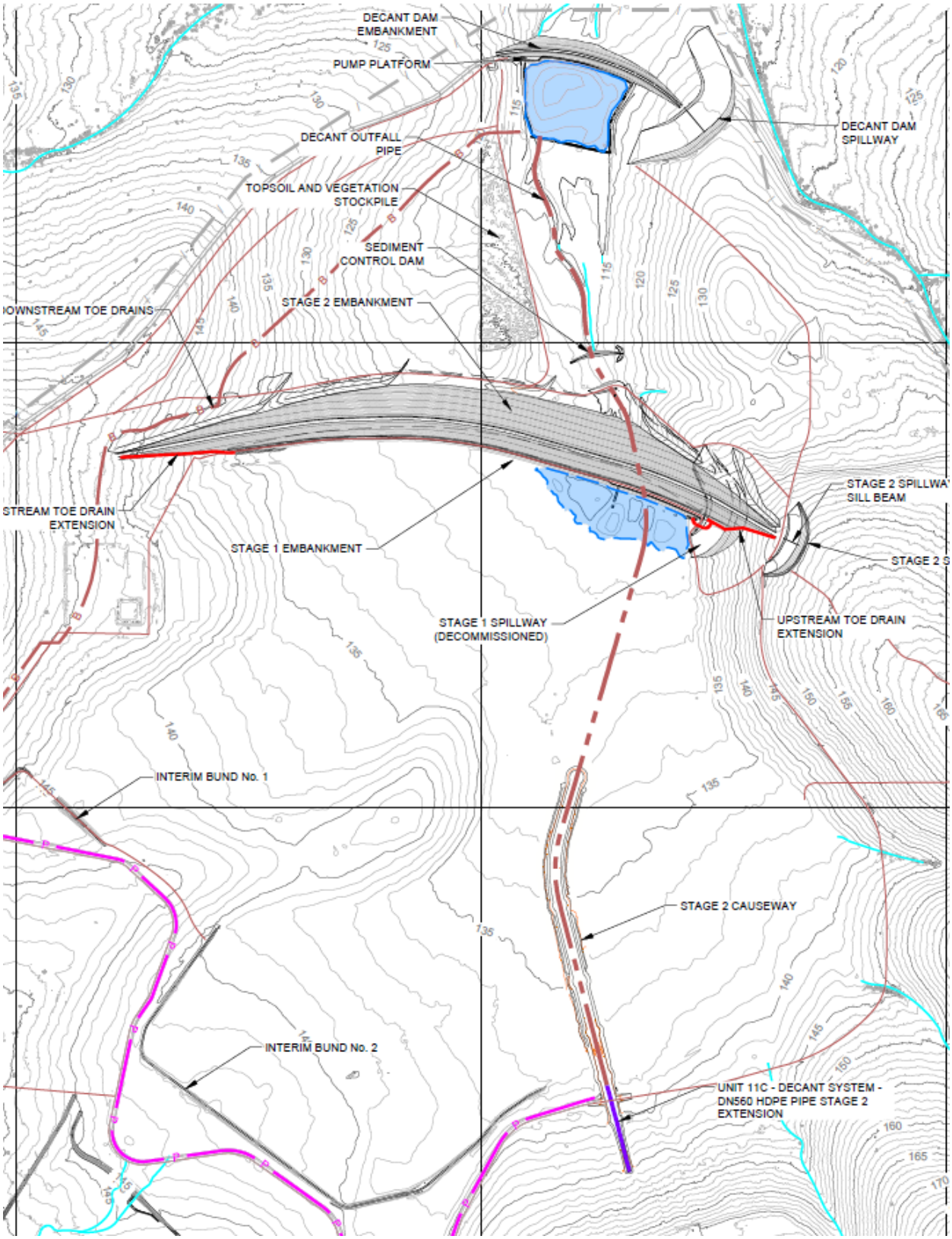

Figure 2.1 TSF Stage 2 as-constructed layout

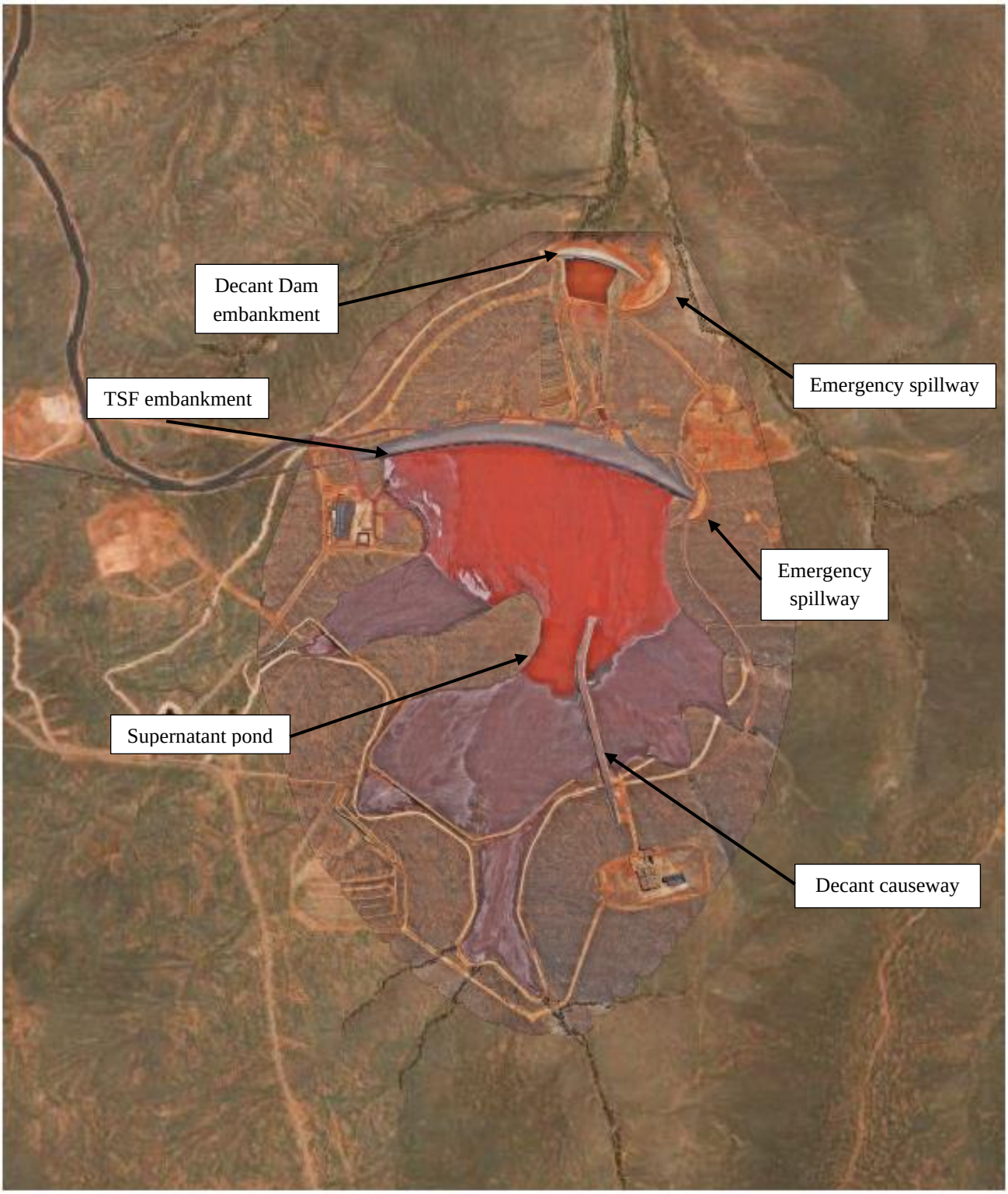

Figure 2.2 Aerial image of the TSF as of June 2024 (source: BHP Carrapateena Survey Department)

2.3 Previous Studies

A TSF raise assessment[4] for expansion to 350 Mdt was completed by Golder Associates Pty Ltd (Golder, now WSP) in January 2020, considering an additional two upstream raises (Stages 7 and 8) to the original permitted design for Stages 1 to 6. Tailings deposition modelling was undertaken for the following average beach slope scenarios, i.e., without concavity in the beach profile:

- 0.7% for thickened tailings slurry, with solids concentration of about 60% w/w.
- 1.5% for a thicker tailings slurry, with solids concentration of about 73% w/w.

The models developed for the above average beach slopes were adopted for an initial TSF staging assessment, prior to considering the 'flatter' and 'steeper' profiles, as summarised in Section 3.4 of this report.

2.4 Proposed extension of Life of Mine and raise option

BHP now intends to increase tailings generation from 145 Mdt to up to about 224 Mdt as part of the transition to block-cave mining. The annual tailings generation rate is expected to increase from about 5.3 Mdt per annum in 2024 to about 12.4 Mdt per annum by 2038.

The design concept is to store the additional tailings in the existing TSF, by raising the maximum height from about 48 m to about 53 m, through construction of a second downstream raise (Stage 3) to the embankment, followed by a series of upstream raises (Stages 4 to 6), with generally higher increments than those in the current approved design. The tailings and water management strategy for the design concept is a continuation of phases of switching between up-valley and down-valley deposition, to maintain the supernatant pond along the Decant Causeway and to facilitate:

- Embankment raises and re-configuration of the tailings distribution system on the raised embankment during the down-valley phase of each stage.
- Re-configuration of the tailings distribution system around the valley reaches during the up-valley phase of each stage.

A TSF raise option assessment[5] for the Stage 3 layout was completed by WSP in November 2023. The assessment considered an upstream, centreline and downstream raise option. The downstream raise option was selected by BHP for development. The updated staged Life of Mine plan is now for a 10.8 m high downstream raise for Stage 3, and upstream raises for Stages 4 to 6 with raise height of 5.5 m (at Stage 4) and 3 m (Stage 5 and Stage 6).

[4] *Carrapateena Expansion Project – Prefeasibility design for thickened and paste tailings options*. Golder (now WSP) report ref. 19129953-004-R-Rev0, January 2020.

[5] *Stage 3 embankment raise options assessment – Carrapateena Tailings Storage Facility*. Carrapateena ref. CA-3630-CIV-REP-1079 Rev0, WSP report ref. PS207335-WSP-MEL-MNG-REP-00002 Rev0, November 2023.

2.5 Battery limits and scope exclusions

The Life of Mine concept design update is limited to the TSF landform, comprising the tailings deposition and water management plan, embankment raises and decant tower system/causeway raises. The following items are excluded from the Life of Mine concept design update scope:

- Assessment of alternative TSF sites.
- Assessment of downstream raise(s) to the existing TSF embankment after Stage 3.
- Assessment of alternative tailings dewatering methods, e.g., possible changes to paste or filtered tailings.
- The tailings delivery and distribution system.
- The return water system.

2.6 Dam safety guidelines, standards, and best practices

2.6.1 Dam safety guidelines and standards

Guidelines, and standards considered applicable to the TSF are listed in Table 2.1 and further information from the guidelines and standards which are considered in the concept design update are described in the following sections.

Table 2.1 Applicable dam safety guidelines and standards

Reference	Issued	Comments
Department of energy and mining (DEM): Mining Act tailings regulation and standards, Mineral Policy 007.	March 2021	Refers to ANCOLD as the primary standard for design.
ANCOLD Guidelines on tailings dams: Planning, design, construction, operation and closure.	July 2019	Primary standard for design.
Global Industry Standard on Tailings Management (GISTM), Global Tailings Review.org	August 2020	All work at Carrapateena is required to be in accordance with GISTM.
International Council on Mining and Metals (ICMM): — Conformance Protocols – Global Industry Standard on Tailings Management. — Tailings Management – Good Practice guide	May 2021	
BHP: Our Requirements – Tailings and Water Storage Facilities.	July 2023	Requirements generally align with those of GISTM.

2.6.2 South Australian standard

Department of Energy and Mining (the regulator) requires the prescribed standards defined in its March 2021 policy document to be adhered to for TSF management and references ANCOLD as the standard for TSF design. It also refers to selected bulletins of other organisations:

- The International Committee on Large Dams (ICOLD), for various design, operation, and closure measures, which are also referenced by ANCOLD.
- The Canadian Dam Association (CDA) for taking a risk informed approach and for emergency preparedness. These items would be addressed in subsequent design phases, i.e., outside the scope of the Life of Mine TSF concept design.

2.6.3 ANCOLD guidance

ANCOLD guidelines are "*not a prescriptive Code of practice*", however, dam regulations of South Australia refer to ANCOLD for design criteria. ANCOLD states that its guidelines are a "*basis for experienced practitioners to use in conjunction with other relevant information and techniques, supplemented by their sound professional judgement*".

Recent ANCOLD guidelines considered applicable to the TSF concept design are:

- Guidelines on Tailings dams – Planning, Design, Construction, Operation and Closure, July 2019.
- Guidelines on the Consequence Categories for Dams, October 2012.
- Guidelines for Design of Dams and Appurtenant Structures for Earthquake, July 2019.
- Guidelines for Geotechnical Investigations, their Foundations, and Appurtenant Structures, May 2020.
- Guidelines on Risk Assessment, July 2022.

2.6.4 Global Industry Standard on Tailings Management

The Global Industry Standard on Tailings Management (GISTM) of August 2020 includes fifteen guiding principles under the following six topics, as presented in Table 2.2. The GISTM guiding principles are incorporated in the Life of Mine concept design update. Commentary on the application is included in Table 2.2.

Table 2.2 GISTM topics and guiding principles, and application commentary

Topic	Guiding Principles	Design application commentary
1 Affected communities.	**1** Respect the rights of project-affected people and meaningfully engage them at all phases of the tailings facility lifecycle, including closure.	n/a
2 Integrated knowledge base.	**2** Develop and maintain an interdisciplinary knowledge base to support safe tailings management throughout the tailings facility lifecycle, including closure.	The concept design was developed based on the site characterisation assessments. A dam breach assessment and a potential human exposure assessment were undertaken, to inform a consequence category assessment.
	3 Use all elements of the knowledge base - social, environmental, local economic and technical - to inform decisions throughout the tailings facility lifecycle, including closure.	
3 Design, construction, operation, and monitoring of the tailings facility.	**4** Develop plans and design criteria for the tailings facility to minimise risk for all phases of its lifecycle, including closure and post closure.	Design criteria based on consequence classification is assessed. Tailings deposition and embankment raise layouts have been developed for the Life of Mine. Slope stability and seepage assessment have been undertaken to inform the Life of Mine embankment design. Construction quality assurance monitoring is provided by the TSF design team, as well as operational monitoring. Monitoring systems designed and installed based on outcomes of design assessments.
	5 Develop a robust design that integrates the knowledge base and minimises the risk of failure to people and the environment for all phases of the tailings facility lifecycle, including closure and post-closure.	
	6 Plan, build and operate the tailings facility to manage risk at all phases of the tailings facility lifecycle, including closure and post-closure.	
	7 Design, implement and operate monitoring systems to manage risk at all phases of the facility lifecycle, including closure.	
4 Management and governance.	**8** Establish policies, systems and accountabilities to support the safety and integrity of the tailings facility.	n/a
	9 Appoint and empower an Engineer of Record.	n/a
	10 Establish and implement levels of review as part of a strong quality and risk management system for all phases of the tailings facility lifecycle, including closure.	n/a

Topic	Guiding Principles	Design application commentary
	11 Develop an organisational culture that promotes learning, communication and early problem recognition.	n/a
	12 Establish a process for reporting and addressing concerns and implement whistleblower protections.	n/a
5 Emergency response and long-term recovery.	**13** Prepare for emergency response to tailings facility failures.	Dam Safety Emergency Plan has been prepared for the TSF.
	14 Prepare for long term recovery in the event of catastrophic failure.	
6 Public disclosure and access to information.	**15** Publicly disclose and provide access to information about the tailings facility to support public accountability.	n/a

n/a = not applicable to ‘design’.

2.6.5 ICMM guidelines

The International Council on Mining and Metals (ICMM) published the 'Tailings Management – Good practice guide' which provides guidance on good governance and engineering practices for responsible tailings management. Part 3 of the guide emphasises the importance of assessing impacts of a TSF failure and addressing credible failure modes throughout the lifecycle of the TSF operation. Credible failure modes were considered in the permitted design (2018) and were considered in the development of the Life of Mine concept update. Refer to Section 6.

2.6.6 Corporate guidelines

The following Corporate (BHP) guidelines are available, and their requirements generally align with those of GISTM:

- Our Requirements – Tailings and Water Storage Facilities. 27 July 2023.
- Our Requirements – Closure and Legacy Management. 13 January 2023.

2.7 Safety in design

A Safety in Design register[6] was prepared for the Stage 1 design and updated for the Stage 2 design. The general control measures (e.g., embankment crest width and slope gradients) have been carried through to the various stages of the Life of Mine concept design.

Note, a Safety in Design register is not included in the scope of this Life of Mine concept design update. A register will be prepared for the detailed design of each future stage, with reference to up to date standards and guidelines, including those of BHP.

[6] *TSF Stage 2 Raise - Safety in Design register for completed works.* Carrapateena ref. CA-3630-CIV-REP-1091, WSP Golder ref. 20144293-061-L-Rev0, January 2024.

3 Tailings characterisation, schedule and capacity

3.1 Ore processing

Ore is currently milled with a target grind size of about 100 micron (µm), resulting in about 80% of particles finer than 75 µm, i.e. a P_{80} of 75 µm. The scheduled increase in production rate is indicated[7] to result in a coarser target grind size of between about 106 µm and 125 µm, resulting in a P_{80} of about 110 µm. A Hydrofloat system is scheduled to be commissioned in early to mid-2025 to process the coarser grind.

Results of geotechnical testwork on 'fine', 'coarse' and 'blended' samples of future tailings were reported[8] in October 2022, however, BHP expects properties of the coarser tailings to be different to those tested. The P_{80} for the blend considered in the testwork was about 75 µm, however, the coarser tailings is now expected to have a P_{80} of about 110 µm. For the Life of Mine concept design, design parameters are based on some of the properties derived from the testwork on the blended tailings and updates on expected parameters provided by BHP. It is assumed that the parameters for the coarse tailings are applicable from the beginning of the down-valley tailings deposition phase of Stage 2 (Stage 2B).

3.2 Tailings parameters and properties

3.2.1 Overview

Tailings parameters and properties adopted for the Life of Mine concept design update are summarised below. All parameters and properties were agreed between BHP and WSP in the Basis of Assessment[9].

3.2.2 Tailings slurry concentration

Tailings slurry is currently thickened by high-rate thickener before being pumped to the TSF. Solids concentration data for the tailings slurry deposited between 19 June 2023 and 26 September 2023 indicates the average solids concentration of the slurry is about 57% w/w with a maximum recorded concentration of 64.7%.

The average solids concentration adopted for the Life of Mine tailings slurry is 62% w/w.

3.2.3 Particle density and particle size distribution

Particle density and particle size distribution (PSD) testing of tailings generated at the Processing Plant is undertaken monthly by BHP.

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7 Email from OZ Minerals (Jones/ Accadia), 28 June 2023.

8 *Geotechnical testwork on Hydrofloat tailings samples*. Carrapateena ref. CA-3630-CIV-REP-1051, WSP Golder ref. PS132268-001-R-Rev0, October 2022,

9 *Life of Mine Concept Design Update – Basis of Assessment, Carrapateena Tailings Storage Facility*. Carrapateena ref. CA-3630-CIV-REP-1070, WSP ref. PS138057-MEL-MNG-REP-0001 Rev0, January 2024.

The average particle density for tests undertaken in 2022 was 3.17 g/cm^3. Results of testwork[10] completed in October 2022 indicated a particle density of 3.67 g/cm^3 for blended tailings. An average particle density of 3.5 g/cm^3 was adopted for this Life of Mine concept design update.

Results of monthly PSD tests in 2022 by BHP indicate a P_{80} of about 75 µm. Testwork on a laboratory prepared 'blended sample indicated a P_{80} of about 75 µm. However, BHP has noted the P_{80} for the blended (coarse) tailings is expected to be between 90 micron and 125 µm, with an expected average of about 110 µm.

A higher particle density may result in a relatively higher average dry density for deposited tailings, however, a coarser tailing is likely to reduce the consolidation performance of the tailings. Coarser tailings typically result in a relatively steeper beach slope profile, due to a change in settling performance along the beach. Refer Section 3.2.5 for adopted beach slope scenarios and applicable gradients.

3.2.4 Average dry density of the tailings

The estimated TSF volume consumed between December 2019 and 21 March 2023, i.e., for the Stage 1 layout, is about 6,630,000 m^3, and total tailings deposited during this period was about 12,691,000 dry tonnes which equates to a dry density of about 1.9 t/m^3. Consolidation testwork[11] undertaken on tailings samples in 2019 indicated a dry density of about 1.95 t/m^3 for a 100 kPa load, i.e., for an average overlying 5 m thickness of tailings. For 10 m of overlying tailings, the dry density was indicated to be about 2 t/m^3.

Laboratory testing was undertaken[12] in 2022 on 'fine' tailings (P_{80} of 19 µm, at a solids concentration of 57% w/w), 'coarse' tailings (P_{80} of 212 µm, 65% w/w) and 'blended' tailings (P_{80} of 75 µm, 72% fine to 28% coarse tailings ratio, 62% w/w). The laboratory test results indicate the blended tailings has a dry density of between 1.81 t/m^3 and 2.36 t/m^3 for loads between 10 kPa and 1600 kPa, respectively. For an equivalent overlying thickness of about 5 m (~100 kPa), the dry density was indicted to be about 2 t/m^3 and for 10 m (~200 kPa), about 2.1 t/m^3.

To account for the likely coarser P_{80} of the future tailings (about 110 µm instead of 75 µm), an average dry density of 1.9 t/m^3 was adopted for Stages 2 onwards, for the Life of Mine concept design update. The average dry density will continue to be reviewed throughout operation through quarterly capacity assessments, with detailed designs for each stage based on an up to date estimate.

3.2.5 Beach slope gradients

Stage 1 operation of the TSF comprised down valley deposition from a series of pipe outlets in valley reaches, with tailings beaching towards the embankment. Stage 2 will be operated in two phases, the first (Stage 2A which commenced in March 2023) being for up-valley deposition from the embankment and the second (Stage 2B) being for down-valley deposition. Both phases are designed to maintain the supernatant pond adjacent to the decant tower system.

The Stage 1 beach slope was measured to be concave with beach slope gradients varying between about 2.4% at the head of the beach and about 0.6% near the toe of the beach. In January 2023 (a few months prior to cessation of Stage 1), beach slope gradients were typically between about 1.7% and 0.8%, The relatively steep beach near the slurry outlets was attributed to valley side slope constraints.

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[10] *Geotechnical testwork on Hydrofloat tailings samples*. Carrapateena ref. CA-3630-CIV-REP-1051, WSP Golder report ref. PS132268-001-R-Rev0, October 2022,

[11] *Tailings Storage Facility – Assessment of Impact of Lower Density Tailings Slurry*. Golder (now WSP) report ref. 19121887-004-R-Rev0, February 2020.

[12] *Geotechnical testwork on Hydrofloat tailings samples*. Carrapateena ref. CA-3630-CIV-REP-1051, WSP Golder report ref. PS132268-001-R-Rev0, October 2022,

The following typical beach slope gradients for deposition from the embankment (Stage 2A) were measured from a beach survey of June 2024:

- Western area of the beach, where deposition is from pairs of outlets: 1.3% and 0.8%.
- Eastern area of the beach, where deposition is from a single outlet: 0.9% to 0.7%.

The following two beach slope profiles were adopted for the tailings deposition modelling (presented in Section 3.2.3), to simulate the expected range of beach slope performance:

- Flatter beach slope scenario: gradients of between 1% (near the outlet) and 0.6% (near the decant area).
- Steeper beach slope scenario: gradients of between 2% (near the outlet) and 0.8% (near the decant area).

The beach scenarios were selected based on the expected range for beach slope performance, with the flatter slope representing relative good storage efficiency in Stage 2 and the steeper slope representing reduced storage efficiency, and therefore a conservative case for Stage 3 raise planning. Both scenarios result in a similar embankment raise height over the Life of Mine.

3.3 Tailings schedule and storage capacity

3.3.1 Tailings generation schedule

Life of Mine tailings generation is scheduled to increase to about 224 Mdt with the transition to block-caving. Annual tailings generation is scheduled to ramp up from about 5.3 Mdt in 2024 to a maximum of about 12.4 Mdt in 2038. The ramp up will progress as follows:

- 5.3 Mdt per annum in 2024 to 6.6 Mdt per annum by 2026.
- 9.4 Mdt per annum by 2030.
- 12.4 Mdt per annum by 2038.

The Life of Mine concept design update is based on the tailings generation schedule and summarised in Table 3.1. The schedule includes actual tailings deposited to end of Stage 1, i.e., late March 2023 (shown in blue text), monthly forecast averages and forecast maximums for each year.

For the total Life of Mine tailings of 224 Mdt and an average dry density of 1.9 t/m^3, volumetric storage capacity of about 118 Mm^3 is required. As noted in Section 3.2.4, a dry density of 1.9 t/m^3 was adopted for the Life of Mine concept design update, based on current performance and potential changes due to coarser tailings.

Table 3.1 Life of mine forecast tailings deposition data for 2020 to June 2046

Period end	Tailings to be deposited (dry tonnes)	Cumulative tailings (dry tonnes)	Average monthly rate of deposition (dry tonnes)
21/03/2023	12,600,000 **(Note 1)**	12,600,000	349,000
31/12/2023	3,720,000 **(Note 2)**	16,300,000	413,000
31/12/2024	5,270,000	21,600,000	439,000
31/12/2025	6,120,000	27,700,000	510,000
31/12/2026	6,600,000	34,300,000	550,000
31/12/2027	6,510,000	40,800,000	543,000
31/12/2028	6,450,000	47,200,000	537,000
31/12/2029	6,970,000	54,200,000	581,000
31/12/2030	9,400,000	63,600,000	783,000
31/12/2031	11,400,000	75,000,000	950,000
31/12/2032	11,400,000	86,400,000	950,000
31/12/2033	11,400,000	97,800,000	950,000
31/12/2034	11,400,000	109,000,000	950,000
31/12/2035	11,400,000	121,000,000	950,000
31/12/2036	11,400,000	132,000,000	950,000
31/12/2037	11,900,000	144,000,000	990,000
31/12/2038	12,400,000	156,000,000	1,030,000
31/12/2039	11,200,000	167,000,000	930,000
31/12/2040	11,700,000	179,000,000	978,000
31/12/2041	11,400,000	191,000,000	950,000
31/12/2042	7,600,000	198,000,000	633,000
31/12/2043	7,600,000	206,000,000	633,000
31/12/2044	7,600,000	213,000,000	633,000
31/12/2045	7,600,000	221,000,000	633,000
30/06/2046	3,100,000	224,000,000	517,000

Table 3.1 notes:

(1) Actual tailings deposited from December 2019 to 21 March 2023, i.e., in the Stage 1 layout.

(2) The total of actual and then forecast tailings for 2023 is about 5 Mdt.

3.3.2 *Tailings deposition modelling*

Tailings beach slope models were prepared in Muk3D software (Version 2022.1.4). Beach slope models were prepared to target the required tailings storage for each stage. The modelling was completed for Stage 3 to Stage 6, and for two beach slope scenarios (as discussed in Section 3.2.5). Each stage of tailing deposition consists of two phases: up-valley from the TSF embankment (Phase A) and down-valley from the valley reaches (Phase B).

The tailings deposition models for each stage are based on the tailings parameters noted in Section 3.2, and the following:

- The tailings generation schedule.
- Providing at least four years of storage capacity by stage.
- An initial staging plan selected based on storage curves for beach models with average beach slope gradients of 0.7% and 1.5% for the flatter and steeper beach slope scenarios, respectively.
- Storage volumes for each stage, selected based on an average dry density of 1.9 t/m^3.

The same elevations for the head of the beach were adopted adjacent to the TSF embankment for each beach slope scenario. The incremental volumetric storage capacity by stage was used as a target for each of the tailings deposition models summarised in Sections 3.3.2.1 and 3.3.2.2. In addition, the tailings deposition modelling was undertaken to:

- Locate the toe of the beach at the designated decant area, i.e., adjacent to the Decant Causeway.
- Locate the low point of the decant area at least 600 m away from the embankment, and as close to the northern end of the Decant Causeway as possible, i.e., around Tower 1, in order to limit the head of beach elevation in the valley reaches, thereby minimising the required elevation head for pumping during the down-valley deposition phase.
- Phase tailings deposition between up-valley and down-valley to allow time for tailings to consolidate near the embankment and improve conditions for upstream raise construction (for Stages 4 to 6) and relocation of tailings delivery pipelines and installation of new outlets.

The deposition models are based on the respective end of Stage 2 filling layouts for each beach slope scenario, and conceptual embankment raise and Decant Causeway raise models for Stages 3 to 6.

3.3.2.1 Flatter beach slope scenario

The staged tailings deposition layouts for the flatter beach slope scenario, for Stages 2 to 6 are presented in Appendix A. Tailings containment is primarily provided by raises to the TSF embankment, with a small saddle dam up to about 4 m high, required on the western side of the Stage 5 layout. The TSF embankment connects with the saddle dam at Stage 6.

The TSF staged storage volumes and beach areas for the flatter beach slope scenario are summarised in Table 3.2.

Table 3.2 TSF staged storage volumes and beach areas for the flatter beach slope scenario

Stage	Date of commencement	Target tailings storage volume (Mm^3)	Embankment crest elevation (RL m)	Head of beach elevation (RL m)	Deposition phase	Modelled tailings storage volume (Mm^3)	Total tailings storage volume for each stage (Mm^3)	Variance relative to target volume (%)	Beach area (ha) (Note 1)	Total beach area (ha)
1	Dec-2019	6.6 (Actual)	133.6	n/a	1	6.6 (Actual)	6.6 (Actual)	-	-	150
2	Mar-2023	18.7 (Actual and forecast)	146.7	146.0	2A/2B	18.7 (Actual and forecast)	18.7 (Actual and forecast)	-	-	336
Stage 1 and 2 sub-total		**25.3**				**25.3**	**25.3**			
3	Feb-2029	22.8	157.5	156.5	3A	15.1	23.0	0.9	248	448
					3B	7.9			288	
4	Jun-2033	24.1	163	162	4A	13.0	25.0	3.7	291	556
					4B	12.0			355	
5	Aug-2037	24.7	166	165	5A	8.7	25.7	4.0	303	690
					5B	17.0			500	
6	Oct-2041	21.1	169	168	6A	7.1	20.8	-1.4 **(Note 2)**	278	744
					6B	13.7			553	
Total storage volume for Stages 3 to 6		**92.7**					**94.5**			
Total for Stages 1 to 6		**118 (Note 3)**					**119.8 (Note 3)**			

Table 3.2 notes:

(1) Portion of beach areas for up-valley and down-valley phases overlap for total stage beach area.

(2) Although Stage 6 has a negative variance, the overall storage achieves the target storage volume.

(3) Total exceeds minimum requirement of 118 Mm^3 based on a total 224 Mdt of tailings at an average dry density of 1.9 t/m^3.

3.3.2.2 Steeper beach slope scenario

The staged tailings beach layouts for the steeper beach slope scenario, for Stages 2 to 6 are presented in Appendix B. For the steeper beach slope scenario, a saddle dam is required for the Stage 5 layout at the head of the valley (southern end of impoundment), and a raise to the saddle dam is required at Stage 6. The Stage 6 saddle dam was modelled as a downstream raise for this assessment.

A steep beach slope may develop as the grind size becomes coarser with the ramp up in production – refer Appendix B. A coarser grind (and Hydrofloat processing) is expected from the start of June 2025. The Stage 2 tailings beach model presented on Figure B001 represents an update to the layout presented in the Stage 2 design report[13]. It was updated based on the following timeline.

- December 2023 (date of beach survey adopted for modelling) to end May 2025: relatively flat beach slope from up-valley deposition from the Stage 2 embankment.
- From June 2025: relatively steep beach slope for remainder of the Stage 2A layout and for the entire Stage 2B layout.

The relatively steeper beach slope scenario for Stage 2 would result in filling by March 2026. Assuming a 12-month period for Stage 3 raise construction, construction would need to commence in early 2025. The staged storage volumes and beach areas for the steeper beach slope scenario are summarised in Table 3.3.

[13] *Stage 2 Raise Design, Tailings Storage Facility*. Carrapateena ref. CA-3630-CIV-REP-1023, Golder (now WSP) report ref. 20144293-016-R-Rev0, December 2021.

Table 3.3 TSF staged storage volumes and tailings beach areas for the steeper beach slope scenario

Stage	Date of commencement	Target tailings storage volume (Mm^3)	Embankment crest elevation (RL m)	Head of beach elevation (RL m)	Deposition phase	Modelled tailings storage volume (Mm^3)	Total tailings storage volume for each stage (Mm^3)	Variance relatively to target volume (%)	Beach area (ha) (Note 1)	Total beach area (ha)
1	Dec-2019	6.6 (Actual)	133.6	n/a	1	6.6 (Actual)	6.6 (Actual)		-	150
2	Mar-2023	8.8 (Actual and forecast)	146.7	146.0	2A Flat	6.4	8.8	n/a **(Note 2)**	111	249
					2A Steep	0.2			38	
					2B	2.2			152	
Stage 1 and 2 sub-total		**15.4**				**15.4**	**15.4**			
3	Apr-2026	22.8	157.5	156.5	3A	11.8	20.9	-8.3 **(Note 3)**	203	420
					3B	9.1			269	
4	Jun-2031	24.1	163	162	4A	12.2	25.5	5.8	246	555
					4B	13.2			387	
5	Sep-2035	24.7	166	165	5A	7.7	25.4	2.8	248	665
					5B	17.7			483	
6	Oct-2039	31.0	169	168	6A	5.9	31.7	2.3	225	791
					6B	25.8			639	
Total storage volume for Stages 3 to 6		**102.6 (Note 4)**					**103.5**			
Total for Stages 1 to 6		**118.0 (Note 5)**					**118.9 (Note 5)**			

n/a = not applicable.

Table 3.3 notes:

(1) Portion of beach areas for up-valley and down-valley phases overlap for total stage beach area.

(2) Modelling undertaken to provide update on timing for Stage 2 filling.

(3) Although the variance is relatively high, the modelled storage volume provides for about 5 years of storage capacity, i.e., more than the minimum target of 4 years.

(4) Additional capacity required for Stages 3 to 6 for the steeper scenario compared to the flatter scenario, as less relatively less capacity is provided in the Stage 2 layout.

(5) Total exceeds minimum requirement of 118 Mm^3 based on a total 224 Mdt of tailings at an average dry density of 1.9 t/m^3.

3.4 Conceptual staging plan

The conceptual staging plans for each beach slope scenario based on the tailings deposition modelling are presented in Table 3.4 (flatter beach) and Table 3.5 (steeper beach). The plans indicate a minimum duration of 1.2 years for the second phase of tailings deposition for each stage (Stage 3 to 6) and each beach slope scenario. Based on the Stage 3 raise options assessment and construction schedule information provided by an earthworks contractor (Exact Contracting), 1.2 years is expected to be sufficient for construction of relatively lower height upstream raises for Stages 4 to 6.

Table 3.4 Updated TSF staging plan for the flatter beach slope scenario – Stages 3 to 6

Stage	Tailings storage volume from staged model (Mm^3)	Cumulative tailings storage volume (Mm^3) (Note 1)	Estimated start date	Estimated end date	Duration of deposition (years)	Tailings elevation at embankment (RL m)	Beach area (ha)	Rate of rise tailings near embankment (m/year)	Embankment crest elevation (RL m)	Embankment raise height (m)	Maximum embankment height (m)
3A	15.1	15.1	Jan-29	Feb-32	3.1	156.5	248	2.5	157.5	10.8	40.9
3B	7.9	23	Feb-32	Jun-33	1.3	n/a	288	n/a (**Note 2**)			
4A	13	36	Jun-33	Aug-35	2.2	162	291	2.1	163	5.5	46.4
4B	12	48	Aug-35	Aug-37	2.0	n/a	355	n/a **(Note 2)**			
5A	8.7	56.7	Aug-37	Dec-38	1.3	165	303	2.0	166	3	49.4
5B	17	73.7	Dec-38	Oct-41	2.8	n/a	500	n/a **(Note 2)**			
6A	7.1	80.8	Oct-41	May-43	1.6	168	278	1.4	169	3	52.4
6B	13.7	94.5	May-43	Jul-46	3.2	n/a	553	n/a **(Note 2)**			

Table 3.4 notes:

(1) Includes actual and forecast tailings to end of Stage 2.

(2) n/a = not applicable, as deposition is variable from valley reaches, not close to an embankment, and therefore the rate of rise is not critical for future upstream raise considerations.

Table 3.5 Updated TSF staging plan for steeper beach slope scenario – Stages 3 to 6

Stage	Tailings storage volume from staged model (Mm^3)	Cumulative tailings storage volume (Mm^3) (Note 1)	Estimated start date	Estimated end date	Duration of deposition (years)	Tailings elevation at embankment (RL m)	Beach area (ha)	Rate of rise for tailings near embankment (m/year)	Embankment crest elevation (RL m)	Embankment raise height (m)	Maximum embankment height (m)
3A	11.8	11.8	Mar-26	Aug-29	3.4	156.5	203	1.7	157.5	10.8	40.9
3B	9.1	20.9	Aug-29	Jun-31	1.8	n/a	269	n/a **(Note 2)**			
4A	12.1	33.1	Jun-31	Jun-33	2.0	162	246	2.5	163	5.5	46.4
4B	13.2	46.3	Jun-33	Aug-35	2.2	n/a	387	n/a **(Note 2)**			
5A	7.7	54	Aug-35	Dec-36	1.3	165	248	2.4	166	3	49.4
5B	17.7	71.7	Dec-36	Oct-39	2.8	n/a	483	n/a **(Note 2)**			
6A	5.9	77.6	Oct-39	Sep-40	0.9	168	225	2.7	169	3	52.4
6B	25.8	103.4	Sep-40	Jul-46	5.8	n/a	639	n/a **(Note 2)**			

Table 3.5 notes:

(1) The total tailings storage volume for the steeper beach slope scenario is more than that for the flatter beach scenario, as less tailings is provided at Stage 2 for the steeper scenario.

(2) n/a = not applicable, as deposition is variable from valley reaches, not close to an embankment, and therefore the rate of rise is not critical for future upstream raise considerations.

4 Tailings dewatering method

4.1 Overview

Tailings slurry is currently dewatered by high-rate thickener to a solids concentration of about 62% w/w, and the thickener underflow is pumped to the TSF. As noted in Section 3.2.2, the Life of Mine study is based on a continuation of high-rate thickening to this solids concentration.

A review of tailings dewatering options[14] was completed by FlSmidth in March 2021 and included in the CarraX Phase 1 Feasibility Study[15] for the TSF (issued in July 2021). The CarraX study considered tailings deposition/placement at an annual rate of about 12 Mdt. The following options were considered, and cost differentials were provided for centrifugal and positive displacement pumping:

1. Continuation of existing high-rate thickening (HRT) technology, i.e., at a solids concentration of about 62% w/w.
2. High-density thickening (HDT) (at the processing plant) to a solids concentration of about 70% w/w, prior to deposition.
3. Paste thickening (adjacent to the TSF) to a solids concentration of about 75% to 80% w/w, prior to deposition.
4. Filtered tailings including HRT and HDT prior to filtration. Filtration to a solids concentration of about 86% w/w prior to mechanical placement. Pressure filtration was indicated to be the most suitable filtration method.

4.2 Dewatering study findings and commentary

The FLSmidth study indicated:

- High density thickening with centrifugal pumps to have relatively low capital and operating costs with significant water savings. Capital expenditure was estimated at about $1.50/tonne, considering new pumps but without considering upgrades to pipelines. This compared to about $1.42/tonne for a continuation of HRT tailings. **Refer TSF design comment 1.**
- The Paste thickening option did not offset the increased capital/operating costs in comparison to high density thickening. **Refer TSF design comment 2.**
- Filtered tailings (including placement) had a significant increase in capital cost that did not offset the significant water savings. Capital expenditure was estimated at between about $5.70/tonne and $6.60/tonne. Nearly 50% of this cost was attributed to conveying over a length of about 4 km to the TSF and mobile conveyor stacking. **Refer TSF design comment 3.**

TSF design comments:

1. Although HDT was the preferred option for the CarraX study based on relatively less water consumption (refer Section 4.3), it would result in significant steepening of the tailings beach and therefore the requirement to construct a larger TSF embankment and larger saddle dams.
2. Furthermore, paste thickening would likely result in beach slopes that are too steep to form over the required TSF impoundment area, i.e., they would either not beach over the required length or would require a relatively larger (and more costly) embankment to contain the beach profile.

[14] *OZ Minerals Carrapateena, Tailings Options Study, FLSmith, 10 March 2021.*

[15] *Tailings Storage Facility CarraX Feasibility Study Phase 1, Carrapateena Project*. Carrapateena ref. CA-3630-CIV-REP-1022, Golder (now WSP) report ref. 20438022-002-R-Rev0, 2 July 2021.

3. Although the study considered conveying over about 4 km, rather than locating the filtration plant adjacent to the TSF, mechanical placement costs at the TSF are still expected to be substantial (particularly compared to hydraulic deposition). Mechanical placement would require likely require substantial areas for temporary stockpiling and a large fleet of trucks, dozers and compaction equipment.

4.3 Water recovery potential

At a tailings generation rate of 12 Mdt per annum, the current tailings dewatering method of HRT would result in about 6.5 GL of water transported to the TSF per year. The relative amount of water transported to the TSF with each dewatering option and the relative improvement of water recovery at the plant for HDT and Filtered tailings is summarised in Table 4.1.

Table 4.1 Summary of estimated water transported to TSF by dewatering method, and relative recovery at plant

Dewatering method	Water transported to TSF (GL/year)	Water transported to TSF (ML/day)	Improvement in water recovery at plant relative to HRT tailings (ML/day)
HRT (~62% w/w)	6.5	17.7	-
HDT (~70% w/w)	5.1	14.1	3.6
Filtration (~86% w/w)	2.0	5.4	11.7

4.4 Dewatering method selection for Life of Mine study

A continuation of high-rate thickening to a solids concentration of about 62% w/w is considered to be best option for the Life of Mine TSF on the basis that it results in a relatively gentle beach profile, and therefore a relatively smaller embankment than what would be required for HDT or Paste tailings.

Although Filtered tailings can be shaped to a relatively gentle profile and therefore require a relatively small embankment, the capital and operating costs are substantially higher than for hydraulic deposition.

5 Climate assessment

5.1 Overview

A climate assessment[16] for Carrapateena was prepared by WSP in August 2023 and is presented in Appendix D. The climate of the region is arid with annual evaporation typically exceeding annual rainfall by a ratio of 17 to 1. Mean annual rainfall is about 184 mm. The mean maximum temperature typically ranges between 17 °C and 35 °C and the mean minimum temperature typically ranges between 6 °C and 20 °C.

5.2 Climate change projection estimation for design rain events

A tabulated summary of rainfall intensity-frequency-duration (IFD) data for the site, sourced from the Bureau of Meteorology website, is included in the climate assessment in Appendix D.

The Australian Rainfall Runoff (ARR) guideline[17] values for expected changes to individual rain events, as percentage changes to design IFDs are presented in Table 4.4 of the climate report, based on Representative Concentration Pathways (RCP). Rainfall depths are presented for two climate change scenarios, RCP4.5 and RCP8.5, which represent low and high global emissions scenarios respectively.

The following design rain events are applicable to flood assessments for the TSF:

- 1 in 100 AEP, 72-hour rain event, for Extreme Storm Storage Allowance criteria of ANCOLD for a 'Significant' environmental spill consequence category facility.
- 1 in 1,000 AEP, critical duration rain event, adopted for the TSF spillway design, considering the large available pond capacity in the TSF impoundment – refer Section 7.6.
- Probable Maximum Precipitation (PMP), 72-hour rain event, considered on the basis of large flood storage capacity in the TSF layouts – refer Table 7.1 and Section 7.3.

The projected rainfall depths for the 1 in 100 AEP, 72-hour design rain event, and the rainfall intensities for the 1 in 1,000 AEP and Probable Maximum Precipitation (PMP) design rain events, are presented in Table 5.1 to Table 5.3, for RCP4.5 and RCP8.5.

Table 5.1 Rainfall depths for 1 in 100 AEP, 72-hour duration design event, for climate change projections

Projected period	Current rainfall depth (mm)	Projected rainfall depth (mm)	
		RCP 4.5	RCP 8.5
Current climate	165	-	-
Near future (2030)	-	177	176
Medium (2050)	-	181	184
Far future (2090)	-	186	208

[16] *Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment*. Carrapateena ref. CA-3630-CIV-REP-1071, WSP report ref. PS138057-WSP-MEL-MNG-REP-00002 Rev0, August 2023.

[17] Ball, J., Babister, M., Nathan, R., Weeks, B., Weinmann, E., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff – A Guide to Flood Estimation*.

Table 5.2 Rainfall intensities for 1 in 1,000 AEP, 1-hr to 24-hr duration design events, for current climate and future climate change projections

Projected period	Rainfall intensity for current climate (mm/hour)			Projected rainfall intensity (mm/hour)					
				RCP 4.5			RCP 8.5		
	1-hour	6-hour	24-hour	1-hour	6-hour	24-hour	1-hour	6-hour	24-hour
Current climate	290	48	10	-	-	-	-	-	-
Near future (2030)	-	-	-	311	52	12.9	309	51	12.9
Medium (2050)	-	-	-	318	53	13.3	323	54	13.4
Far future (2090)	-	-	-	328	55	13.7	365	61	15.4

Table 5.3 Rainfall depth and intensities for the 1 in 1,000,000 AEP (PMP), 72-hour duration event, for current climate and climate change projections

Projected period	Rainfall for current climate		Projected rainfall			
			RCP 4.5		RCP 8.5	
	Depth (mm)	Intensity (mm/hr)	Depth (mm)	Intensity (mm/hr)	Depth (mm)	Intensity (mm/hr)
Current Climate	770	11	-	-	-	-
Near future (2030)	-	-	825	11.5	820	11.4
Medium (2050)	-	-	845	11.7	857	11.9
Far future (2090)	-	-	870	12.1	969	13.5

6 Dam breach and consequence category assessments

6.1 Credible failure mode register

A review of potential dam breach failure modes was undertaken to identify credible failure modes and proposed controls for the Life of Mine stages of the TSF. A register listing the failure modes and controls is presented in Appendix G. The embankment failure mode categories in the register are:

- Overtopping
- Slope instability
- Internal erosion

The credible failure modes identified for consideration in a dam breach assessment were:

- Tailings delivery pipe break and scour erosion of the embankment, leading to overtopping.
- Liquefaction of foundation (deposited tailings) of upstream raises, leading to slope instability.

6.2 Dam breach assessment

A dam breach assessment[18] was completed for the Stage 3 and Stage 6 layout and the report is presented in Appendix H. Extreme flood conditions (ponded runoff from a Probable Maximum Precipitation, 72-hour event) were adopted for each scenario analysed and these show downstream runout extents, as well as depth and velocity of flow.

The dam breach scenarios adopted for analysis are summarised in Table 6.1.

Table 6.1 Summary of scenarios adopted for the Carrapateena TSF dam breach assessment

Scenario	Breach location	Failure mechanism	Weather condition	Stage and layout (Note 1)	Ponded water
1	TSF Embankment	Slope instability by liquefaction of tailings.	Post-flood day	End of Stage 6, flatter tailings beach scenario.	72 hr Probable Maximum Precipitation (PMP) **(Note 2)**
2	TSF Embankment	Overtopping following scour of embankment crest from tailings pipe break.	Post-flood day	End of Stage 6, flatter tailings beach scenario.	72 hr PMP **(Note 2)**
3	TSF Embankment	Overtopping following scour of embankment crest from tailings pipe break.	Post-flood day	End of Stage 3, flatter tailings beach scenario.	72 hr PMP **(Note 2)**

[18] *Tailings Storage Facility - Dam Breach Assessment for 220 Mt Life of Mine Study*. Carrapateena ref. CA-3630-CIV-REP-1097, WSP report ref. PS138057-WSP-MEL-MNG-REP-0005 Rev0, 27 November 2024.

Scenario	Breach location	Failure mechanism	Weather condition	Stage and layout (Note 1)	Ponded water
4	TSF Embankment	Slope instability by liquefaction of tailings	Sunny day	End of Stage 6, flatter tailings beach scenario	Operational pond **(Note 3)**

Table 6.1 notes:

(1) Refer to Life of Mine staging and concept layouts[19].

(2) Assigned an Annual Exceedance Probability of 1 in 10 million in the climate assessment[20].

(3) An operational pond volume of about 20,000 m^3 was adopted, based on the estimated pond volume over the tailings surface in mid-2024, as per the June 2024 capacity assessment[21].

For each scenario, it was assumed that the Decant Dam failed due to the background flood (i.e., the PMP) prior to the TSF failing and therefore was not considered in the assessment.

The dam breach runout simulation results for Scenario 2 (the most conservative case) are summarised in Table 6.2.

[19] *Carrapateena Tailings Storage Facility - Staged Life of Mine Concept Layouts*. Carrapateena ref. CA-3630-CIV-REP-1096, WSP report ref. PS138057-WSP-MEL-MNG-REP-00003 Rev1, September 2024.

[20] *Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment*. Carrapateena ref. CA-3630-CIV-REP-1071, WSP report ref. PS138057-WSP-MEL-MNG-REP-00002 Rev0, August 2023.

[21] *Tailings Storage Facility, Capacity Assessment based on June 2024 Beach Facility*. Carrapateena ref. CA-3630-CIV-REP-1113. WSP report ref. PS200475-WSP-MEL-MNG-REP-00026 Rev0, 18 November 2024.

Table 6.2 Summary of key simulation results: Scenario 2 (Stage 6 layout, overtopping)

Location	Distance from breach location (Note)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum depth velocity product (DV) (m^2/s)	Flood severity classification	Formation time of full breach of embankment (min)	Flood arrival time (min)
Decant Dam	0.7	22.9	8.8	> 100	H6	39	9
Access track downstream of Decant Dam	6.5	10	8	77	H6		38
Small stock watering dam near Lake Torrens	13	6.6	6.6	41	H6		63
Entry to Lake Torrens	15	3.4	6.8	22	H6		72

Table 6.2 note: Distance from TSF along runout path.

6.3 Consequence category and design criteria

Consequence category assessments informed by the dam breach assessment results and an exposure assessment undertaken for the Stage 2 layout were undertaken in accordance with ANCOLD and GISTM and are presented in Appendix I.

The assessments indicate:

- A '**Significant**' environmental spill consequence category under ANCOLD.
- A '**High C**' dam breach consequence category under ANCOLD.
- A '**Very High**' dam breach consequence category under GISTM.

The design criteria associated with guidelines and identified consequence category are summarised in the consequence category assessments report Appendix I and are re-presented in Table 6.3 below.

Table 6.3 Consequence category and design criteria summary by guideline/standard

Regulation/Guideline	Consequence category	Flood management		Earthquake	
		Design criteria	**Comments and report sections**	**Design criteria**	**Comments and report sections**
ANCOLD Guidelines on Tailings Dams, July 2019	**High C** (dam breach failure)	Flood discharge (based on dam failure category) — 1:100,000 AEP rain event and 1:10 AEP wind for wave runup freeboard, or — Probable Maximum Flood (PMF).	Combined flood storage and discharge capacity exceeds PMF, refer Sections 7.3 and 7.6.	Operational design earthquake (Safety Evaluation Earthquake) — 1:2,000 AEP earthquake event. Post closure design earthquake, larger of: — Maximum Credible Earthquake. — 1:10,000 AEP earthquake event.	Stage 3 embankment raise — Assumed post-seismic strength reduction for foundation clay and considered the scenario where clay is completely removed for the Stage 3 foundation. Refer to Section 9.1. — Settlement of Stage 3 embankment estimated to be about 12 mm for 1 in 10,000 AEP earthquake event. Refer to Section 9.2. Stages 4 to 6 embankment raises — Assumed liquefaction of tailings for Stages 4 to 6. Refer to Section 9. — Numerical deformation analysis to be undertaken for detailed design for each future upstream raise.
	Significant (environmental spill)	Environmental flood storage (Extreme Storm Storage Allowance, based on environmental spill category) — 1:100 AEP, 72-hour rain event. — 1:10 AEP wind for wave runup freeboard. — 0.5 m contingency freeboard.	Decant Dam sized for 1:100 AEP 72-hour rain event without additional freeboards. Refer Sections 7.4 and 7.5.	Not applicable.	
Global Industry Standard on Tailings Management, August 2020	**Very High**	Operations and Closure (Active care) — 1:5,000 AEP rain event. Passive-Closure (Passive care) — 1:10,000 AEP rain event.	Combined flood storage and discharge capacity exceeds PMF. Refer Sections 7.3 and 7.6.	Operations and Closure (Active care) 1:10,000 AEP event.	
	Extreme (Note 1)	Operations and Closure (Active care) — 1:10,000 AEP rain event.		Maximum Design Earthquake (MDE) — Return period of 1 in 10,000 years (1 in 10,000 AEP event), or: — Maximum Credible Earthquake.	

Regulation/Guideline	Consequence category	Flood management		Earthquake	
		Design criteria	**Comments and report sections**	**Design criteria**	**Comments and report sections**
ICMM Tailings Management Good Practice Guide, May 2021	n/a **(Note 2)**	<u>Maximum Design Flood (MDF)</u> — Rainfall with return period of 1 in 10,000 years (1 in 10,000 AEP rain event), or: — Probable Maximum Flood, if recommended by the Engineer of Record or required in jurisdiction.			— Earthquake load assessment for seepage decant outfall pipe to be completed.

Table 6.3 notes:

(1) GISTM notes for Requirement 4.2 that designs should be implemented for a higher consequence category or the '**Extreme**' consequence category external loading criteria.

(2) n/a = not applicable. ICMM does not advocate a consequence category system, but rather to adopt robust design based on conservative criteria with the goal of preventing catastrophic failures. It recommends adopting conservative design criteria that generally align with the '**Extreme**' consequence category of GISTM.

7 Water Management Assessment

7.1 Overview

Water management design assessments were undertaken in accordance with 'Australian Rainfall & Runoff' 2019 (ARR 2019), adopting the design rain and wind data that was presented in the climate assessment report (Appendix D).

Consistent with the approved TSF design (2018), the Life of Mine concept design update is based on controlling surface water adjacent the Decant Causeway which is located in the southern area of the facility, i.e. directing water away from the TSF embankment and to the causeway. For the current and future layouts, water is removed by a series of decant towers within the Decant Causeway and conveyed to the Decant Dam via a DN560 HDPE decant outfall pipe that was installed with the Stage 1 works (and extended southward at Stage 2). Due to the partial perimeter tailings deposition arrangement, large flood surge capacity is available for the Stage 2 layout and will be available during future stages of the TSF.

7.2 Water balance

A water balance assessment was undertaken for three selected TSF stages (Stages 3, 5 and 6), and for two beach slope scenarios (relatively flat and steep), considering inflows to and outflows from the TSF and Decant Dam, and a summary of the assessment with tabulated results is presented in Appendix E.

The water balance assessment indicates that for all scenarios, the water decanted to the Decant Dam peaks during Stage 3B and decreases progressively with each subsequent stage. This is primarily due to the increased tailings beach area that provides more surface area for evaporation. Some reduction also occurs due to climate change reducing the overall rainfall available and increasing the evaporation rate. This is despite the increase in tailings deposition rate that is forecast with each stage, compared to 2023 deposition rates.

The water balance indicates that over most stages, the steeper beach scenario results in more water decanted to the Decant Dam compared to the flatter scenario, except at Stage 6 when the beach area is relatively larger. It also indicates that in any given year, the monthly net water in the Decant Dam is expected to be highest between April and September when evaporation rates are relatively lower.

The indicated maximum required pump-out rate from the Decant Dam for the maximum rainfall scenario is about 11,400 m^3/day over a month, i.e., above the maximum pumping rate that occurred during 2023 (about 7,000 m^3/day) and is higher than the available water consumption rate at the Processing Plant, for the Stage 3 layout and the maximum rainfall scenario factored for climate change. Assuming one month accumulation in the Decant Dam at this net inflow rate and an average pump-out rate of 6000 m^3/day, then about 170,000 m^3 of water would be expected to accumulate over a month during 'maximum' wet conditions. This accumulation would consume a portion of the total ~440,000 m^3 of the available flood storage capacity, as expected in wet conditions, followed by drawdown as excess water is used at the Plant.

The indicative pump-out rates for the median rainfall scenarios (maximum of about 3,100 m^3) are below the existing available pump capacity at the Decant Dam. Both the average and maximum indicated pump-out rates decrease from Stage 3 to Stage 6.

On the basis of the water balance for the Life of Mine tailings deposition schedule, current flood storage capacity in the Decant Dam and predicted reductions in future net water in the Decant Dam, an upgrade to the Decant Dam is not considered necessary.

7.3 TSF flood surge capacity

Available flood storage capacity for each of the TSF stages considered in this report is listed in Table 7.1.

Table 7.1 Summary of available flood storage capacity for existing and future raise layouts

TSF Stage	Tailings beach profile	Spillway Invert elevation (m RL) (Note 1)	Estimated available pond volume to spillway invert elevation (Mm^3)
2	Flatter	145.6 **(Note 2)**	4
2	Steeper	145.6 **(Note 2)**	12.7
3	Flatter	156.5	19.1
3	Steeper	156.5	31.1
4	Flatter	158.2 **(Note 3)**	7.3
4	Steeper	158.2 (**Note 3**)	18.5
5	Flatter	165	18.5
5	Steeper	165	32.3
6	Flatter	168	19.6
6	Steeper	168	26.9

Table 7.1 notes:

(1) Assumes the emergency spillway invert elevation is 1 m below the TSF embankment crest. Estimated volumes are between the tailings surface and the spillway invert.

(2) Volume to spillway invert elevation about 1.1 m below TSF crest elevation of RL 146.7 m.

(3) Volume to invert elevation of RL 158.2 m at the natural saddle on the eastern side of the TSF impoundment.

Volumes for Stage 4 reported in Table 7.1 are to the invert elevation of the topographical saddle (about RL 158.2 m) on the eastern side of the TSF impoundment. Additional flood storage capacity, if required, could be provided by a small saddle dam, e.g., 1.8 m high for crest elevation of RL 161 m, to be 1 m below the TSF crest elevation.

7.4 Decant Dam storage capacity

The Decant Dam was constructed to provide about 515,000 m^3 of storage capacity. This allows for the estimated runoff from a 1 in 100 AEP, 72-hour rain event (440,000 m^3, refer to Section 7.5), an operational volume of 55,000 m^3, and an additional 0.1 m of freeboard to the emergency spillway invert.

7.5 Flood runoff estimates

Based on the assessment completed for the Stage 2 design report[22] in 2021, the estimated runoff volume for the 1 in 100 AEP, 72-hour design rain event (without factoring for climate change) for the 1,390 ha catchment of the TSF and the combined 1500 ha of the TSF and Decant Dam, was about 404,000 m^3 and 440,000 m^3 respectively. This flood event was selected based on the minimum Extreme Storm Storage Allowance using the fall-back method under ANCOLD[23], for a 'Significant' Environmental Spill Consequence category facility. The runoff volumes were estimated considering initial losses of 20 mm followed by 20% of remaining rainfall over the combined TSF and Decant Dam catchment area draining to the respective pond locations in the TSF and Decant Dam.

The estimated runoff volumes for the 1 in 100 AEP, 72-hour design rain event, for climate change projections (refer to Section 5.2) and the catchments of the TSF and Decant Dam, also considering initial losses of 20 mm followed by 20% of remaining rainfall draining to the respective pond locations, are presented in Table 7.2.

Based on the available TSF pond storage capacity in each Life of Mine stage layout (refer to Table 7.1), the surge pond from the estimated runoff from 1 in 100 AEP, 72-hour design rain event for all climate projections is expected to be contained in the TSF. For the Decant Dam, the estimated runoff for the 1 in 100 AEP, 72-hour event would likely exceed the flood storage capacity for 'worse' case climate projections beyond 2030. A reduction to the maximum normal operating pond volume allowance may be required to satisfy the 2030 projections.

The acceptable operational pond volume and flood storage capacity of the Decant Dam should be reviewed before 2030.

Table 7.2 Estimated runoff volume for 1 in 100 AEP, 72-hour duration design rain event for a range of climate change projections – TSF and Decant Dam

Projected period	Estimated runoff volume draining to TSF decant area in TSF (m^3)		Estimated runoff volume draining to pond in Decant Dam (m^3)	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Near future (2030)	436,000	433,000	471,000	468,000
Medium (2050)	448,000	455,000	484,000	491,000
Far future (2090)	463,000	522,000	500,000	563,000

The estimated runoff volumes for the PMP, 72-hour duration event for climate change projections and assuming 100% runoff are presented in Table 7.3. The surge pond from these events is likely to be contained within the Life of Mine layouts, except at Stage 4. As noted, in Section 7.3, additional flood storage capacity could be provided at Stage 4 by forming a small saddle dam on the eastern side of the impoundment.

[22] *Stage 2 Raise Design, Tailings Storage Facility, Carrapateena Project*, Carrapateena ref. CA-3630-CIV-REP-1023, Golder (now WSP) report ref. 20144293-016-R-Rev0, December 2021.

[23] *Guidelines on Tailings Dams - Planning, Design, Construction, Operation and Closure.* ANCOLD, May 2012. Note, this earlier version of the guideline was applicable at the time of the Stage 1 design.

Table 7.3 Estimated runoff volumes in the TSF for the PMP, 72-hour duration event for a range of climate change projections

Time period	Estimated runoff volume (Note)		
	Current climate	RCP 4.5	RCP 8.5
Current	10,703,000	-	-
Near future (2030)	-	11,463,000	11,399,000
Medium (2050)	-	11,741,000	11,912,000
Far future (2090)	-	12,094,000	13,464,000

Table 7.3 note: for a catchment area of 1,390 ha and 100% runoff.

7.6 Emergency spillway sizing

7.6.1 Tailings storage facility spillway

For spillway sizing, ANCOLD guidelines[24] suggest setting the initial water level at the spillway invert before routing design floods through a TSF spillway and contributing catchment. However, an exception is provided where extreme flood storage is provided for within the impoundment. In this instance, the spillway sizing may be determined based on a routing assessment that considers the large flood surge capacity. All future stages of the TSF are expected to have large flood surge capacity, as noted in Table 7.1, however, it is considered good practice by ANCOLD to include an emergency spillway as an additional control against embankment overtopping.

For a 'High C' consequence category facility, the ANCOLD guidelines suggest a 1 in 100,000 AEP design rain event with wave freeboard for a 1 in 10 AEP wind gust, or the PMF with no wind wave effects as the design flood event. The TSF has the surge capacity to hold two back-to-back 72-hour PMP events without activating the emergency spillway. In addition to this large surge capacity, an emergency spillway has been included for the critical duration 1 in 1000 AEP rain event, with an initial water level at the spillway invert, and allowing for a nominal 0.5 m of freeboard.

A spillway sizing assessment was undertaken for the Stage 3 layout (flatter beach slope scenario, as presented in Appendix A) and is considered applicable to future stages for concept design. The assessment considered a catchment area of about 1,390 ha and allowed for attenuation of rainfall runoff over the pond area in the impoundment, according to the pond surge capacity above the spillway invert. The input parameters adopted for the assessment are summarised in Table 7.4.

[24] *Guidelines on Tailings Dams - Planning, Design, Construction, Operation and Closure*. ANCOLD, July 2019.

Table 7.4 Parameters adopted for concept spillway sizing assessment for the future Stage 3 layout

Input parameter	Value	Commentary
Catchment area (ha)	1,390	Catchment area reporting to the TSF supernatant pond.
TSF layout	Stage 3, flatter beach	-
Design rain event	1 in 1,000 AEP	-
Climate change scenario	RCP4.5, 2030 time horizon	Approximate fill date for the Stage 3 layout. RCP 4.5 represents a more conservative increase to design rainfalls than RCP 8.5 at 2030.
Initial water level (m RL)	156.5	Spillway invert elevation for Stage 3
Slope of spillway (%) **(Note)**	1	
Spillway base width (m)	25	
Spillway side slopes (XH:1V)	4	
Spillway depth (m)	1	
Average catchment slope (%)	2.7	Based on assessment of catchment topography
Catchment impervious area (%)	32	Based on a pond at RL 156.5 m and a catchment area of 1,390 ha.
Initial loss (mm)	35	Refer infiltration test work report[25].
Continuing loss (mm/hr)	2	Refer infiltration test work report[18].

Table 7.4 note: spillway gradient downstream of the sill beam.

The emergency spillway sizing assessment results are presented in Table 7.7 , and the inflow and outflow hydrographs for the 1 in 1000 AEP, critical duration rain event are presented in Figure 7.1.

Table 7.7 TSF emergency spillway analysis results for a 1 in 1,000 AEP critical duration rain event with initial water level at the spillway invert

Parameter	Value
Critical duration (**Note**)	24 hours
Peak inflow rate (m^3/s)	241
Peak outflow rate (m^3/s)	12.6
Maximum flow depth (m)	0.5
Available freeboard remaining (m)	0.5

Table 7.7 note: based on the event resulting in the peak water level in the Decant Dam pond above the spillway invert.

[25] *Carrapateena Expansion Water Assessment - Surface Water Baseline Update Report*, Carrapateena ref. CA-ENV-REP-1010_1, EMM, 5 May 2021.

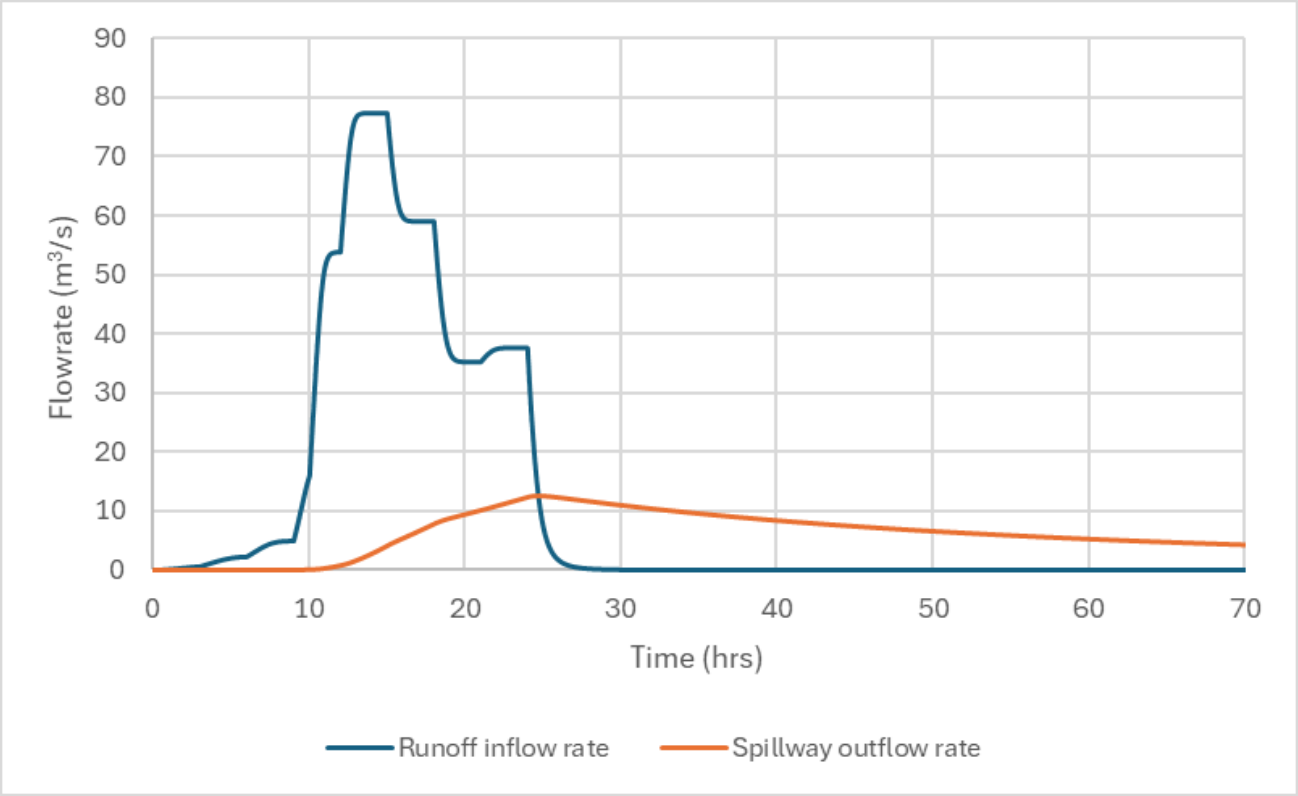


Figure 7.1 Inflow and outflow hydrographs for critical duration (24-hour), 1 in 1,000 AEP rain event

For the detailed design of the TSF emergency spillway for Stage 3 and of future stages, a risk-based approach may be taken to refine the spillway sizing or omit the spillway, noting that for most stage layouts, there is surge capacity for a 72-hr PMP, which represents a very low probability event (AEP of 1 in 1,000,000).

7.6.2 Decant Dam spillway

The Decant Dam emergency spillway was sized at Stage 1 for discharge of a 1 in 1,000 AEP critical duration rain event, as per design criteria of ANCOLD for a 'Significant' consequence category facility. The sizing assessment was based on the Stage 1 TSF layout which had negligible flood attenuation capacity due to the decant area being adjacent to the TSF embankment. For the existing Stage 2 layout and future stage layouts that have large surge and attenuation capacity, the capacity of the Decant Dam spillway exceeds that of a 1 in 1,000 AEP event.

Although the consequence category for the TSF has subsequently been revised to 'High C' under ANCOLD (resulting in spillway design criteria for 1 in 100,000 AEP event), the risk associated with failure of the Decant Dam is relatively lower than for failure of the TSF embankment and therefore a smaller design event is considered appropriate. However, to demonstrate the capacity of the current Decant Dam spillway, a flood routing assessment was undertaken for the 1 in 100,000 AEP event.

The assessment considered a catchment area of about 100 ha and allowed for attenuation of rainfall runoff over the pond area, according to the pond storage curve above the spillway invert. The input parameters adopted for the assessment are summarised in Table 7.5. A constant inflow was considered of 240 l/s as the maximum outflow rate from the TSF gravity decant system.

Rainfall data for 1 in 100,000 AEP design event was factored for climate change to 2050 by the more conservative RCP8.5 scenario, as described in the Life of Mine climate assessment[26]. For conservatism, infiltration losses were not considered in the flood routing assessment.

Table 7.5 Input parameters for Decant Dam spillway assessment

Input parameter	Value	Commentary
Catchment area (ha)	~100	Catchment area reporting to Decant Dam pond based on topography assessment. Note, the original design assessment considered 110 ha.
Design rain event	1 in 100,000 AEP	-
Climate change scenario	RCP8.5, to year 2050	
Initial water level (m RL)	117.3	Spillway invert elevation for the Decant Dam spillway.
Spillway base width (m)	60	
Spillway side slopes (XH:1V)	4	
Spillway depth (m)	1.1	
Slope of spillway (%)	1.3	
Inflow from TSF decant system	240 l/s	Refer to Stage 2 design report[27].
Average catchment slope (%)	4.7	Based on assessment of catchment topography.

The emergency spillway sizing assessment results are presented in Table 7.6, and the inflow and outflow hydrographs for the 1 in 100,000 AEP, critical duration rain event are presented in Figure 7.2. The hydrographs show dual peaks which are a function of the temporal pattern.

Table 7.6 Decant Dam emergency spillway assessment results for the 1 in 100,000 AEP event with initial water level at the spillway invert

Parameter	Value
Critical duration rain event (**Note**)	45 minutes
Peak inflow rate (m^3/s)	147
Peak outflow rate (m^3/s)	51.5
Maximum flow depth (m)	0.7
Available freeboard remaining (m)	0.4

Table 7.6 note: results in the peak water level in the Decant Dam pond above the spillway invert.

[26] *Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment*, Carrapateena ref. CA-3630-CIV-REP-1071, WSP report ref. PS138057-WSP-MEL-MNG-REP-00002 Rev0, August 2023.

[27] *Stage 2 Raise Design, Tailings Storage Facility, Carrapateena Project*. Carrapateena ref. CA-3630-CIV-REP-1023, Golder (now WSP) report ref. 20144293-016-R-Rev0, December 2021.

The assessment indicated a maximum flow depth of about 0.7 m through the spillway during the 1 in 100,000 AEP critical duration event. This flow depth combined with the ~0.4 m freeboard required for wind setup and wave runup effects, results in a total depth requirement of 1.1 m, which is satisfied by the current spillway arrangement. The existing spillway therefore satisfies the design criteria of ANCOLD, as well as the smaller GISTM design criteria (1 in 10,000 AEP rain event).

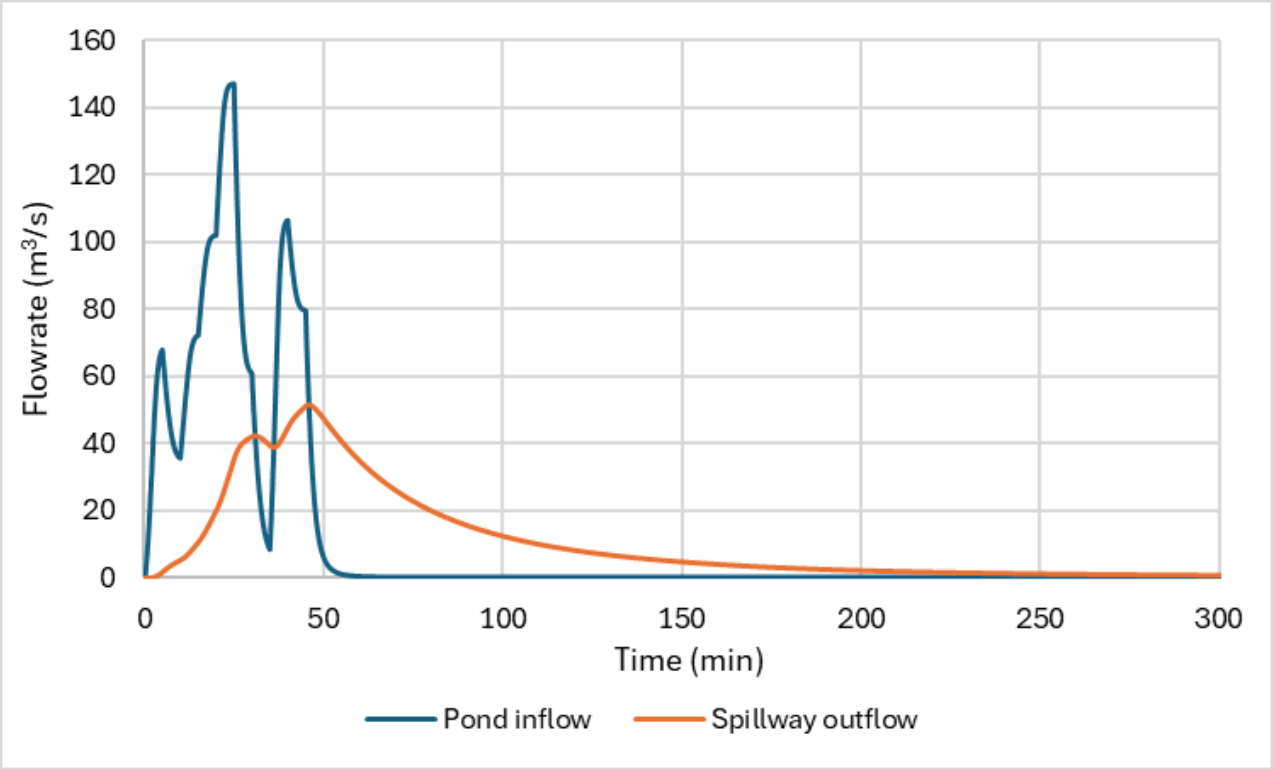


Figure 7.2 Inflow and outflow hydrographs for the Decant Dam spillway, 1 in 100,000 AEP, 45 minute (critical duration) rain event

8 Seepage assessment and management measures

A seepage assessment was undertaken using the two-dimensional (2D) finite element numerical modelling software Seep/W developed by GeoStudio to estimate the seepage from the TSF.

A report summarising the results of the assessment is presented in Appendix F. Key findings of the assessment are:

- Shallow lateral seepage below the TSF embankment is predicted to reduce from about 200 kL/day in Stage 1 to about 25 kL/day by the end of Stage 6. On this basis, the Life of Mine concept design update does not include additional measures for shallow lateral seepage collection. Existing collection systems near the downstream toe of the Stage 2 embankment will be extended downstream of the projected Stage 3 embankment as part of the Stage 3 raise.
- Vertical seepage through the base of the TSF impoundment is predicted to reduce from about 350 kL/day in Stage 1 to about 20 kL/day by the end of Stage 6. Due to seepage from tailings slurry and the supernatant pond and the low storativity of the bedrock beneath the TSF, groundwater is expected to mound over the Life of Mine, leading to a phreatic surface within the TSF. The phreatic surface is considered in the slope stability assessment as presented in Section 9.

The Life of Mine concept design update includes the following seepage depressurisation measures:

- Extensions of the upstream toe drain to the new abutments of each embankment raise.
- Rockfill shear keys in the foundation of each upstream embankment raise, with a seepage collection drain and extraction pipes.

9 Geotechnical stability assessment

9.1 Embankment Slope Stability

9.1.1 Overview

An embankment slope stability assessment was undertaken using the Rocscience's Slide 2 with the GLE/Morgenstern-Price method to estimate the Factor of Safety for comparison against minimum Factor of Safety values recommended by ANCOLD tailings dam guidelines[28]. The assessment is presented in Appendix J and is summarised below.

9.1.2 Section analysed

The embankment cross-section selected for analysis is shown on Figure 013 of Appendix C and is also presented in Figure 9.1 (below). The embankment raise configuration for the relatively flat tailings beach scenario was adopted for the stability assessment as it would result in relatively more tailings beneath the upstream raises and therefore less embankment fill, relative to the steep beach scenario. For the selected cross section, each stage embankment was progressively analysed for slope stability.

[28] *Guidelines on Tailings Dams – Planning, design, construction, operation and closure*. Revision 1. ANCOLD, July 2019.

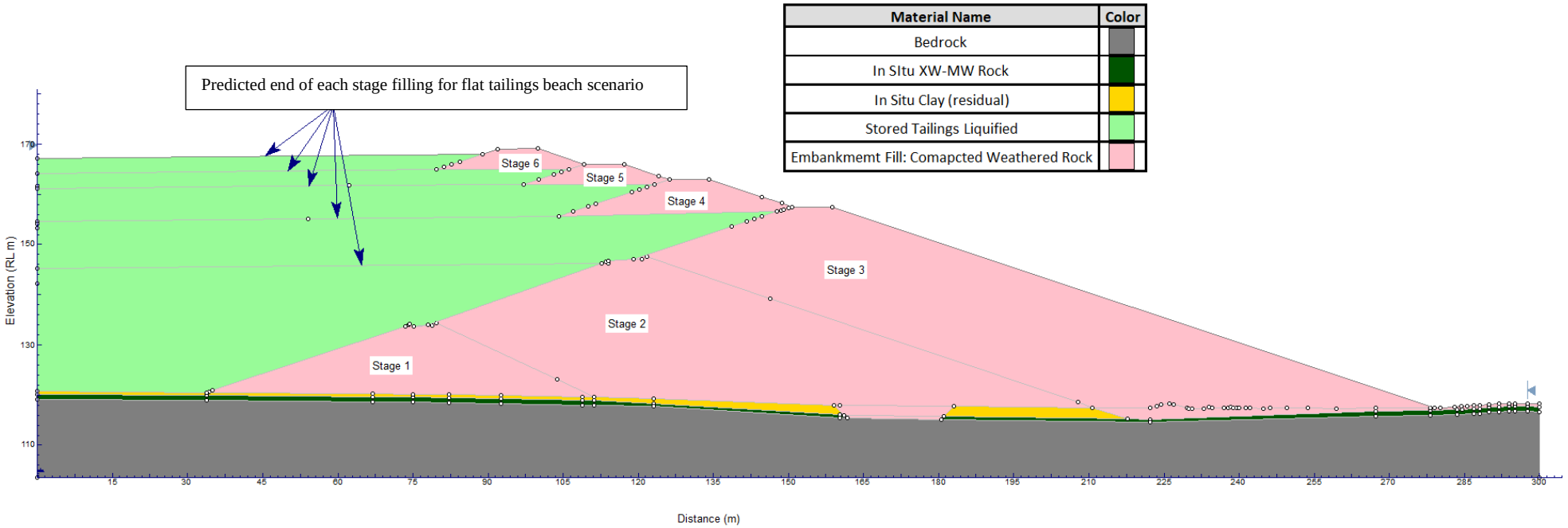


Figure 9.1 Geometry of selected TSF embankment cross section

9.1.3 Outcomes

The embankment slope stability assessment indicates the following:

- Stage 3 downstream raise: *In situ* clay downstream of the Stage 2 embankment should either be removed or a rockfill shear key formed through the clay, to achieve a minimum factor of safety of 1.5.
- Stages 4 to 6 upstream raises: Upstream toe berms and shears keys are required, to provide resistance to upstream and downstream failure surfaces respectively. The configuration of these toe berms and shear keys are shown on the cross sections in Figure 9.2 and Figure 9.3. The adopted dimensions for the toe berms and shear keys are summarised in Table 9.1.

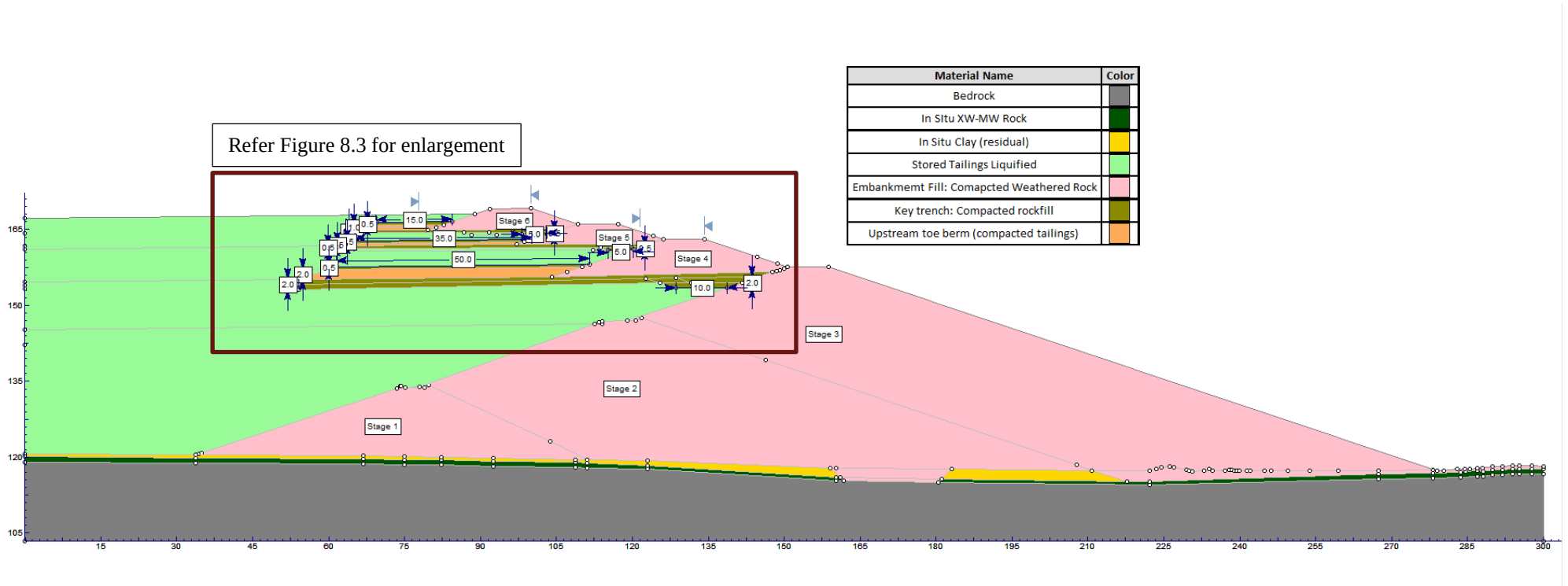


Figure 9.2 TSF embankment cross section with toe berms and shear keys for upstream raises

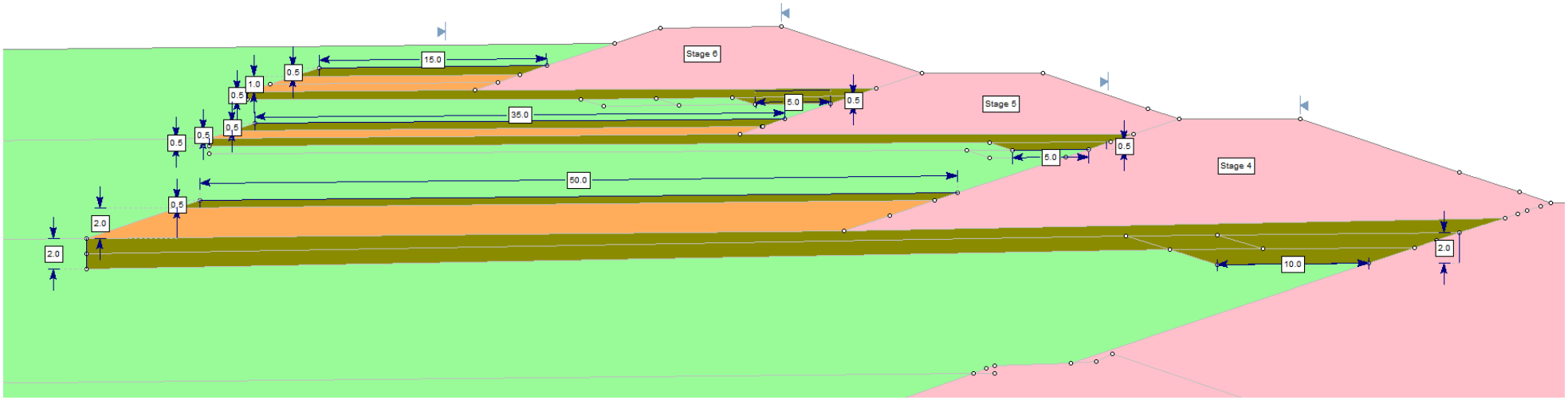


Figure 9.3 Enlargement of Stages 4 to 6 embankment raises, showing toe berms and shear keys

Table 9.1 Dimensions for toe berms and shear keys for Stages 4 to 6

Stage	Rockfill platforms and toe berms			Shear keys
	Rockfill platform	**Compacted Tailings**	**Rockfill erosion protection layer**	**Coarse Rockfill**
Stage 4	2 m thick by 50 m wide, below the upstream raise and below the extents of the upstream toe berm	2 m thick by 50 m wide	0.5 m thick by 50 m wide	1 m deep (below platform) by 10 m wide
Stage 5	0.5 m thick by 35 m wide, below the upstream raise and below the extents of the upstream toe berm	0.5 m thick by 35 m wide	0.5 m thick by 35 m wide	0.5 m thick (below platform) by 5 m wide
Stage 6	0.5 m thick by 15 m wide, below the upstream raise and below the extents of the upstream toe berm	1 m thick by 15 m wide	0.5 m thick by 15 m wide	0.5 m thick (below platform) by 5 m wide. **(Note)**

Table 9.1 note: shear key not required for Stage 6 embankment slope stability but included should an additional raise be considered in the future.

9.2 Deformation Analysis

9.2.1 Stage 3 embankment raise

A simplified deformation analysis for the Stage 3 embankment was undertaken to estimate settlements from the design earthquake and the potential impact this has on operational freeboard.

The assessment indicated that the expected settlement following a 1 in 10,000 AEP earthquake event is about 12 mm (0.03% of the approximate 41 m embankment height).

The concept design for the Stage 3 embankment includes Operational Freeboard of 1 m, which allows for potential variations in beach slope performance and embankment settlement. Predicted settlement of 12 mm for a 1 in 10,000 AEP earthquake event represents less than 2% of the Operational Freeboard, which is relatively negligible.

9.2.2 Stages 4 to 6 embankment raises

Numerical deformation analysis for the upstream raises over tailings will be undertaken for the future detailed design of Stage 4 to 6.

10 Life of Mine concept design summary

10.1 Overview

The Life of Mine embankment raises will likely be formed with compacted rockfill, sourced from quarries near the TSF and/or mine waste rock stockpile(s). A geosynthetic liner will likely be installed on the upstream face of each embankment raise.

The embankment staging plan is the same for the flatter and steeper beach slope scenarios, except for the saddle dam that is required at the head of the valley at Stages 5 and 6 for the steeper beach slope scenario.

The following geometry was adopted for the embankment and saddle dams:

- 3:1 (H:V) downstream slopes.
- 3:1 (H:V) upstream slopes.
- 8 m crest width.
- For the Stage 3 downstream raise, the upstream toe of the embankment raise is offset 5 m from the upstream crest edge of the Stage 2 embankment, to facilitate geosynthetic liner anchoring.
- For the upstream raises, the downstream toe of the embankment raise connects to the upstream crest edge of the existing/previously constructed embankment.

Embankment modelling was completed in Autodesk Civil 3D (2022), based on the crest elevations summarised in Table 3.2 of Section 3.4.

10.2 Conceptual embankment raise design

The embankment for each raise will likely be formed with a main zone of compacted rockfill and the following:

- A 1 m thick layer of coarse rockfill on the downstream face, for erosion protection.
- A 0.5 m thick layer of compacted screened rockfill on the upstream face, to form a bedding surface for liner installation.
- A bituminous geomembrane liner on the upstream face and ballast tubes over the liner. Note, the requirement for the liner will be reviewed with each stage design, noting that a seepage depressurisation system will be installed in the foundation of upstream raises.
- A 0.3 m thick layer of compacted screened rockfill at the embankment crest to form a wearing course for vehicle traffic and safety bunds at both sides of the crest. Local thickening near the upstream crest edge to facilitate liner anchoring.
- 0.7 m high safety bunds at the embankment crest edges.
- Upstream toe drains to be extended to the abutments of the embankment for each stage.

Foundation preparation for the embankment will likely include the following:

- Clearing of the footprint area and stripping of topsoil.
- For the Stage 3 downstream raise, stripping of clay downstream of the Stage 2 embankment to expose weathered bedrock. This may be refined at future design to removal within a shear key trench.
- Scarification of *in situ* clay between the abutments for embankment raises, to depth of 0.3 m.

For Stages 4 to 6 upstream raises:

- Trench excavation in tailings at the downstream toe area of each raise, for shear keys. Installation of a non-woven geotextile layer across the base of trench, a seepage collection drain at the downstream side of the trench and backfilled with coarse rockfill.
- Installation of seepage extraction pipes at 100 m intervals along the shear keys. It is expected that water sensors would be installed in each extraction pipe, to indicate when extraction by a mobile pump is required.
- A layer of coarse rockfill will be placed over and/or pushed into tailings surface to form pioneer layer over the footprint of each upstream embankment raise (extends over the shear key) and over the footprint of the upstream toe berms.
- Upstream toe berms will be formed with compacted tailings, covered with a layer of compacted rockfill for erosion protection.

10.3 Conceptual Decant Causeway raise design

The Decant Causeway will be raised by the centreline raise method. Future design updates will consider sub-staging of each raise, subject to raise height and slope stability considerations.

Foundation preparation for each raise to the causeway will include/consider the following:

- Clearing of the footprint area on natural ground and stripping of surface soils.
- Scarification of desiccated tailings surfaces (where present) within the raise footprint, to a depth of 0.4 m.
- Placement of a layer of geosynthetic reinforcement over soft tailings surfaces within the raise footprint, subject to the condition of the tailings.
- Placement of a layer of coarse rockfill over/into tailings surface within the raise footprint to form a pioneer layer. The quantity schedules include an allowance for a 1 m thick layer.

The raise for each stage will be formed with a main zone of compacted rockfill and the following:

- A layer of geosynthetic reinforcement 1 m above the crest of the previous stage causeway for differential settlement crack control.
- Raises to each decant tower.
- Filter rock (50 mm to 300 mm particle size) around each decant tower raise.
- A 0.3 m thick layer of screened rockfill at the causeway crest to form a wearing course for vehicle traffic
- 0.7 m high safety bunds at both sides of the causeway crest.

10.4 Embankment fill quantities

Estimated embankment fill quantities by stage for the flatter beach slope scenario are summarised in Table 10.1 and fill quantities for the steeper beach scenario are summarised in Table 10.2. The quantities include the fill required for the saddle dams.

The quantities do not include additional fill that would be required to account for foundation stripping and excavations for shear keys. These quantities and fill requirements for raises to the Decant Causeway and a breakdown of quantities by material type are provided in the schedule of quantities – refer Section 11 and Appendix K.

Table 10.1 Estimated embankment fill quantities for the flatter beach slope scenario

Embankment raise	Main embankment				Expected date of layout commissioning
	Crest elevation (RL m)	Raise height (m)	Raise method	Incremental fill volume (m^3)	
Stage 3	157.5	10.8	Downstream	2,526,000	Jan-29 **(Note 1)**
Stage 4	163.0	5.5	Upstream	470,000	May-33
Stage 5	166.0	3	Upstream	275,000 **(Note 2)**	May-37
Stage 6	169.0	3	Upstream	302,000	May-41
Total fill quantity				**3,573,000**	

Table 10.1 notes:

(1) There is limited timeframe to review tailings beach performance between mid-2025 (when mill throughput ramps up) and March 2026, when the embankment would be required for the steep beach scenario. Therefore, construction of the Stage 3 embankment should be completed by March 2026, to accommodate a potential steep beach.

(2) The volume of the western saddle dam (12,000 m^3) is included in the total volume.

Table 10.2 Estimated embankment fill quantities for the steeper beach slope scenario

Embankment raise	Main embankment				Saddle dam (southern)				Expected date of layout commissioning
	Crest elevation (RL m)	Raise height (m)	Raise method	Incremental fill volume (m^3)	Crest elevation (RL m)	Raise height (m)	Raise method	Incremental volume (m^3)	
Stage 3	157.5	10.8	Downstream	2,526,000	No saddle dam	-	-	-	Mar-26
Stage 4	163	5.5	Upstream	470,000	No saddle dam	-	-	-	Jun-31
Stage 5	166	3	Upstream	275,000 **(Note)**	181	8.2	Starter	123,000	Aug-35
Stage 6	169	3	Upstream	302,000	181.5	8.7	Downstream	18,000	Oct-39
Total volume				**3,573,000**				**141,000**	

Table 10.2 note: The volume of the western saddle dam (12,000 m^3) is included in the total volume.

11 Schedule of Quantities

Schedules of quantities (material take-off schedules) prepared for the Stage 3 to Stage 6 raises based on the concept designs are provided in Appendix K.

12 Conceptual closure plan

The concept closure plan for the TSF was outlined in the report for the approved TSF design[29].

Updated layout plans and a typical cross section for the TSF at closure are presented on Figures 022, 023 and 024 in Appendix C. The closure plan comprises:

- Decommissioning of the tailings delivery and gravity decant systems.
- An upgrade of the emergency spillway.
- Limited erosion protection measures for the tailings surface and limited reshaping of the TSF embankment.
- Possible demolition of the Decant Dam embankment.

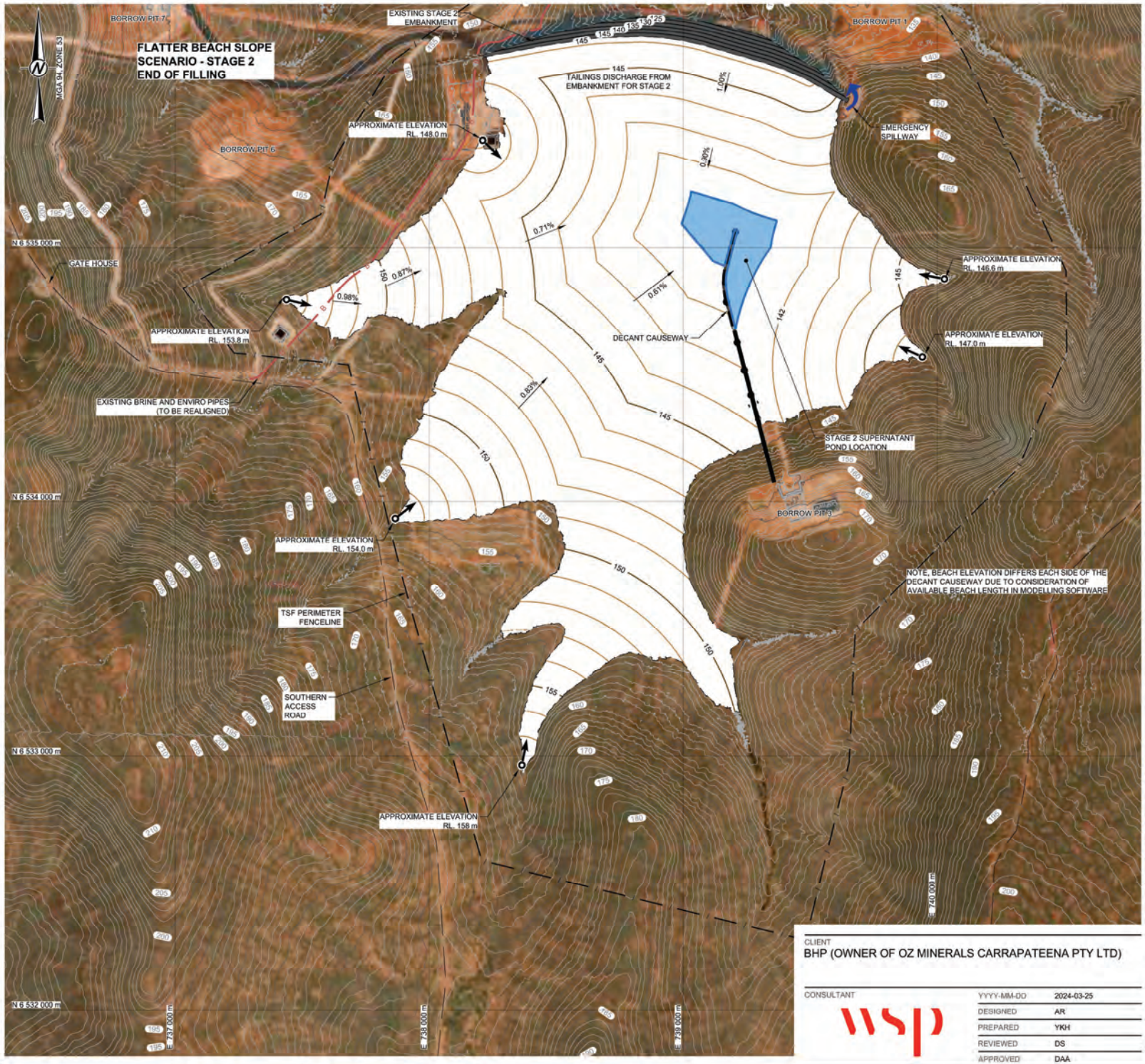
[29] *Tailings Storage Facility design report for the PEPR*. Golder (now WSP) report ref. 1660055-045-R-Rev2, July 2018.

13 Closing

A Limitation Statement is presented in Appendix L.

Appendix A

Staged TSF layouts for flatter beach slope scenario



LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- STAGE 2 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

2023 DECEMBER SURVEY GENERATED FROM INFORMATION PROVIDED IN BHP FILE: TSF Survey 271223 0.5m Point Cloud.las, DATED 27 DECEMBER 2023

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PREPARED	YKH
REVIEWED	DS
APPROVED	DAA

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
FLATTER BEACH SLOPE SCENARIO / STAGE 2 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	A001

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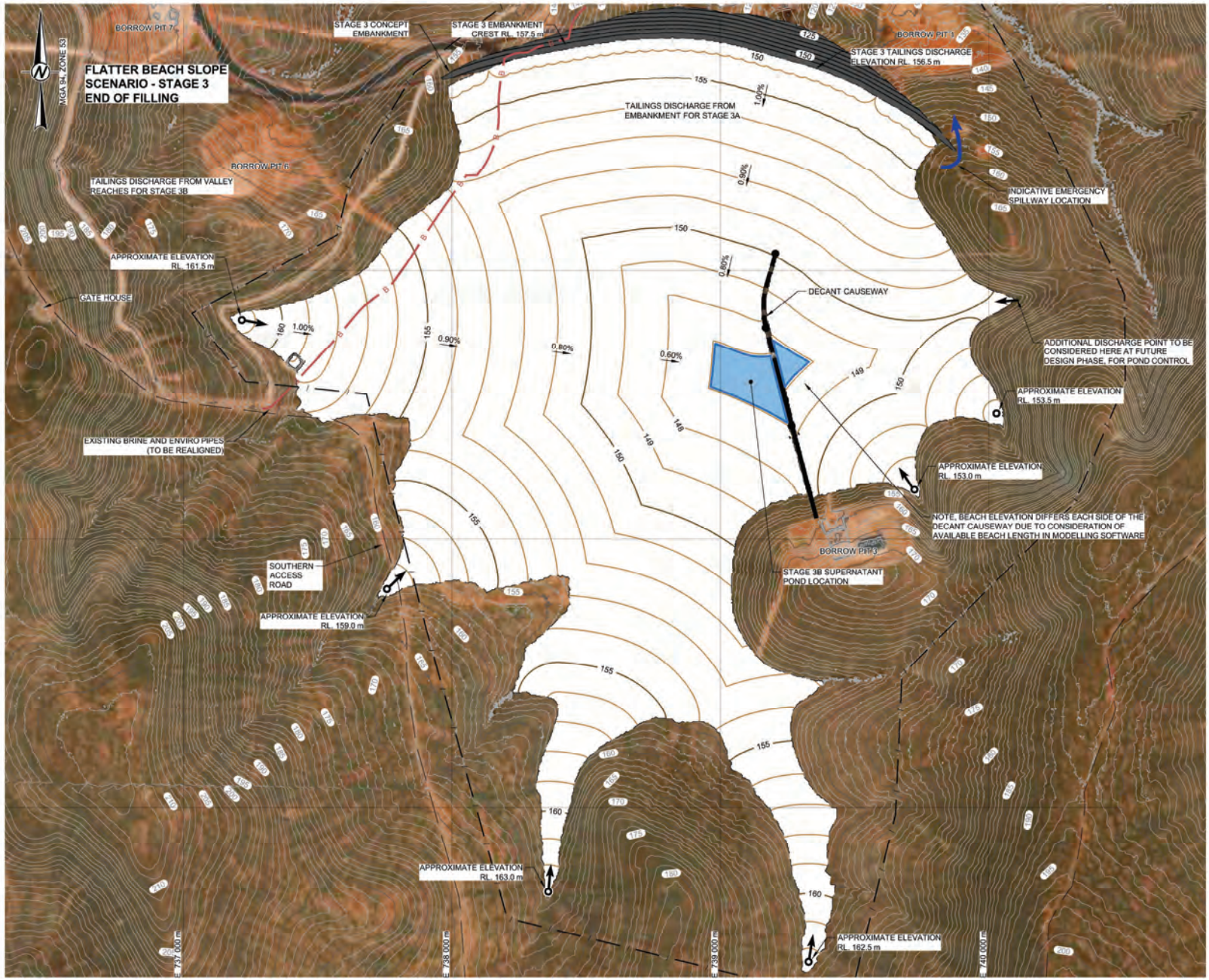

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- STAGE 3 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: Stage3A tailings surface.dwg, Stage3B tailings surface.dwg, DATED 09 FEBRUARY 2024

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PROJECT
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CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
FLATTER BEACH SLOPE SCENARIO / STAGE 3 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	A002

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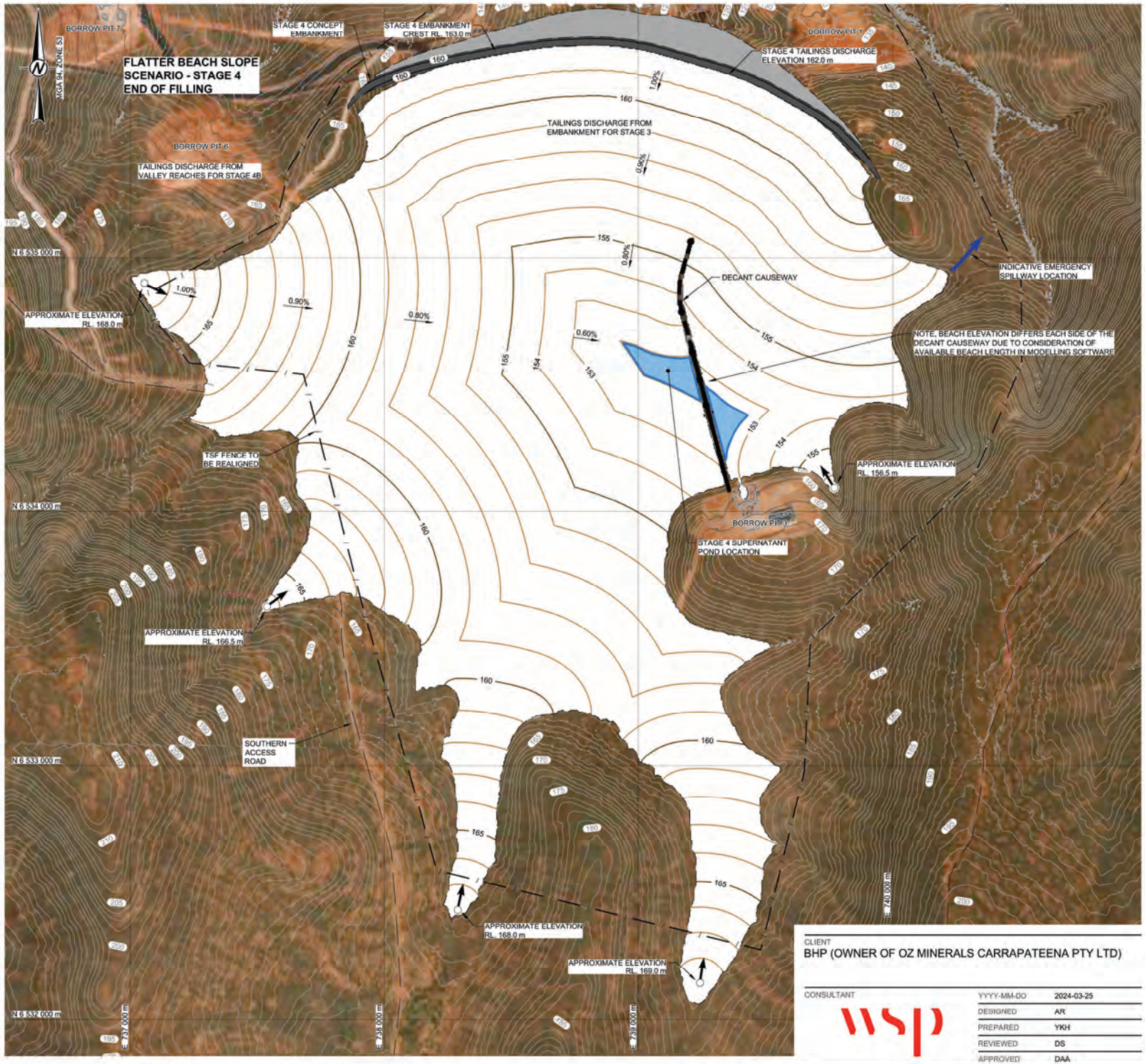

LEGEND

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- STAGE 4 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: 4A tailings beach.dwg, 4B_tailings beach.dwg, DATED 09 FEBRUARY 2024

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TITLE
FLATTER BEACH SLOPE SCENARIO / STAGE 4 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	A003

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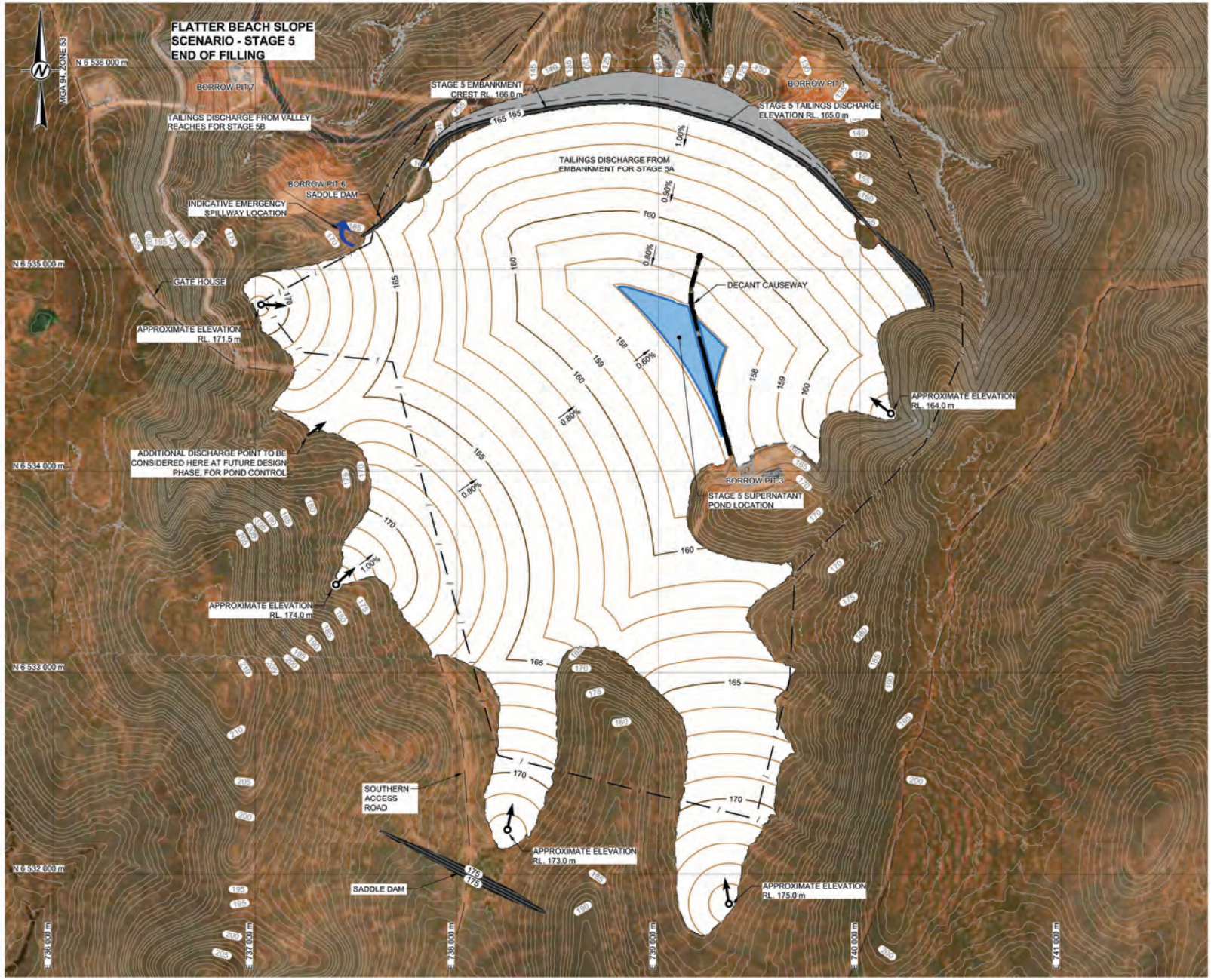

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- STAGE 5 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: 5A tailings beach (V2).dwg, 5B tailings beach (V2).dwg, DATED 09 FEBRUARY 2024

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APPROVED	DAA

PROJECT
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TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
FLATTER BEACH SLOPE SCENARIO / STAGE 5 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	A004

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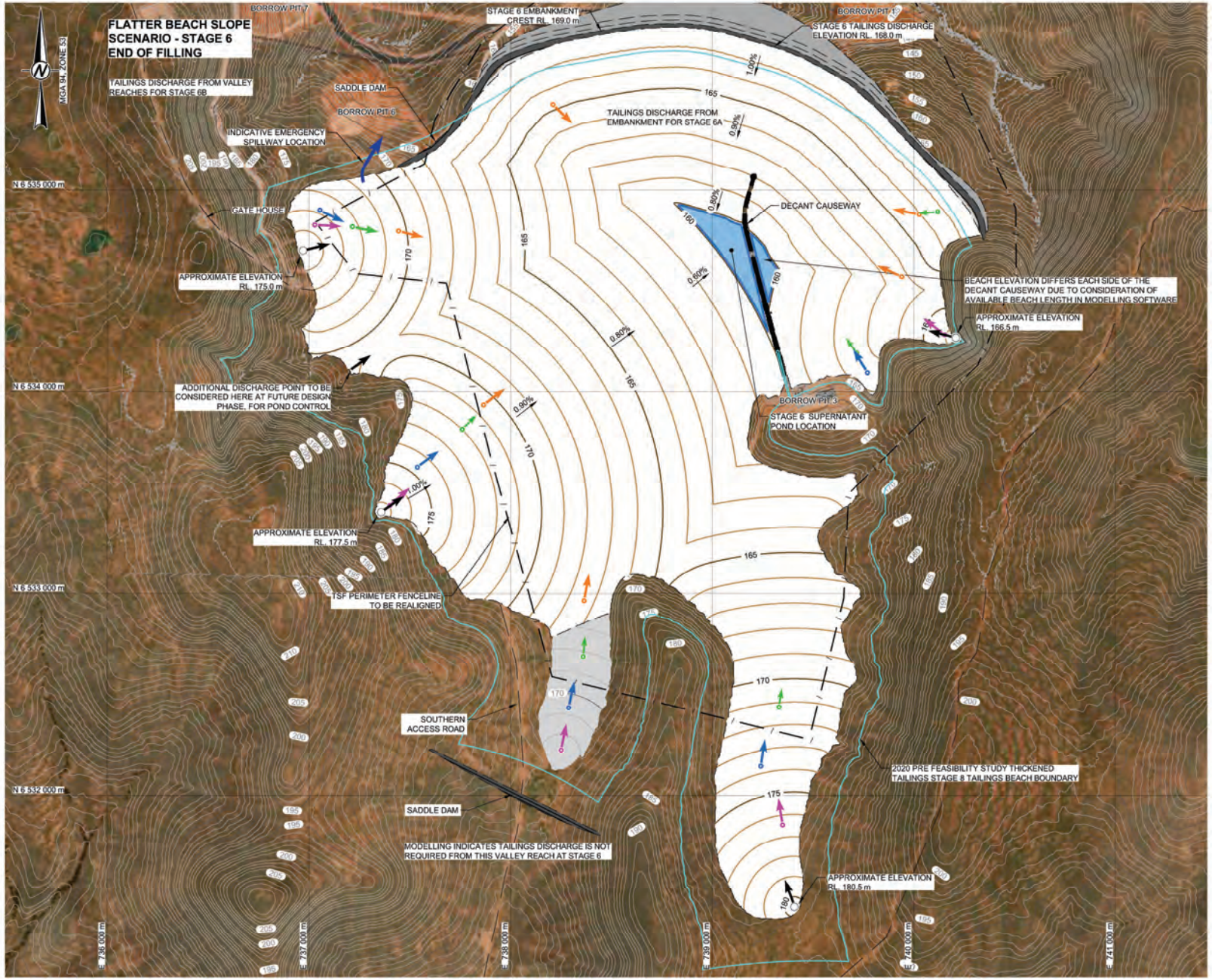

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- PREVIOUS STAGES TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- STAGE 6 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT STAGE 2
- DISCHARGE POINT STAGE 3
- DISCHARGE POINT STAGE 4
- DISCHARGE POINT STAGE 5
- DISCHARGE POINT STAGE 6

REFERENCE(S)

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3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: 6A tailings beach V2.dwg, 6B tailings beach V2.dwg, DATED 09 FEBRUARY 2024

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TITLE
FLATTER BEACH SLOPE SCENARIO / STAGE 6 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	A005

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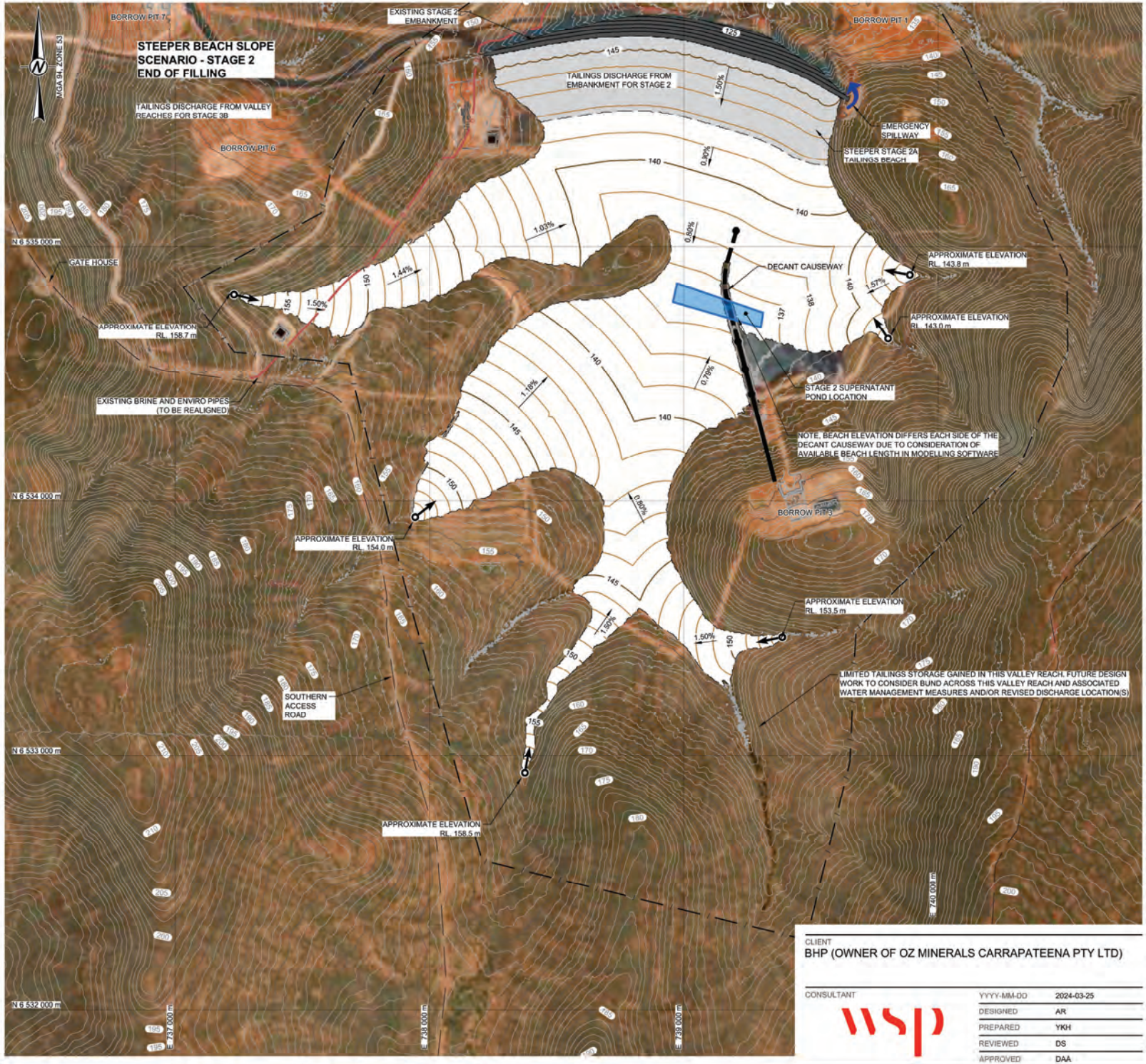
Appendix B

Staged TSF layouts for steeper beach slope scenario



LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- STAGE 2 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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APPROVED	DAA

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CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
STEEPER BEACH SLOPE SCENARIO / STAGE 2 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	B001

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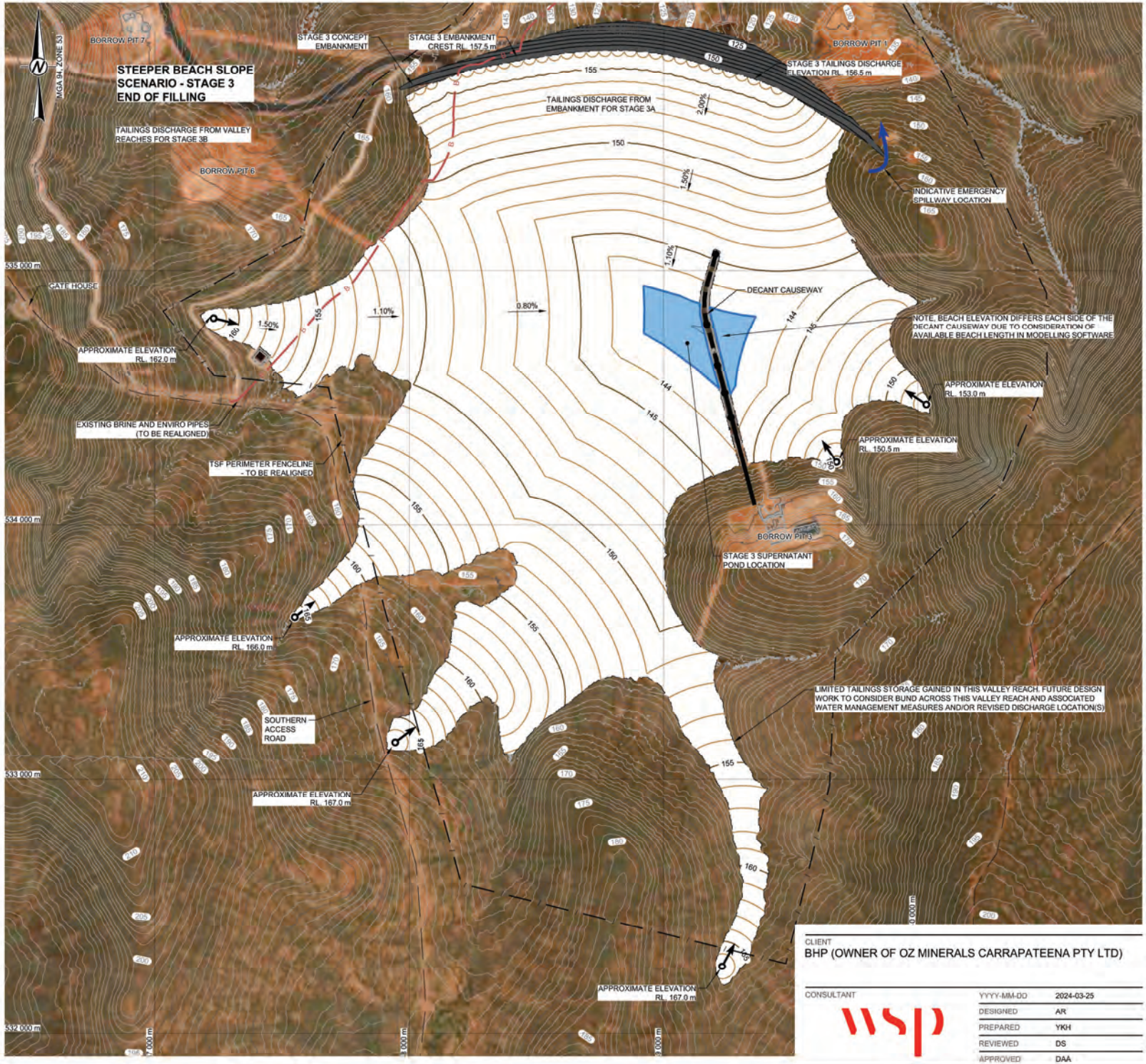

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- STAGE 3 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: S3A steep tailings beach.dwg, S3B steep tailings beach.dwg, DATED 09 FEBRUARY 2024

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CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
STEEPER BEACH SLOPE SCENARIO / STAGE 3 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	B002

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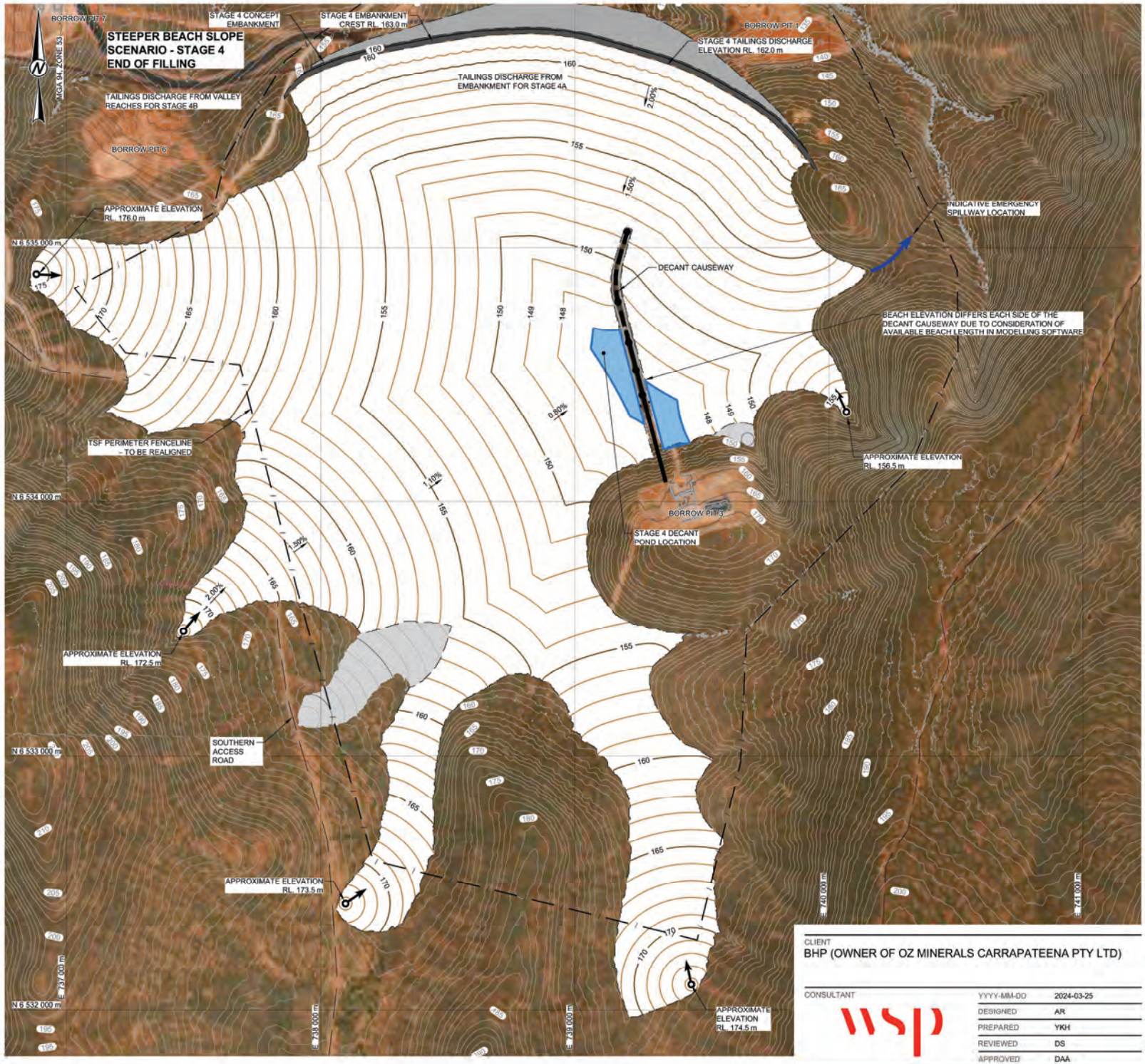

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- PREVIOUS STAGES TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- STAGE 4 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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2. ALL CO-ORDINATES ARE REFERENCED IN METRES TO MAP GRID AUSTRALIA (MGA 94, ZONE 53).
3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: S4A steep tailings beach.dwg, S4B steep tailings beach.dwg, DATED 09 FEBRUARY 2024

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PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
STEEPER BEACH SLOPE SCENARIO / STAGE 4 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
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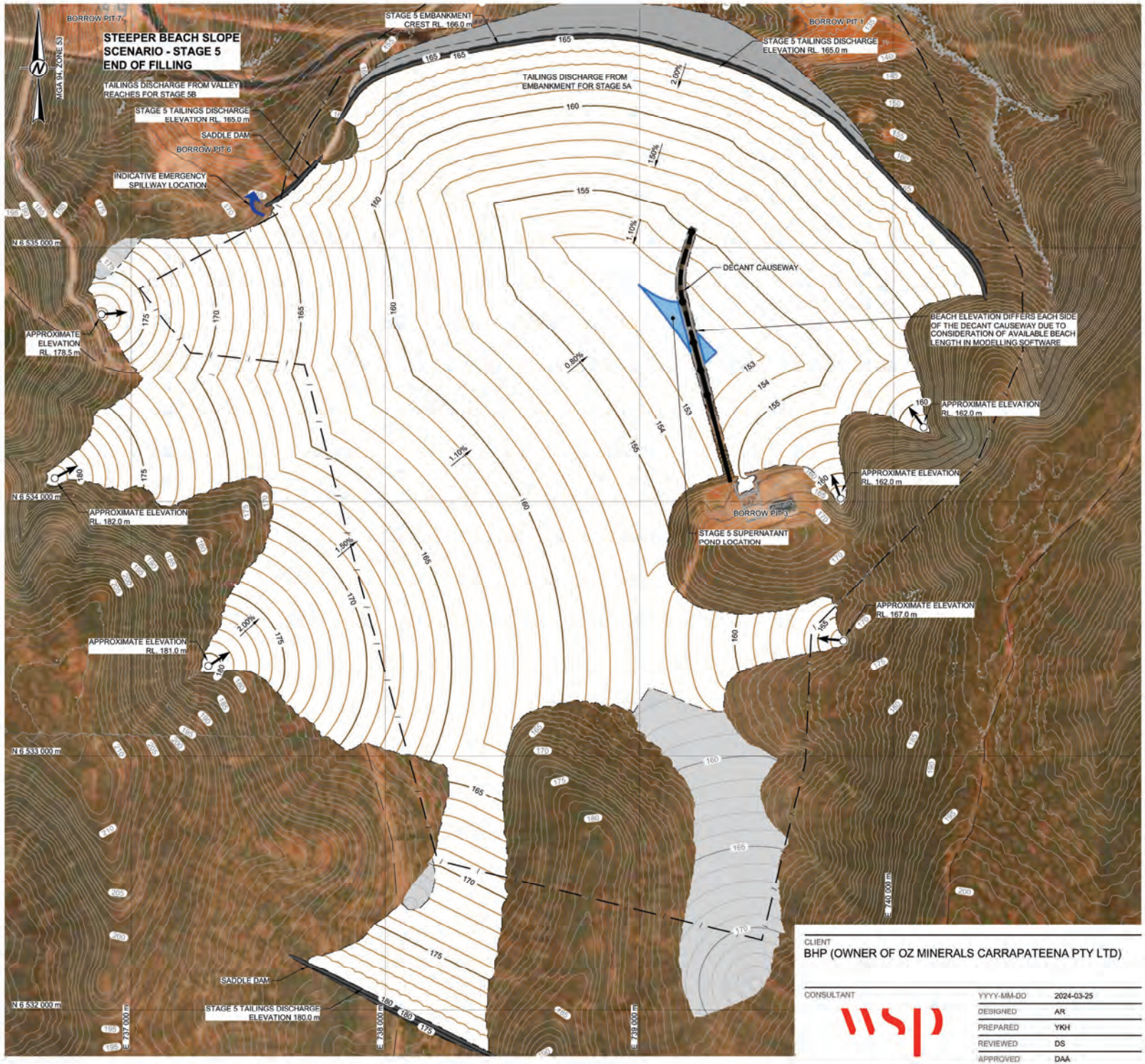

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- PREVIOUS STAGES TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- STAGE 5 TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT

REFERENCE(S)

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2. ALL CO-ORDINATES ARE REFERENCED IN METRES TO MAP GRID AUSTRALIA (MGA 94, ZONE 53).
3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: S5A steep tailings beach V2.dwg, S5B steep tailings beach V2.dwg, DATED 09 FEBRUARY 2024

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REVIEWED	DS
APPROVED	DAA

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

TITLE
STEEPER BEACH SLOPE SCENARIO / STAGE 5 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
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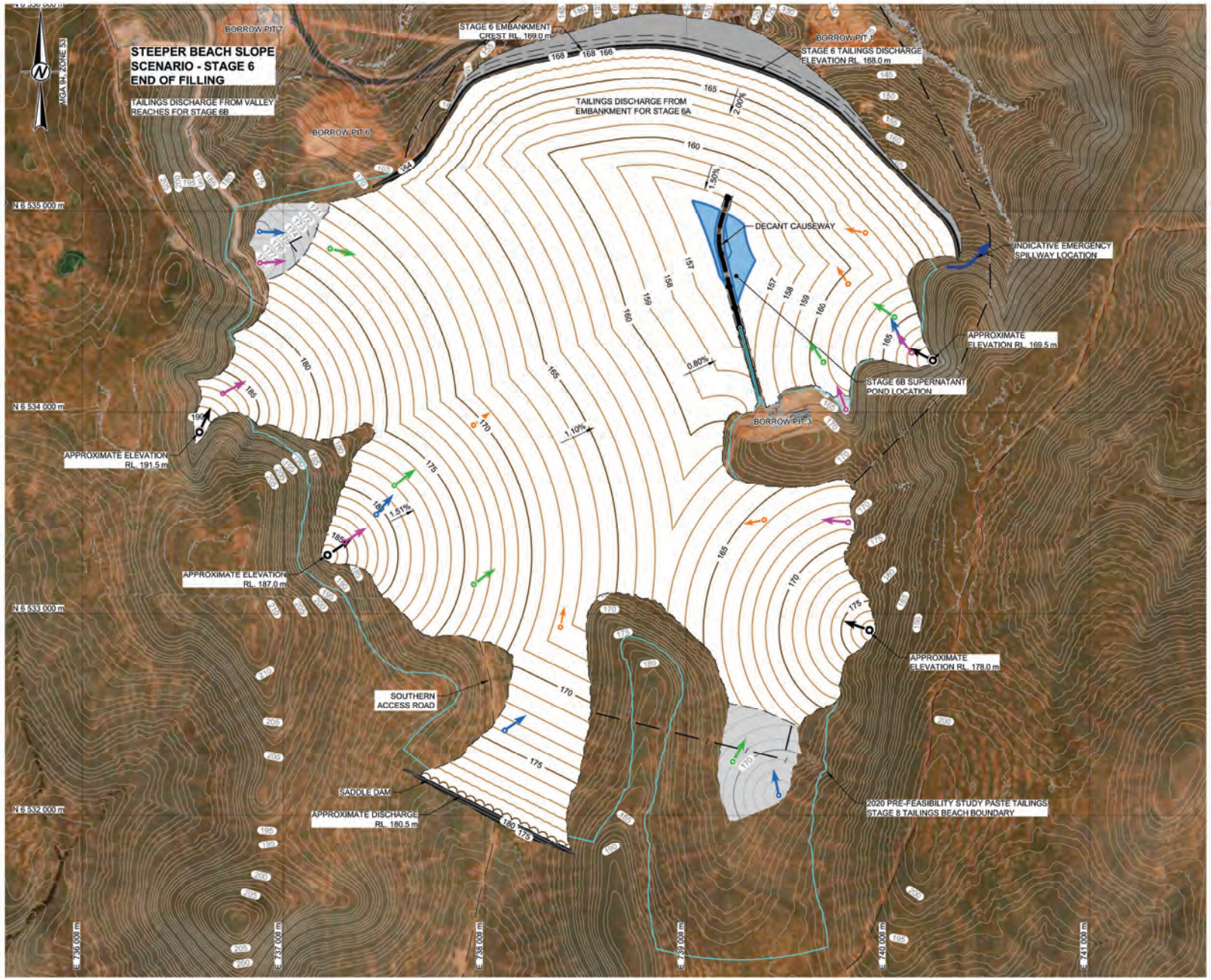

LEGEND

- 2023 DECEMBER SURVEY CONTOURS AT 1 m INTERVALS
- PREVIOUS STAGES TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- STAGE 6 STEEP TAILINGS BEACH CONTOURS AT 1 m INTERVALS
- EXISTING TSF PERIMETER FENCELINE
- SUPERNATANT POND
- DISCHARGE POINT STAGE 2
- DISCHARGE POINT STAGE 3
- DISCHARGE POINT STAGE 4
- DISCHARGE POINT STAGE 5
- DISCHARGE POINT STAGE 6

REFERENCE(S)

2023 DECEMBER SURVEY GENERATED FROM INFORMATION PROVIDED IN BHP FILE: TSF Survey 271223 0.5m Point Cloud.las, DATED 27 DECEMBER 2023

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NOTE(S)

1. ALL LEVELS ARE REFERENCED IN METRES TO AUSTRALIAN HEIGHT DATUM (AHD).
2. ALL CO-ORDINATES ARE REFERENCED IN METRES TO MAP GRID AUSTRALIA (MGA 94, ZONE 53).
3. TAILINGS BEACH GENERATED FROM MUK3D EXPORT FILES: S6A hydr tailings.dwg, Stage 6B hydr tailings.dwg, DATED 19 MARCH 2024

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 500 1,000
1:20,000 METRES

CLIENT
BHP (OWNER OF OZ MINERALS CARRAPATEENA PTY LTD)

CONSULTANT
wsp

YYYY-MM-DD	2024-03-25
DESIGNED	AR
PREPARED	YKH
REVIEWED	DS
APPROVED	DAA

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 220 Mt LIFE OF MINE

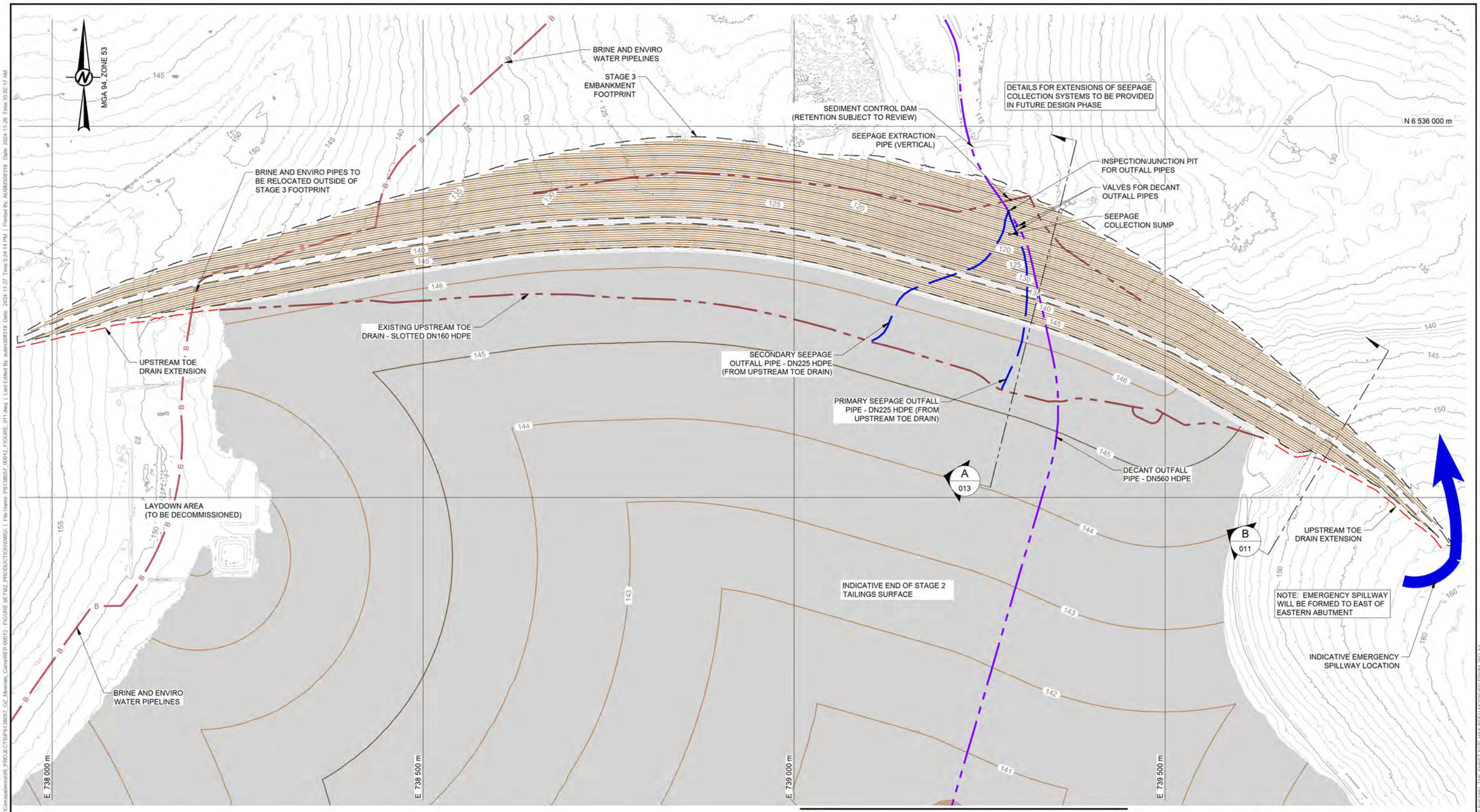
TITLE
STEEPER BEACH SLOPE SCENARIO / STAGE 6 PREDICTED END OF FILLING - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057	REP-0003	0	B005

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A1

Appendix C

Staged embankment layout plans and sections



LEGEND

- EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS
- STAGE 2 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 100 200

1:5,000 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 3 RAISE - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	001

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A1

25 mm

0

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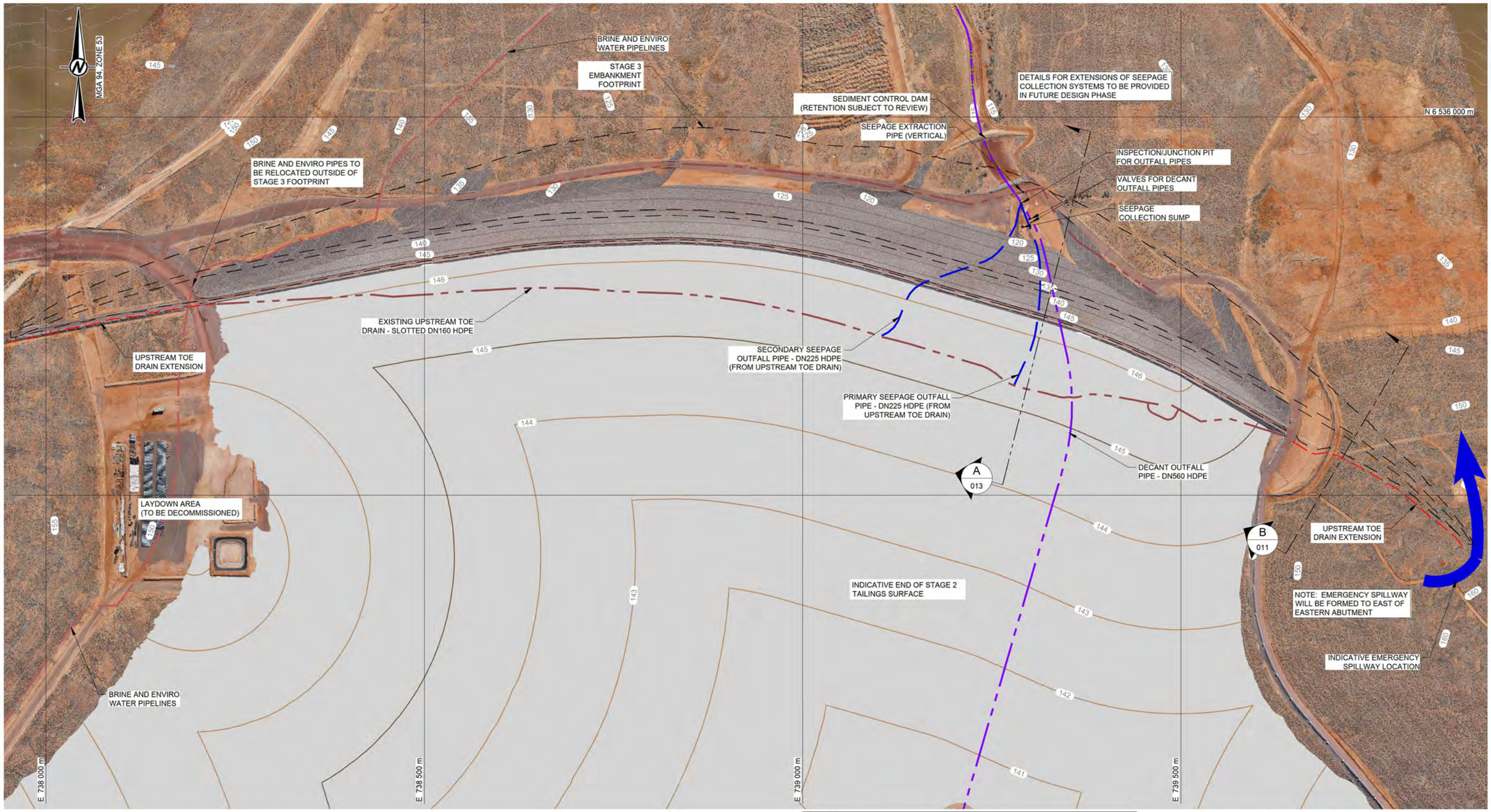

LEGEND

- EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS
- STAGE 2 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 100 200

1:5,000 METRES

CLIENT
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DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 3 RAISE FOOTPRINT - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	002

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25 mm

0

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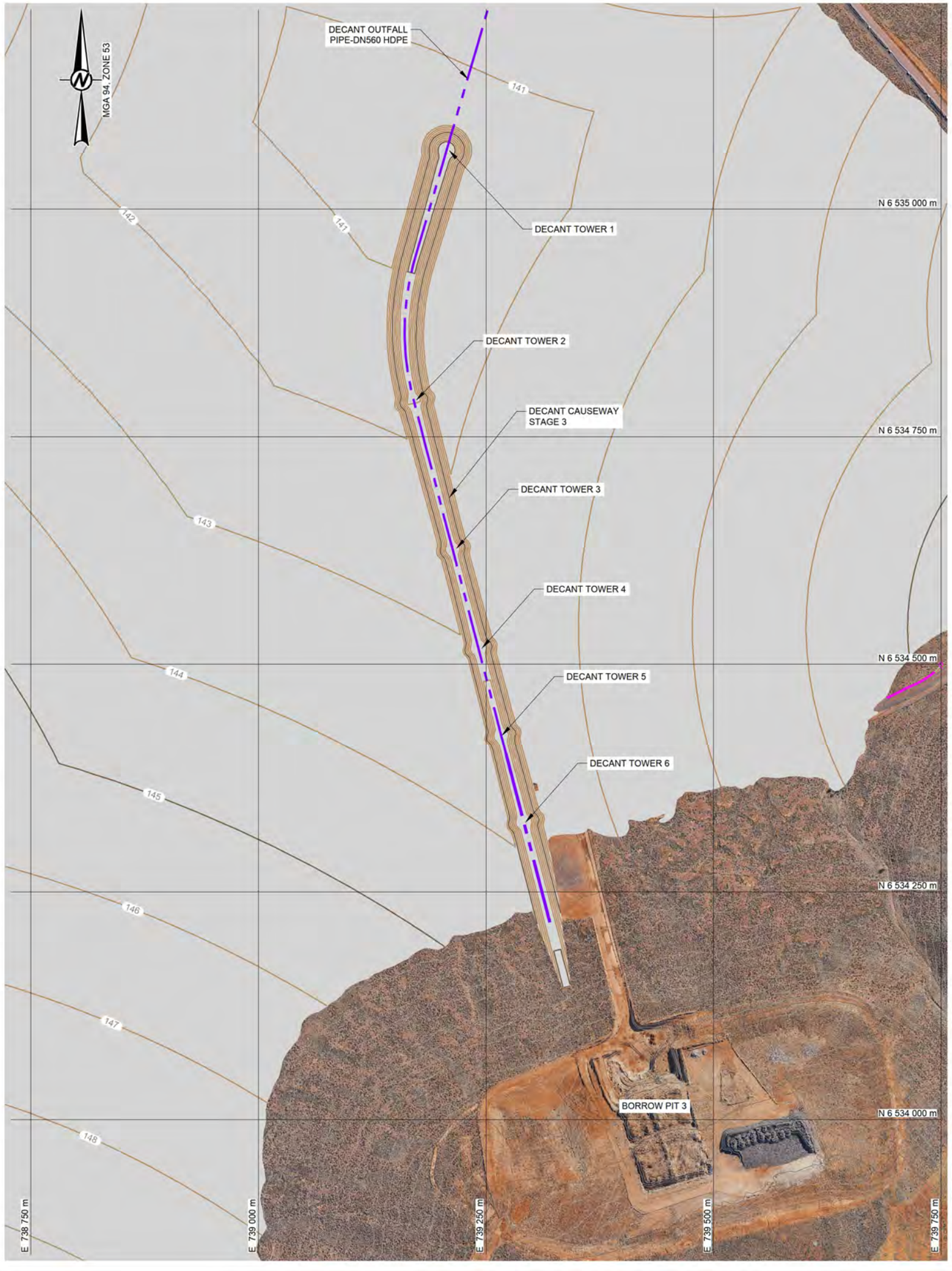

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 2 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 100 200

1:5,000 METRES

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REVIEWED	DAA
APPROVED	FWG

PROJECT

CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE

TSF DECANT CAUSEWAY STAGE 3 RAISE - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014		0	003

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm

MGA 94, ZONE 53

STAGE 4 EMBANKMENT FOOTPRINT

DETAILS FOR EXTENSIONS OF SEEPAGE COLLECTION SYSTEMS TO BE PROVIDED IN FUTURE DESIGN PHASE

EXISTING UPSTREAM TOE DRAIN - SLOTTED DN160 HDPE

SECONDARY SEEPAGE OUTFALL PIPE - DN225 HDPE (FROM UPSTREAM TOE DRAIN)

UPSTREAM TOE DRAIN EXTENSION

PRIMARY SEEPAGE OUTFALL PIPE - DN225 HDPE (FROM UPSTREAM TOE DRAIN)

A 013

DECANT OUTFALL PIPE - DN560 HDPE

B 010

UPSTREAM TOE DRAIN EXTENSION

INDICATIVE END OF STAGE 3 TAILINGS SURFACE

INDICATIVE STAGE 4 EMERGENCY SPILLWAY

DECANT CAUSEWAY STAGE 4

N 6 536 000 m

N 6 535 500 m

N 6 535 000 m

N 6 534 500 m

E 737 000 m

E 737 500 m

E 738 000 m

E 738 500 m

E 739 000 m

E 739 500 m

E 740 000 m

E 740 500 m

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 3 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT
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PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 4 RAISE - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	004

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25 mm

0

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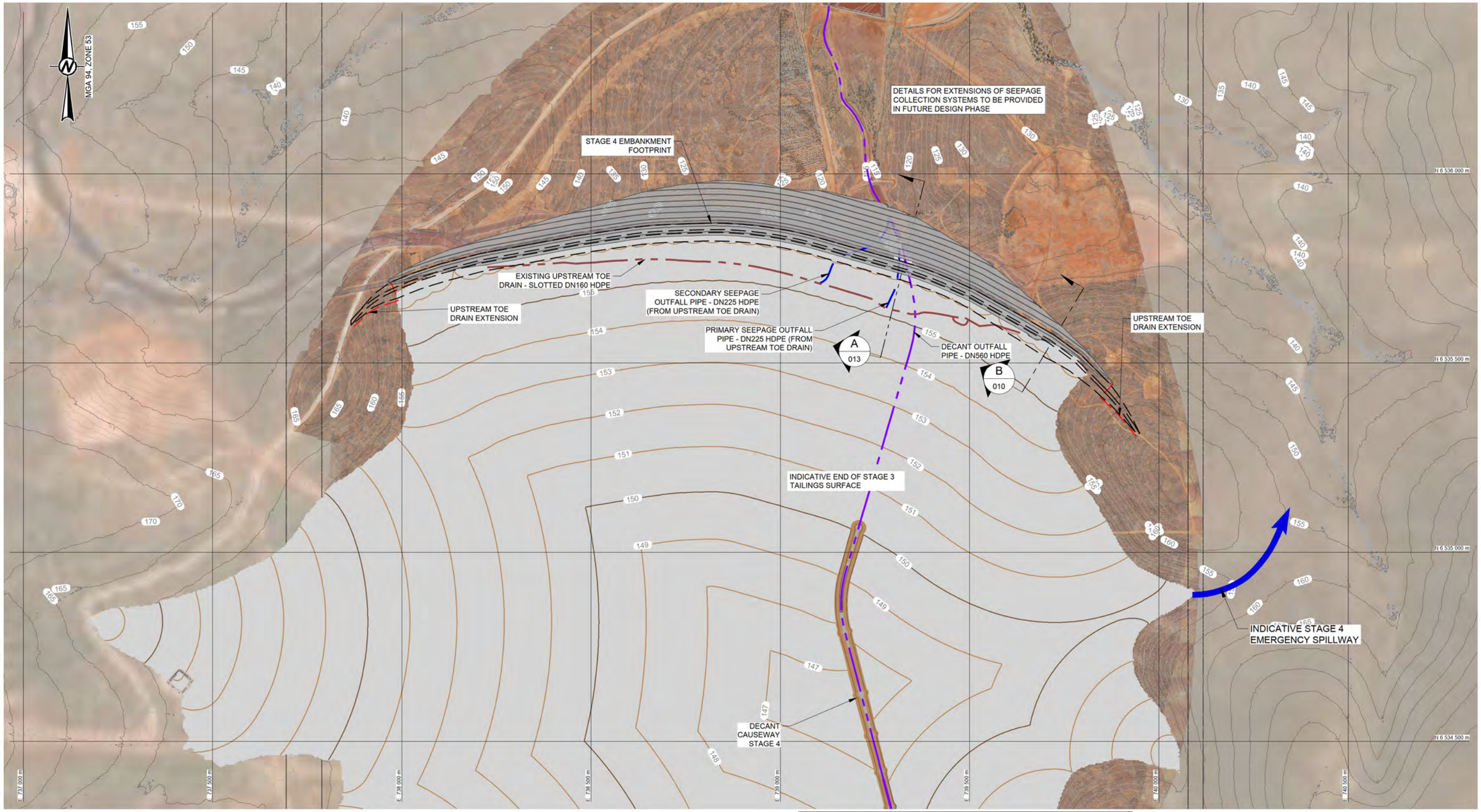

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 3 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
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PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 4 RAISE FOOTPRINT - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	005

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25 mm

0

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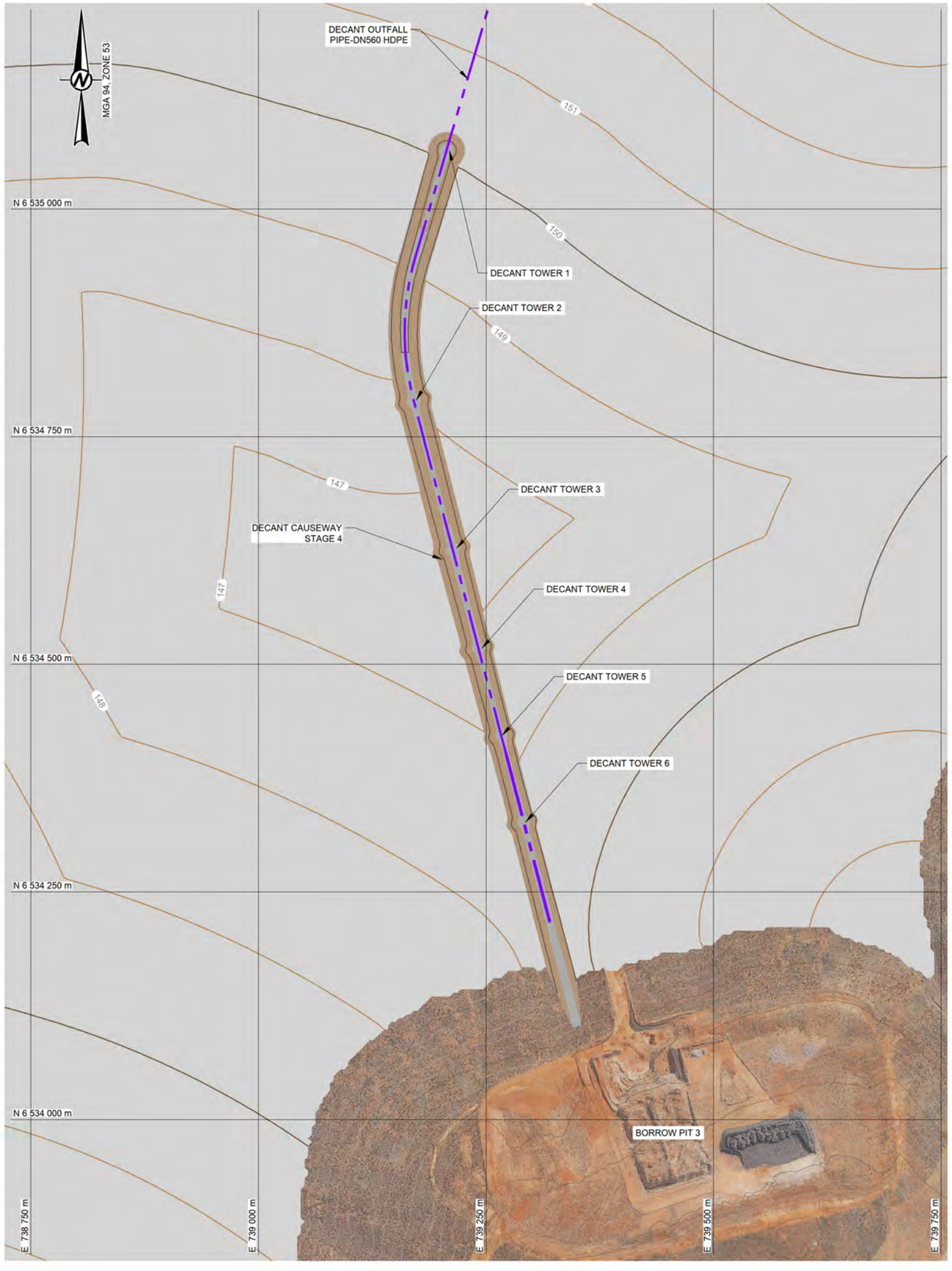

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 3 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 100 200

1:5,000 METRES

CLIENT

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PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT

CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE

TSF DECANT CAUSEWAY STAGE 4 RAISE - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014		0	006

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

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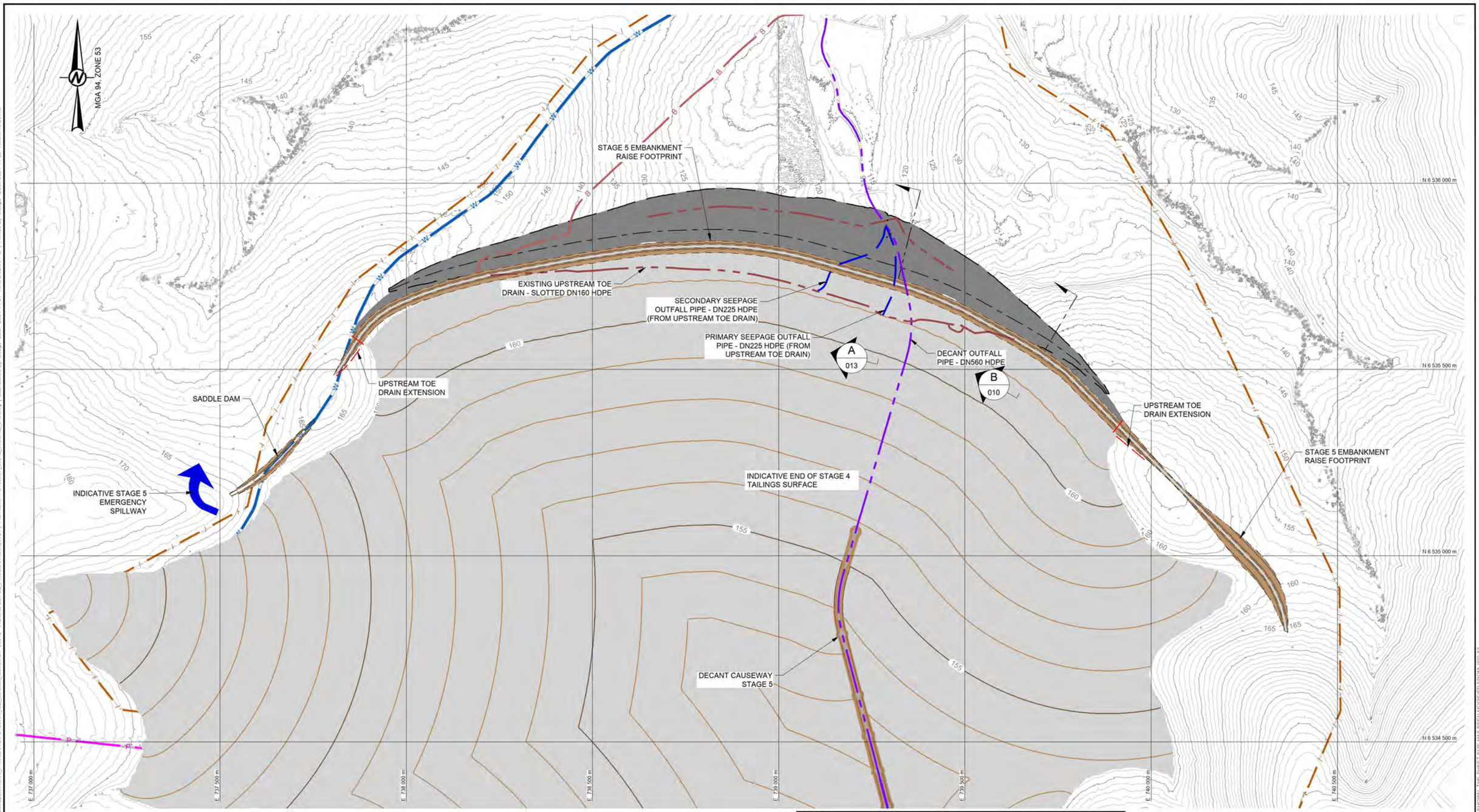

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 4 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOTE(S)

1. REFER FIGURE B4 IN REPORT WSP REPORT REF. PS138057-WSP-MEL-MNG-REP-00003 FOR LAYOUT PLAN SHOWING SOUTH SADDLE DAM

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT
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CONSULTANT
wsp

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REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 5 RAISE - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	007

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25 mm

0

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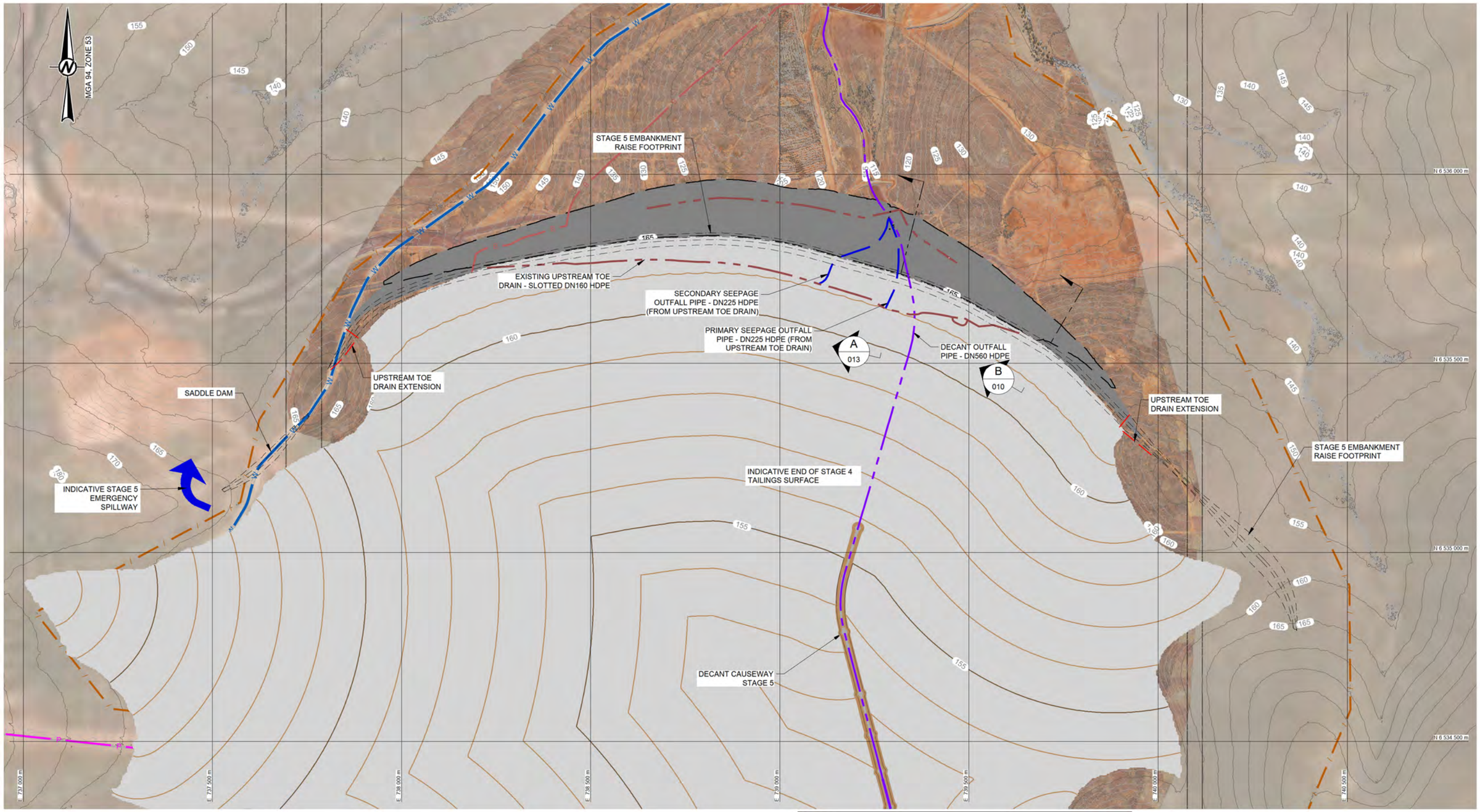

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 4 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOTE(S)

1. REFER FIGURE B4 IN REPORT WSP REPORT REF. PS138057-WSP-MEL-MNG-REP-00003 FOR LAYOUT PLAN SHOWING SOUTH SADDLE DAM

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT
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CONSULTANT
wsp

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DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 5 RAISE FOOTPRINT - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	008

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25 mm

0

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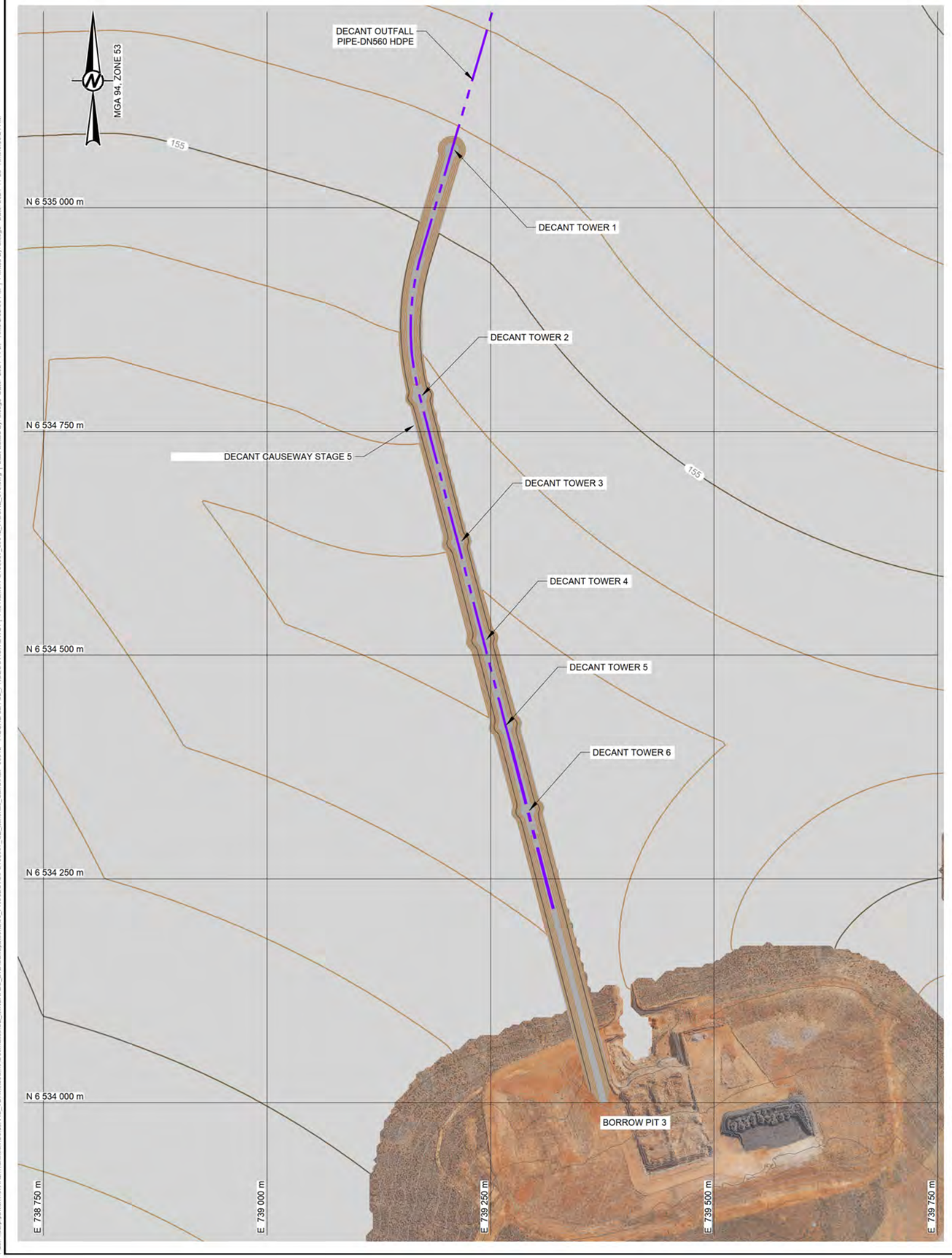

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 4 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOTE(S)

1. REFER FIGURE B4 IN REPORT WSP REPORT REF. PS138057-WSP-MEL-MNG-REP-00003 FOR LAYOUT PLAN SHOWING SOUTH SADDLE DAM

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 100 200

1:5,000 METRES

CLIENT
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DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF DECANT CAUSEWAY STAGE 5 RAISE - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014		0	009

© THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25 mm
0

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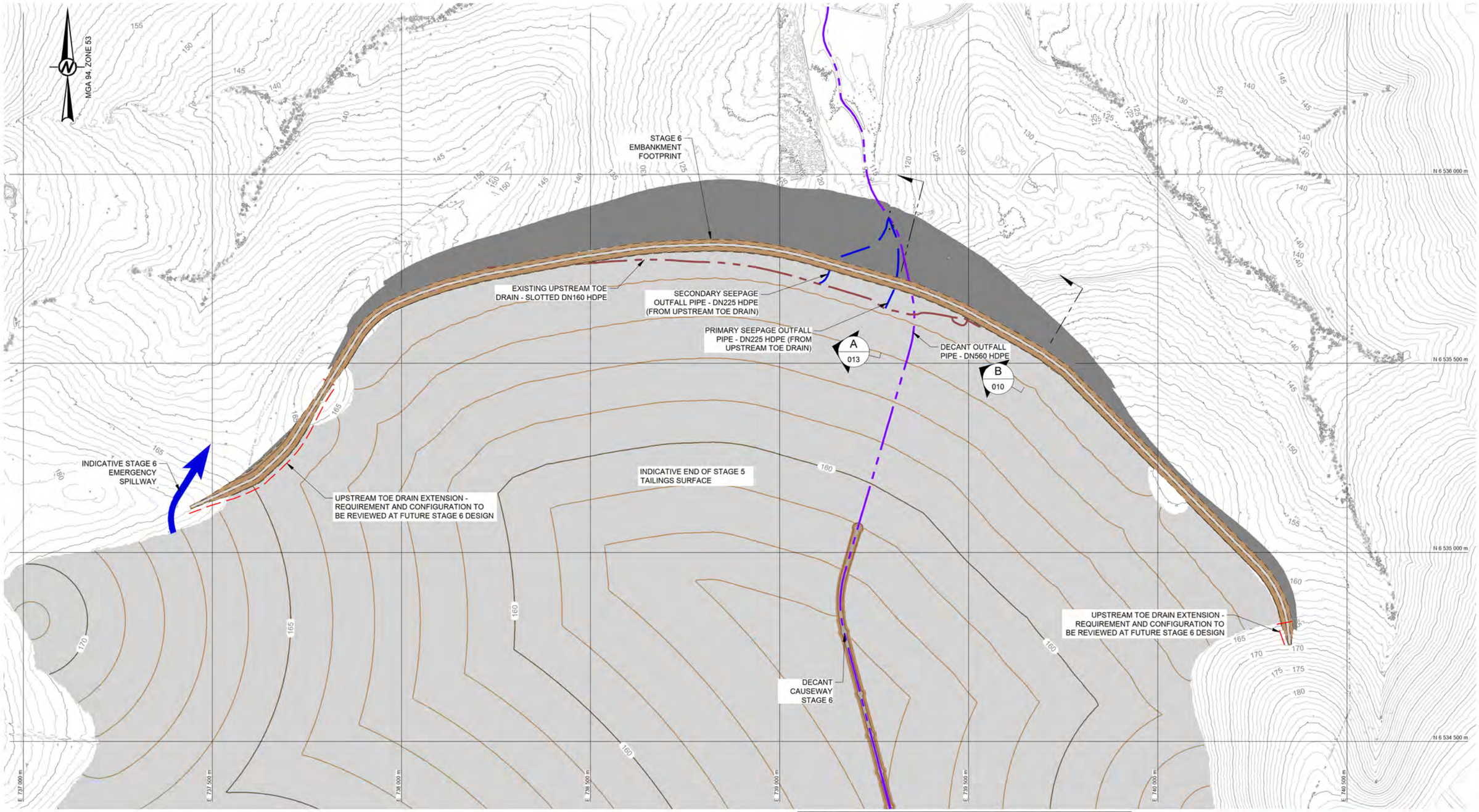

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 5 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOTE(S)

1. REFER FIGURE B4 IN REPORT WSP REPORT REF. PS138057-WSP-MEL-MNG-REP-00003 FOR LAYOUT PLAN SHOWING SOUTH SADDLE DAM

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT

BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

PROJECT

CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

CONSULTANT

wsp

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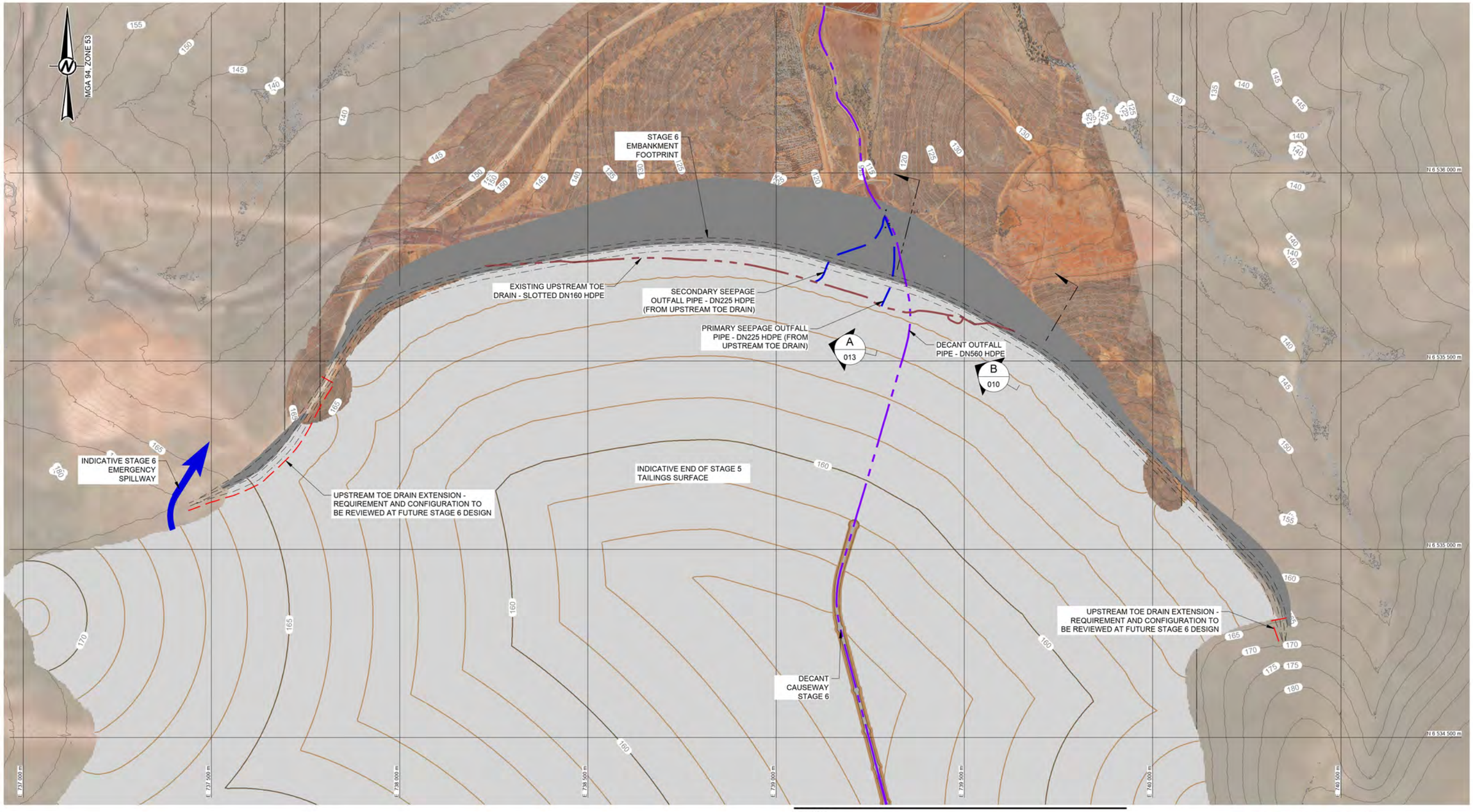
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

TITLE

TSF EMBANKMENT STAGE 6 RAISE - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	010

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm



LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 5 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOTE(S)

1. REFER FIGURE B4 IN REPORT WSP REPORT REF. PS138057-WSP-MEL-MNG-REP-00003 FOR LAYOUT PLAN SHOWING SOUTH SADDLE DAM

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

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DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT STAGE 6 RAISE FOOTPRINT - GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	011

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25 mm
0

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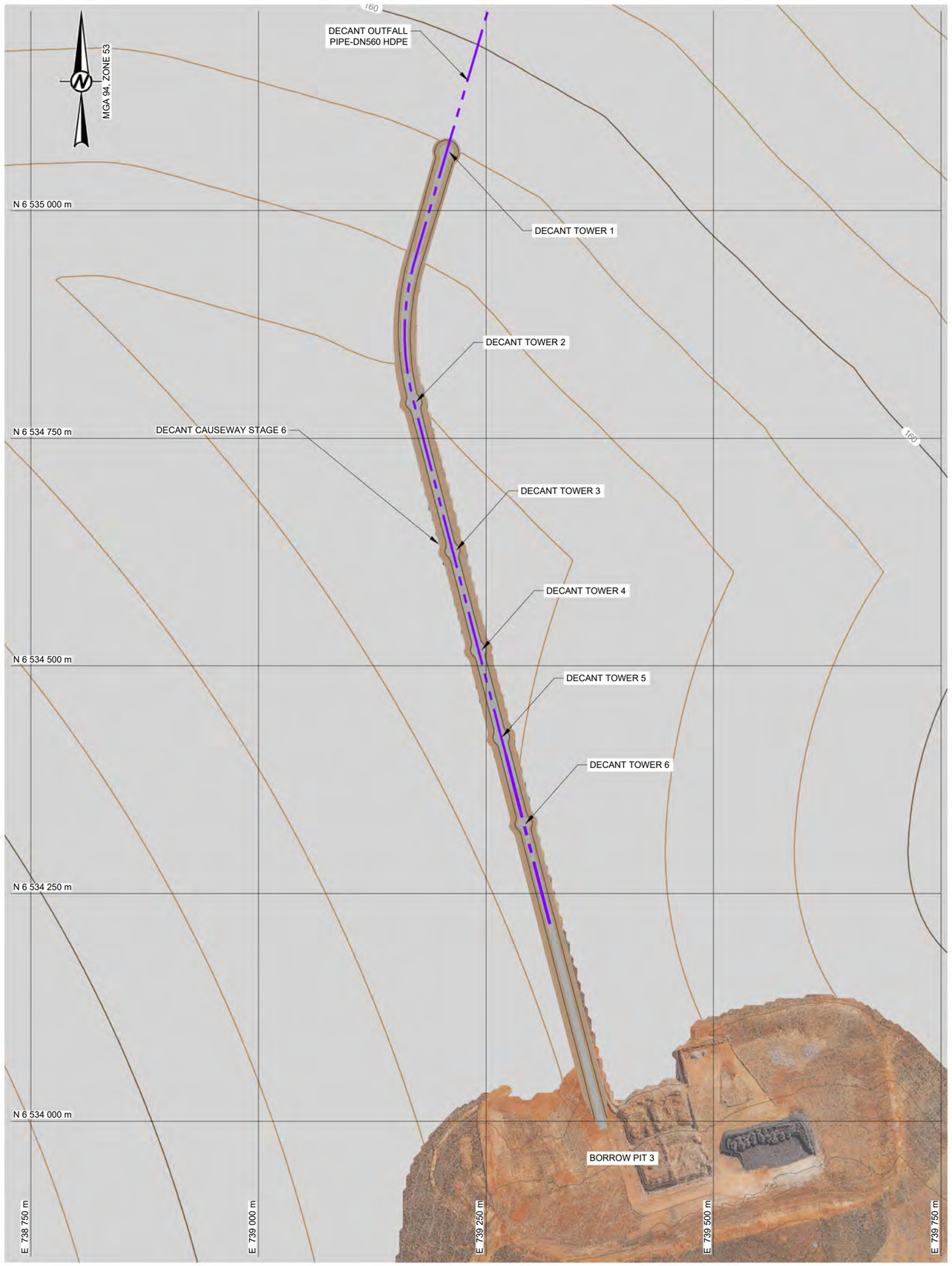

LEGEND

EXISTING TOPOGRAPHY AT 1 m CONTOUR INTERVALS

STAGE 5 TAILINGS BEACH STEEPER SCENARIO AT 1 m CONTOUR INTERVALS

NOTE(S)

1. REFER FIGURE B4 IN REPORT WSP REPORT REF. PS138057-WSP-MEL-MNG-REP-00003 FOR LAYOUT PLAN SHOWING SOUTH SADDLE DAM

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 250 500

1:10,000 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF DECANT CAUSEWAY STAGE 6 RAISE - GENERAL LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014		0	012

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

0

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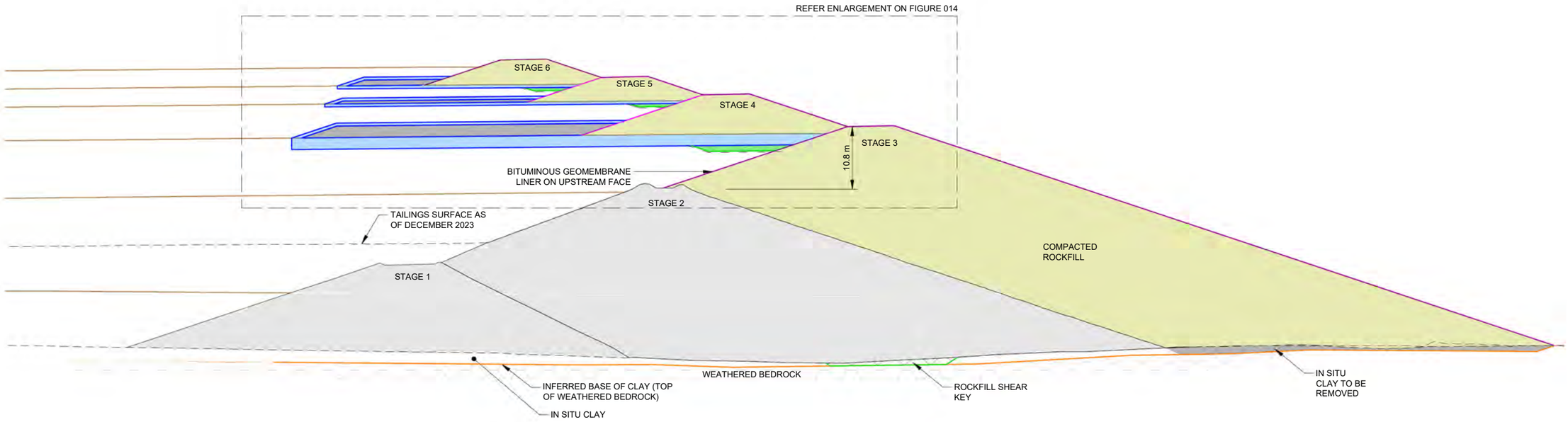
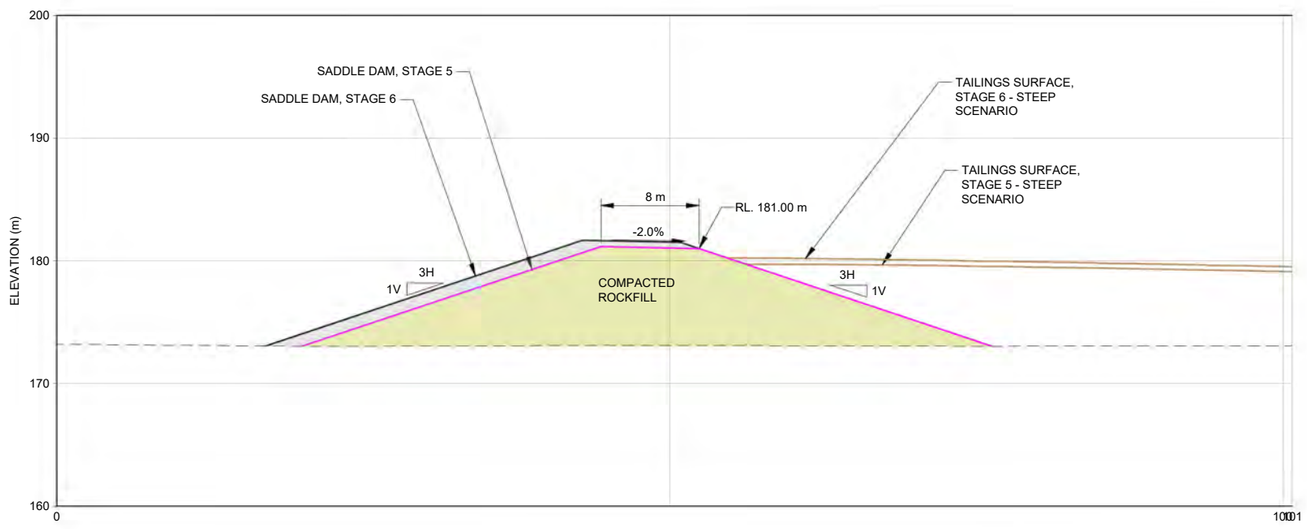


LIFE OF MINE EMBANKMENT RAISE CROSS SECTION
SCALE 1:750



SOUTH SADDLE DAM - CROSS SECTION
SCALE 1:500

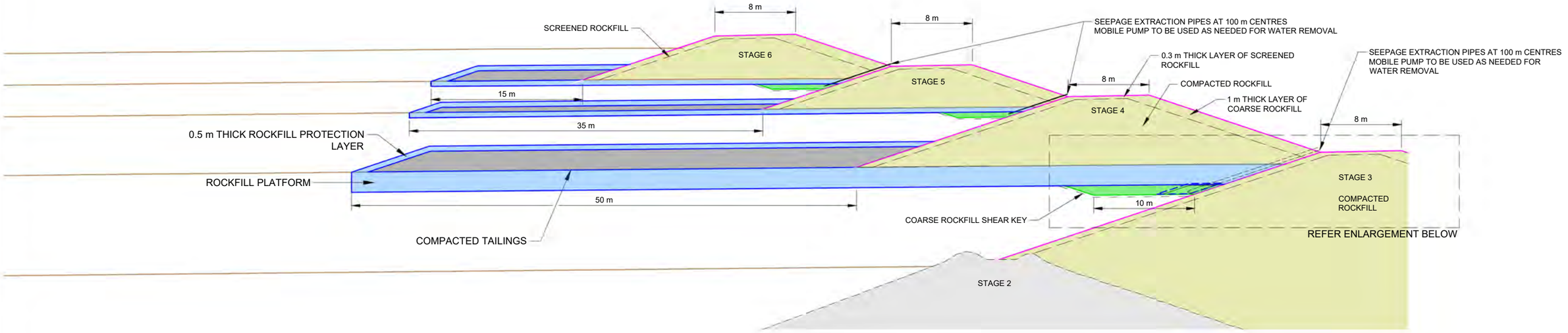
NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

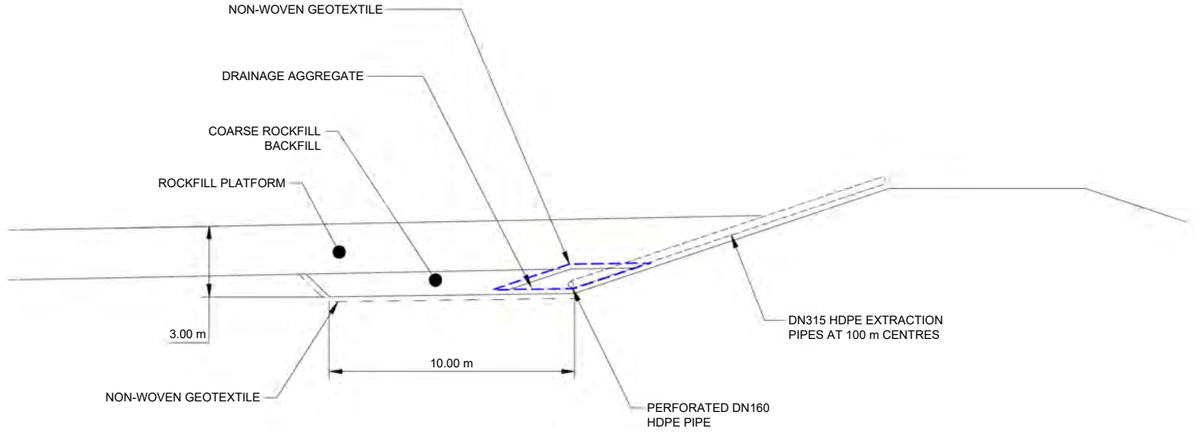
0 12.5 25
1:750 METRES

CLIENT	BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD
CONSULTANT	wsp
YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG
PROJECT	CARRAPATEENA TAILINGS STORAGE FACILITY CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE
TITLE	**TSF EMBANKMENT - LIFE OF MINE RAISES - TYPICAL CROSS SECTION**
PROJECT NO.	PS138057-WSP-MEL-MNG-PLN-00014
REV.	0
FIGURE	013

Path: \\corp.pbwan.net\ANZ\Transition\Golder\AU_VDI\Melbourne\Geomatics\OZ_MINERALS_LTD\Carrapateena\99_PROJECTS\PS138057_OZ_Minerals_Carra\REP-00012 - FIGURE SET\02_PRODUCTION\DWGs | File Name: PS138057_00012_FIGURE_019.dwg | Last Edited By: alesg0 Date: 2024-11-27 Time:3:10:41 PM | Printed By: alesg0 Date: 2024-11-27 Time:5:11:45 PM
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm
0



TSF EMBANKMENT - STAGE 4 TO 6 UPSTREAM RAISES
SCALE 1:400



SHEAR KEY ENLARGEMENT
SCALE 1:500 m

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 10 20
1:400 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT - STAGES 4 TO 6 UPSTREAM RAISES - TYPICAL CROSS SECTION

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	014

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
0 25 mm

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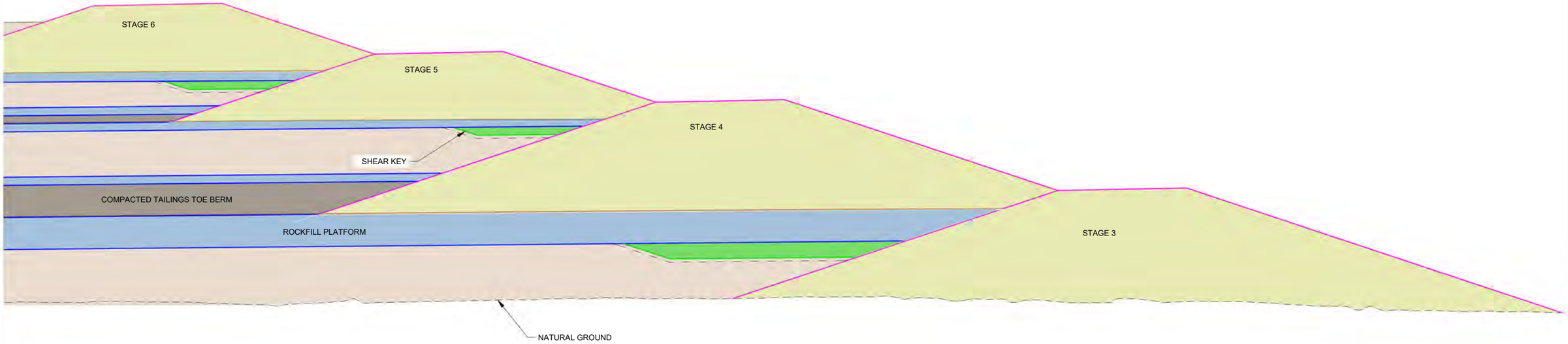


TSF EMBANKMENT - TYPICAL CROSS SECTION NEAR ABUTMENT OF STAGE 3 RAISE
SCALE 1:250

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 5 10
1:250 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

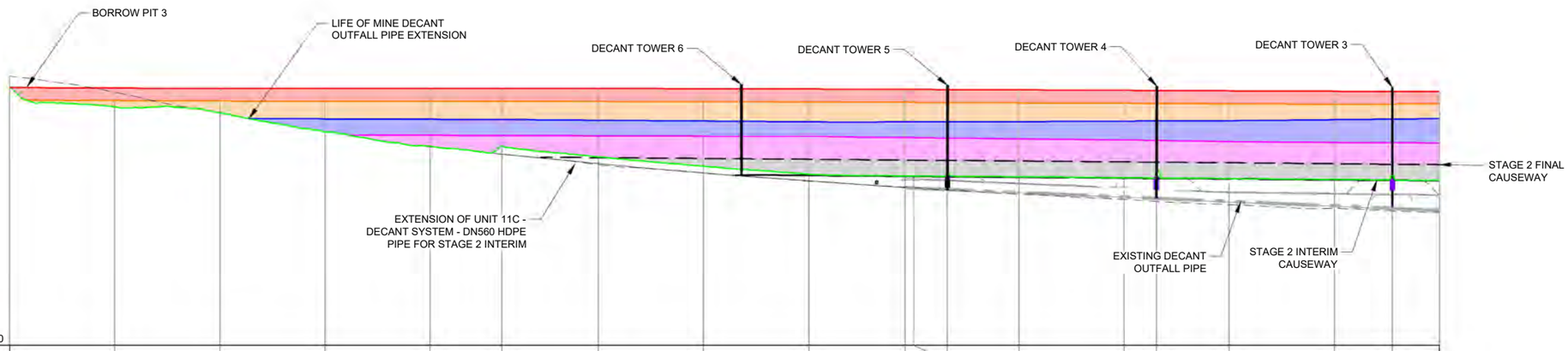
PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
TSF EMBANKMENT - STAGES 3 TO 6 RAISE NEAR STAGE 3 ABUTMENT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	015

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm
0

Path: \\corp.pbwan.net\ANZ\Transition\Golder\AU_VDI\Melbourne\Geomatics\OZ_MINERALS_LTD\Carrapateena\099_PROJECTS\PS138057_OZ_Minerals_Carra\REP-00012 - FIGURE SET\02_PRODUCTION\DWG\ | File Name: PS138057_00012_FIGURE_019.dwg | Last Edited By: aleng0 Date: 2024-11-27 Time:3:10:41 PM | Printed By: aleng0 Date: 2024-11-27 Time:5:05:09 PM



DATUM 100.00																				
STAGE 6 CAUSEWAY RAISE		161.24	161.20	161.21	161.20	161.18	161.15	161.08	161.01	160.92	160.91	160.88	160.81	160.69	160.65	160.58	160.48	160.42	160.42
STAGE 5 CAUSEWAY RAISE		158.27	158.15	158.09	158.10	158.09	158.04	157.99	157.91	157.83	157.83	157.79	157.72	157.62	157.58	157.49	157.38	157.40	157.42
STAGE 4 CAUSEWAY RAISE				153.91	153.81	153.75	153.58	153.39	153.20	153.17	153.18	153.19	153.24	153.37	153.41	153.48	153.71	153.85	153.97
STAGE 3 CAUSEWAY RAISE					150.00	149.95	149.87	149.78	149.69	149.45	149.42	149.33	149.15	148.89	148.78	148.50	148.30	148.23	148.17
STAGE 2 FINAL CAUSEWAY RAISE								144.48	144.28	144.07	144.04	143.99	143.88	143.67	143.59	143.45	143.23	143.09	143.01
MARCH 2024 SURVEY/STAGE 2 INTERIM CAUSEWAY	161.35	156.81	155.31	150.82	147.44	147.47	144.86	142.62	140.75	140.32	140.31	140.96	140.11	139.90	139.75	139.67	139.51	140.42	139.27
ORGINAL GROUND SURFACE	164.07	160.23	155.23	150.90	147.24	145.50	142.99	141.04	139.09	137.68	137.53	136.96	136.00	134.76	134.24	133.49	132.64	132.02	131.62
CHAINAGE	0.00	50.00	100.00	150.00	200.00	234.10	280.00	330.00	380.00	425.89	430.00	445.99	480.00	530.00	545.38	580.00	630.00	657.61	680.00

HORIZ. SCALE 1:2,500
VERT. SCALE 1:1,250

C DECANT CAUSEWAY LONG SECTION (CH. 0.00 to CH. 680.00)

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 25 50
1:1,250 METRES

0 50 100
1:2,500 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

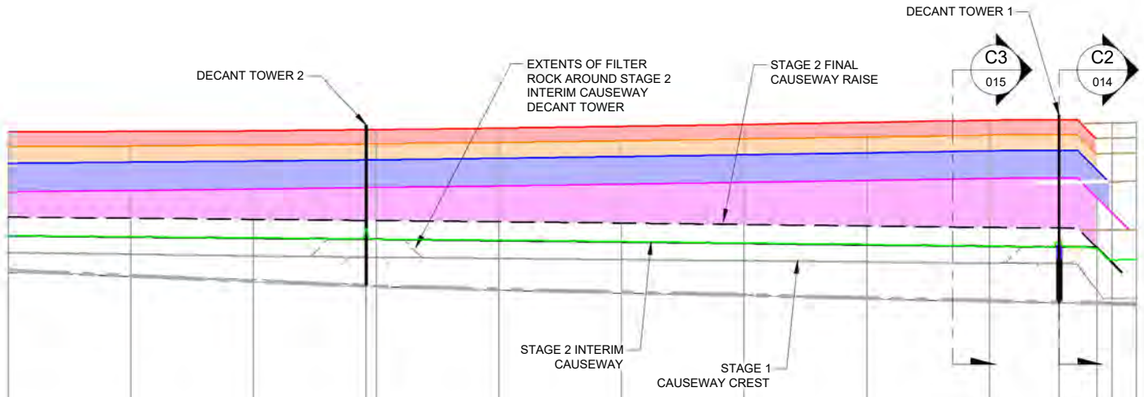
PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
DECANT CAUSEWAY LONG SECTION SHEET 1

PROJECT NO. PS138057-WSP-MEL-MNG-PLN-00014
REV. 0
FIGURE 016

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm
0

Path: \\corp.pbwan.net\ANZ\Transition\Golder\AU_VDI\Melbourne\Geomatics\OZ_MINERALS_LTD\Carrapateena\99_PROJECTS\PS138057_OZ_Minerals_Care\REP-00012 - FIGURE SET\02_PRODUCTION\DWG\ | File Name: PS138057_00012_FIGURE_023.dwg | Last Edited By: aulw510225 Date: 2024-11-14 Time:4:56:40 PM | Printed By: aleeg0 Date: 2024-11-27 Time:5:02:51 PM



DATUM 100.00													
STAGE 6 CAUSEWAY RAISE	160.42	160.46	160.57	160.81	160.84	161.13	161.50	161.88	162.32	162.74	162.78		
STAGE 5 CAUSEWAY RAISE	157.42	157.49	157.70	157.91	157.94	158.24	158.56	158.94	159.33	159.70	159.74		
STAGE 4 CAUSEWAY RAISE	153.97	154.21	154.43	154.65	154.67	155.00	155.33	155.71	156.10	156.52	156.56	152.67	
STAGE 3 CAUSEWAY RAISE	148.17	148.45	148.71	149.01	149.04	149.35	149.71	150.09	150.47	150.87	150.97	147.08	143.97
STAGE 2 FINAL CAUSEWAY RAISE	143.01	142.78	142.55	142.34	142.34	142.06	141.79	141.49	141.20	140.90	140.79		
MARCH 2024 SURVEY/STAGE 2 INTERIM CAUSEWAY	139.27	139.01	138.79	140.60	138.51	138.33	138.04	137.74	137.47	137.12	137.72	136.63	134.26	134.36
ORGINAL GROUND SURFACE	131.62	130.90	130.27	129.09	128.95	128.10	127.50	127.15	126.57	125.87	125.52	125.47	125.42	125.38
CHAINAGE	680.00	730.00	780.00	825.89	830.00	880.00	930.00	980.00	1030.00	1080.00	1108.43	1123.78	1130.00	1140.00

HORIZ. SCALE 1:2,500
VERT. SCALE 1:1,250

C DECANT CAUSEWAY LONG SECTION (CH. 680.00 to CH. 1140.00)

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 25 50
1:1,250 METRES

0 50 100
1:2,500 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

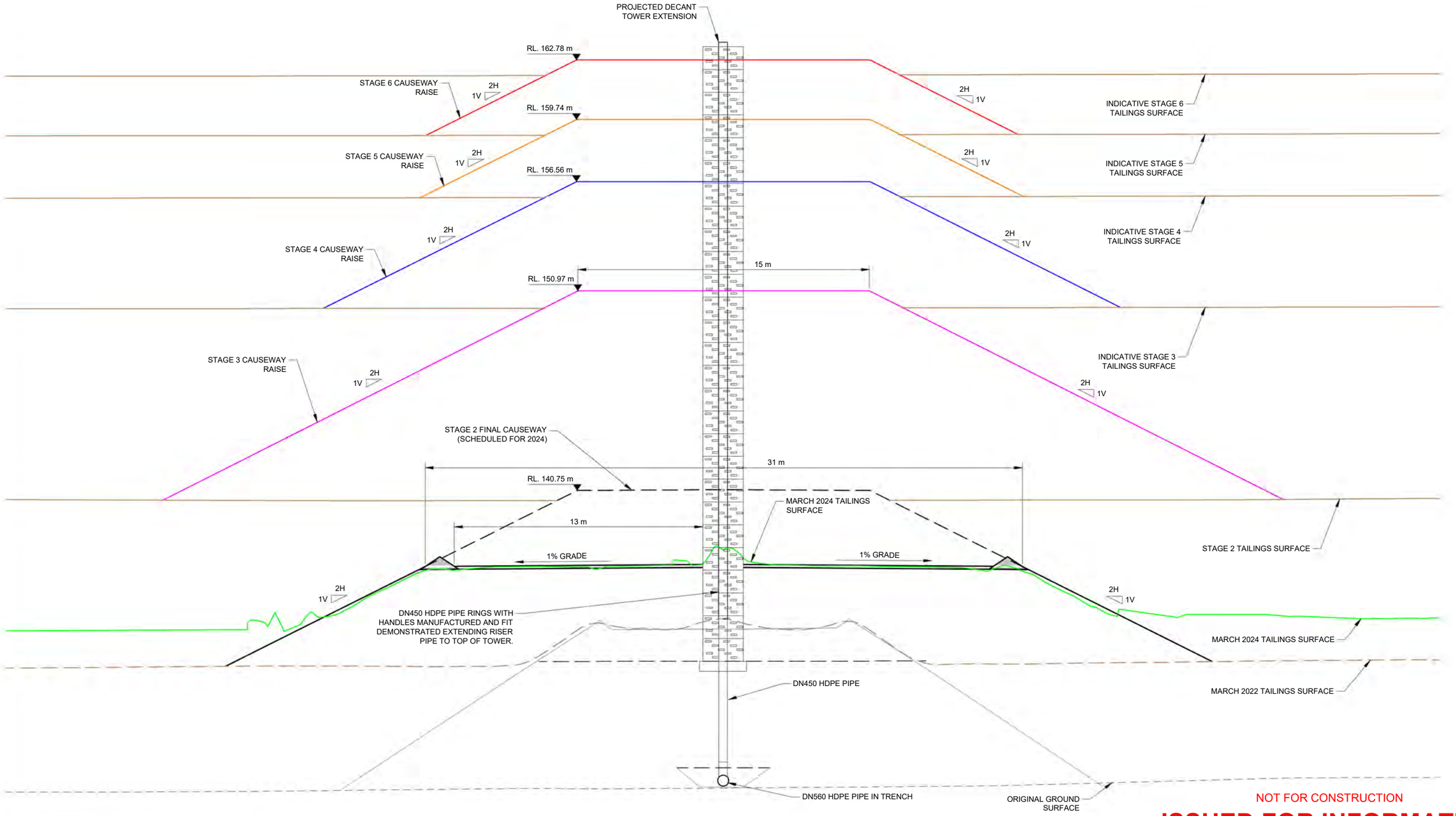
PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
DECANT CAUSEWAY LONG SECTION SHEET 2

PROJECT NO. PS138057-WSP-MEL-MNG-PLN-00014
REV. 0
FIGURE 017

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm
0

Path: \\corp.pbwan.net\ANZ\Transition\Golder\AU_VDI\Melbourne\Geomatics\OZ_MINERALS_LTD\Carrapateena\99_PROJECTS\PS138057_OZ_Minerals_Carra\REP-00012 - FIGURE SET\02_PRODUCTION\DWG\ | File Name: PS138057_00012_FIGURE_023.dwg | Last Edited By: aulw510225 Date: 2024-11-14 Time:4:56:40 PM | Printed By: alleq0 Date: 2024-11-27 Time:5:01:39 PM



NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 5 10

1:200 METRES

SCALE 1:200 C2 DECANT CAUSEWAY TYPICAL SECTION AT DECANT TOWER

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
DECANT CAUSEWAY TYPICAL SECTION SHEET 1

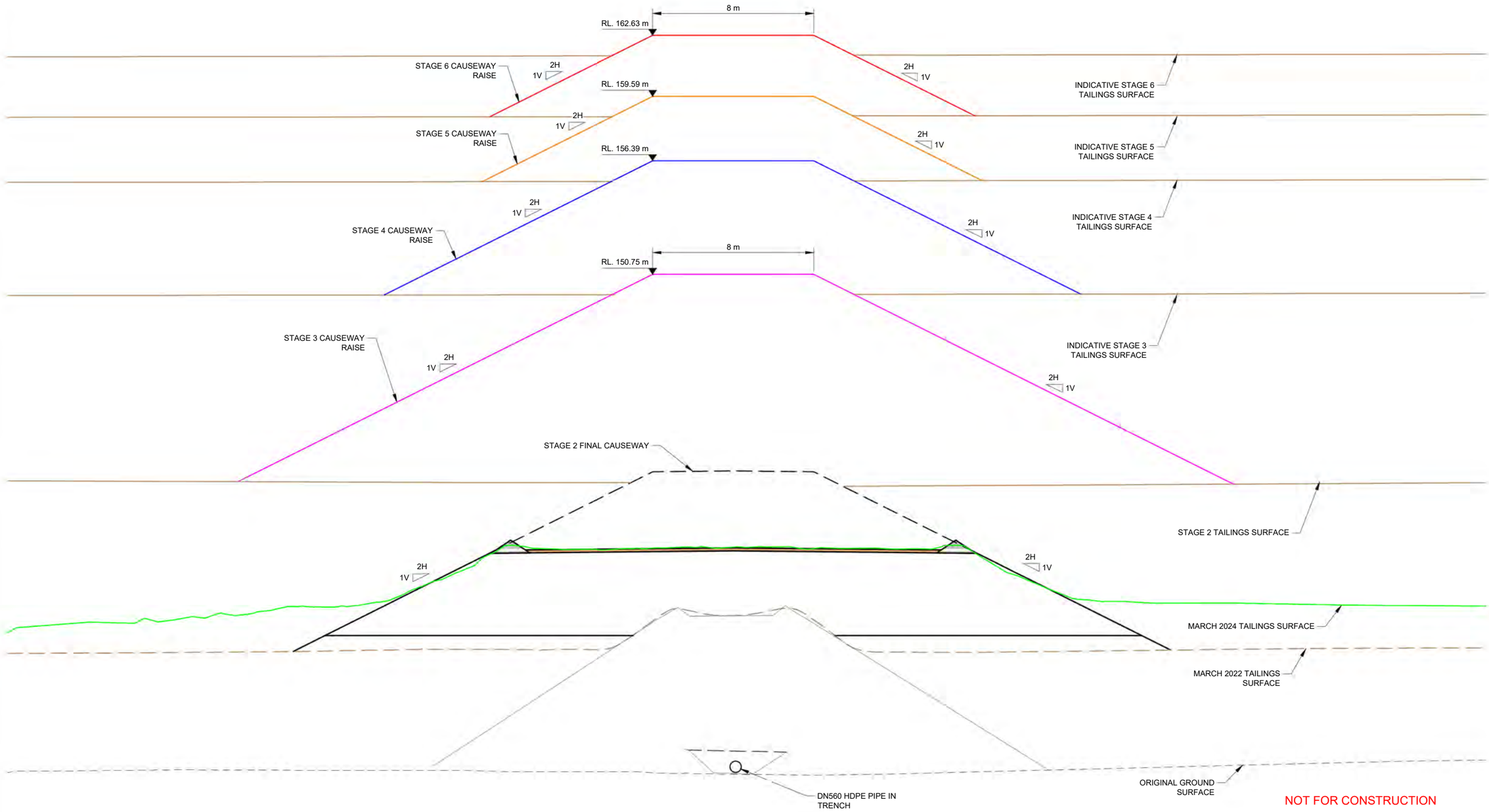
PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	018

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

0

Path: \\corp.pbwan.net\ANZ\TT\melb\on\Golder\AU_VDI\Melbourne\Geomatics\OZ_MINERALS_LTD\Carrapateena\09_PROJECTS\PS138057_OZ_Minerals_Carra\REP-00012 - FIGURE SET\02_PRODUCTION\DWG\ | File Name: PS138057_00012_FIGURE_023.dwg | Last Edited By: aulw510225 Date: 2024-11-14 Time:4:56:40 PM | Printed By: alieq0 Date: 2024-11-27 Time:5:00:06 PM



SCALE 1:200 C3 DECANT CAUSEWAY - TYPICAL SECTION FOR PORTIONS BETWEEN DECANT TOWERS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 5 10
1:200 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
DECANT CAUSEWAY TYPICAL SECTION SHEET 2

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	019

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm
0

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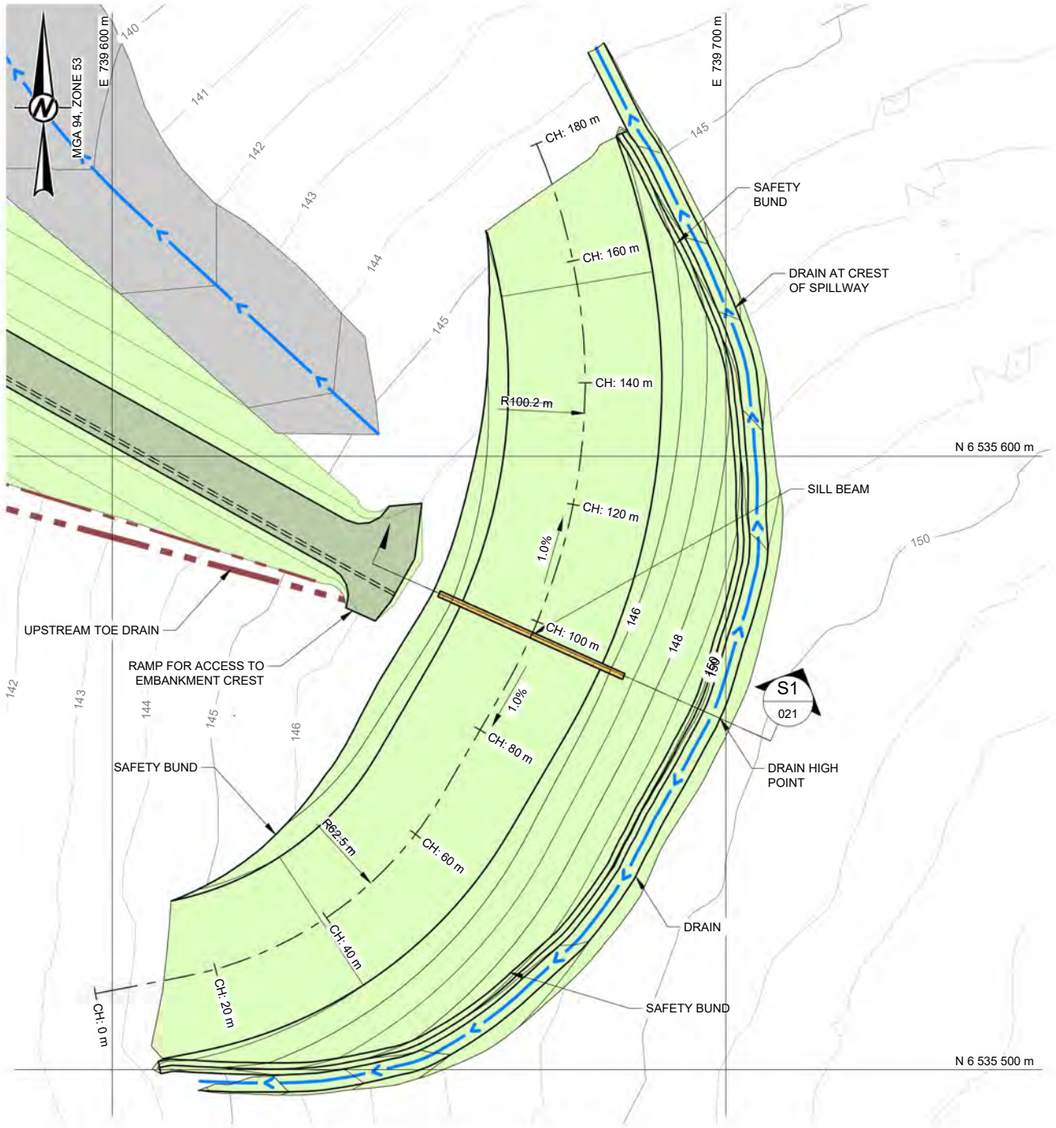
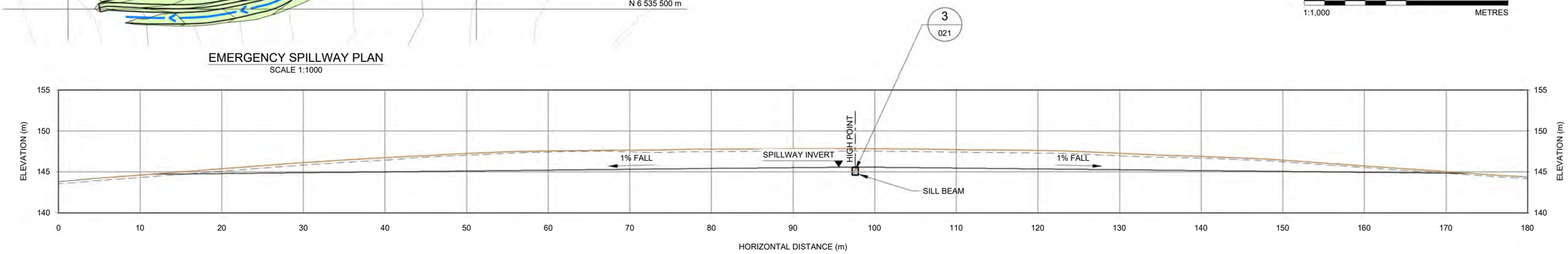


EMERGENCY SPILLWAY PLAN
SCALE 1:1000



EMERGENCY SPILLWAY LONG SECTION
SCALE 1:500

LEGEND

ORIGINAL GROUND SURFACE CONTOURS AT 1 m INTERVALS

STAGE 2 TSF EMBANKMENT CONTOURS AT 1 m INTERVALS

SPILLWAY DETAILS ARE AS PER THOSE FOR THE STAGE 2 LAYOUT. STAGE 2 LAYOUT IS PROVIDED AS A CONCEPTUAL LAYOUT FOR THE STAGE 3 TO 6 SPILLWAYS

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 10 20
1:500 METRES

0 25 50
1:1,000 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
EMERGENCY SPILLWAY GENERAL LAYOUT

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	020

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25 mm

0

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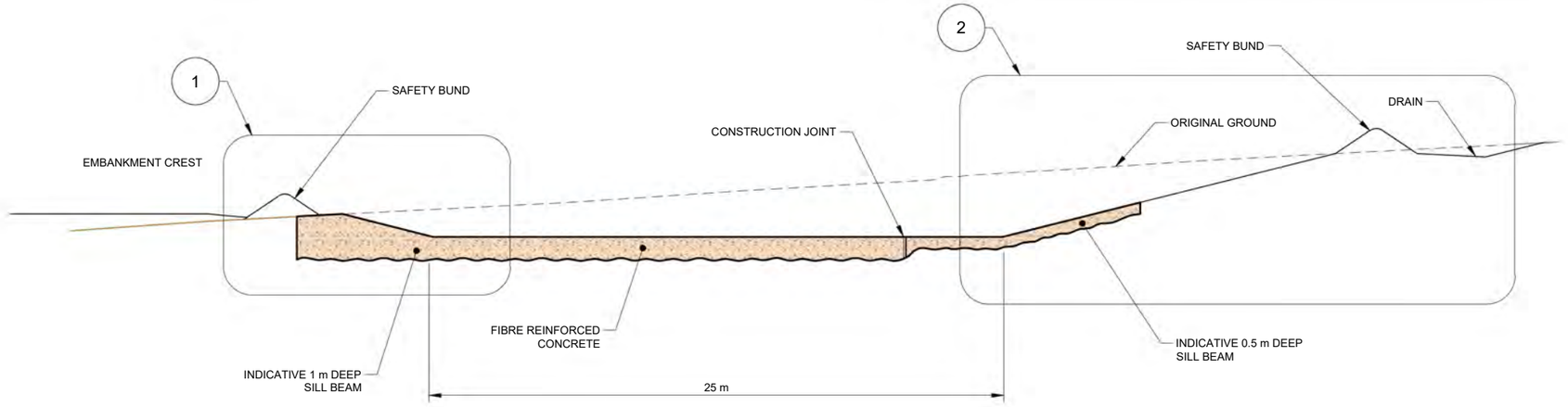
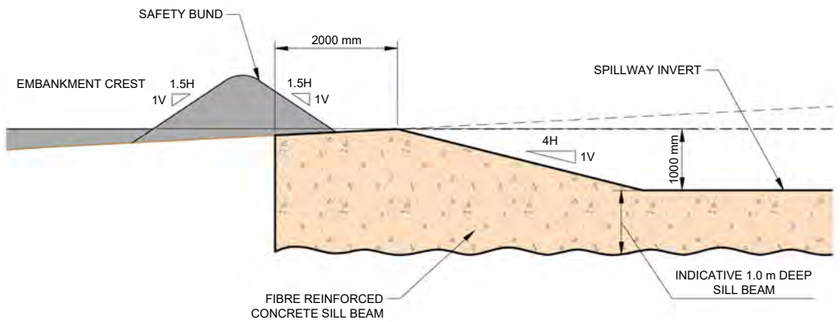
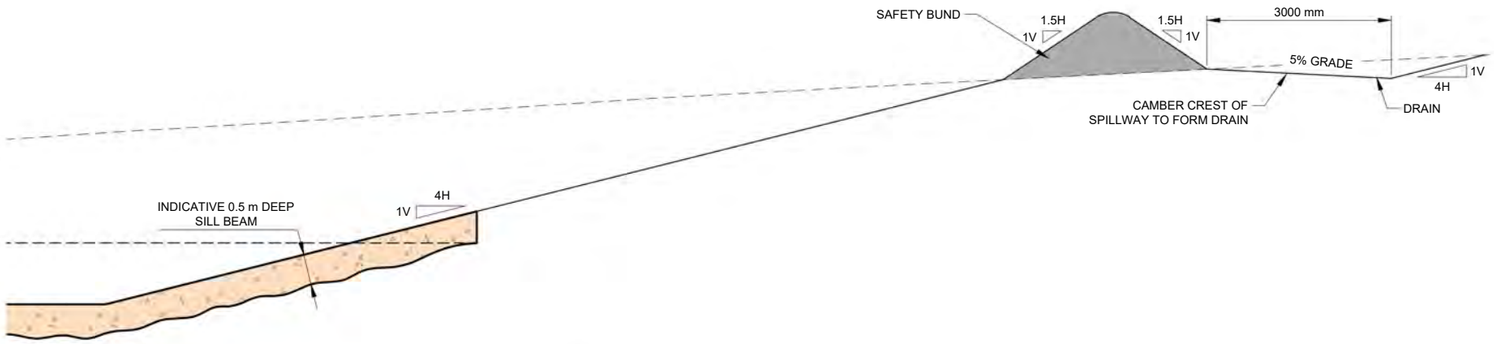


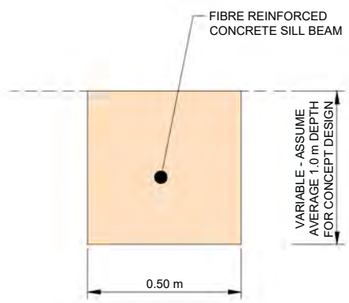
SCALE 1:250 S1 020 TSF EMERGENCY SPILLWAY SECTION THROUGH SILL BEAM



SCALE 1:100 1 EMERGENCY SPILLWAY DETAIL



SCALE 1:100 2 EASTERN SPILLWAY DETAIL



SCALE 1:20 3 020 CONCRETE SILL BEAM CROSS SECTION

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 2.5 5
1:100 METRES

0 5 10
1:250 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
EMERGENCY SPILLWAY TYPICAL SECTION AND DETAILS FOR EACH STAGE

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	021

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
0 25 mm

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MGA 94, ZONE 53

E 736 000 m
E 738 000 m
E 740 000 m
E 742 000 m

N 6 536 000 m
N 6 534 000 m
N 6 532 000 m

RETENTION OF DECANT DAM TO BE CONFIRMED BY CLOSURE STUDIES

INDICATIVE CLOSURE SPILLWAY

STAGE 6 EMBANKMENT

TSF CLOSURE LANDFORM

STEEP TAILINGS BEACH SLOPE SCENARIO

INDICATIVE POND LOCATION FOR RAINFALL RUNOFF AT CLOSURE

D
024

DECANT CAUSEWAY

SADDLE DAM

LEGEND

- EXISTING SURFACE CONTOURS AT 1.0 m INTERVALS
- CLOSURE SURFACE CONTOURS AT 1.0 m INTERVALS
- WATERCOURSE
- TSF DRAINAGE CATCHMENT
- FENCE LINE

NOT FOR CONSTRUCTION

ISSUED FOR INFORMATION

0 500 1,000
1:25,000 METRES

CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
CONCEPT CLOSURE PLAN GENERAL LAYOUT
STEEP TAILINGS BEACH SCENARIO

PROJECT NO.	REV.	FIGURE
PS138057-WSP-MEL-MNG-PLN-00014	0	022

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

0 25 mm

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MGA 94, ZONE 53

E 736 000 m

E 738 000 m

E 740 000 m

E 742 000 m

N 6 536 000 m

N 6 534 000 m

N 6 532 000 m

FLAT TAILINGS BEACH
SLOPE SCENARIO

RETENTION OF DECANT DAM TO BE
CONFIRMED BY CLOSURE STUDIES

INDICATIVE CLOSURE
SPILLWAY

STAGE 6 EMBANKMENT

TSF CLOSURE
LANDFORM

INDICATIVE POND
LOCATION FOR RAINFALL
RUNOFF AT CLOSURE

D
024

DECANT CAUSEWAY

LEGEND

- EXISTING SURFACE CONTOURS AT 1.0 m INTERVALS
- CLOSURE SURFACE CONTOURS AT 1.0 m INTERVALS
- WATERCOURSE
- TSF DRAINAGE CATCHMENT
- FENCE LINE

NOT FOR CONSTRUCTION

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0 500 1,000

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BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
CONCEPT CLOSURE PLAN GENERAL LAYOUT
FLAT TAILINGS BEACH SCENARIO

PROJECT NO.	REV.	FIGURE
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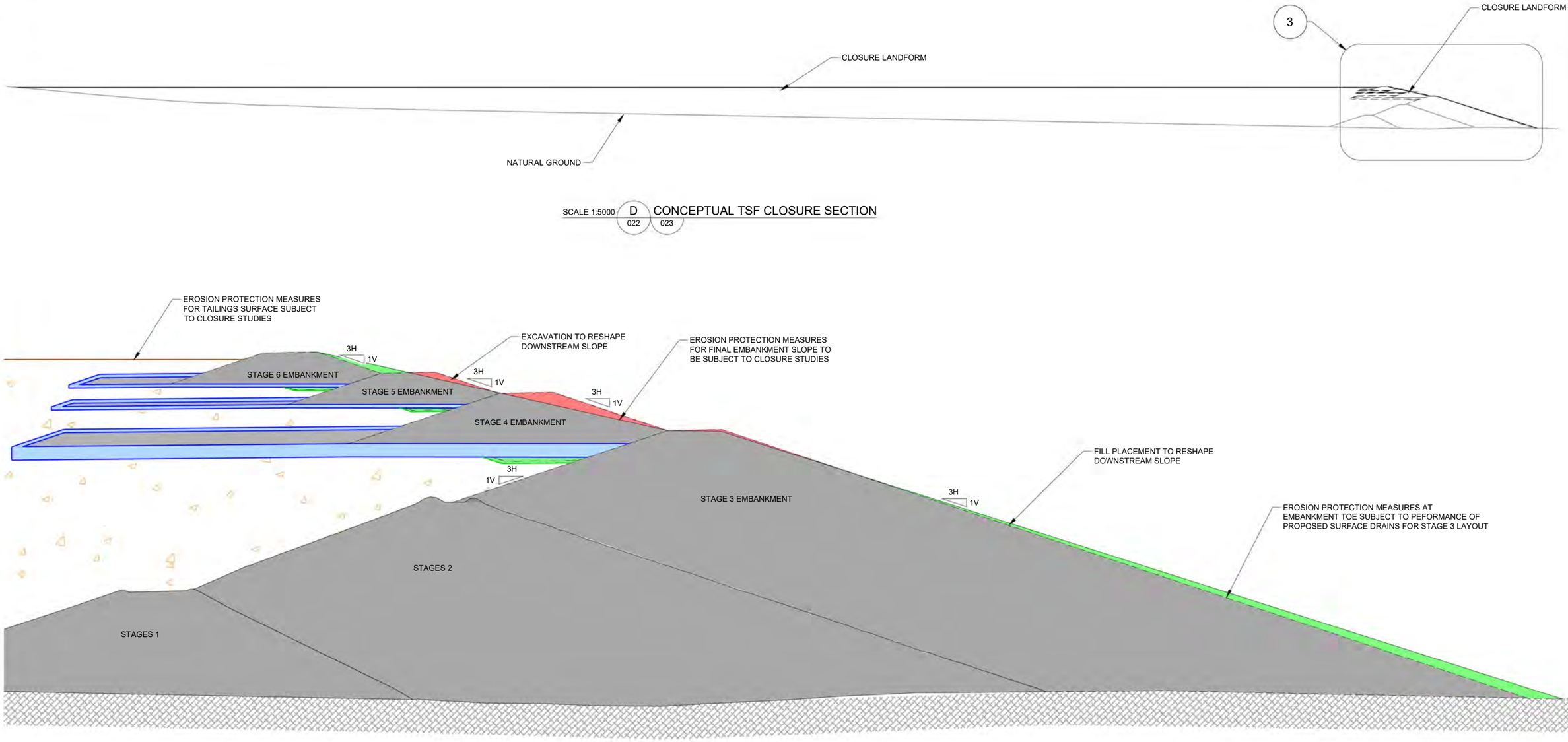

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CLIENT
BHP, OWNER OF OZ MINERALS CARRAPATEENA PTY LTD

CONSULTANT
wsp

YYYY-MM-DD	2024-11-28
DESIGNED	HQ
PREPARED	LW/EG
REVIEWED	DAA
APPROVED	FWG

PROJECT
CARRAPATEENA
TAILINGS STORAGE FACILITY
CONCEPT DESIGN UPDATE FOR 224 Mdt LIFE OF MINE

TITLE
CONCEPT CLOSURE PLAN CROSS SECTION

PROJECT NO.	REV.	FIGURE
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Appendix D

Climate Assessment

OZ Minerals Carrapateena

July 2023

Life of Mine Study - Climate Assessment

Carrapateena Tailings Storage Facility CA-3630-CIV-REP-1071 RevA

Question today
Imagine tomorrow
Create for the future

Life of Mine Study - Climate Assessment
Carrapateena Tailings Storage Facility
CA-3630-CIV-REP-1071 RevA

OZ Minerals Carrapateena

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Rev	Date	Details
0	08 August 2023	Issue for information

	Name	Date	Signature
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Reviewed by:	Nigel Moon	08 August 2023	
Approved by:	David Accadia	08 August 2023	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Appendix A Limitations statement

1 Introduction

This report presents OZ Minerals Carrapateena Pty Ltd (OZ Minerals) with a design climate data assessment for the Carrapateena Tailings Storage Facility (TSF), in South Australia.

The assessment includes the following items:

- A summary of site collected climate data (collected onsite: rainfall and evaporation rates).
- A summary of climate statistics sourced from the Bureau of Meteorology (BoM) (Wind, rainfall, temperature, evaporation).
- Description of design wind gust speeds.
- Estimation of design rainfall for short durations (up to 72 hours), and long-term durations (30 days to annual) and,
- The potential effects of climate change on design events.

The presented climate statistics include assessments of monthly, 90-day, and annual rainfall, pan evaporation rates, temperature, and wind speeds. A comparison is also drawn between collected data on-site and the data presented in the BoMs weather station records.

2 Summary of Site Climate Data

2.1 Climate data sources

This assessment was completed utilising publicly available climate data from the BoM[1] and Queensland Government's SILO database[2], as well as climate data provided by OZ Minerals via email (05 and 06 July 2023) from on-site monitoring.

Table 2.1 Summary of climate data sources

Station name	Station ID/Location	Parameters	Data period	No. years of data	Data source
Carrapateena on-site monitoring	N/A	Rainfall, Evaporation	18 May 2020 to 03 July 2023	~3	OZ Minerals Carrapateena
Grid point	31.29 S 137.51 E **(Note 1)**	Rainfall, Evaporation	1 January 1889 to 1 July 2023	~134	Scientific Information for Land Owners (SILO) Data Drill
Woomera Aerodrome	16001 (31.16 S 136.81 E) **(Note 2)**	Mean wind speed	1949 to 2010	61	Bureau of Meteorology (BoM)
		Wind roses	1954 to 2019	65	
		Temperature, Monthly Rainfall	1949 to 2023	74	
		Evaporation	1967 to 2017	47	

Notes:

(1) TSF Location.

(2) Closest active BoM weather station. Distance from TSF about 86.5 km.

2.2 Climate Summary Statistics

Historical climate data including rainfall, pan evaporation rate, temperature, and wind speeds, have been evaluated from the nearest active BoM weather station: Woomera Aerodrome.

2.2.1 Monthly Rainfall

Monthly and hydrological year annual (October to September) rainfall statistics for the period 1949 to 2023 (73 complete hydrological years) are presented in Table 2.2 and Figure 2.1 below. Also plotted in Figure 2.1 is mean monthly evaporation for comparison, as described in Section 2.2.2.

[1] Bureau of Meteorology. (2023). *Climate Data Online*. Retrieved from http://www.bom.gov.au/climate/data/

[2] Queensland Government. (2023). *SILO: Australian climate data from 1889 to yesterday*. Retrieved from https://www.longpaddock.qld.gov.au/silo/

Table 2.2 Long-term rainfall statistics (mm) from BoM Woomera Aerodrome historical data.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Minimum (mm)	0	0	0	0	0	0	0	0	0	0	0	0	53.6
10th Percentile (mm)	0.4	0	0	0	0.4	1.7	0.9	0.9	0.5	0.7	0.6	0.8	96.1
Mean (mm)	**18.1**	**18.9**	**12.7**	**12.8**	**17.5**	**15.6**	**13.8**	**12.9**	**14.3**	**16.9**	**16.9**	**14.2**	**183.9**
Median (mm)	10.4	9.2	3.9	6.6	10.9	9.2	9.4	7.9	8.5	10.3	11.6	8.3	162.8
90th Percentile (mm)	46.8	53.1	33.7	40.7	38	38	31.1	28.5	40.5	49.9	40.1	31.6	280.1
Maximum (mm)	105.8	121.2	191.2	72.6	119.4	70.2	64.7	72.6	85.9	137.2	130.6	85.6	493
Highest daily rainfall (mm)	66.4	85.4	138.4	68.6	53.4	47.2	24.1	31.2	41	74.4	90	58.2	138.4

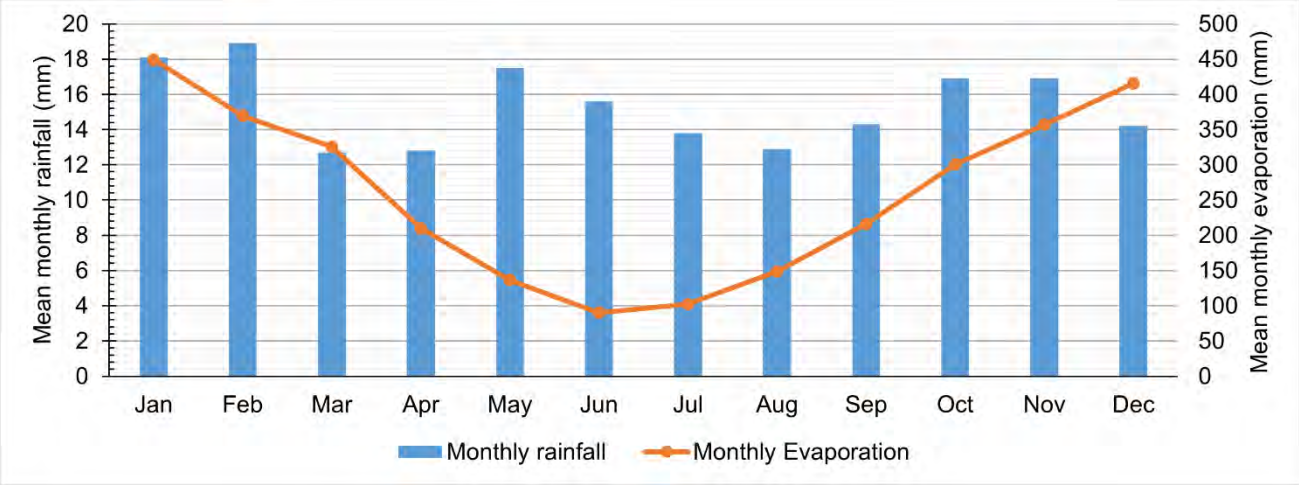

Figure 2.1 Mean monthly rainfall and evaporation based on BoM Woomera historical data.

This data indicates that larger rain events are more likely to occur between January and July but there is a relatively even distribution of rainfall throughout the year.

2.2.2 Evaporation

Monthly and annual pan evaporation statistics for the period of 1967 to 2017 (47 years) is presented in Table 2.3 and Figure 2.2 below based on data from the BoM Woomera Aerodrome station.

Table 2.3 Long-term pan evaporation statistics (mm) from BoM Woomera aerodrome historical data

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily evaporation (mm)	14.5	13.2	10.5	7.0	4.4	3.0	3.3	4.8	7.2	9.7	11.9	13.4	8.6
Mean monthly evaporation (mm)	450	370	326	210	136	90	102	149	216	301	357	415	260

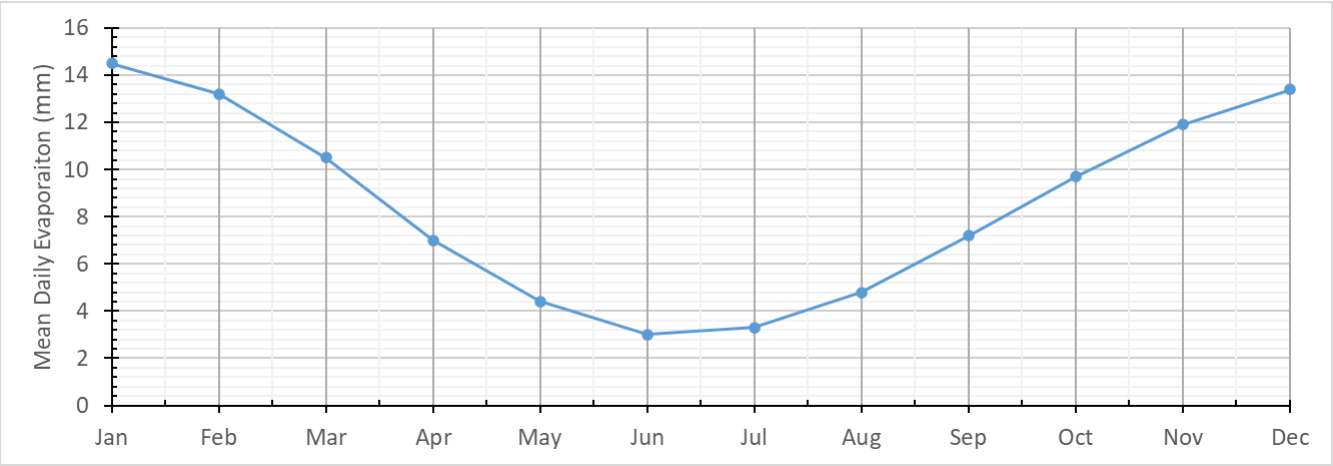

Figure 2.2 Mean daily evaporation rates based on BoM Woomera Aerodrome historical data.

2.2.3 *Temperature*

Monthly and annual temperature statistics for the period of 1949 to 2023 (74 years), based on Woomera Aerodrome BoM station are presented in Table 2.4 and Table 2.5 and are presented graphically in Figure 2.3. Provided are both minimum and maximum daily temperature statistics.

Table 2.4 Long-term daily minimum temperature statistics (ºC) from BoM weather station Woomera Aerodrome.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Minimum	8.3	10.3	8.4	4.8	-0.3	0	-0.9	-1.4	1.8	4.4	5.5	8.8	-1.4
10th Percentile	14.7	14.5	12.6	9.2	5.9	3.3	2.9	3.6	5.7	8.3	10.7	12.7	-
Mean	19.6	19.4	16.9	13.2	9.4	6.7	5.8	6.8	9.5	12.5	15.4	17.8	12.8
90th Percentile	25.5	24.7	21.7	17.7	13.4	10.3	9.0	10.4	13.8	17.3	21.4	23.5	-
Maximum	34.7	32.2	27.8	24	18.9	16.1	15.4	17.5	23.2	29.5	30.2	32.3	34.7

Table 2.5 Long-term daily maximum temperature statistics (ºC) from BoM weather station Woomera Aerodrome.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	15.9	16.3	15.4	13.8	10.3	9.4	8.3	8.5	12.3	11.6	13.1	18.4
10th Percentile	27.8	27.0	24.2	20.3	16.5	14.1	13.9	15.0	17.2	20.0	23.0	25.6
Mean	34.6	33.7	30.5	25.7	20.6	17.4	17.1	19.0	22.8	26.5	29.9	32.5
90th Percentile	41.4	40.1	36.8	31.6	25.5	21.0	20.8	24.0	29.5	33.7	37.6	39.5
Maximum	48.1	46.8	43.0	39.9	31.4	28.9	28.6	32.6	38.6	41.9	46.9	48.2

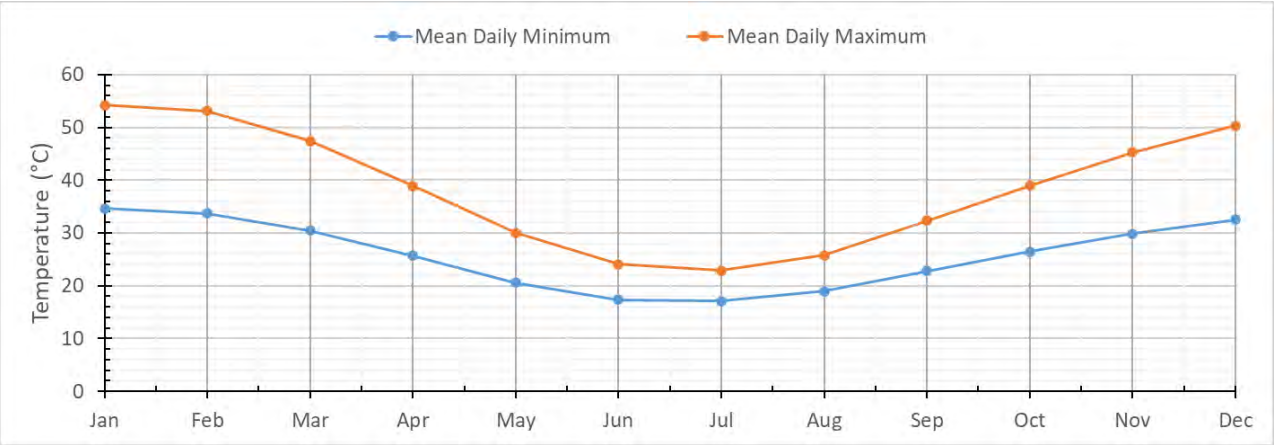

Figure 2.3 Mean daily minimum and maximum temperature based on BoM weather station Woomera Aerodrome

2.2.4 *Wind Statistics*

Mean wind speed statistics were obtained from the Woomera Aerodrome BoM station for the operational period of 1949 to 2010, with maximum gust speed provided between 1949 and 2023. Long term mean wind speed trends are presented in Table 2.6 and graphically in Figure 2.4.

Table 2.6 Long-term mean and max wind speeds (km/hr) from BoM weather station Woomera Aerodrome

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean 9am wind speed (km/h)	20.8	19.6	18.2	15.4	12.1	10.7	11.5	14.6	19.8	21.8	21.6	20.8	17.2
Mean 3pm wind speed (km/h)	17.8	16.7	16.1	15.4	16	17.1	18.5	20.2	20.8	20.7	19.2	18.9	18.1
Maximum wind gust speed (km/h)	118	115	91	91	111	126	93	106	115	124	167	141	167

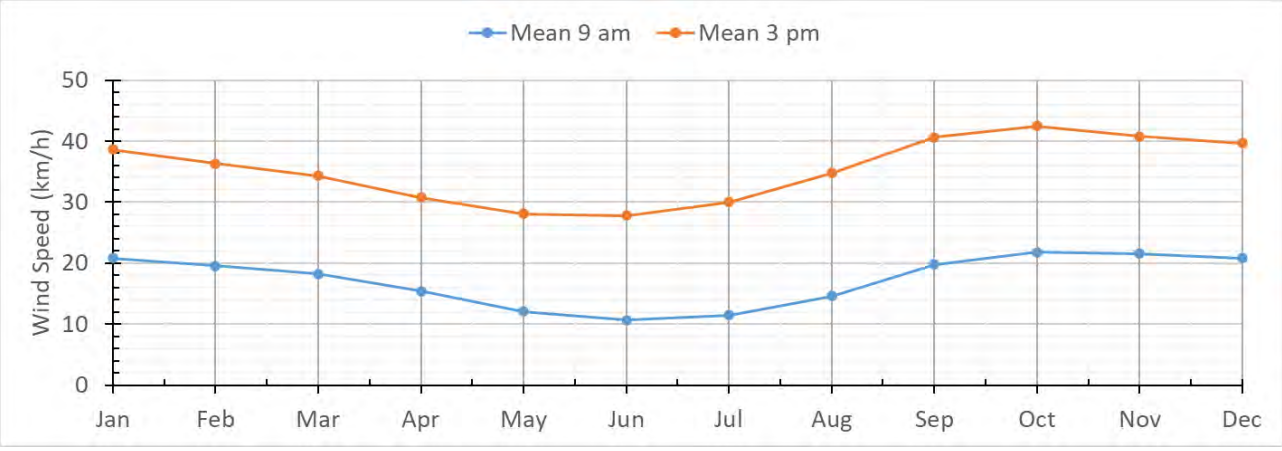

Figure 2.4 Mean daily 9am and 3pm wind speeds based on BoM weather station Woomera Aerodrome

In addition to mean and maximum wind speeds per month, wind-rose diagrams for the Woomera Aerodrome station were obtained from the BoM[3] and are presented in Figure 2.5. Wind-rose diagrams provide indications of wind strength, direction, and frequency, and are based on observations made during the period of operation.

The wind-rose diagram may be interpreted via the following:

- The direction of the branch represents a dominant wind from that compass direction (e.g., North, South-east, etc.)
- The centre circle indicates 'calm' conditions.
- Each coloured segment of a branch represents a band of wind speeds, and the length of that branch indicates the frequency of winds at that speed in that direction.

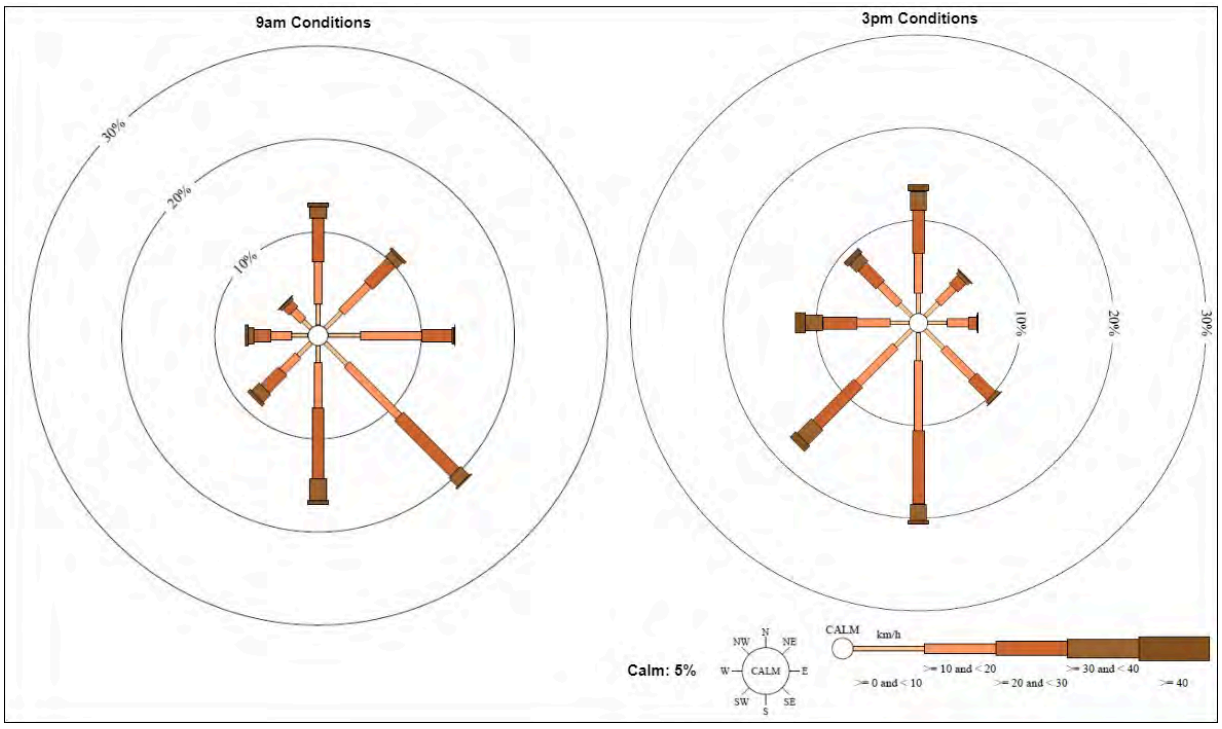

Figure 2.5 Wind roses for observations at Woomera Aerodrome BoM weather station (01 July 1954 to 31 July 2019)

2.2.5 Design wind speeds

Design wind speeds have been estimated based on the Australian Standards for determining wind actions for use in structural design[4]. Carrapateena falls into Region A0 for the purposes of the standard. Maximum design wind gust speeds for Region A0 are presented in Table 2.7 for varying Annual Exceedance Probabilities (AEP 1 in 1, to AEP 1 in 5,000 events).

[3] Bureau of Meteorology. (2023). *Climate Data Online*. Retrieved from http://www.bom.gov.au/climate/data/

[4] Standards Australia. (2021). *Australian/New Zealand Standard, Structural design actions, Part 2: Wind actions*, Ref: AS/NZS 1170.2:2021. In Structural design actions, Part 2: Wind Actions.

Table 2.7 Design 0.2 second wind gust for Regions A0 to A5 (Table 3.1(A) in Australian Standard 1170.2:2021).

AEP (1 in x)	0.2 second wind gust	
	(m/s)	(km/hr)
1	30	108
5	32	115
10	34	122
20	37	133
50	39	140
100	41	148
200	43	155
500	45	162
1,000	46	166
2,000	48	173
5,000	50	180

2.3 Site Climate Data

2.3.1 Rainfall

Rainfall data collected on-site was provided for the period between 18 May 2020, and 03 July 2023, for the Automatic Weather Stations (AWS) at the Carrapateena TSF, the western access road, and South Gap station. The timeseries from the TSF AWS has been compared to data from the same period from the BoM Woomera Aerodrome station, and the long-term SILO dataset, to ascertain appropriateness of the BoM and SILO series for analysis of long-term trends.

The cumulative daily rainfall timeseries from three data sources (site data, BoM, and SILO) are plotted Figure 2.6, and the monthly timeseries is plotted in Figure 2.7. Correlation plots are shown between these data sources in Figure 2.8 and Figure 2.9, where the red line indicates a 1:1 match to site data.

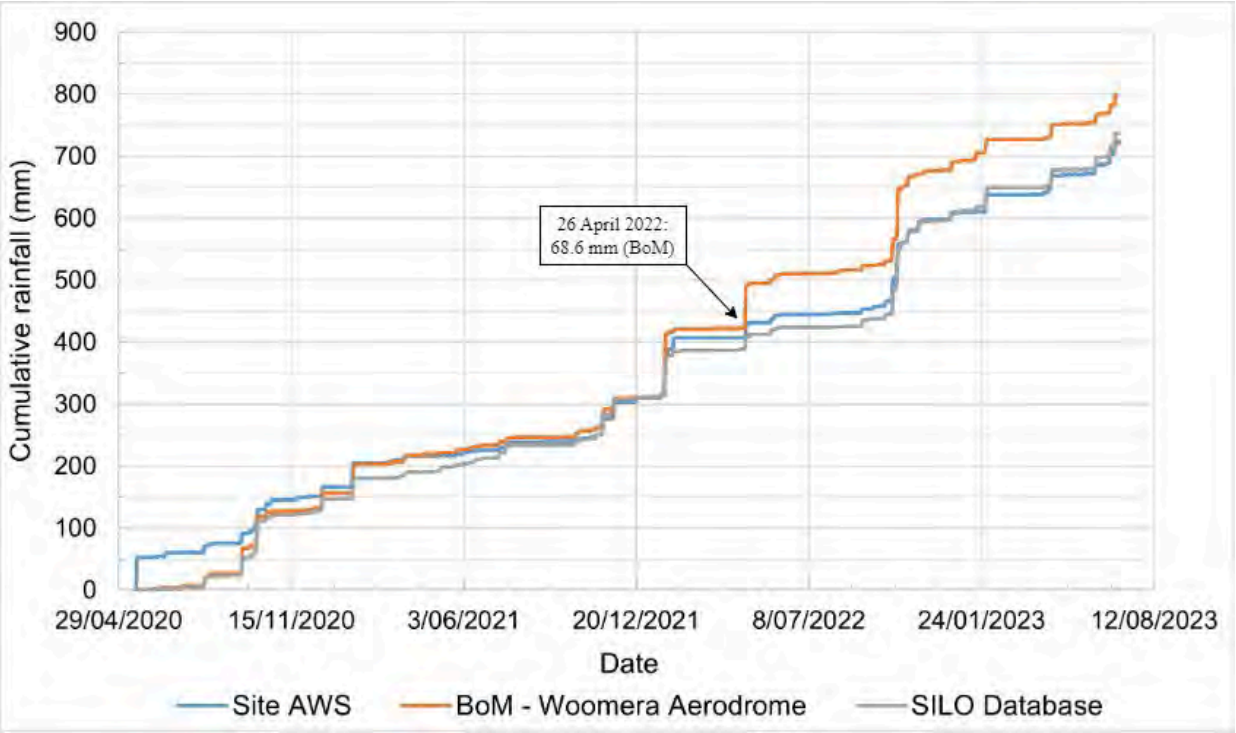

Figure 2.6 Cumulative daily rainfall comparison between site data, BoM Woomera Aerodrome, and SILO (18 May 2020 to 30 June 2023)

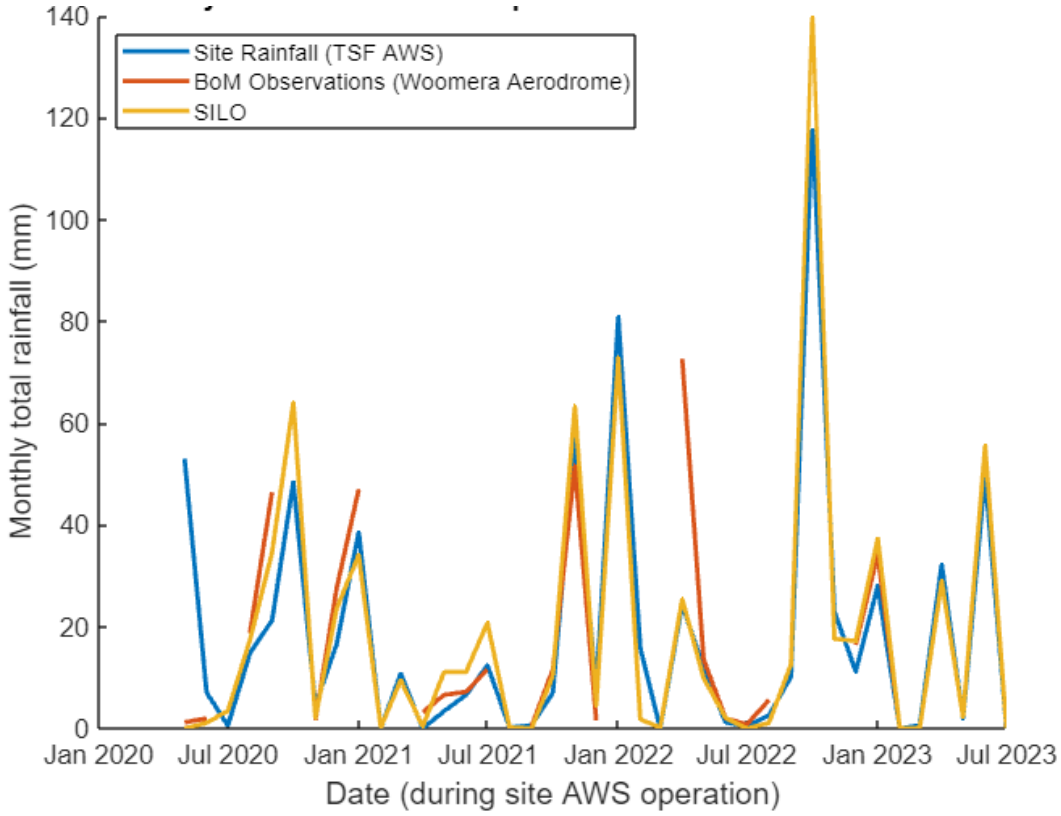

Figure 2.7 Monthly total rainfall comparison between site data, BoM Woomera Aerodrome, and SILO

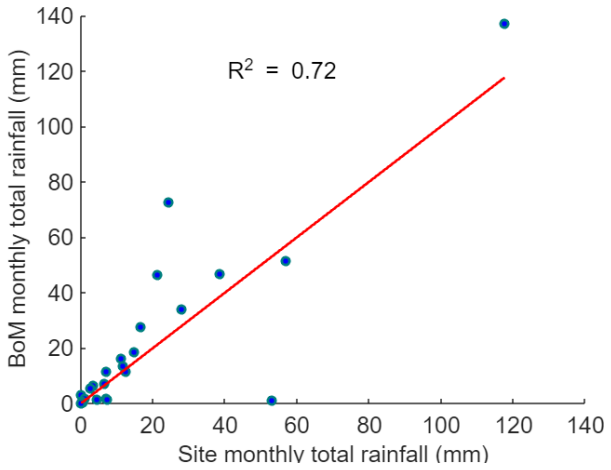

Figure 2.8 Monthly rainfall correlation plot: site and BoM

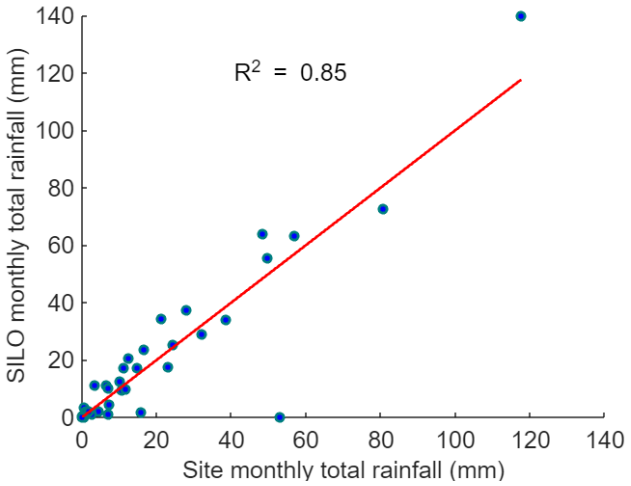

Figure 2.9 Monthly rainfall correlation plot: site and SILO

The data sets from the BoM and from SILO show acceptable agreement for monthly rainfall totals, particularly the SILO data. While caution should be taken in applying these for rainfall on individual specific days, the datasets are appropriate for use in monthly scale analyses, such as those in Section 3. The cumulative plots shown in Figure 2.6 also indicate good agreement particularly between the SILO and site datasets. Additionally, although the BoM cumulative timeseries appears relatively higher than the site data, this is largely attributed to a rainfall event on 26 April 2022 of a measured 68.6 mm. When this event is omitted the three datasets show good agreement for this analysis.

The SILO data used in the design rainfall in Section 3 shows good agreement to the site data, with a tendency to slightly overestimate monthly total rainfall depths, indicating that the design rainfalls in Section 3 are likely conservative.

2.3.2 *Evaporation rate*

Evaporation data was collected from the on-site AWS at the Carrapateena TSF, for the period between 18 May 2020, and 03 July 2023. The timeseries from the site weather station has been compared to the data from the same period sourced from the SILO project. A comparison of these two is shown in Figure 2.10, and the correlation between the two in

Figure 2.11 indicating the closeness of the SILO dataset, to the site AWS dataset (red line represents a perfect fit between the two data sets, the R^2 value compares the SILO data to that 'perfect fit' line).

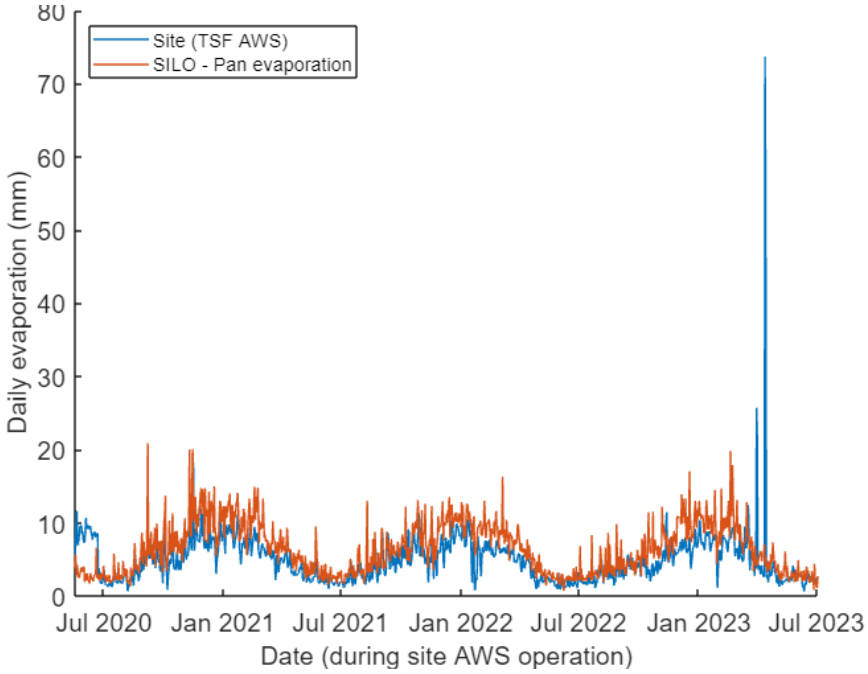

Figure 2.10 Daily evaporation comparison between site AWS data and SILO

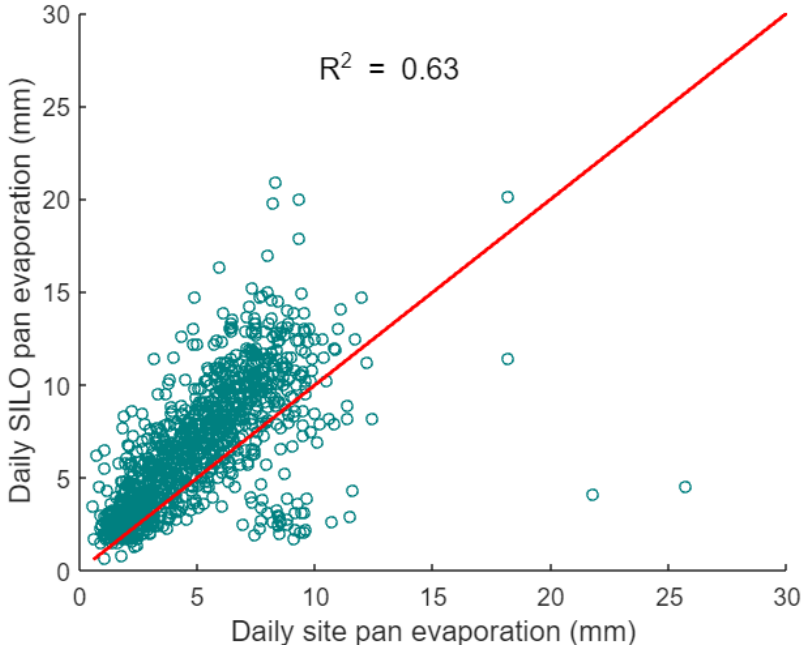

Figure 2.11 Correlation plot between daily site pan evaporation data and SILO pan evaporation data

The above analysis indicates that the SILO dataset is appropriately close to the data gathered by the on-site AWS. Both seasonality and magnitude are well captured as seen in Figure 2.10, however the SILO dataset tends to slightly overestimate evaporation rates as compared to the site data.

Note, some outliers exist, notably a daily evaporation rate of 54.3 mm, and 73.7 mm recorded by the AWS on 13 and 14 April 2023 respectively, these can be seen in Figure 2.10, and have been omitted from the analysis as they are likely measurement errors.

3 Design Rainfalls

3.1 Individual Design Events (up to 72 hours)

Intensity-frequency-duration (IFD) curves data up to the 1 in 2,000 AEP were sourced from the BoM's online IFDs[5] for the TSF location.

The Probable Maximum Precipitation (PMP) is assigned an AEP of 1:1,000,000 as per the Australian Rainfall Runoff (ARR) guidelines[6], and is estimated using the following methods for the Carrapateena TSF contributing catchment:

- The Generalised Short-Duration Method[7] (GSDM, durations up to 3-hours),
- The Generalised Southeast Australia Method[8] (GSAM, durations up to 96 hours).

Extreme rainfall events between the 1 in 2000 AEP event and the PMP were interpolated as per the ARR guidelines. The resulting rainfall depth-duration-frequency relationships are presented in Table 3.1 for events up to the 72-hour PMP.

5 Bureau of Meteorology. (2023). *Design Rainfall Data System (2016).* Retrieved from http://www.bom.gov.au/water/designRainfalls/revised-ifd/

6 Ball, J., Babister, M., Nathan, R., Weeks, B., Weinmann, E., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff - A Guide to Flood Estimation.*

7 Bureau of Meteorology. (2003). *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method.* Melbourne.

8 Bureau of Meteorology. (2006). *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Southeast Australia Method, October 2006*. Melbourne.

Table 3.1 Rainfall depth-duration-frequency relationship for various annual exceedance probabilities

Event Duration	Rainfall depth (mm) for AEP (1 in x) events														
	1	2	5	10	20	50	100	200	500	1,000	2,000	50,000	10k	100k	1 Mil (PMP)
15 min	1.7	7.88	12.4	15.9	19.7	25.4	30.2	35.8	44.7	52.4	61.3	74.5	85.0	119.5	150
30 min	2.4	10.5	16.5	21.1	26.1	33.5	39.7	47.2	58.8	69.1	80.8	98.3	112.4	160.9	220
45 min	2.87	12.1	18.9	24.2	29.8	38.2	45.3	53.7	67	78.6	92	112.2	128.8	188.1	280
1 hour	3.23	13.3	20.7	26.4	32.5	41.5	49.2	58.5	72.9	85.6	100	121.8	139.7	205.4	320
1.5 hour	3.76	15.2	23.4	29.7	36.6	46.6	55.2	65.6	81.7	96	112	136.2	156.3	230.7	370
2 hour	4.15	16.6	25.5	32.3	39.7	50.6	59.9	71.1	88.7	104	122	149.4	172.1	256.4	410
3 hour	4.69	18.8	28.7	36.4	44.6	56.9	67.5	80.1	99.8	117	137	167.4	192.6	286.3	460
6 hour	5.59	23.2	35.4	44.8	55.2	70.7	84	99.8	124	146	171	208.5	238.9	344.4	480
12 hour	6.37	28.3	43.5	55.5	68.8	88.6	106	126	157	184	215	261.0	297.5	416.6	520
18 hour	6.76	31.4	48.7	62.5	77.8	101	121	143	178	210	245	296.7	337.3	466.9	560
24 hour	6.99	33.5	52.4	67.5	84.4	109	131	156	194	228	267	324.7	370.0	512.8	600
36 hour	7.26	36.2	57.2	74.2	93.4	121	146	175	218	257	301	366.1	417.3	579	680
48 hour	7.4	37.8	60.1	78.4	99	129	155	185	232	273	320	389.7	444.5	618.3	730
72 hour	7.55	39.5	63.3	83	105	137	165	197	246	290	341	416.7	476.3	663.9	770

3.2 Long term design rainfalls

Historical daily rainfall data has been sourced from the SILO project (national data) presented by the Queensland Government, for the estimation of long-duration design rainfalls. The RMC Bestfit statistical software package[9] (Version 1.0) from the United States Army Corps. of Engineers (USACE) was used to estimate up to the 1 in 1,000 AEP events, by fitting statistical distributions to the annual data presented in SILO.

For the 30-day, 90 day, and annual design rainfalls, the 95% and 5% confidence limits as well as expected means of AEP events are provided. In the case of the 90-day and annual timeseries, it was determined that the Gumbel (EVI) parameter relationship was the most appropriate with the lowest overall error. In the case of the 30-day timeseries, the Gumbel (EVI) and Generalised Extreme Value (GEV) distributions gave the lowest overall error, however the GEV better captured the more extreme values within the 90% credible confidence interval.

3.2.1 30-day design event

A frequency analysis was carried out on the maximum cumulative 30-day rainfall for each hydrological year between 1889 to 2023, using SILO rainfall data. This analysis used the GEV distribution to fit the 30-day maxima timeseries from SILO. The results of this analysis are presented graphically in Figure 3.1, and in Table 3.2.

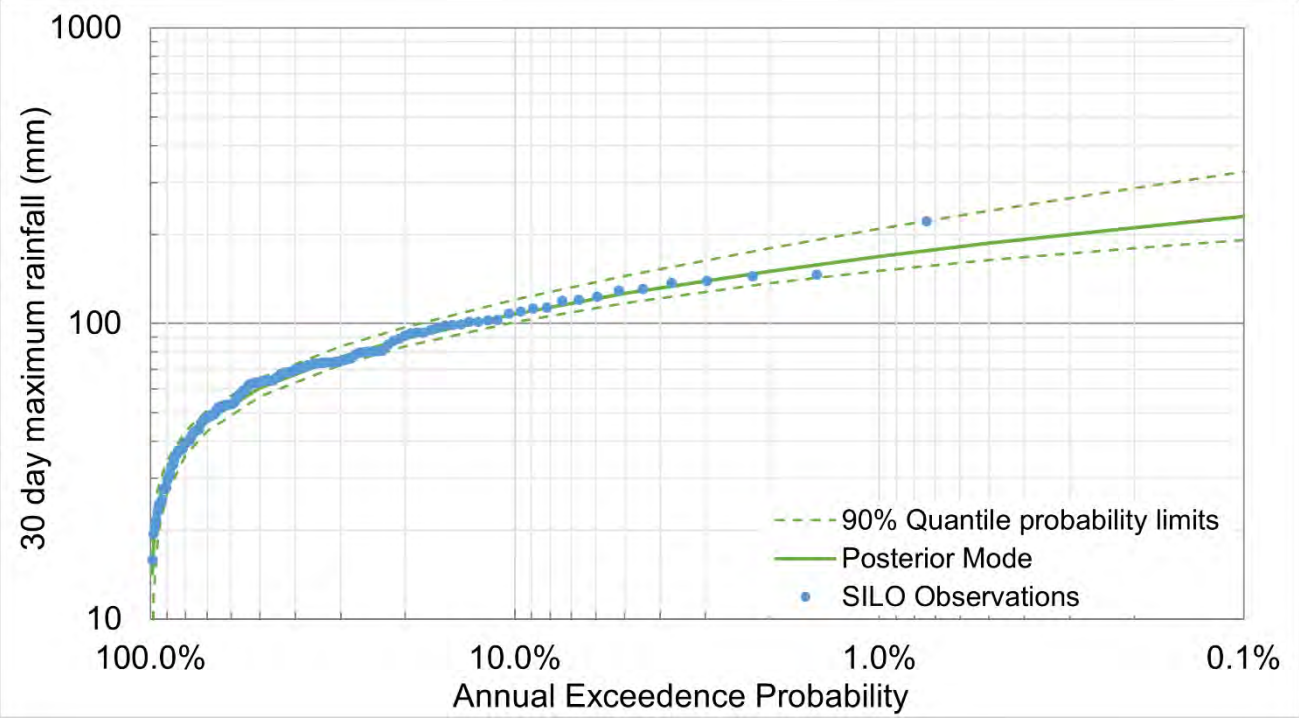

Figure 3.1 30-day cumulative maximum rainfall frequency analysis plot (Based on SILO data)

[9] United States Army Corps. of Engineers (USACE). (2023). *RMC-Bestfit, Version 1.0 [software]*. Retrieved from https://www.rmc.usace.army.mil/Software/RMC-BestFit/

Table 3.2 Estimated 30-day design rainfall (mm)

AEP (%)	AEP (1 in X)	30 day design rainfall depths (mm)		
		Upper confidence limit	Lower confidence limit	Expected value
99%	1	18	7	14
50%	2	65	56	61
20%	5	97	84	89
10%	10	120	101	108
5%	20	145	117	126
2%	50	180	137	150
1%	100	209	151	168
0.1%	1000	326	192	230

3.2.2 90-day design event

A frequency analysis was carried out on the maximum cumulative 90-day rainfall for each hydrological year between 1889 to 2023, using SILO rainfall data. This analysis used the Gumbel distribution to fit the 90-day maxima timeseries from SILO. The results from this analysis are presented graphically in Figure 3.2, and in Table 3.3.

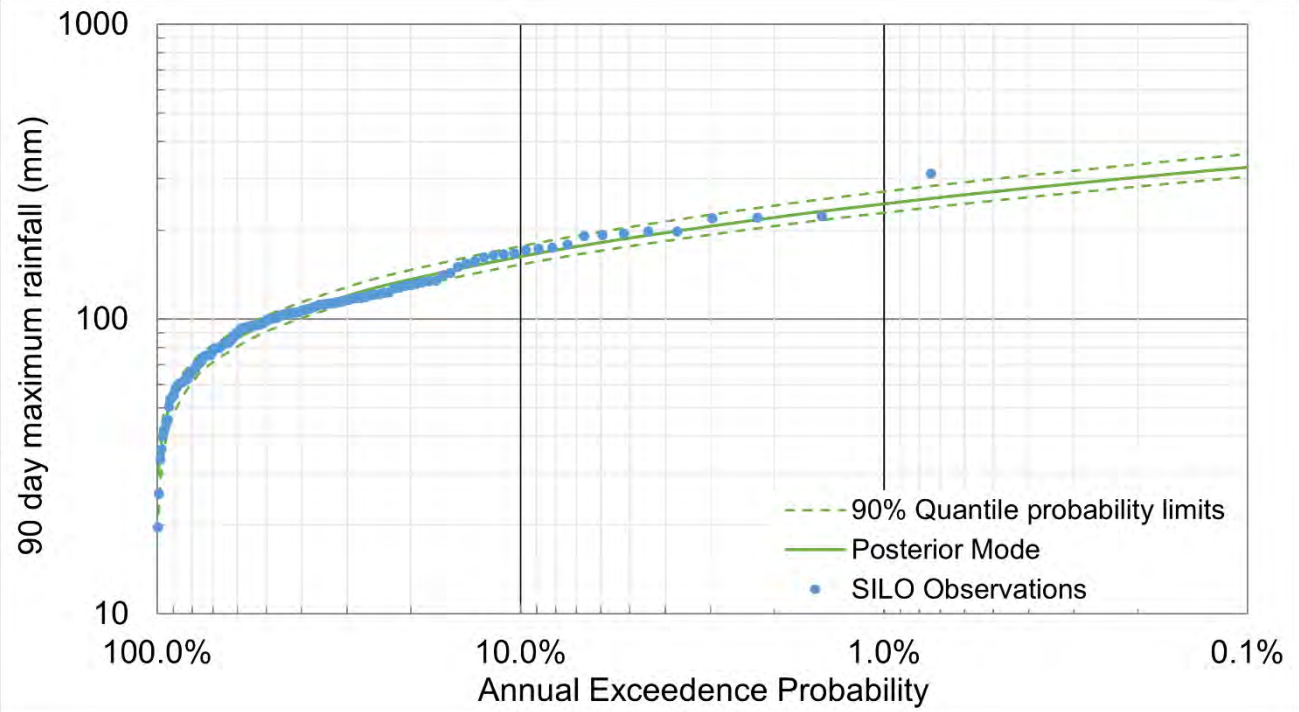

Figure 3.2 90-day rainfall frequency analysis plot

Table 3.3 Estimated 90-day design rainfall (mm)

AEP (%)	AEP (1 in X)	90 day design rainfall depths (mm)		
		Upper confidence limit	Lower confidence limit	Expected value
99%	1	35	22	29
50%	2	103	91	96
20%	5	147	128	136
10%	10	176	153	163
5%	20	205	177	188
2%	50	242	207	221
1%	100	270	229	246
0.1%	1,000	362.2	303.5	327.6

3.2.3 *Annual design rainfalls*

A frequency analysis was carried out on the cumulative annual rainfall for each hydrological year between 1889 to 2023, using SILO rainfall data. This analysis used the Gumbel distribution to fit the annual maxima timeseries from SILO. The results from this analysis are presented graphically in Figure 3.3, and in Table 3.4.

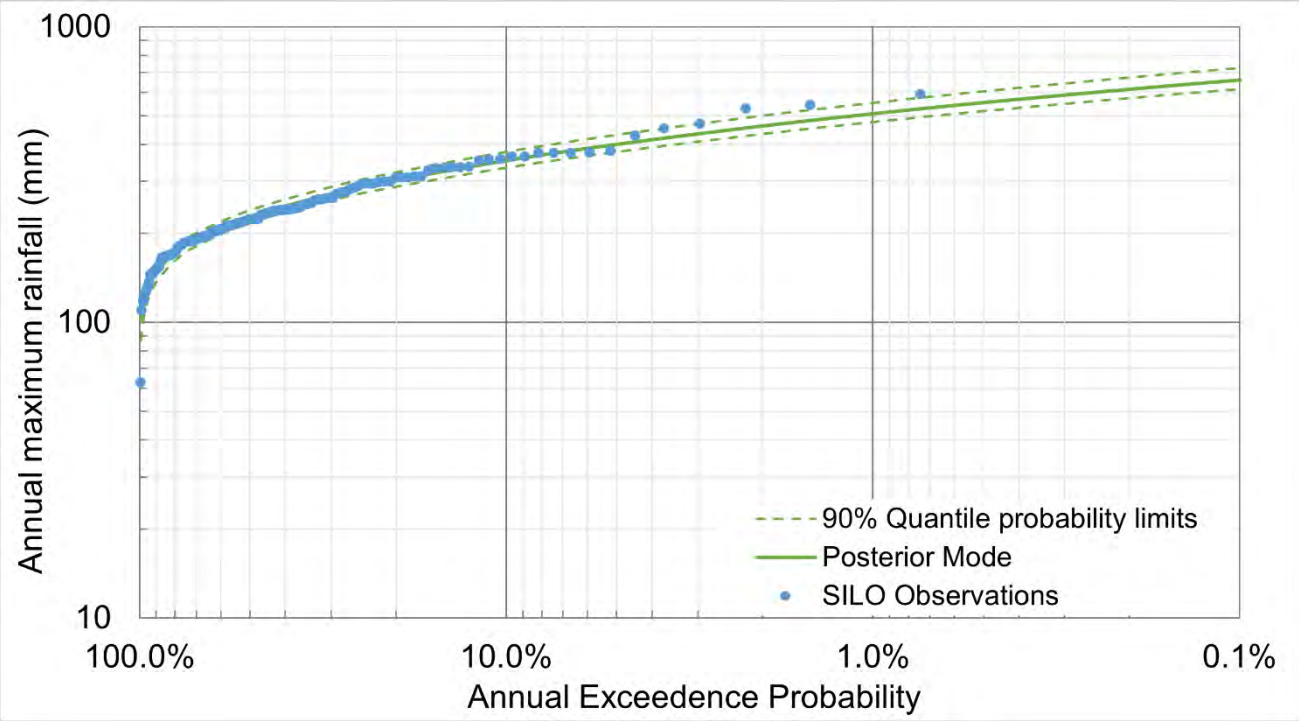

Figure 3.3 Annual cumulative rainfall frequency analysis

Table 3.4 Estimated annual design rainfalls (mm)

AEP (%)	AEP (1 in X)	Annual rainfall depths (mm)		
		Upper confidence limit	Lower confidence limit	Expected value
99%	1	113	87	102
50%	2	240	217	228
20%	5	322	288	303
10%	10	377	333	352
5%	20	431	377	400
2%	50	500	433	462
1%	100	553	476	508
0.1%	1000	725	615	661

4 Climate Change

4.1 Climate change projections for climate statistics

Climate change estimates were developed using current guidance for climate change projections in South Australia (SA) by the Government of South Australia (Department for Environment and Water)[10]. These guidelines provide summaries of State and regional climate projections for SA, specifically the NSW and ACT Regional Climate Modelling (NARCliM) 1.5 project, and Climate Change in Australia (CCIA) project which include temperature and rainfall changes for near and far future timelines.

The NARCliM project is a research partnership between the NSW and ACT governments and the University of NSW Climate Change Research Centre, and the CCIA provides results based on a joint project between the Bureau of Meteorology and the CSIRO, undertaken between 2012 and 2015.

Included in the above guidelines is a summary for Woomera, adopted for the Carrapateena assessment.

4.1.1 Projected daily temperature change for Woomera

Projected temperature changes for Woomera are summarised in Table 4.1 for near (2030) medium (2050), and long term (2090) projections.

Table 4.1 Predicted mean daily temperature changes (ºC) for Woomera based on NARCliM 1.5 (from SA Climate change guidance document, Table 4.17 and 4.18)

Temperature change parameter			**Predicted daily temperature change (º)**					
Season		**1986 to 2005 baseline**	**Near future (2030)**		**Medium (2050)**		**Far future (2090)**	
			RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Annual Mean	Max	26.1	+1.4	+1.3	+1.9	+2.2	+2.5	+4.7
	Min	12.8	+1	+1.1	+1.4	+1.6	+1.9	+3.6
Summer	Max	33.8	+1.5	+1.3	+1.8	+2.3	+2.4	+4.4
	Min	18.8	+1.3	+1.4	+1.8	+1.9	+2	+3.6
Autumn	Max	26	+1.1	+1.2	+1.5	+1.9	+2	+4.3
	Min	13.2	+0.9	+1	+1.2	+1.6	+1.7	+3.5
Winter	Max	18.1	+1.4	+1.2	+1.5	+2	+2.3	+4.3
	Min	6.6	+0.7	+0.9	+1	+1.5	+1.7	+3.3
Spring	Max	26.6	+1.5	+1.6	+2.5	+2.5	+3.1	+5.6
	Min	12.7	+1	+1.1	+1.8	+1.7	+2.3	+3.9

Note, compared to a 1986 to 2005 baseline from six Global Climate Models (GCMs).

[10] Department for Environment and Water. (2022). *Guide to climate projections for risk assessment and planning in South Australia | 2022*. Adelaide: Government of South Australia, through the Department for Environment and Water, Retrieved from https://www.environment.sa.gov.au/topics/climate-change/climate-science-knowledge-resources/latest-climate-projections-for-sa.

4.1.2 Projected rainfall change for Woomera

Projected rainfall changes for Woomera are summarised in Table 4.2, for near (2030) medium (2050), and long term (2090) projections, presented in the SA guidelines on climate change for risk assessment[11].

Table 4.2 Predicted changes in annual net rainfall for Woomera based on NARCliM 1.5 (from SA Climate change guidance document, Table 4.17 and 4.18)

Mean rainfall change (%)	Near future (2030)		Medium (2050)		Far future (2090)	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Annual	-9%	-7%	-13%	-21%	-19%	-35%
Summer	12%	13%	7%	-11%	-13%	-13%
Autumn	-10%	-10%	-18%	-26%	-28%	-38%
Winter	-18%	-13%	-16%	-18%	-16%	-37%
Spring	-4%	-10%	-16%	-24%	-17%	-44%

Note compared to a 1986 to 2005 baseline from six Global Climate Models (GCMs).

4.1.3 Projected evapotranspiration rate changes for Woomera

Projected evapotranspiration rate changes for Woomera are summarised in Table 4.3, for near (2030) medium (2050), and long term (2090) projections. These are provided via the SA guidelines on climate change for risk assessment in South Australia, adapted from a study by Charles and Fu[12]. Note evapotranspiration rate is a joint measure of evaporation (from water bodies), and transpiration (plant activity). Also note values are for the SA Arid Lands region, which Carrapateena falls into for the purposes of these projections.

Table 4.3 Predicted percent changes in annual evapotranspiration rates for the SA Arid lands (from SA Climate change guidance document, Table 8.1)

Projection period	Predicted percent change	
	RCP4.5	RCP8.5
Near future (2030)	2.7	3.2
Medium (2050)	3.8	5.2
Far future (2090)	5.2	10.2

Note compared to a 1986 to 2005 baseline from six Global Climate Models (GCMs).

[11] Department for Environment and Water. (2022). *Guide to climate projections for risk assessment and planning in South Australia | 2022.* Adelaide: Government of South Australia, through the Department for Environment and Water, Retrieved from https://www.environment.sa.gov.au/topics/climate-change/climate-science-knowledge-resources/latest-climate-projections-for-sa.

[12] Charles, S. P., & Fu, G. (2015). *Statistically Downscaled Projections for South Australia*, Goyder Institute for Water Research Technical Report Series No. 15/1. Retrieved from Adelaide, South Australia

4.2 Climate change projection estimation for design rainfall events

The ARR provide guidance for expected changes to individual rain events, as percentage changes to design IFDs, based on project global climate models, and for specific emissions scenarios[13]. The ARR guidelines, as well as the guidelines presented by the Department for Environment and Water in SA, recommend the use of Representative Concentration Pathways (RCP) 4.5 and 8.5 (low and high emissions scenarios respectively) for impact assessment. These adjustment factors for Woomera are based on the predicted annual max daily temperature changes in Table 4.1, and are summarised in Table 4.4 for three time periods and for RCP4.5 and 8.5, according to the method presented in the ARR guidelines[14] (see equation below).

$$I_P = I_{ARR} * 1.05^{T_m}$$

Where I_P is the adjusted rainfall depth, T_m is the temperature change, and I_{ARR} is a given design rainfall intensity (pre-climate change adjustment).

In order to use these values to estimate the potential of climate change on design rainfalls, the design IFD (See Table 3.1) can be increased by the percentages in Table 4.4, for a chosen year and emissions scenario.

Table 4.4 Climate change rainfall factors for individual rain events for Woomera using the ARR method

Projection period	**Predicted percent change**	
	RCP4.5	RCP8.8
Near future (2030)	7.1%	6.5%
Medium (2050)	9.7%	11.3%
Far future (2090)	13.0%	25.8%

[13] Ball, J., Babister, M., Nathan, R., Weeks, B., Weinmann, E., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff - A Guide to Flood Estimation*. Retrieved from

[14] Ball, J., Babister, M., Nathan, R., Weeks, B., Weinmann, E., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff - A Guide to Flood Estimation.*

5 Limitations

This climate assessment (this Report) is provided by WSP for OZ Minerals in response to our scope of work described in the Statement of Work 3 (CAR-CON-2871), executed in June 2023 and in reference to the Master Services Agreement CAR-CON-936, 6 Jul2 2022.

This Report should be read in conjunction with the limitations described in Appendix A.

Appendix A

Limitations statement

Limitation Statement

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Appendix E

Water Balance

1 Water balance

1.1 Overview

A water balance assessment was undertaken for three selected TSF stages (Stages 3, 5 and 6), and for two beach slope scenarios (flat and steep), considering inflows to and outflows from the TSF and Decant Dam. Inflows are limited to tailings slurry water and rainfall, i.e., discharge of water from other sources were not considered. Outflows were limited to evaporation, seepage losses, and water retained in the pores of the tailings (i.e., interstitial water), which is also considered an outflow in the water balance. The water balance assumes that net/remaining water at the end of each month in the Decant Dam is removed by pumping to the Processing Plant ponds. The inflows and outflows are listed in Table 1.1.

Table 1.1 Summary of inflows and outflows at the Tailings Storage Facility and Decant Dam

Inflows	Outflows
Tailings slurry water, based on the tailings deposition rate in the final year of the respective stage layout.	Evaporation from: — The tailings surface, considering differences between wet and dry areas. — The supernatant pond on the tailings surface. — The pond in the Lined Decant Cell of the Decant Dam.
Rainfall runoff from: — The crest and upstream slope of the TSF and Decant Dam embankments. — The tailings surface. — The catchment area beyond the edges of the tailings surface and the Lined Decant Cell in the Decant Dam.	Seepage losses at the base of the TSF. Note, seepage losses from the Decant Dam were considered as negligible during normal operation when water is maintained within the Lined Decant Cell.
Direct rainfall onto: — The supernatant pond on the tailings surface. — The pond in the Lined Decant Cell.	Interstitial water (water retained in tailings deposit as pore water).
No other water inflows	*Return water (water balance assumes net water at end of each month is pumped from the Decant Dam to the Processing Plant ponds)*

The catchment area of the tailings storage area is about 1390 ha and the catchment area of the Decant Dam, including the contributing tailings storage area, is about 1500 ha. Within the tailings storage catchment, the ratio of tailings beach to exposed natural ground increases over the life of mine. For the water balance assessment, the predicted tailings surface at the end of each stage of filling was considered and these areas are summarised in Section 1.2.

1.2 Scenario overview

The TSF layouts adopted for the water balance are summarised in Table 1.2.

Table 1.2 Overview of TSF layout conditions for the water balance assessment

Parameter	TSF stage layout (Note 1)					
	Stage 3 flatter	**Stage 3 steeper**	**Stage 5 flatter**	**Stage 5 steeper**	**Stage 6 flatter**	**Stage 6 steeper**
Start year	2029	2026	2037	2035	2041	2039
End year (Assessed)	2032	2031	2040	2039	2045	2046 (**Note 4**)
Active tailings beach area (ha) (**Note 2**)	288	291	500	483	553	639
Total tailings beach area (ha)	448	420	690	665	744	791
Annual forecast tailings deposition rate (Mt) (**Note 3**)	11.4	11.4	11.7	11.2	7.6	7.6

Notes:

1. Refers to end of deposition at each Stage.
2. At end of stage filling layout. Each active area is therefore the down-valley discharge beach.
3. Based on the LoM schedule summarised in the Basis of Assessment.
4. Forecast data for 2045 adopted.

1.3 Rainfall and climate inputs

The water balance assessment was completed for median and maximum monthly rainfall data, as presented in the Climate Assessment[1] completed in August 2023. Annual median and maximum total rainfall volumes have been distributed across January to December according to the monthly rainfall distribution, using data from the Bureau of Meteorology (covers years from 1949 to 2023), to represent a potential 'Maximum year' or 'median year'.

Changes to evaporation rates and to rainfall depths due to climate change from two Representative Concentration Pathways (RCPs) are also as per the climate assessment and are presented in Table 1.3 and Table 1.4 for evaporation and rainfall changes respectively. Note RCP4.5 and RCP8.5 represent medium and high relative global emissions scenarios respectively. For scenarios that considered scaling due to climate change, Stage 3 and Stage 5 were scaled to the 2030 climate change values, and Stage 6 was scaled to 2050 (refer tables Table 1.3 and Table 1.4). As the end of Stage 5 filling is currently scheduled to occur mid-way between these two horizons, 2030 was adopted as this resulted in more total rainfall compared to the 2050 case.

[1] Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment, WSP Ref: PS138057-WSP-MEL-MNG-REP-00002 Rev0 (Carrapateena Ref: CA-3630-CIV-REP-1071 Rev0).

Table 1.3 Predicted changes in annual net rainfall for Woomera (refer climate assessment report for Carrapateena)

Mean rainfall change (%)	Near future (2030)		Medium (2050)		Far future (2090)	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Annual	-9%	-7%	-13%	-21%	-19%	-35%
Summer	12%	13%	7%	-11%	-13%	-13%
Autumn	-10%	-10%	-18%	-26%	-28%	-38%
Winter	-18%	-13%	-16%	-18%	-16%	-37%
Spring	-4%	-10%	-16%	-24%	-17%	-44%

Table 1.4 Predicted percent changes in annual evapotranspiration rates for the South Australian Arid lands.

	RCP4.5	RCP8.5
Near future (2030)	2.7	3.2
Medium (2050)	3.8	5.2
Far future (2090)	5.2	10.2

Note, for Stage 5 layout, as the final operation year (2040) falls mid-way between the available climate change dates above, 2030 was adopted, as it presents a lower overall change to rainfall, and is therefore more conservative for assessing net water in the Decant Dam.

1.4 Parameters

A summary of the parameters adopted for the water balance is presented in Table 1.5.

Table 1.5 Adopted water balance parameters

Parameter	Adopted/estimated value	Comments
Solids concentration of tailings slurry (%, w/w)	62	Weight of solids over total weight of solids and water (refer LoM basis of assessment)
Specific Gravity / density of water (t/m^3)	1.03	Assuming some salinity.
TSF catchment area (ha)	1390	Total catchment area, excluding Decant Dam.
Decant Dam catchment area (ha)	110	Excluding TSF catchment area.
Supernatant pond area over tailings surface (ha)	3	Assumed based on conditions over Stage 1 and 2.
Decant Dam pond area at RL 112.5 m (maximum operating level) (ha)	3.4	-
Average moisture content for the tailings deposit (%, w_w/w_s) (weight of water over the weight of solids)	24	Estimated for a tailings particle density of 3.5 t/m^3 (Specific Gravity of 3.5), and average dry density of 1.9 t/m^3 for the tailings (refer LoM basis of assessment).

Parameter	Adopted/estimated value	Comments
Coefficient of evaporation from the tailings surface	0.31	Assumed coefficient to convert pan evaporation to evaporation of moisture from tailings surface. Average for active (wet) and inactive and dormant (relatively dry) beach areas. Calibrated based on return water data for 2023.
Coefficient of evaporation for pond water on the tailings surface and in the Decant Dam	0.7	Assumed value based on ponded water.
Runoff coefficient (active tailings beach)	0.4	Assumed.
Runoff coefficient (inactive tailings beach and earthen surfaces)	0.2	Assumed. Earthen surfaces include crest and slopes of Decant Dam embankment, crest of TSF embankment, and natural ground surface within catchments.
Seepage losses (% of total inflow water)	1.8	Percent of total slurry water lost to seepage through the base of the TSF based on shallow lateral seepage collected at an average rate of 180 kL/day. Additional losses are expected but 1.8% is conservative relative to outflows to the Decant Dam.

1.5 Net water estimates

Summaries of the monthly net water (after consideration of monthly inflows and outflows, and gravity decant of net water from the TSF and pump removal of net water in the Decant Dam at the end of each month) for end of deposition layouts for are presented in Table 1.6, Table 1.7, and Table 1.8 for the TSF and Decant Dam. Three climate (rainfall and evaporation rate) scenarios are presented.

- The monthly water balance assuming the 2024 median climate conditions for all stages is summarised in Table 1.6.
- The water balance adopting the median rainfall scaled for climate change scenario RCP4.5 is summarised in Table 1.7.
- The water balance adopting the maximum annual rainfall values for climate change scenario RCP4.5 is summarised Table 1.8.

The information presented in Table 1.6, Table 1.7, and Table 1.8 indicates.

- The TSF net water peaks during Stage 3B and diminishes from Stage 5B to Stage 6B.
- The climate change scenario results in less net water in comparison with the median case.

Table 1.6 Net monthly water for TSF and Decant dam, using median (1949 to 2023) rainfall for all stages

Month	Estimated monthly net water in the TSF (m^3)						Estimated monthly net water in the Decant Dam (m^3)					
	End Stage 3 Flat	End Stage 3 Steep	End Stage 5 Flat	End Stage 5 Steep	End Stage 6 Flat	End Stage 6 Steep	End Stage 3 Flat	End Stage 3 Steep	End Stage 5 Flat	End Stage 5 Steep	End Stage 6 Flat	End Stage 6 Steep
January	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0
April	86,700	105,300	0	0	0	0	82,400	101,000	0	0	0	0
May	203,600	215,700	118,200	110,500	0	0	202,800	214,900	117,300	109,700	0	0
June	263,100	271,100	211,600	200,500	73,200	62,400	263,400	271,400	212,000	200,900	73,500	62,700
July	240,500	249,600	179,200	169,100	38,600	25,700	240,100	249,200	178,800	168,600	38,100	25,200
August	172,800	185,900	76,300	69,700	0	0	170,500	183,700	74,100	67,500	0	0
September	82,700	101,800	0	0	0	0	78,500	97,600	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,049,400**	**1,129,400**	**585,300**	**549,800**	**111,800**	**88,100**	**1,037,700**	**1,117,800**	**582,200**	**546,700**	**111,600**	**87,900**

Table 1.7 Net monthly water for TSF and Decant dam, using median (1949 to 2023) rainfall scaled for climate change scenario RCP4.5

Month	Estimated monthly net water in the TSF (m^3)						Estimated monthly net water in the Decant Dam (m^3)					
	End Stage 3 Flat	End Stage 3 Steep	End Stage 5 Flat	End Stage 5 Steep	End Stage 6 Flat	End Stage 6 Steep	End Stage 3 Flat	End Stage 3 Steep	End Stage 5 Flat	End Stage 5 Steep	End Stage 6 Flat	End Stage 6 Steep
January	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0
April	75,000	94,100	0	0	0	0	70,200	89,300	0	0	0	0
May	193,300	205,800	104,500	97,100	0	0	192,000	204,400	103,100	95,800	0	0
June	251,400	259,600	197,100	186,300	56,800	45,100	251,100	259,300	196,800	185,900	56,500	44,800
July	229,400	238,700	165,100	155,200	22,000	8,300	228,300	237,600	164,000	154,100	21,000	7,200
August	160,300	173,800	60,000	53,800	0	0	157,400	171,000	57,100	50,900	0	0
September	72,900	92,500	0	0	0	0	68,300	88,000	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0
Total	**982,300**	**1,064,500**	**526,700**	**492,400**	**78,800**	**53,400**	**967,300**	**1,049,600**	**521,000**	**486,700**	**77,500**	**52,000**

Table 1.8 Net monthly water for TSF and Decant dam, using maximum (1949 to 2023) rainfall scaled for climate change scenario RCP4.5

Month	Estimated monthly net water in TSF (m^3)						Estimated monthly net water in Decant Dam (m^3)					
	End Stage 3 Flat	End Stage 3 Steep	End Stage 5 Flat	End Stage 5 Steep	End Stage 6 Flat	End Stage 6 Steep	End Stage 3 Flat	End Stage 3 Steep	End Stage 5 Flat	End Stage 5 Steep	End Stage 6 Flat	End Stage 6 Steep
January	0	0	0	0	0	0	0	0	0	0	0	0
February	0	33,500	0	0	0	0	1,200	34,600	1,200	1,200	400	400
March	0	6,300	0	0	0	0	0	2,500	0	0	0	0
April	143,600	162,800	5,200	2,900	0	0	143,900	163,100	5,500	3,200	0	0
May	287,100	299,700	210,000	201,600	48,100	33,900	292,700	305,300	215,700	207,300	52,800	38,600
June	327,500	335,900	282,800	271,200	147,000	139,300	332,900	341,200	288,100	276,500	152,500	144,800
July	296,700	306,200	240,900	230,300	101,800	91,600	300,700	310,100	244,800	234,300	105,900	95,700
August	223,300	236,900	130,900	124,000	0	0	225,100	238,700	132,700	125,800	2,000	2,000
September	154,600	174,300	14,100	12,000	0	0	156,100	175,900	15,600	13,600	400	400
October	54,900	82,400	0	0	0	0	55,100	82,600	300	300	0	0
November	0	6,500	0	0	0	0	0	4,700	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,487,700**	**1,644,500**	**883,900**	**842,000**	**296,900**	**264,800**	**1,507,700**	**1,658,700**	**903,900**	**862,200**	**314,000**	**281,900**

1.6 Decant Dam pump-out rates

The average pump-out rate in the Decant Dam between in 2023 typically averaged between 3,000 and 4,000 m^3/day, as noted in the 2023 annual inspection report[2].

Indicative pump out rates based on the water balance are presented in Table 1.9. The assessment indicates that the maximum pump out rate occur during Stage 3 (steeper beach profile) and is about 9,000 m^3/day under current median climate conditions and could be up to about 11,400 m^3/day under maximum rainfall and RCP4.5 climate change. The average and maximum pump out rates all decrease from Stage 3 to Stage 6. The maximum pump out rate for Stage 6 reducing to about 2,100 m^3/day for the Stage 6 layout for the steep beach slope scenario under current climate conditions, about 1,500 m^3/day for RCP4.5 climate change, and 4,800 m^3/day under maximum rainfall when scaled to RCP4.5.

Table 1.9 Average and maximum pump out rates for the Decant Dam

TSF layout	Pump out rates (Note)					
	Median climate (1949 to 2023)		RCP4.5 median climate		RCP4.5 max climate	
	Annual average (m^3/day)	Maximum monthly (m^3/day)	Annual average (m^3/day)	Maximum monthly (m^3/day)	Annual average (m^3/day)	Maximum monthly (m^3/day)
3B flat	2,800	8,800	2,700	8,400	4,100	11,100
3B steep	3,100	9,000	2,900	8,600	4,500	11,400
5B flat	1,600	7,100	1,400	6,600	2,500	9,600
5B steep	1,500	6,700	1,300	6,200	2,400	9,200
6B flat	300	2,500	200	1,900	900	5,100
6B steep	200	2,100	100	1,500	800	4,800

Note: all pump out rates assume all water entering the Decant Dam in a given month is also pumped out during the same month.

1.7 Breakdown of inflows and outflows

A breakdown of inflow and outflow components is presented in Table 1.10, Table 1.11, and Table 1.12, for the TSF and Decant Dam.

[2] Tailings Storage Facility - Annual Inspection Report January 2023 to January 2024, WSP ref: PS200475-WSP-MEL-MNG-REP-00019 Rev0, Carrapateena ref: CA-3630-CIV-REP-1094 Rev0, 8 March 2023.

Table 1.10 Inflow and outflow breakdown for TSF and Decant dam, using median rainfall (1949 to 2023) for all stages (not scaled for climate change)

TSF inflows and outflows								Decant Dam inflows and outflows							
Water balance component		% of total inflow						Water balance component		% of total flow					
		End Stage 3 flat	End Stage 3 steep	End Stage 5 flat	End Stage 5 steep	End Stage 6 flat	End Stage 6 steep			End Stage 3 flat	End Stage 3 steep	End Stage 5 flat	End Stage 5 steep	End Stage 6 flat	End Stage 6 steep
Inflows	Slurry water	93%	93%	92%	92%	88%	87%	Inflows	Discharged from TSF	96%	97%	94%	93%	73%	69%
	Rainfall	7%	7%	8%	8%	12%	13%		Rainfall	4%	3%	6%	7%	27%	31%
	Total inflows	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**		**Total inflows**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Outflows **(Note 1)**	Evaporation	48%	47%	55%	55%	62%	62%	Outflows	Evaporation	5%	4%	7%	7%	27%	32%
	Seepage	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%		Seepage	0%	0%	0%	0%	0%	0%
	Retained interstitial **(Note 2)**	36%	36%	36%	36%	35%	34%		**Total outflows**	**5%**	**4%**	**7%**	**7%**	**27%**	**32%**
	Subtotal	**86%**	**85%**	**93%**	**93%**	**98%**	**98%**	**Net Water**		**95%**	**96%**	**93%**	**93%**	**73%**	**68%**
	Net water (discharge to Decant Dam)	14%	15%	7%	7%	2%	2%								
	Total outflows	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**								

Notes shown below Table 1.12.

Table 1.11 Inflow and outflow breakdown for TSF and Decant dam, using median rainfall (1949 to 2023) scaled for climate change scenario RCP4.5

TSF inflows and outflows								Decant Dam inflows and outflows							
Water balance component		% of total inflow						Water balance component		% of total flow					
		End Stage 3 flat	End Stage 3 steep	End Stage 5 flat	End Stage 5 steep	End Stage 6 flat	End Stage 6 steep			End Stage 3 flat	End Stage 3 steep	End Stage 5 flat	End Stage 5 steep	End Stage 6 flat	End Stage 6 steep
Inflows	Slurry water	93%	93%	92%	92%	89%	89%	Inflows	Discharged from TSF	96%	96%	93%	93%	68%	59%
	Rainfall	7%	7%	8%	8%	11%	11%		Rainfall	4%	4%	7%	7%	32%	41%
	Total inflows	**100%**	**100%**	**100%**	100%	**100%**	**100%**		**Total inflows**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Outflows **(Note 1)**	Evaporation	49%	48%	55%	55%	62%	62%	Outflows	Evaporation	5%	5%	8%	8%	33%	42%
	Seepage	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%		Seepage	0%	0%	0%	0%	0%	0%
	Retained interstitial **(Note 2)**	36%	36%	36%	36%	35%	35%		**Total outflows**	**5%**	**5%**	**8%**	**8%**	**33%**	**42%**
	Subtotal	**87%**	**86%**	**93%**	**93%**	**98%**	**99%**	**Net Water**		**95%**	**95%**	**92%**	**92%**	**67%**	**58%**
	Net water (discharge to Decant Dam)	13%	14%	7%	7%	2%	1%								
	Total outflows	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**								

Notes shown below Table 1.12.

Table 1.12 Inflow and outflow breakdown for TSF and Decant dam, using maximum (1949 to 2023) rainfall scaled for climate change scenario RCP4.5

TSF inflows and outflows								Decant Dam inflows and outflows							
Water balance component		% of total inflow						Water balance component		% of total flow					
		End Stage 3 flat	End Stage 3 steep	End Stage 5 flat	End Stage 5 steep	End Stage 6 flat	End Stage 6 steep			End Stage 3 flat	End Stage 3 steep	End Stage 5 flat	End Stage 5 steep	End Stage 6 flat	End Stage 6 steep
Inflows	Slurry water	81%	81%	80%	79%	73%	72%	Inflows	Discharged from TSF	93%	93%	88%	88%	73%	71%
	Rainfall	19%	19%	20%	21%	27%	28%		Rainfall	7%	7%	12%	12%	27%	29%
	Total inflows	**100%**	**100%**	**100%**	100%	**100%**	**100%**		**Total inflows**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Outflows **(Note 1)**	Evaporation	49%	47%	57%	57%	65%	66%	Outflows	Evaporation	6%	6%	10%	10%	23%	25%
	Seepage	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%		Seepage	0%	0%	0%	0%	0%	0%
	Retained interstitial **(Note 2)**	32%	32%	31%	31%	29%	28%		**Total outflows**	**6%**	**6%**	**10%**	**10%**	**23%**	**25%**
	Subtotal	**83%**	**81%**	**90%**	**90%**	**95%**	**96%**	**Net Water**		**94%**	**94%**	**90%**	**91%**	**77%**	**75%**
	Net water (discharge to Decant Dam)	17%	19%	10%	10%	5%	4%								
	Total outflows	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**								

Notes for Table 1.10, Table 1.11, and Table 1.12:

1. Outflow component percentages are based on respective annual totals relative to the total annual inflow of water into the TSF.
2. The rate of retained interstitial water is proportional to the rate of slurry transport entering the TSF.

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1.8 Summary of assessment

This water balance assessment indicates that for all scenarios, the water being decanted to the Decant Dam peaks during Stage 3B and decreases progressively with each subsequent stage. This is primarily due to the increased tailings beach area providing more area for evaporation. Some reduction also occurs due to climate change reducing the overall rainfall available and increasing the evaporation rate. This is despite the increase in tailings deposition rate that is forecast with each stage, compared to current deposition rates.

The water balance indicates that over most stages, the steeper beach scenario results in more decant water to the Decant Dam compared to the flatter scenario, except at Stage 6 when the beach area is relatively larger. It also indicates that in any given year, the monthly net water in the Decant Dam is expected to be highest between April and September when evaporation rates are relatively lower.

Indicative pump-out rates from the Decant Dam for the maximum rainfall scenarios are above the maximum pumping rate that occurred during 2023 (about 7,000 m^3/day), for some stage layouts and climate scenarios. However, the indicative pump-out rates for the median rainfall scenarios (maximum of about 3,100 m^3) are below the existing available pump capacity at the Decant Dam. The maximum pump out rate under the maximum rainfall scenario was about 11,400 m^3/day (Stage 3 steep). Both the average and maximum indicated pump-out rates decrease from Stage 3 to Stage 6.

On the basis of the water balance for the life of mine tailings deposition schedule, and predicted reductions in future net water in the Decant Dam, an upgrade to the Decant Dam capacity is not required.

Appendix F

Seepage Assessment

BHP, owner of OZ Minerals Carrapateena Pty Ltd

Seepage Assessment for Life of Mine Concept Design Update to Tailings Storage Facility CA-3630-CIV-REP-1108

Carrapateena, South Australia

November 2024

Question today
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Seepage Assessment for Life of Mine Concept Design Update to Tailings Storage Facility
CA-3630-CIV-REP-1108
Carrapateena, South Australia

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	Name	Date	Signature
Prepared by:	Mei Zheng	28 November 2024	
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Approved by:	Gareth Phillips	28 November 2024	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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APPENDIX A **STAGE 1 SEEPAGE ANALYSIS CALIBRATION**

APPENDIX B **LIMITATION STATEMENT**

1 Introduction

This report presents BHP with a seepage assessment for the updated Life of Mine concept design of the Tailings Storage Facility (TSF). The Life of Mine concept design update considers storage of about 224 Million dry tonnes (Mdt) over six stages: the existing Stage 1 and Stage 2 layout, a future Stage 3 downstream raise and upstream raises for Stages 4 to 6. The assessment comprises two-dimensional seepage analyses for the end of filling layouts for Stages 2 to 6. The objectives of the seepage assessment are to:

- Estimate the rate of seepage from the base of the TSF for each remaining Life of Mine stage, i.e. downward seepage across the tailings impoundment area.
- Estimate the shallow lateral seepage rates below the TSF embankment for each remaining Life of Mine stage.

2 Background

2.1 Seepage assessment for permit stage

A seepage assessment[1] was undertaken in 2017 to support the permitting of the Carrapateena TSF. The permitted design was for storage of 145 Mdt of tailings and considered the following:

- Stage 1: ~17 m high starter embankment.
- Stage 2: ~13 m high downstream raise.
- Stages 3 to 6: upstream raises, with raise heights varying between 7 m (Stage 3) and 3 m (Stages 5 and 6).

Based on the parameters adopted for the assessment and inclusion of a 1 m thick clay liner in the watercourses within the impoundment, the following seepage estimates were made:

- Seepage through the base of the TSF: 7 kL/day at Stage 1, increasing to about 207 kL/day by end Stage 6.
- Shallow lateral seepage to downstream toe of the TSF embankment: 11 L/day, decreasing to about 8 L/day by end Stage 6.

For Stages 1 and 2, the rate of seepage was estimated with the assumption that the supernatant pond would be only over the tailings beach, and not in contact with natural ground. During the development of the tailings beach for Stage 1 and for Stage 2 the supernatant pond extended against and over a significant area of natural ground and is still the case as of July 2024. Hence the actual seepage rate at the downstream end of the TSF embankment has been significantly higher than estimated (see further discussion in Section 2.4).

Note, following the seepage assessment, the design thickness of the clay layer over the watercourses was reduced to 0.5 m and the layer was constructed to this minimum thickness.

2.2 Starter layout construction and commissioning

The Stage 1 starter embankment layout and impoundment preparation works were constructed between November 2018 and August 2019, and tailings deposition commenced in earnest in March 2020. During Stage 1 operation the supernatant pond was designed and operated adjacent to the embankment.

The starter embankment layout included a cut-off drain downstream of both the Stage 1 embankment and the then projected Stage 2 embankment footprint, with a sump (DN315 HDPE riser pipe) for pump extraction. The cut-off drain was excavated at least 0.5 m into the bedrock.

2.3 Shallow seepage and measured rates via collection

Wet patches from shallow lateral seepage developed near the downstream toe of the Stage 1 embankment in June 2020, i.e., about 4 months after commissioning of the TSF. The wet patches were upstream of the cut-off drain. Temporary sumps were installed and prior to their decommissioning at end of May 2021, the combined measured rate from all sumps was about 100 kL/day. The temporary sumps were replaced in June 2021 with seepage collection drains in the Stage 2 embankment foundation, and a sump (with 1.5 m diameter concrete pit) for pump extraction outside the footprint of the projected Stage 2 embankment. The Stage 2 embankment, including upstream bituminous geomembrane liner was subsequently constructed between November 2021 and December 2022.

[1] Carrapateena Project – Tailings Storage Facility - Seepage Assessment, November 2017. Golder (now WSP) ref. 1648044-017-M.

Since the installation of the Stage 2 seepage collection system, the combined pumped rate from both 'permanent' sumps peaked at about 300 kL/day in mid-August 2023 but declined to about 225 kL/day by February 2024. i.e., orders of magnitude higher than the estimated seepage rates from the original model. During Stage 1 operation the supernatant pond extended over a significant area of natural ground on the eastern side of the impoundment, a scenario which was not part of the original model.

Wet patches and minor seepage flow from shallow lateral seepage also developed near the toe of the Stage 2 embankment (during raise construction) in March 2022. The extent of seepage declined following the transition of the supernatant pond away from the TSF embankment and away from the natural ground on the eastern side, which commenced with Stage 2 tailings deposition operation in late March 2023. It has since remained steady at about 225 kL/day (as of May 2024) due to the supernatant pond being temporarily against the topographical spur to the west of the Decant Causeway.

2.4 Stage 1 seepage calibration analysis

In mid-2022, during Stage 1 operation and following installation of the second seepage collection system, a seepage calibration analysis was undertaken. The analysis is summarised in Appendix A, noting that detailed reporting was not undertaken at the time. The calibration analysis enabled the refinement of the hydraulic conductivities and storage of the different geotechnical units under the TSF, as follows:

- **Tailings deposit**: Anisotropy changed from 0.1 to 1, i.e., changing the hydraulic conductivity from being laterally dominant to being equal in both lateral and vertical axes.
- **Foundation: *in situ* clayey residual and colluvial soils in impoundment footprint**: Hydraulic conductivity changed from 1×10^{-9} m/s to 5×10^{-7} m/s, i.e., to be of higher permeability.
- **Foundation: Highly to Moderately Weathered bedrock**: Hydraulic conductivity changed from 5×10^{-6} m/s to 1×10^{-5} m/s, and volumetric water content changed from 0.2 to 0.3, i.e., to be of higher permeability and with a higher ratio of water volume to rock volume.

Parameters from the calibration analysis were adopted for the updated Life of Mine seepage assessment – refer Section 3.7, with the addition of progressive reduction in the permeability of the deposited tailings from ongoing consolidation of the tailings.

Note the Life of Mine seepage assessment was developed for the TSF impoundment ground conditions outside the clay lined original watercourses, as this condition represented the majority of the impoundment footprint.

2.5 TSF layout and life of mine raise study

Staged concept plans[2] for the Life of Mine TSF were prepared in March 2024 for storage of about 224 Mdt of tailings. The raise plan was developed to accommodate both a relatively flat and a relatively steep tailings beach scenario and is summarised below.

- Stage 3: ~10.8 m high downstream raise.
- Stage 4: ~5.5 m high upstream raise.
- Stage 5: ~4 m high upstream raise.
- Stage 6: ~3 m high upstream raise.

[2] Tailings Storage Facility, Staged Life of Mine Concept Layouts, March 2024. Carrapateena ref. CA-3630-CIV-REP-1096 / WSP ref. PS138057-WSP-MEL-REP-00003.

3 SEEP/W model development

3.1 General approach

The seepage assessment was undertaken using the software Seep/W developed by Geostudio, similar to the previous seepage assessments for the Carrapateena TSF. Seep/W is an industry-standard two-dimensional (2D) finite element numerical modelling software, widely used for the estimation of seepage from TSFs and water dams.

The analyses were conducted using a staged development sequence, in which the foundation, embankment and tailings were simulated in layers based on their estimated hydrogeological properties.

3.2 Representative cross-section

The alignment of the hydrogeological model adopted for the seepage assessment and the end-of filling tailings surface for Stage 6 (the relatively steeper beach scenario) is presented in Figure 3.1. The cross-section alignment (shown in red) is oriented in an approximate north-south direction through the TSF embankment and was adopted with the supernatant pond being the closest to the TSF embankment and located near the end of the Decant Causeway. This location was considered to represent a reasonably conservative cross section for the estimation of seepage from the various development stages on the TSF. The downstream Decant Dam was not included in the model.

A transient model was developed based on the as-constructed information for the Stages 1 and 2 embankment and the proposed future raises for Stages 3 to 6, as per the March 2024 Life of Mine study. The seepage model cross section adopted is considered to represent an approximate 600 m length of the embankment, as shown by the yellow dimension line in Figure 3.1. This length approximates the highest portion of the TSF embankment and includes the extents of the original two watercourses in the footprint of the embankment.

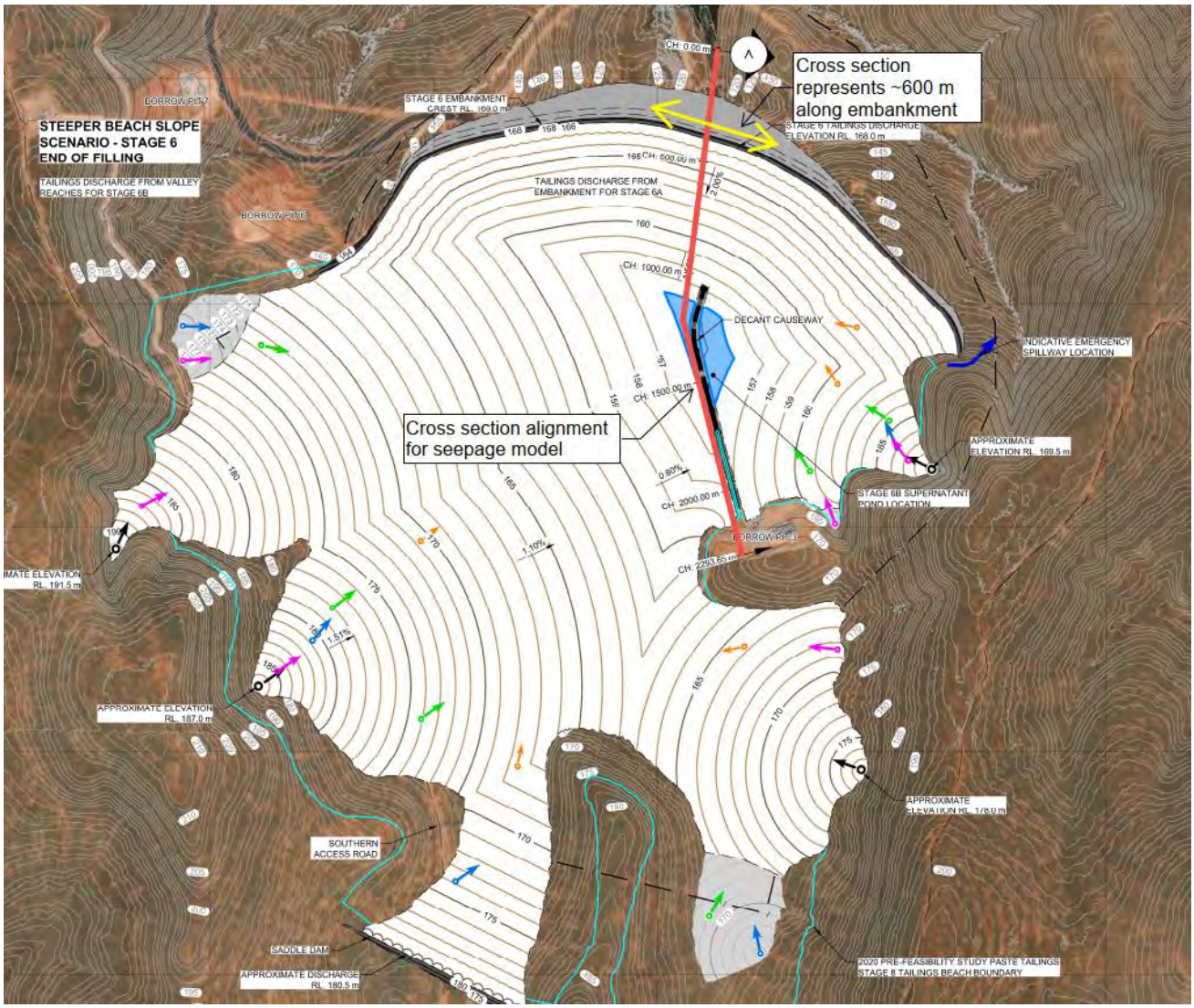

Figure 3.1 Cross-section alignment on predicted end of Stage 6 filling layout

3.3 Modelled stages

Seven stages of TSF development were modelled in the seepage assessment. The tailings elevation at the embankment and the timeframe for each transient model are summarised in Table 3.1. The surveyed tailings profile for Stage 1 interim (September 2021) and Stage 2 interim (December 2023) were adopted.

The Life of Mine concept design layouts[3] for tailings deposition for the end of Stages 2 to 6 were adopted with a conservative size of the supernatant pond.

The embankment raise configuration is shown in Figure 3.2, noting that the model for seepage analysis was extended to the natural ground hill slope on the southern side of the tailings impoundment, as per the alignment shown in Figure 3.1.

[3] Tailings Storage Facility, Staged Life of Mine Concept Layouts. Carrapateena ref. CA-3630-CIV-REP-1096 / WSP ref. PS138057-WSP-MEL-REP-00003, March 2024.

Table 3.1 Summary of staging parameters for seepage analyses

Parameter	Modelled TSF Stages						
	Stage 1 Interim	**Stage 2 Interim**	**Stage 2 end**	**Stage 3 end**	**Stage 4 end**	**Stage 5 end**	**Stage 6 end**
Deposition commencement (or adopted interim) date	Mar-20	Sep-21	Dec-23	Apr-26	Jun-31	Sep-35	Oct-39
Deposition end date	Sep-21	Dec-23	Mar-26	May-31	Aug-35	Sep-39	Jun-46
Deposition duration (years)	1.5	2.25	2.3	5.2	4.2	4.0	6.7
Embankment crest elevation (RL m)	133.6 **(Note)**	146.8	146.8	157.5	163	166	169
Tailings elevation at embankment (RL m)	~127.6	137.6	146.3	156.5	162	165	168

Note: embankment elevation adjacent to the Stage 1 decant area.

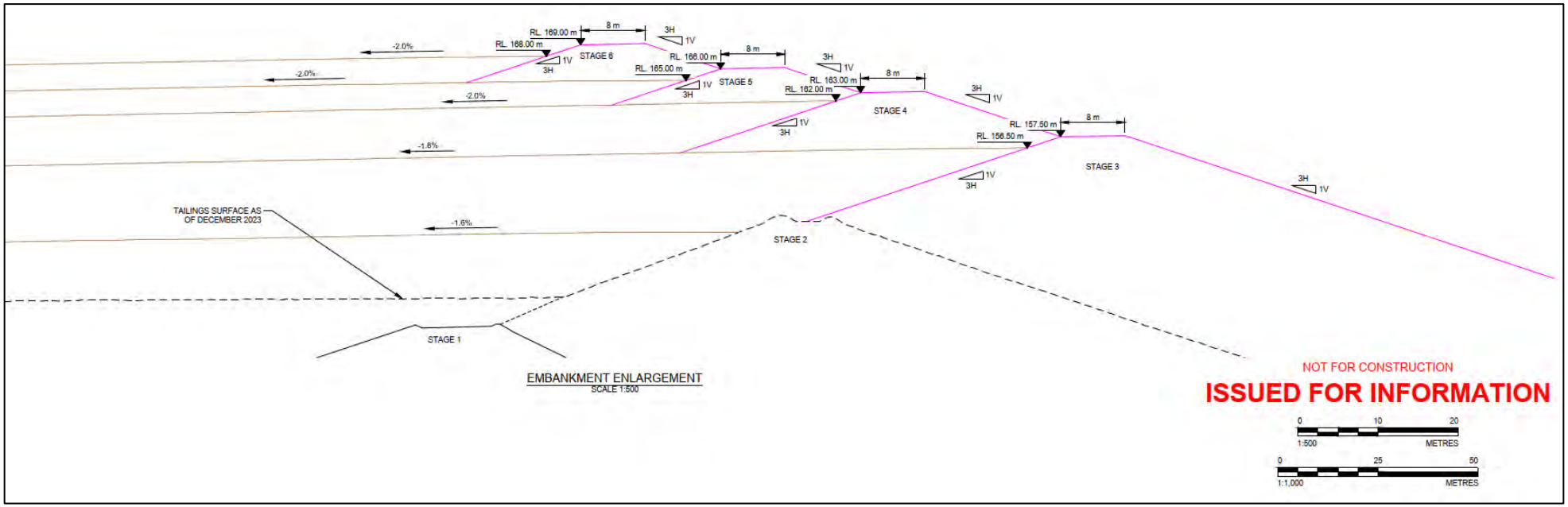

Figure 3.2 Embankment cross section and tailings elevations for Stages 2 to 6

3.4 Subsurface geology

The subsurface geology for the updated seepage model is generally consistent with the original seepage analysis[4] undertaken in 2017 and the Stage 1 seepage calibration analysis undertaken in 2022 (refer Appendix A). The relevant geological features in the model are:

- Foundation *in situ* clay layer with a thickness of about 0.5 m in the tailings impoundment area and increasing to 1.5 m from the Stage 1 embankment foundation towards the downstream toe area of the Stage 3 embankment, based on site geotechnical investigations.
- Foundation bedrock (upper) – Highly to Moderately Weathered quartzite bedrock representing average thickness of about 2 m.
- Foundation bedrock (lower) – Slightly Weathered to Fresh quartzite bedrock with a thickness of about 90 m.

3.5 Supernatant pond

The following conditions were adopted for the supernatant pond in the seepage model:

- During the operation of Stage 1 TSF, the supernatant pond was located against the embankment. In the Stage 1 Interim model, a 1 m water head was applied over the tailings and approximate 200 m length along the cross-section model to simulate the supernatant pond and saturated tailings.
- Following the transition of down-valley tailings deposition to up-valley for the first phase of Stage 2 deposition, the supernatant pond has migrated south to the gravity decant tower system. The supernatant pond was modelled around the decant tower system for Stages 2 to 6 over an approximate 300 m length along the section alignment, based on the tailings beach models with a maximum of 1 m depth of supernatant water. It was assumed the supernatant pond is a constant source of liquid into the model.

3.6 Seepage model

The seepage model developed for the cross-section is presented in Figure 3.3. The as-constructed embankment geometry was adopted for Stages 1 and 2. The Stage 1 embankment was formed with compacted weathered rockfill (sourced from borrow pits), with an upstream transition layer of Gravelly Sand followed by a compacted clay layer and a bituminous geomembrane liner on the upstream face. The Stage 2 embankment was formed with compacted mine rockfill and a bituminous geomembrane liner on the upstream face. Compacted rockfill, a transition layer and a bituminous geomembrane liner was also adopted for the modelled Stages 3 downstream raise embankment and the Stages 4 to 6 upstream raise embankments.

A shear key was formed in the Stage 2 foundation with coarse (free-draining) rockfill and seepage collection pipes to a sump. This drain was included in the seepage model. The lateral seepage was measured in the model at the upstream side of the rockfill shear key (refer to the location in Figure 3.3).

A toe drain is located along the upstream toe of the Stage 1 and Stage 2 embankment, with gravity discharge to the Decant Dam via a pipe junction pit and the decant outfall pipe. A free discharge boundary condition for the upstream toe drain was included in the seepage model.

The downward seepage within the TSF impoundment was measured from the surface of the 'Foundation *in situ* clay layer', from the upstream toe of Stage 1 embankment to the southern side of the TSF impoundment.

[4] Carrapateena Project – Tailings Storage Facility – Seepage Assessment. Golder report, ref. 168044-017-M-Rev 5, Nov 2017.

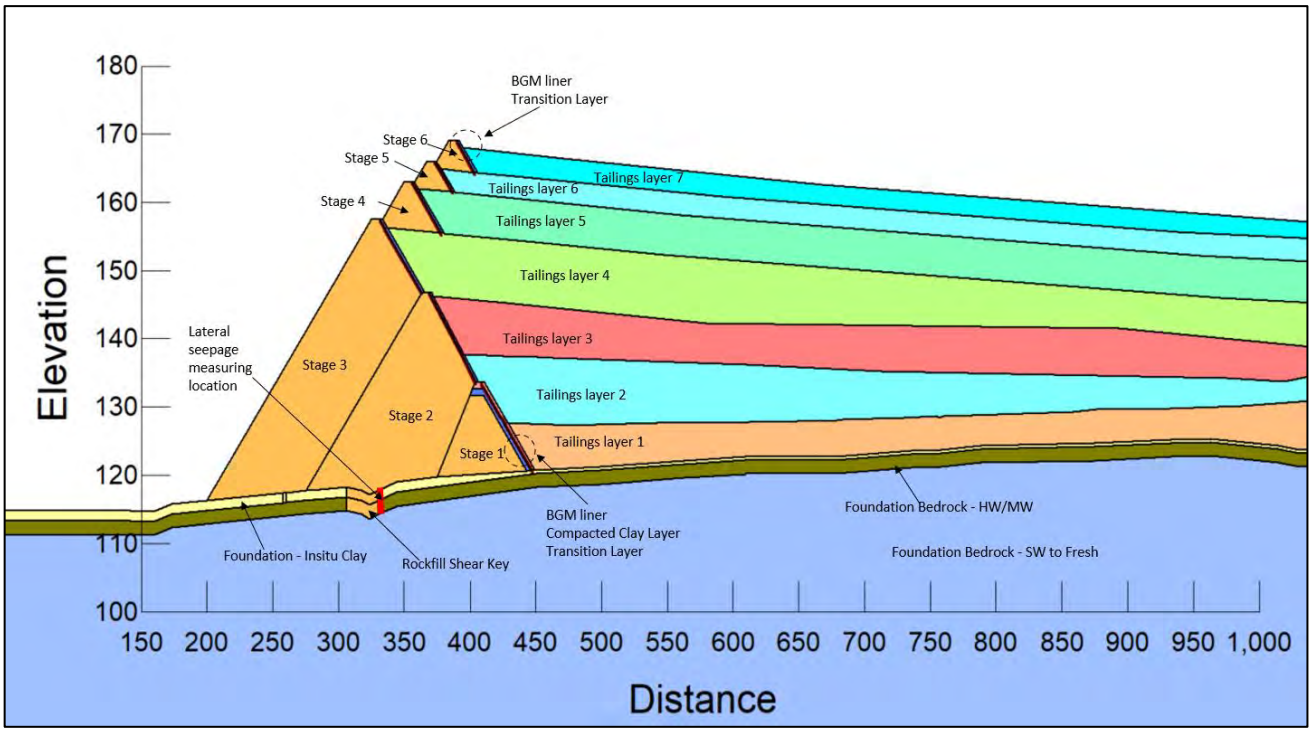

Figure 3.3 Seepage model for TSF at end of Stage 6 (model image truncated at right for clarity)

3.7 Hydraulic parameters

3.7.1 Overview

The hydraulic parameters adopted for foundation and embankment materials are summarised in Table 3.2.

Table 3.2 Summary of hydraulic parameters for Life of Mine seepage assessment

Material type	Hydraulic conductivity (m/s)	Anisotropy (kv/kx)	Volumetric water content	Material model
Bituminous Geomembrane Liner	1.00×10^{-9}	1	0	Saturated
Compacted clay – upstream sloping layer in TSF embankment	1.00×10^{-8}	0.1	0.15	Saturated/ Unsaturated
Foundation bedrock - Slightly Weathered to Fresh Quartzite	1.00×10^{-7}	1	0.15	Saturated
Foundation bedrock – Highly to Moderately Weathered Quartzite	1.00×10^{-5}	1	0.30	Saturated
Foundation *in situ* clay	5.00×10^{-7}	0.1	0.25	Saturated/ Unsaturated
Tailings deposit	**(Note)**	1	0.50	Saturated
Transition material – upstream sloping layer in Stage 1 TSF embankment	1.00×10^{-6}	1	0.20	Saturated
Embankment rockfill – compacted weathered and/or mine rockfill	1.00×10^{-5}	1	0.20	Saturated/ Unsaturated

Note: The hydraulic conductivity for the tailings in the analysis included reducing permeability of the tailings layers due to ongoing consolidation of the tailings from the self weight of the overlying tailings layers. Refer Section 3.7.2.

3.7.2 Tailings consolidation

The permeability of tailings undergoes changes due to consolidation from loading from overlying layers, which leads to a reduction in void ratio and hence a reduction in permeability. Tailings slurry consolidometer testwork[5] completed in 2020 showed the permeability values ranged from 3×10^{-8} m/s to 2.6×10^{-9} m/s, for effective confining loads of between 10 kPa and 1600 kPa. This data with the associated estimated coefficient of consolidation (C_v) were used to estimate the permeability of each stage of tailings deposition layer in the model as presented in Table 3.3.

Table 3.3 Tailing layer permeability (m/s) in each staged model

Tailings layer	Stage 1 Interim	Stage 2 Interim	Stage 2 end	Stage 3 End	Stage 4 End	Stage 5 End	Stage 6 End
Tailings layer 1 (Stage 1 interim)	3×10^{-8}	1.11×10^{-8}	5.79×10^{-9}	4.37×10^{-9}	3.64×10^{-9}	3.17×10^{-9}	2.85×10^{-9}
Tailings layer 2 (upper Stage 1 and Stage 2 interim)	Not deposited	3×10^{-8}	1×10^{-8}	5.18×10^{-9}	3.89×10^{-9}	3.24×10^{-9}	2.83×10^{-9}
Tailings layer 3 (end Stage 2)	Not deposited	Not deposited	3×10^{-8}	8.93×10^{-9}	6.81×10^{-9}	5.79×10^{-9}	5.15×10^{-9}
Tailings layer 4 (end Stage 3)	Not deposited	Not deposited	Not deposited	3×10^{-8}	1.60×10^{-8}	9.63×10^{-9}	7.47×10^{-9}
Tailings layer 5 (end Stage 4)	Not deposited	Not deposited	Not deposited	Not deposited	3×10^{-8}	1.80×10^{-8}	1.00×10^{-8}
Tailings layer 6 (end Stage 5)	Not deposited	Not deposited	Not deposited	Not deposited	Not deposited	3×10^{-8}	1.8×10^{-8}
Tailings layer 7 (end Stage 6)	Not deposited	Not deposited	Not deposited	Not deposited	Not deposited	Not deposited	3×10^{-8}

[5] Tailings Storage Facility, Assessment of Impact of Lower Density Tailings Slurry. Golder (now WSP), report ref. 19121887-004-R-Rev0, 21 February 2020.

3.8 Boundary conditions

The boundary conditions adopted for the seepage model are described in Table 3.4.

Table 3.4 Seepage model boundary conditions

Boundary condition	Location	Value	Description
Initial groundwater	Downstream side model boundary	RL 30 m	The initial groundwater level, to represent the estimated groundwater level prior to TSF operation. Applied in the initial steady state model only.
	Upstream side model boundary	RL 31 m	
Potential seepage face	All ground surfaces outside TSF basin	0 m^3/sec	A potential seepage face (water rate) boundary condition to remove ground water that reaches the ground surface.
	Bottom and upstream side of the rockfill shear key	0 m^3/sec	Replicate the gravity flow from the shear key and associated downstream pumps for the seepage collections systems that remove water.
	Stage 1 upstream toe drain	0 m^3/sec	Gravity flow removal of seepage that reaches the upstream toe drain.
Supernatant pond	Stage 1 Interim model: at the embankment (~200 m length)	Water total head of 1 m	Pond location based on the surveyed aerial image, assumed pond depth of 1 m.
	Stage 2 Interim model: 650 m away from the embankment (~200 m length)	Water total head of 1 m	Pond location based on the surveyed aerial image, assumed pond depth of 1 m.
	~ 300 m length at supernatant pond location for 'Stage 2 End' model to 'Stage 6 End' model	Water total head of 1 m	Assumed average 1 m depth of supernatant pond, i.e., 1 m water head at the surface of the tailings over the extents of the supernatant pond.

3.9 Modelling limitations

The following seepage modelling limitations and assumptions should be noted:

- The seepage assessment utilises two-dimensional (2D) sectional models to represent a three-dimensional layout, therefore the model does not consider potential complex spatial effects such as sub-surface geology features and simplification of seepage front from the supernatant pond.
- The influence of rainfall and evaporation were not included.
- The storativity and hydraulic conductivity of the bedrock was estimated, in the absence of any site-specific test results of the bedrock.

4 Modelling results

4.1 Lateral seepage

The lateral seepage was measured from the upstream side of the rockfill shear key in the Stage 2 embankment and estimates are presented in Table 4.1. The results from the 2D seepage model were extrapolated by multiplying the unit seepage rate over the 600 m width (lengthways along embankment), to represent the seepage that could be collected by the rockfill shear key. The estimated decline in the rate of shallow lateral seepage over the Life of Mine is also presented in Figure 4.1 (in Section 4.2).

The modelled lateral seepage rate in the Stage 1 Interim and Stage 2 Interim models is lower than the measured seepage from the site, as the Life of Mine model considered the supernatant pond being entirely over tailings and not partially over natural ground. By the end of Stage 2 tailings deposition, the supernatant pond is predicted to be entirely over the tailings surface. The estimated additional rate of seepage when the pond extended on to the natural ground on the eastern side of the impoundment in 2022 was about 50 m^3/day (assuming pond to natural ground contact zone of 20 m), as presented in Appendix A.

The modelled flow rate from the upstream toe drain was estimated at about 11.5 m^3/day during the Stage 1 filling period, and progressively reduced to negligible flow rate once the entire toe drain length was covered by tailings in subsequent stages. The outflow from the upstream toe drain is into the decant outflow collection system and is not included in the site measured downstream seepage collection system flow rate.

The average shallow lateral seepage rate by the end of Stage 6 is estimated to be about 27 m^3/day, for the design condition of the entire supernatant pond being located near the decant tower system and over deposited tailings only.

Table 4.1 Estimated lateral seepage

Stage	Time (Years)	Maximum seepage* (m^3/day)	Average seepage (m^3/day) (Note)
Stage 1 Interim	1.5	197	127
Stage 2 Interim	3.8	101	28
Stage 2 end	6.1	22	22
Stage 3 End	11.3	22	20
Stage 4 End	15.4	21	21
Stage 5 End	19.4	26	25
Stage 6 End	26.1	27	27

Note: The maximum and average seepage rate are related to the transient analyses.

The seepage rate measured on site in May 2024 was about 225 m^3/day. As of mid-2024, the supernatant pond was making extensive contact with the natural ground over the side of a topographic spur near the centre of the impoundment area, which is considered to be the main source of the higher lateral seepage rate.

The seepage rate estimated from SEEP/W provides an approximate indication of the potential seepage magnitude. The values in the table should not be directly compared to the seepage flow rate measured on-site due to the limitations discussed in Section 3.9.

4.2 Downward seepage

The seepage through the impoundment of the TSF was measured in the model from the surface of the *in situ* foundation clay and estimates are presented in Table 4.2. The results from the 2D seepage model were extrapolated to the entire TSF by considering a 200 m width (average dimension of supernatant pond in east-west direction) over the length of tailings in the seepage model.

The maximum modelled seepage flow into the base of TSF was at the beginning of the deposition, and gradually reduced to about 20 m^3/day. The trend of the downward seepage from the TSF over the Life of Mine is presented in Figure 4.1.

Note, there will be an additional quantity of consolidation water that is extruded from the tailings over time, as it reduces in void ratio and consolidates. The rate of consolidation water is estimated to be similar to the downward seepage rate related to the supernatant pond, with the consolidation seepage rate limited by the permeability of the consolidating tailings, and the direction of extruded seepage flow during consolidation, i.e., it will be a combination of upward migration adding to supernatant pond volume, and seepage downwards into the impoundment stratigraphy.

The estimated seepage rates are expected to increase to at least double the values in the Table 4.2 during the consolidation period of the tailings, which is estimated to extend over at least 4 years after tailings deposition ends.

Table 4.2 Seepage through the base of the TSF

Stage	Time (Year)	Maximum seepage* (m^3/day)	Average seepage (Note) (m^3/day)
Stage 1 Interim	1.5	354	162
Stage 2 Interim	3.8	48	24
Stage 2 end	6.1	16	15
Stage 3 End	11.3	15	13
Stage 4 End	15.4	15	13
Stage 5 End	19.4	18	17
Stage 6 End	26.1	21	20

Note: The maximum and average seepage rate are related to the transient analyses.

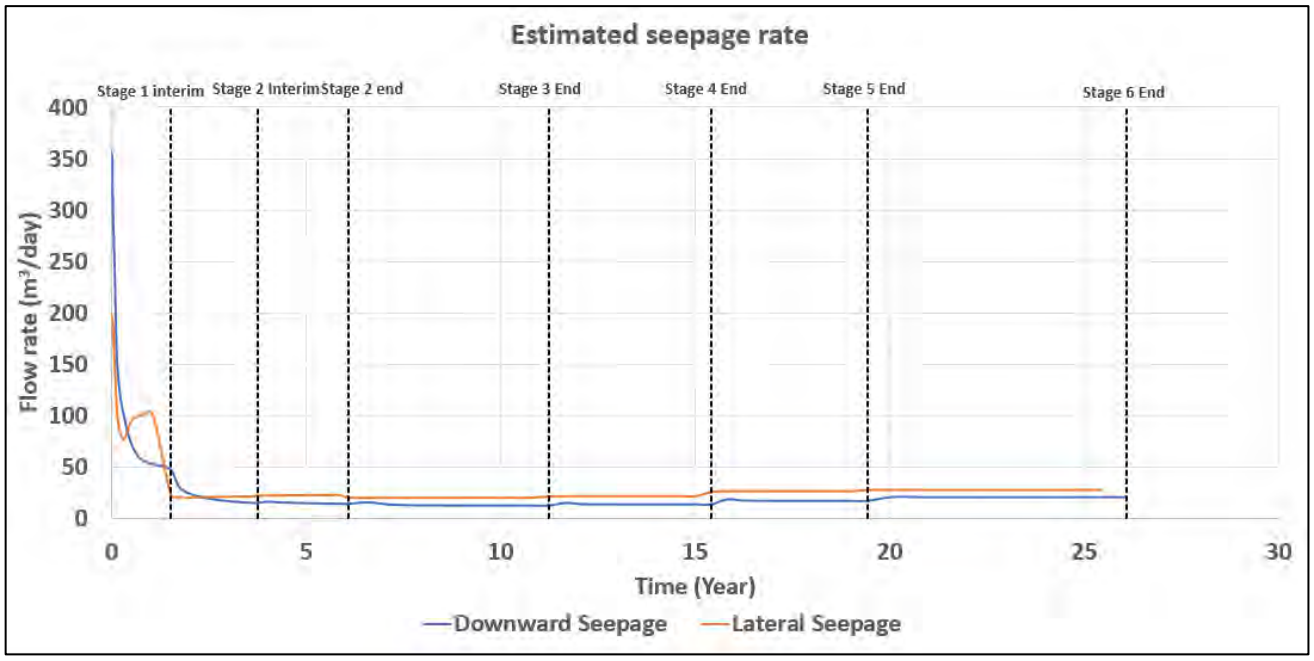

Figure 4.1 Estimated lateral and downward seepage rate over the Life of Mine

The 'spike' in the lateral seepage at year 1 is a modelling result caused by the instantaneous application of a supernatant pond at the end of the Stage 2 Interim model. The slight seepage increase from Stage 5 is attributed to the elevated water head over time.

4.3 Phreatic surface

The predicted phreatic surface at the end of Stage 6 is presented in Figure 4.2. The deposition of tailings combined with the supernatant pond, leads to localised rise in the groundwater table within the TSF footprint. This phenomenon is primarily attributed to the low 'storativity' of the Slightly Weathered to Fresh quartzite bedrock. The low storativity is a function of the tight bedrock mass with primary storage/pathways for seepage via discontinuities in the bedrock.

The deposition of tailings slurry and the resultant supernatant pond creates a continuous source of water that infiltrates the tailings and underlying material. The bedrock was modelled with a relatively low permeability which limits the extent of sideways seepage within the modelled cross section. As a result, the infiltrating water from the pond increases the hydraulic mound, causing the groundwater table to rise directly beneath and adjacent to the pond.

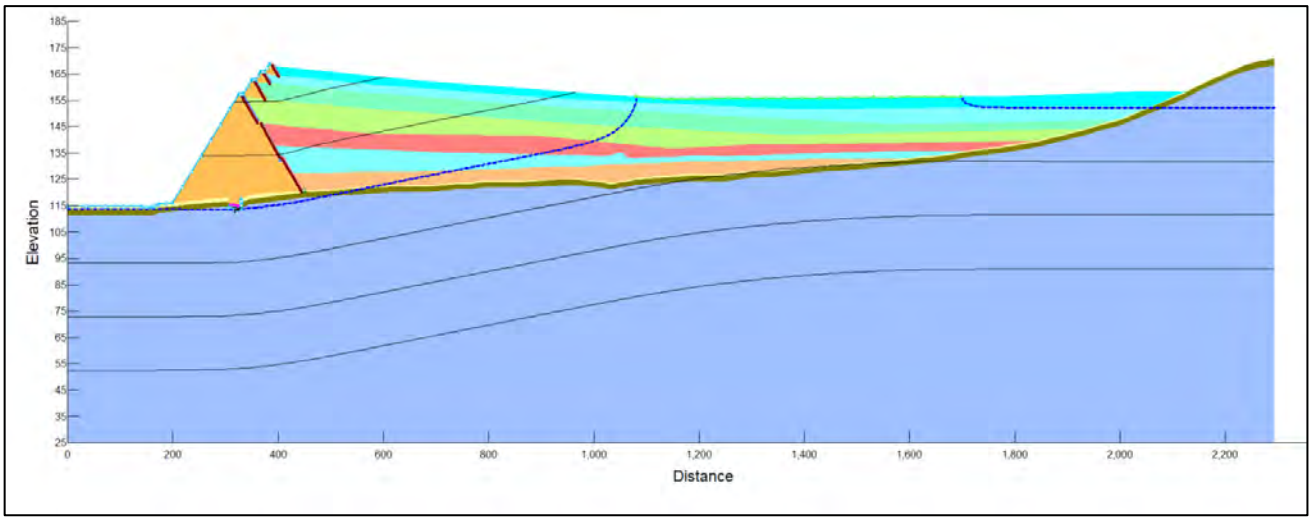

Figure 4.2 Predicted phreatic surface at end of Stage 6

4.4 Suggested actions

Based on the results of this assessment, the following actions could be considered to further calibrate and refine the model:

- At the end of each stage of operation, review groundwater levels in monitoring boreholes near the TSF and calibrate the seepage model to better estimate the underlying hydrogeological conditions below the TSF.
- Investigate the viability of conducting pumping tests in the bedrock to better estimate its hydrogeological properties.

5 Closing

This report presents the results of a 2D seepage analysis for the updated Life of Mine TSF layout.

Estimates rates for shallow lateral seepage below the embankment and seepage from the base of the TSF are presented, for a condition where the supernatant pond is over tailings only. Experience has shown that if the supernatant pond extends over the natural ground, the seepage rates could be doubled. The Life of Mine plan will predominately result in the supernatant pond being over tailings only.

A limitation statement is provided in Appendix B.

Appendix A

Stage 1 Seepage Analysis Calibration

1 Stage 1 seepage analysis calibration

1.1 Overview

A seepage analysis was undertaken by Golder (now WSP) in mid-2022 to calibrate the seepage model with actual rates of seepage pumped from the collection sumps downstream of the Tailings Storage Facility (TSF) embankment. Sensitivity analyses for various parameters were undertaken to understand the influence of each on the rate of seepage.

1.2 Stage 1 Seepage modelling

1.2.1 General approach

The seepage analysis was undertaken using the two-dimensional finite element modelling software SEEP/W (GeoStudio 2021). The analysis was conducted using a phased development process, in which the tailings were simulated in layers.

1.2.2 Representative sections

The Stage 1 seepage calibration analysis was conducted by considering the combined seepage for two cross-sections representative of two different pond conditions, as described in Table 1.1. The alignment of the two sections is shown in Figure 1.1.

Table 1.1 Details of cross-section adopted in seepage assessment

Cross-section	Cross-section description	Representative length along (parallel to) the embankment
1	Cross-section adjacent to the main watercourse, with about 1 m of *in situ* clay overlying weathered bedrock. For the model, a tailings surface 2 m below the Stage 1 embankment crest was adopted and it was assumed the entire tailings deposit was saturated, by modelling a pond over the entire tailings surface (a cross-section length of 500 m), but not extending onto natural ground.	~ 600 m
2	Cross-section through area of the supernatant pond, as of March 2022, spanning both tailings and natural ground, with the pond covering tailings over a cross-section length of about 200 m and natural ground over about 20 m.	~ 100 m

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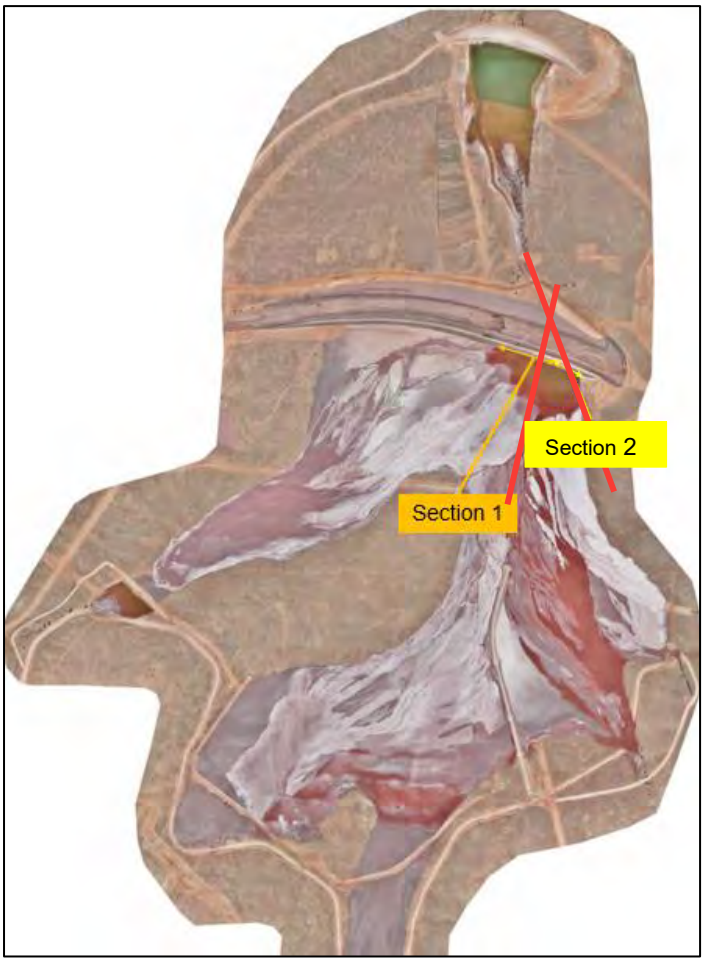

Figure 1.1 Cross section location (March 2022 aerial photo of TSF taken by drone, supplied by Alexander Symonds)

1.2.3 Assumptions

The seepage calibration analysis adopted the following assumptions:

- Tailings in the Stage 1 impoundment was modelled in phases to simulate progressive filling.
- Hydraulic parameters for the subsurface soil and bedrock, embankment fill materials and the tailings deposit were initially adopted based on the 2017 seepage assessment[1], prior to the sensitivity and calibration analyses.
- The toe drain located at the upstream toe of the Stage 1 embankment was not considered in the model as a relatively small amount of water was being discharged from the drain.
- The seepage was measured in the model at the downstream toe of Stage 1 embankment to a depth of 3 m, i.e., into the 'Highly to Moderately Weathered' bedrock). Refer to the location of measurement on the cross sections in Figure 1.2 and Figure 1.3.
- The influence of rainfall and evaporation were not included.

1.2.4 Seepage model

The seepage models developed for the two cross sections are presented in Figure 1.2 and Figure 1.3.

[1] Carrapateena Project – Tailings Storage Facility – Seepage Assessment. Golder (now WSP) report ref. 1648044-017-M-Rev5, 29 November 2017.

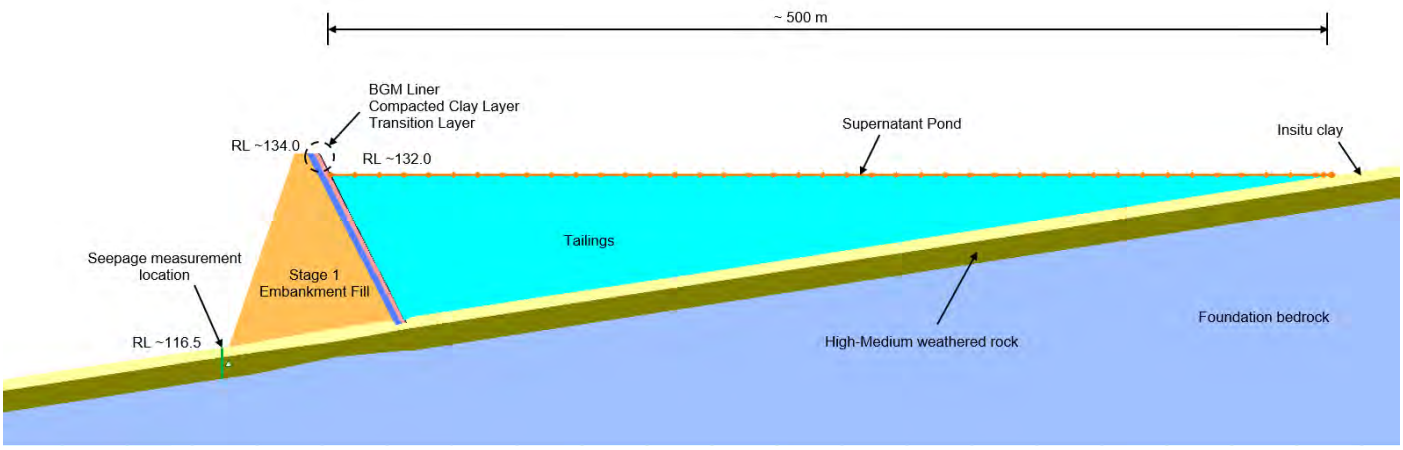

Figure 1.2 Section 1 seepage model – adjacent to main watercourse

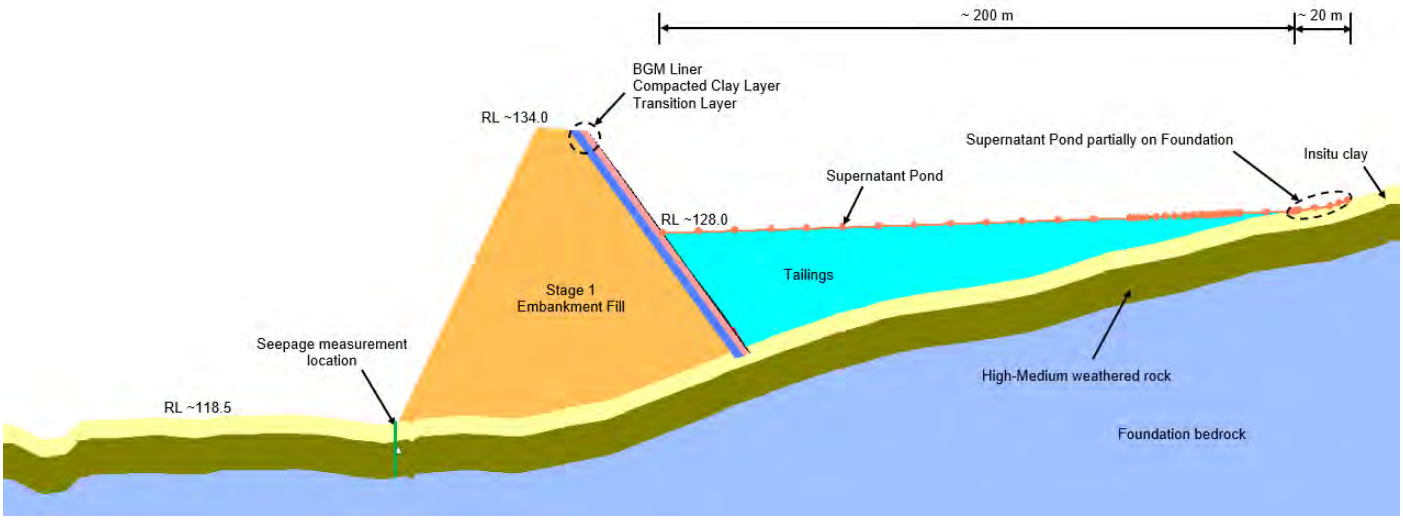

Figure 1.3 Section 2 seepage model – through supernatant pond, near east abutment

1.2.5 Hydraulic parameters

The hydraulic parameters adopted for analysis were based on the 2017 seepage assessment, with a range of values considered for sensitivity analysis and calibration. A comparison of the parameters is presented in Table 1.2. The parameters adopted for the calibrated model are considered as the base case scenario when compared with the sensitivity analyses in Section 1.3.

Table 1.2 Summary of hydraulic parameters

Material type	Parameter adopted in (year)	Hydraulic conductivity (m/s)	Anisotropy (k_v/k_x)	Volumetric water content	Material model
Bituminous Geomembrane Liner	2017	Not considered in 2017 assessment			
	2022	1.00E-09	1	0.10	Saturated
Compacted clay zone (upstream sloping in TSF embankment)	2017	1.00E-10	0.1	0.15	Saturated/ Unsaturated
	2022	1.00E-08	0.1	0.15	Saturated/ Unsaturated
Foundation bedrock – Slightly Weathered to Fresh	2017	1.00E-07	1	0.15	Saturated
	2022	1.00E-07	1	0.15	Saturated
Foundation bedrock – Highly to Moderately Weathered bedrock	2017	5.00E-06	1	0.20	Saturated
	2022	1.00E-05	1	0.30	Saturated
Foundation *in situ* clay	2017	1.00E-09	0.1	0.25	Saturated/ Unsaturated
	2022	5.00E-07	0.1	0.25	Saturated/ Unsaturated
Tailings deposit	2017	1.00E-08	0.1	0.50	Saturated
	2022	1.00E-08	1	0.50	Saturated
Transition zone, upstream sloping in embankment (Compacted screened weathered rockfill)	2017	1.00E-06	1	0.25	Saturated
	2022	1.00E-06	1	0.20	Saturated
Embankment fill (Compacted weathered rockfill)	2017	1.00E-05	1	0.20	Saturated/ Unsaturated
	2022	1.00E-05	1	0.20	Saturated/ Unsaturated

1.2.6 Boundary conditions

The boundary conditions of the seepage calibration model were selected based on historical site information and existing site conditions at the Carrapateena TSF:

- Constant head boundary conditions were applied along the edges of the model to represent the estimated groundwater level at the site of the TSF prior to deposition. The constant head boundaries reflect a groundwater level of about RL 30 m to RL 31 m between the two boundaries of the developed models. These boundary conditions remained in place throughout the sub-phases of Stage 1. Although some mounding of groundwater has occurred, it is relatively minor and at some depth below the base of the TSF and therefore would not influence the rate of seepage from the TSF.

- A 2 m water head over the tailings was modelled to simulate the supernatant pond and saturated tailings.
- A drainage boundary layer was modelled at the downstream toe of the embankment to simulate an open drain for seepage measurement.

1.2.7 Modelling results

The estimated seepage rate from the calibration modelling is presented in Table 1.3.

Table 1.3 2022 Seepage modelling results (base case)

Section	Lateral seepage	
	Flux ($m^3/s/m^2$)	Rate (L/d)
Section 1	1.01E-6	157,000
Section 2	1.95E-6	51,000
Total lateral seepage through the Stage 1 embankment (Base case)		**208,000**

1.3 Sensitivity analysis

An analysis was carried out for the sensitivity of hydraulic parameters on the rate of seepage. The results of the sensitivity analysis are presented in Table 1.4.

Table 1.4 Sensitivity analysis results

Material	Parameter	Value	Lateral Seepage (L/d)			Effect on model
			Section 1	Section 2	Total	
Stage 1 seepage modelling results (Base case)			**157,075**	**50,554**	**207, 619**	-
Tailings deposit	Hydraulic conductivity (m/s)	5.0E-8	237,946	59,357	297,302	High
		1.0E-7	237,715	62,364	336,079	High
Foundation: *in situ* clay	Anisotropy (kv/kx)	1.0	168,739	55,702	224,441	Low
	Hydraulic conductivity (m/s)	9.0E-7	159,719	51,996	211,715	Low
Foundation: Highly to Moderately Weathered bedrock	Anisotropy (kv/kx)	0.01	147,588	47,952	195,540	Low
		0.1	164,851	50,181	215,032	Low
		10	155,053	50,544	205,597	Low
	Hydraulic conductivity (m/s)	2.0E-5	279,936	76,464	356,400	High
Foundation: Slightly Weathered to Fresh bedrock	Hydraulic conductivity (m/s)	1.0E-8	167,495	53,317	220,812	Low

1.4 Conclusion

The shallow lateral seepage measured from the calibrated seepage model is about 200 kL/day for the base case scenario (described in Table 1.3 and Table 1.4). This compares reasonably well to the maximum seepage pump-out rate measured between January 2022 and April 2022 of about 170 kL/day.

Appendix B

Limitation statement

Limitation Statement

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Appendix G

Credible Failure Mode Register

Carrapateena – Tailings Storage Facility – Failure Modes and Controls Register

Risk ID No.	Cause	Credible failure mode (Y/N)	Embankment stages where failure mode is credible	Design controls and mitigating site conditions	Monitoring activities to support design controls
1. Overtopping of TSF or Decant Dam embankment, resulting in scour erosion of the embankment and an uncontrolled release of tailings and/or water.					
1.1.	Significant rain event and flooded impoundment	Y	— TSF embankment – all stages — Decant Dam	— Large flood storage/surge capacity. — Gravity decant system in TSF. — Emergency spillways - Wide trapezoidal shape - Sized assuming water at spillway invert prior to design rain event. - TSF spillway design assumes blockage of gravity decant system. - Decant Dam spillway sized assuming peak outflow from TSF spillway. — Embankment freeboard.	— Maintain minimum Operational Freeboard at the TSF embankment of 0.5 m. — Inspect the supernatant pond to ensure it is in the designated decant area and freeboard is balanced either side of the decant causeway. — Inspect the emergency spillways to ensure they are free of blockages. — Monitor integrity of decant system, including decant inlets and turbidity at pipe junction pit and outlet, checking valve is locked in open position, and checking steel grates are in place.
1.2.	Loss of freeboard due to localised slump of tailings deposit and surge towards the decant/spillway area	Y	— TSF embankment – all stages	— Thickened tailings slurry. — Tailings deposition strategy: cycling between outlets and thin layer deposition following by drying and desiccation.	— Monitor tailings beach shape, rheology, and slurry density. — Monitor rate of tailings deposition and forecast tailings schedule to ensure design rate of rise is not exceeded. — Maintain minimum Operational Freeboard at the TSF embankment of 0.5 m. — Inspect the supernatant pond to ensure it is in the designated decant area and freeboard is balanced either side of the Decant Causeway. — Quarterly tailings beach surveys and capacity assessments, including review of freeboard and surface depressions.
1.3.	Loss of freeboard due to overfilling of tailings storage	Y	— TSF embankment – all stages	— Increasing tailings beach area allows for progressive reduction of rate of rise for tailings deposition. — Tailings deposition strategy (cycling between outlets). — Scheduling and timely capital allocation for future embankment raises.	
1.4.	Isolated loss of freeboard due to unforeseen tailings flow path to embankment	Y	— TSF embankment – all stages	— Tailings deposition strategy: cycling between outlets to distribute tailings.	
1.5.	Loss of freeboard due to post-construction settlement of embankment or due to earthquake induced settlement	Y	— TSF embankment – all stages — Decant Dam	— Additional embankment height for post-construction settlement. — Low earthquake seismicity region.	— Maintain minimum Operational Freeboard at the TSF embankment of 0.5 m. — Monitor embankment for settlement and lateral displacement greater than 30 mm, via Global Navigation Satellite System (GNSS) equipped beacons and interferometric synthetic-aperture radar (InSAR) service.
1.6.	Loss of freeboard due to scour erosion through embankment crest from tailings delivery pipeline break	Y	— TSF embankment – all stages	— Conveyor belt under valves and pipe outlets for scour protection. — Limited design controls available for tailings delivery pipeline. Pipe break erosion assessment for Stage 2 embankment indicates scour erosion through the crest could occur within about 3 to 5 hours.	— Monitor and maintain tailings delivery pipeline for defects and leaks, including valves and flanges at discharge outlets. — Video camera monitoring (hourly checks in control room) of tailings delivery pipeline along embankment crest.
1.7.	Loss of freeboard due to excavation through the embankment crest	Y	— TSF embankment – all stages — Decant Dam	Not applicable	— Monitor for unapproved excavations through the embankment crest. **Develop controls where required for pipeline culverts.**

Risk ID No.	Cause	Credible failure mode (Y/N)	Embankment stages where failure mode is credible	Design controls and mitigating site conditions	Monitoring activities to support design controls
1.8.	Displacement of impounded water or surge of water from failure of an internal structure	Y	— TSF embankment – all stages — Decant Dam	— Existing interim bunds and future bunds within TSF impoundment have limited pond capacity on upstream side. Future bunds to include overflow spillways. — Sediment Control Dam has limited pond capacity on upstream side. Includes passive decant pipe and emergency spillway. — Slope stability assessments for Decant Causeway. Foundation improvement measures for construction over tailings. — Large flood surge capacity and emergency spillways designed for respective catchment areas.	— Monitor for non-designed structures / modifications within impoundments. — Monitor and manage pond location at Decant Causeway and balance freeboard either side to maintain stability.
1.9.	Displacement of impounded water due to a landslide into the storage area	N	Nil	— Relatively gentle valley slopes upslope of impoundments. — Borrow pits at edges of impoundments have limited potential for ponding and/or low risk of landslide due to shallow depth to quartzite bedrock.	Not applicable
1.10.	Displacement of impounded water in the Decant Dam due to failure of the TSF embankment	Y	— Decant Dam	— As per TSF design controls and monitoring activities.	
2. **Slope Instability of TSF or Decant Dam embankment, resulting in slope failure and an uncontrolled release of tailings and/or water**					
2.1.	Loss of embankment fill strength due to seepage and high phreatic surface	Y	— TSF embankment Stages 1 to 3 — Decant Dam	— TSF embankment formed with compacted rockfill. — Decant Dam embankment formed with compacted rockfill shoulders either side of a compacted clay core. — Embankment design allows for high phreatic surface. - Slope stability assessment for TSF Stage 2 embankment to inform pore pressure triggers. **Assessment to be updated for Stage 3 raise.** - Slope stability assessment for Decant Dam embankment indicates there are no pore pressure triggers for instability. — Bituminous Geomembrane liner on the upstream slope of the TSF embankment. — Bituminous Geomembrane lined cell in the Decant Dam.	— Inspect the supernatant pond to ensure it is in the designated decant area. — Maintain bituminous geomembrane liner free of significant defects. — Monitor vibrating wire piezometers (VWPs) to ensure pore pressures remain below equivalent critical phreatic surface for TSF embankment slope stability.
		Y	— TSF embankment Stages 4 to 6	— Bituminous Geomembrane liner on the upstream slope of the TSF embankment raises. — Supernatant pond located some distance from the embankment. — Life of Mine seepage assessment indicates the phreatic surface does not develop in the embankment, i.e., does not extend through the foundation of the upstream raises. — Embankment design based on slope stability assessment for high phreatic surface. **Pore pressure triggers to be developed for each stage design.**	

Risk ID No.	Cause	Credible failure mode (Y/N)	Embankment stages where failure mode is credible	Design controls and mitigating site conditions	Monitoring activities to support design controls
2.2.	Low strength foundation and or loss of foundation strength due to seepage and/or embankment load	Y	— TSF embankment Stages 1 to 3 — Decant Dam	— Geotechnical investigations have typically identified clayey soil and shallow depth to quartzite bedrock. Alluvium at Decant Dam foundation in watercourse area. — Reduced strength of foundation clay adopted in TSF embankment stability assessments. — Rockfill shear keys into bedrock for TSF Stage 2 embankment foundation. Removal of clay within critical areas of foundation for the Stage 3 raise based on embankment slope stability assessment. — Seepage depressurisation system in Stage 2 embankment foundation in watercourse area. — Sediment Control Dam limits Decant Dam water from backing up to the TSF embankment. Passive outlet limits sustained pond in Sediment Control Dam that may form against downstream toe of TSF embankment. — Cut-off key trench through alluvium to bedrock in Decant Dam embankment foundation. Embankment slope stability assessment for as-constructed geometry.	— Monitor VWPs to ensure pore pressures remain below equivalent critical phreatic surface for TSF embankment slope stability. — Monitor for cracks.
		Y	— TSF embankment Stages 4 to 6	— Tailings deposition strategy: cycling between outlets and thin layer deposition followed by drying and desiccation, alternating between up-valley and down-valley deposition to limit accumulations of saturated tailings that may be susceptible for liquefaction. — Embankment slope stability assessments assume tailings in foundation of upstream raises has liquefied. Adopted design measures to address low strength tailings: - Upstream toe berms to limit upstream slope failure. - Rockfill shear keys at downstream toe of upstream raises. — Geotechnical investigation to identify any weak tailings in the foundation of upstream embankment raises. — Low earthquake seismicity region, therefore, low risk of dynamic liquefaction of tailings. — Numerical deformation analyses for liquefaction of tailings in foundation of upstream raises. — Seepage depressurisation system in upstream raise foundation.	
2.3.	Cracks in embankment due to variable foundation conditions and/or embankment fill conditions	Y	— TSF embankment - all stages — Decant Dam	— Natural ground foundation for TSF embankment (Stages 1 to 3) and approaches to abutments (Stages 4 to 6). Clayey soil and quartzite bedrock. — Transition/filter zones either side compacted clay core in Decant Dam embankment. — Numerical deformation analyses for liquefaction of tailings in foundation of upstream raises.	— Monitor embankment for cracks larger than 10 mm wide. — Monitor embankment for settlement and lateral displacement greater than 30 mm, via GNSS equipped beacons and InSAR.

Risk ID No.	Cause	Credible failure mode (Y/N)	Embankment stages where failure mode is credible	Design controls and mitigating site conditions	Monitoring activities to support design controls
2.4.	Scour erosion due to flood event and/or pond fetch, resulting in reduction of resistive forces	Y	— TSF embankment – all stages — Decant Dam	— Decant area is some distance from TSF embankment from Stage 2 onwards. — Coarse rockfill on the downstream slope of the TSF embankment and large portion of the toe area for erosion protection. — Coarse rockfill on the upstream and downstream slopes of the Decant Dam embankment. — Bituminous Geomembrane liner on the upstream slope of the TSF embankment and in the cell of the Decant Dam. — Wearing course and embankment crest cross-fall, with drainage slots through the safety bund at the upstream edge.	— Monitor condition of erosion protection measures and/or eroded slopes, and repair as required. — Maintain water in the lined cell of the Decant Dam during normal operation.
2.5.	Scour erosion due to flood event and inadequate spillway erosion protection	Y	— TSF embankment – all stages — Decant Dam	— Spillway excavated into bedrock. Spillways configured to direct outflow away from embankments. — Reinforced concrete sill beam.	— Monitor spillway surface, including sill beam.
2.6.	Scour erosion from tailings slurry discharge onto embankment	Y	— TSF embankment – all stages	— Conveyor belt under valves and pipe outlets for scour protection.	— Monitor and maintain tailings delivery pipeline for defects and leaks, including valves and flanges at discharge outlets.
2.7.	Undercutting excavation, resulting in reduction of resistive forces	Y	— TSF embankment – all stages — Decant Dam	Not applicable.	— Monitor for unapproved excavation in embankment slopes or within 30 m of the embankment toe.
2.8.	Tree root depressions and erosion at slope and/or toe	N	Nil	Tree growth in region is limited to natural watercourses.	Not applicable
2.9.	Excessive loading of embankment	Y	— TSF embankment – all stages — Decant Dam	— Driving width between safety bunds restricts size of vehicles that can access embankments.	— Signage indicates maximum load of vehicles that can access embankments.
2.10.	Rapid drawdown and loss of stabilising effect of water on the embankment	Y	— TSF embankment – all stages — Decant Dam	— Decant area is some distance from TSF embankment from Stage 2 onwards. — Bituminous Geomembrane liner on the upstream slope of the TSF embankment. — Bituminous Geomembrane liner in cell of Decant Dam. — Transition layer, compacted rockfill shoulder and coarse rockfill layer on upstream face of compacted clay core in the Decant Dam embankment.	— Maintain bituminous geomembrane liner free of significant defects. — Maintain water in the lined cell of the Decant Dam during normal operation.

Risk ID No.	Cause	Credible failure mode (Y/N)	Embankment stages where failure mode is credible	Design controls and mitigating site conditions	Monitoring activities to support design controls
3. Internal Erosion					
3.1.	Seepage via loose fill or other pathways in embankment and concentrated leak erosion or backward piping erosion	Y	— TSF embankment – all stages — Decant Dam	— Supernatant pond some distance from TSF embankment from Stage 2 onwards. — Controlled selection and compaction of embankment fill. — Transition layer on downstream side of compacted clay in Stage 1 TSF embankment to limit migration of clay particles into rockfill. — Transition zone on upstream side and filter zone on downstream side of compacted clay core in Decant Dam embankment. — Upstream toe drain for TSF embankment to locally depressurise tailings. — Seepage depressurisation system in Stage 2 embankment foundation in watercourse area. — Seepage depressurisation system in upstream raise foundation. — Bituminous Geomembrane liner on the upstream slope of the TSF embankment and in the cell of the Decant Dam.	— Maintain bituminous geomembrane liner free of significant defects. — Maintain water in lined cell of Decant Dam during normal operation. — Monitor downstream slope and toe of embankment for signs of seepage flow. — Monitor embankment slopes for erosion.
3.2.	Seepage via loose fill around pipe penetrations and concentrated leak erosion or backward piping erosion	Y	— TSF embankment – all stages	— Supernatant pond some distance from pipe penetrations for Stages 2 to 6. — Concrete encasement where pipes penetrate Stage 1 compacted clay layer on upstream face of embankment. Transition layer on downstream side of compacted clay. — Batten bar connection of bituminous geomembrane liner to concrete encasement. — Sand encasement downstream of concrete encasement for seepage depressurisation. Low fines content in sand for filter function. — Bituminous geomembrane liner over concrete encasement for brine and enviro pipe penetrations through Stage 2 embankment. Filter berm over end of grouted pipes.	— Monitor outlet area of pipe penetrations for seepage discharge. — Monitor downstream slope of embankment for signs of seepage flow.
3.3.	Seepage via sand encasement around pipe penetrations and concentrated leak erosion of interface material	Y	— TSF embankment – all stages	— Concrete block installed at downstream end of sand encasement of decant outfall pipes. — Filter berm over end of grouted brine and enviro pipes.	— Monitor downstream slope and toe of embankment for signs of seepage flow.
3.4.	Seepage through clay on crest of Stage 1 embankment and concentrated leak erosion or backward piping erosion	Y	— TSF embankment – Stage 2 onwards	— Supernatant pond some distance from embankment from Stage 2 onwards. — Test slots excavated to assess clay integrity (indicating that connection of the Stage 1 and 2 liners is not required). — Transition layer under compacted clay at crest of Stage 1 embankment, to limit migration of clay particles into rockfill. — Tailings deposition strategy (cycling between outlets).	

Risk ID No.	Cause	Credible failure mode (Y/N)	Embankment stages where failure mode is credible	Design controls and mitigating site conditions	Monitoring activities to support design controls
3.5.	Gravity decant system collapse	Y	— TSF embankment – all stages	— Pipe designed for predicted embankment/tailings load, internal scour and deflection. **Assessment to be undertaken for updated Life of Mine load and earthquake load.** — Low earthquake seismicity region, therefore low risk of decant system failure due to seismic load.	— Monitor integrity of decant system, including decant inlets and turbidity at pipe junction pit and outlet, check valve is locked in open position, and checking steel grates are in place.
3.6.	Contact erosion due to cracks in embankment foundation, or horizontal interfaces between fine and coarse materials	Y	— TSF embankment – all stages — Decant Dam	— Compacted weathered rockfill TSF embankment and compacted rockfill shoulders in Decant Dam embankment. — Rockfill shear keys constructed in foundation of Stage 2 TSF embankment raise. — Open cracks not observed in foundation of existing embankments. — Cut-off key in Decant Dam embankment foundation to intercept cracks and/or open joints.	— Maintain water in lined cell of Decant Dam during normal operation. — Monitor downstream slope of embankment for signs of seepage flow.
3.7.	Internal erosion due to dispersive soil	N	Nil	Geotechnical investigations have not identified dispersive soil at embankment foundation or for fill used to form embankment.	Not applicable.
3.8.	Animal borrows and decaying tree roots	N	Nil	— No known species of burrowing animals on site. — Tree growth in region is limited to natural watercourses. Furthermore: — Coarse rockfill on slopes of slope of Decant Dam embankment and downstream slope of TSF embankment would limit burrowing or tree growth. Bituminous geomembrane lined areas would also prevent burrowing and tree growth. — Compacted rockfill TSF embankment and compacted rockfill shoulders at Decant Dam embankment.	Not applicable.

HQ/DAA

Appendix H

Dam Breach Assessment

BHP, owner of OZ Minerals Carrapateena Pty Ltd

November 2024

Tailings Storage Facility - Dam Breach Assessment for Life of Mine Study CA-3630-CIV-REP-1097 Rev0

Carrapateena, South Australia

Question today
Imagine tomorrow
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Tailings Storage Facility - Dam Breach Assessment for Life of Mine Study
CA-3630-CIV-REP-1097 Rev0
Carrapateena, South Australia

BHP, owner of OZ Minerals Carrapateena Pty Ltd

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We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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1 Introduction

This report presents BHP, owner of OZ Minerals Carrapateena Pty Ltd, with a dam breach assessment for the Stage 3 and Stage 6 (final) layout for the Carrapateena Tailings Storage Facility (TSF).

The assessment comprises analyses of four failure scenarios: one for the future Stage 3 layout and three for the future Stage 6 layout, using the end of filling beach models developed in the Life of Mine assessment[1].

- **Scenario 1**: Static liquefaction failure of the upstream raises of the Stage 6 embankment at the end of Stage 6 filling, followed by erosion of the downstream embankment down to natural ground. This scenario adopts the flatter beach profile from the Life of Mine assessment, and was a post-flood day scenario.
- **Scenario 2:** Overtopping failure of the Stage 6 embankment at the end of Stage 6 filling, triggered by erosion of the crest due to a breach of the main tailings delivery pipeline. Erosion from overtopping occurs from the Stage 6 crest to natural ground, and was a post-flood day scenario.
- **Scenario 3:** Overtopping failure of the Stage 3 embankment at the end of Stage 3 filling, triggered by erosion of the crest due to a breach of the main tailings delivery pipeline. Erosion from overtopping occurs from the Stage 3 crest to natural ground, and was a post-flood day scenario.
- **Scenario 4:** Static liquefaction failure of the upstream raises of the Stage 6 embankment at the end of Stage 6 filling, followed by erosion of the downstream embankment down to natural ground. This scenario adopts the flatter beach profile from the Life of Mine assessment, and was a sunny day scenario.

All scenarios considered a breach of the embankment in the region of the eastern watercourse, i.e., at the location where the embankment is highest.

[1] Tailings Storage Facility, Staged Life of Mine Concept Layouts, Carrapateena ref: CA-3630-CIV-REP-1096, WSP ref: PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

2 Site description and background

2.1 Site overview

The TSF is located about 4.5 km south-south-east of the ore processing plant and about 15 km south of the Carrapateena arm of the ephemeral Lake Torrens (refer Figure 2.1 for site overview). The facility comprises a tailings storage area and a Decant Dam, both of which are formed by cross-valley embankments across the ephemeral Eliza Creek. Stage 2 TSF embankment raise construction and installation of the Stage 2 tailings distribution system was completed in early 2023 and operation of the Stage 2 layout commenced in late March 2023 with tailings deposition from the raised embankment. Since late March 2023, the switch from down-valley deposition (Stage 1) to up-valley deposition at Stage 2A has moved the supernatant pond away from the embankment and to the Decant Causeway.

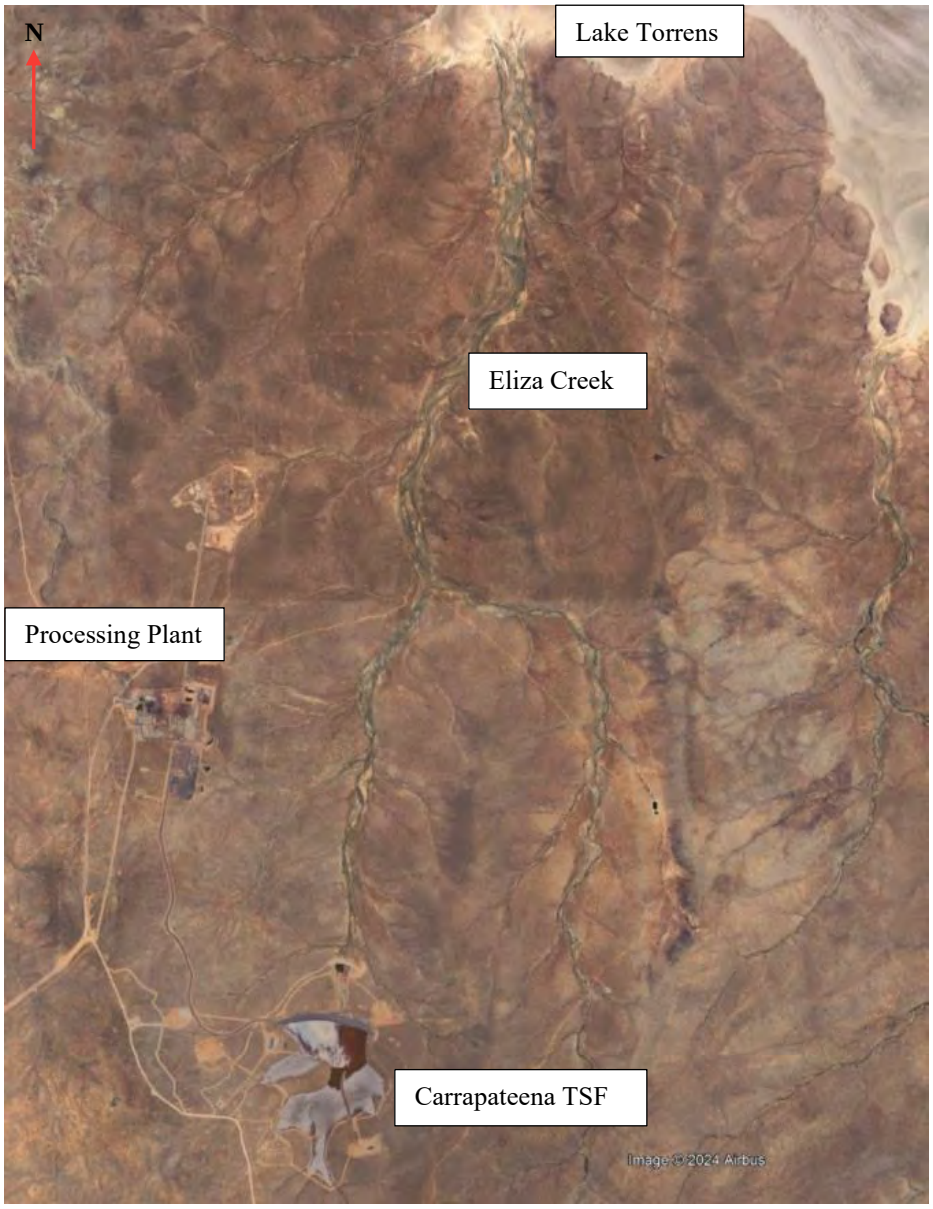

Figure 2.1 Carrapateena site overview (image source: Google Earth, February 2024 (TSF), October 2023 (Downstream Eliza Creek))

For the Stage 2A layout, tailings are deposited up-valley into the TSF from a series of 28 outlet pipes along the TSF embankment, fed by a tailings delivery pipeline. Tailings are deposited as a slurry with an average mass concentration of about 59% (weight of solids over total weight of solids and water), as per records for the period between January 2023 and January 2024 (refer to Annual Inspection Report[2]).

This assessment adopted the future predicted end of filling layouts for Stage 3 and Stage 6. General layouts of these stages per the Life of Mine staging and concept layouts report[3] are presented in Figure 2.2 and Figure 2.3.

2.2 Beach model and TSF layout

For the Scenarios considered in this dam breach assessment, the 'flatter' beach slope scenario was adopted. The beach models adopted were as per the Life of Mine staging and concept layouts report issued in September 2024 and are presented in Figure 2.2 and Figure 2.3. The flatter scenario for the Stage 3 layout has more tailings in the facility, with a total of about 48.3 million dry tonnes (Mdt) compared to 36.3 Mdt in the steeper scenario and is therefore considered more conservative to assess. For Stage 6, the flatter scenario is also more conservative, as there is more tailings closer to the embankment and therefore there is a greater potential tailings release volume.

[2] *Tailings Storage Facility - Annual Inspection Report January 2023 to January 2024*, Carrapateena ref. CA-3630-CIV-REP-1094, WSP report ref. PS200475-WSP-MEL-MNG-REP-00019 Rev0, 8 March 2023.

[3] *Tailings Storage Facility, Staged Life of Mine Concept Layouts*, Carrapateena ref: CA-3630-CIV-REP-1096, WSP ref: PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

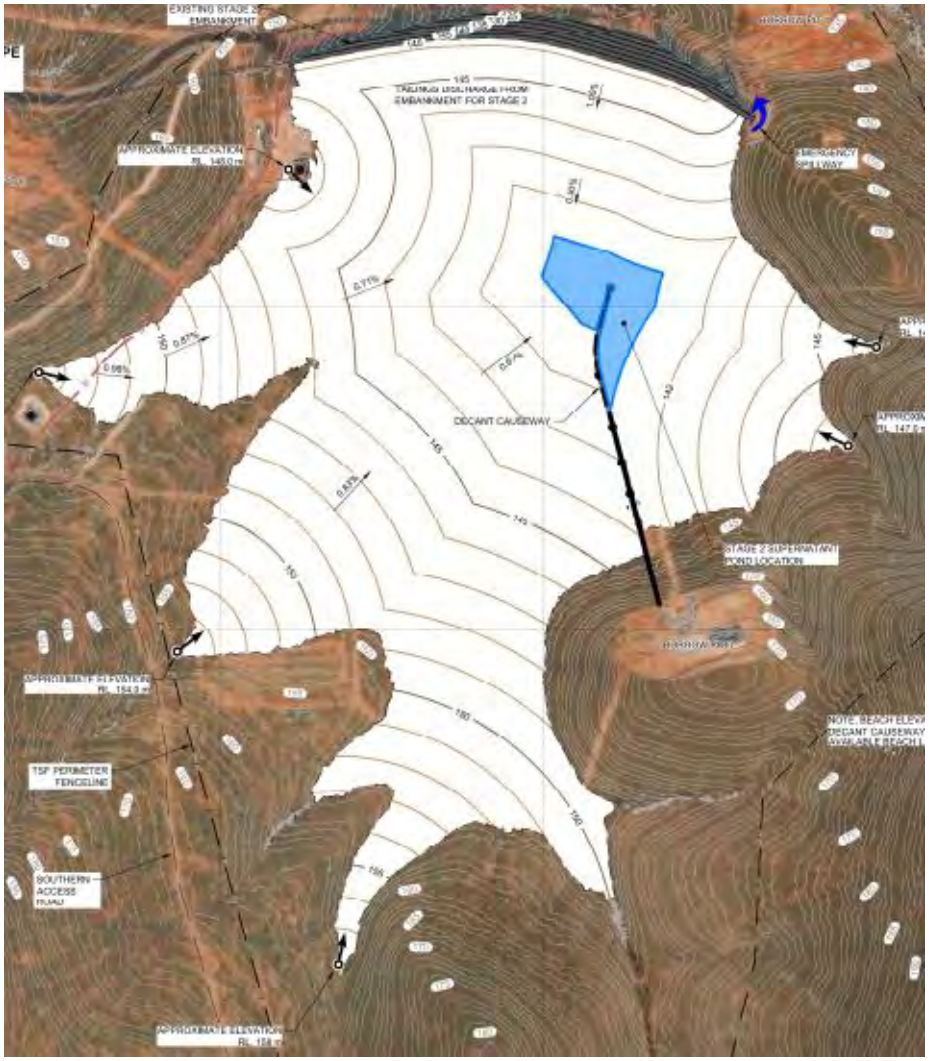

Figure 2.2 Stage 3 predicted end of filling layout – flatter beach slope scenario

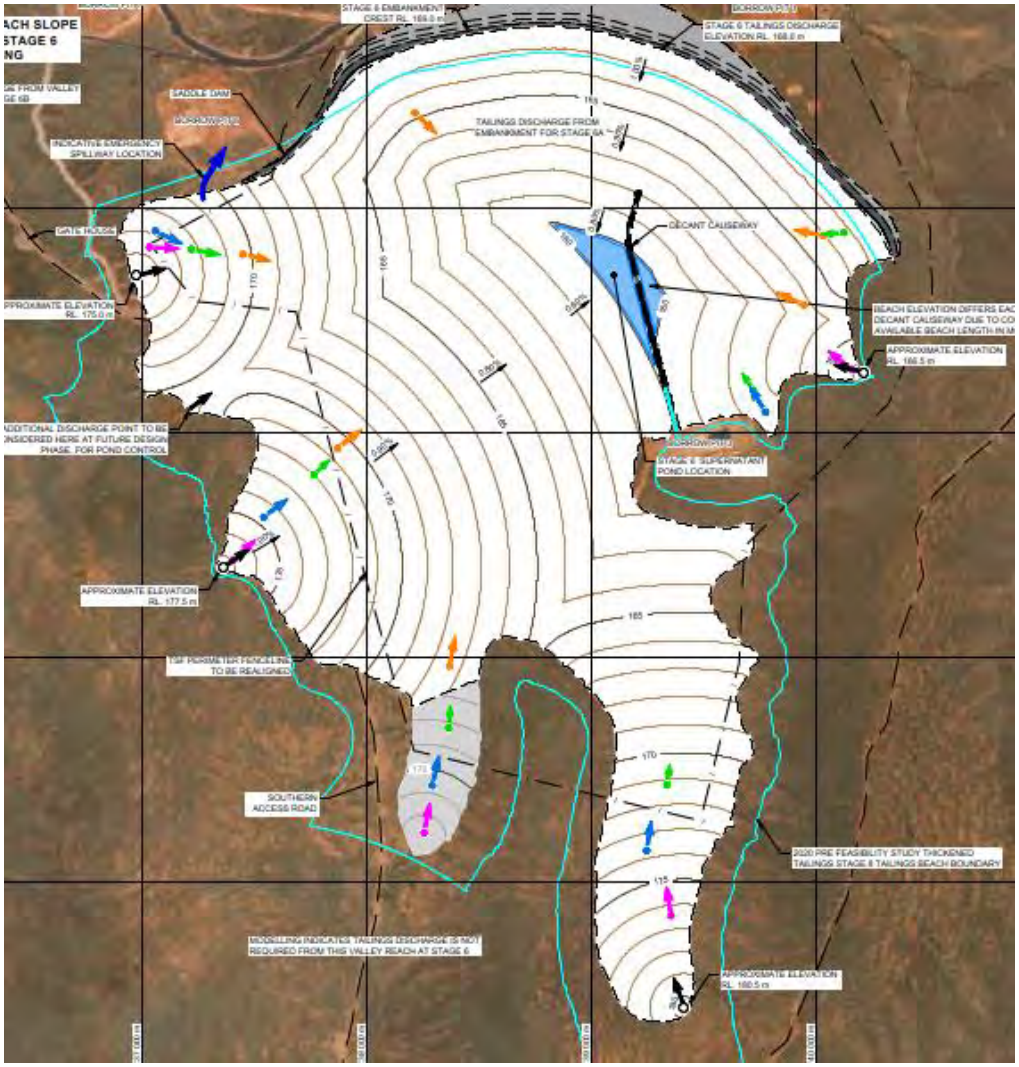

Figure 2.3 Stage 6 predicted end of filling layout – flatter beach slope scenario

2.3 TSF characteristics

The key characteristics of the Carrapateena TSF adopted in this assessment are summarised in Table 2.1.

Table 2.1 Summary of key characteristics for Carrapateena TSF

Characteristic	Current layout	Layouts for dam breach analysis	
	Stage 2 embankment	Stage 3 embankment	Stage 6 embankment
Location	Latitude: 31° 17' 17" S Longitude: 137° 30' 45" E		
Total reporting catchment area (ha)	1,390		
Embankment crest width (m)	8		
Embankment crest elevation (RL m)	146.7	157.5	169
Spillway invert elevation (RL m)	145.7	156.5	168
Maximum height of embankment (m) **(Note 1)**	29	40.5	52
Upstream slope gradient	2.7H:1V (**Note 2**)	3H:1V	3H:1V
Downstream slope gradient	3H:1V	3H:1V	3H:1V

Table 2.1 notes:

1. Above watercourse centreline and measured between crest and downstream toe.
2. Upstream slope gradient of 2.7H:1V for Stage 2 embankment, upstream slope gradient of 3H:1V for Stage 1 embankment.

2.4 Previous assessments

A dam breach assessment[4] was completed in 2017 for the Stage 6 concept design layout of the TSF, for storage of 145 Mdt of tailings. This assessment analysed the runout extent in Eliza Creek downstream of the facility, from the TSF and Decant Dam separately, as non-Newtonian, and Newtonian flows respectively:

- Runout of 21.75 Mm^3 of tailings from the Stage 6 layout of the TSF. This volume represented 30% of the predicted end of filling volume of 72.5 Mm^3 of tailings. The (then) predicted average dry density was 2.0 t/m^3, however 1.7 t/m^3 was adopted for conservativism. A volumetric solids concentration of 50% v/v (volume of solids over total volume of solids and water) was adopted for the mobilised tailings. No ponded water on the tailings surface was considered for this scenario.
- Runout 0.5 Mm^3 (500 ML) of water from the Decant Dam, considering operational water of about 40 ML and estimated runoff from a 1 in 100 AEP, 72-hour rain event of about 460 ML.

The analyses were for breach of the respective embankments and runout downstream along Eliza Creek towards Lake Torrens. For the assessment, it was assumed the Decant Dam embankment had failed first, followed by the TSF embankment, i.e., the tailings runout was not mitigated by the Decant Dam. The embankment breach mechanism considered in each model was internal erosion, noting that mechanisms for consideration in modelling software at the time were limited.

[4] Carrapateena Project - *Carrapateena Project - Tailings Storage Facility Dam Break Study*, WSP ref: 1660055-009-M-Rev3, 21 March 2017.

These analyses indicated potential runout extents of up to 8 km from the TSF embankment failure, and about 16 km (into Lake Torrens) from the Decant Dam failure, with a total superimposed runout area of about 11.6 km^2, without considering the impact area in Lake Torrens.

The Newtonian flow of water showed runout reaching Lake Torrens, about 15 km downstream of the Decant Dam, after about 10 hours. The non-Newtonian tailings flow showed runout ceasing about 8 km downstream of the TSF, after about 11 hours. For the tailings runout analysis, the Carreau model[5] was adopted to simulate the behaviour of the tailings outflow in Flow 3D modelling software, using rheology data adopted from literature[6].

[5] Carreau, P. J. (1972). Rheological Equations from Molecular Network Theories. *Transactions of The Society of Rheology, 16* (1), 99-127. doi:10.1122/1.549276

[6] Julien, P. Y., & Lan, Y. (1991). *Rheology of Hyperconcentrations.* Journal of Hydraulic Engineering, 117(3), 346-353. doi:10.1061/(ASCE)0733-9429(1991)117:3(346)

3 Dam failure overview

3.1 Failure mechanisms

There are three failure mode categories for embankment dams: overtopping, internal erosion and slope instability. These are described below:

- **Overtopping Failure**: Overtopping primarily occurs when the pond storage capacity is insufficient to contain a rain event and/or the spillway capacity is insufficient to discharge a rain event, freeboard is compromised, and the embankment crest overtops. Spillway capacity could be constrained if the outlet is inadequately sized, blocked/obstructed, or damaged.

  Freeboard could be compromised if:

  - The embankment crest elevation is reduced, e.g., due to seismic loading causing deformation and settlement or by a break of a tailings pipeline causing scour erosion and loss of freeboard.
  - The available freeboard is reduced by overfilling by tailings deposition.

- **Internal erosion (including piping erosion)**: Internal erosion failure occurs when seepage through an embankment and/or the foundation starts to dislodge and remove solid particles and discharge the solids in suspension downstream of the embankment. For internal erosion to occur, there would need to be a sufficient hydraulic gradient, soil that is susceptible to internal erosion and a preferential pathway. The four sub-categories of internal erosion, as described by the US Society on Dams (USSD[7]) are:

  - Concentrated leak erosion.
  - Backward piping erosion.
  - Contact erosion.
  - Internal instability.

- **Slope instability:** instability of an earthen embankment slope is typically caused by one of the following mechanisms:

  - High pore water pressure in the embankment: An increase in pore pressure results in a decrease in the shear strength of embankment fill, which could lead to slope failure, slumping/sloughing, deformation, and ultimately loss of the facility through overall failure. A rising phreatic surface may also increase the likelihood of conditions conducive to static liquefaction where tailings are contractive. (Applicable to future proposed upstream raises of the Carrapateena TSF).
  - Removal of resistive forces along upstream or downstream slopes: The resistive forces could be a portion of the embankment. Failure of the slope could result if the geometry of an embankment is modified, either by steepening a slope or an undercutting excavation at the toe of an embankment.
  - Excessive erosion of embankment slopes: Excessive erosion could cut into the embankment crest and/or slope, resulting in instability and slope failure, due to removal of resistive forces e.g., through wind or surface water/rainfall runoff.

[7] United States Society on Dams (USSD), *Introduction to Internal Erosion in Dams and their foundations*., December 2021

- Foundation failure: Failure of the foundation of an embankment could occur in several ways, including through excessive loading that exceeds the strength of the foundation material, through seepage and strength reduction, through seismic loading, or through weak zones in the foundation. Foundation failure could result in slope instability due to excessive deformation or overtopping due to excessive settlement.
- Differential settlement: Can occur within the embankment or at the abutments (e.g., at the transition between natural ground and tailings foundation for future upstream raises), resulting in cracking of an embankment and subsequent slope instability. Pond water, possibly exacerbated by a large rain event, could lead to erosion and progressive widening of the crack, destabilising an embankment slope.

The analyses presented in this report considered overtopping due to a tailings delivery pipe break scenario reducing embankment freeboard for the Stage 3 and Stage 6 layouts, and liquefaction failure for Stage 6 initiated in the upstream raised portions of the embankment (refer Section 4 for failure mechanisms).

3.2 Sunny day vs. flood day scenarios

The potential for dam failure and the consequence category for a dam is generally determined by assessing the consequence of dam failure under two different climatic scenarios:

- **Sunny Day Failure**: Failure occurring without any rainfall or natural flooding during the dam breach. As noted in Section 4, Sunny Day failure can consider a post-flood day pond. The consequence of failure is taken as the impact of the entire inundation extent.
- **Flood Induced Failure**: Failure that occurs during a natural flood event. The consequence of failure is taken as the impact of the incremental increase in flood extent from the natural flood extent.

3.3 Flow behaviour – Newtonian vs. non-Newtonian

A tailings dam breach analysis is generally more complex than a water dam breach analysis. Depending upon the solids concentrations of the released tailings and water, the slurry can possess Newtonian (e.g., water) or non-Newtonian characteristics (e.g., mud floods, mud flows). In general, for water floods, the travel time will be faster, and the inundation area will be larger than for mud floods. Non-Newtonian assessments have a larger data requirement due to characterisation of the tailings flow properties.

The spectrum of flow behaviour as a function of solids concentration is provided by the Canadian Dams Association (CDA)[8] and is presented in Table 3.1 and Figure 3.1 below. The flow characteristics consider suspended sediment from a potential discharge, rubble collected in a potential breach, and the potential for of tailings from a breach.

[8] Canadian Dams Association (CDA). (2021). *Technical Bulletin: Tailings Dam Breach Analyses*.

Table 3.1 Flow behaviour as a function of solids concentration (Table 8.1, CDA Technical Bulletin, 2021)

Dam breach assessment case (CDA)	Flow type	Solids concentration by volume (Note 1, 2)	Flow Characteristics (Not TSF specific)
1A, 1B	Water Flood	< 0.20	Water flood with conventional suspended sediment load and bedload.
	Mud flood	0.20 to 0.30	Distinct wave action; fluid surface; all particles resting on channel bed in quiescent fluid condition.
		0.30 to 0.35	Separation of water on surface; waves travel easily, most sand and gravel size particles have settled out and move as bedload.
		0.35 to 0.40	Marked settling of gravel and cobble size. particles; spreading nearly complete on horizontal surface; liquid surface with two fluid phases appears; waves travel on surface.
1A, 2A (**Note 3**)		0.40 to 0.45	Flow mixes easily; shows fluid properties in deformation; spreads on horizontal surface but maintains an inclined fluid surface; waves appear but dissipate rapidly.
2A (**Note 3**)	Mudflow/ Flow slide/ Tailings flow	0.45 to 0.48	Flow of saturated, liquefied tailings at or above liquid limit forming a slurry; may show fluid like properties.
		0.48 to 0.55	Flow of saturated liquefied tailings; may show fluid like properties.
2B (**Note 4**)	Slumping / Flow slide / Debris flow	0.55 to 0.65	Various forms of outflow movement of non-liquefied, partly, or fully saturated tailings, does not show fluid properties.
		0.65 to 0.80	Various forms of outflow movement of non-liquefied, moist, or partly saturated tailings, does not show fluid properties.

Table 3.1 notes (as per Table 8.1 from CDA Bulletin):

(1) The conversion from solids concentration by volume (C_v) to solids concentration by weight (C_w) is based on the Specific Gravity for sediments of 2.65.

(2) The solids concentration in the outflow is not the only parameter that defines the tailings rheology and the flow liquefaction, as the tailings composition, chemistry, gradation, and downstream topography (e.g., slope inclination, degree of confinement) may also impact the outflow behaviour.

(3) The flow of liquefied tailings can be similar to mud floods with higher solids concentrations or mudflows depending on the water content, relative volume of outflow, tailings characteristics, topographic conditions, etc.

(4) For Case 2B solids concentration is not the only factor; the site-specific liquefaction potential of the tailings should be evaluated prior to defining the relevant Tailings Dam Breach Analysis case.

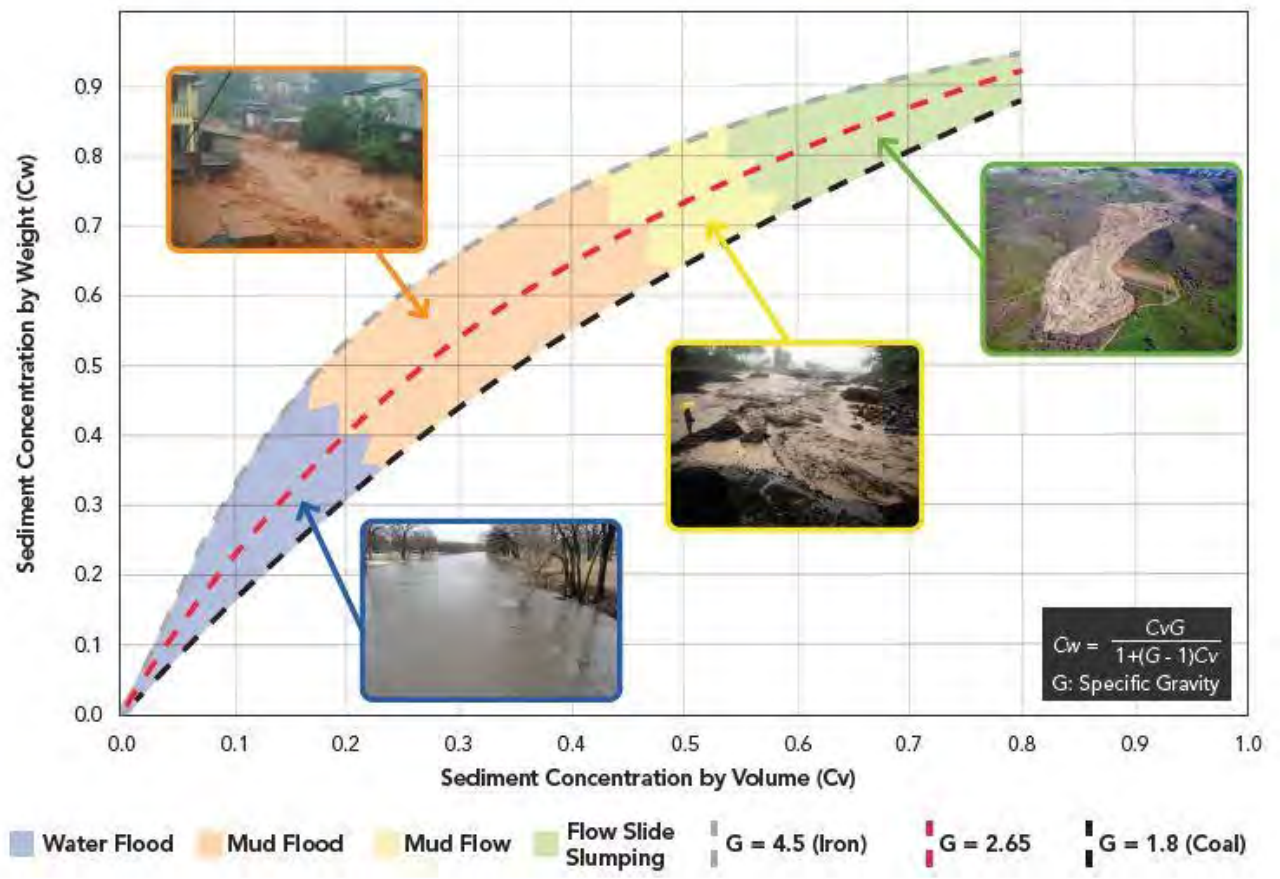

Figure 3.1 Flow type behaviour as a function of solids concentration (Figure 8.1, CDA Technical Bulletin, 2021)

3.4 Australian Rainfall Runoff guidelines – flood severity

The inundated area can be categorised by flood severity to assess the potential hazard. The flood severity indicates the likely impact/damage caused by the flood to people, vehicles, and buildings. Guidance on categorisation of the flood severity provided in the Australian Rainfall and Runoff (ARR) guidelines[9] was used for this assessment.

Flood severity in ARR is described by six hazard classifications, based on the maximum flood depth, velocity, and depth-velocity product (DV) at a given location. The adopted hazard classifications are presented graphically in Figure 3.2 and are tabulated in Table 3.2 from the ARR guidelines, adapted from a report by the UNSW Water Research Laboratory[10].

[9] Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, P., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff - A Guide to Flood Estimation*.

[10] Smith, G. P., Davey, E. K., & Cox, R. J. (2014). *Flood Hazard UNSW Australia Water Research Laboratory Technical Report 2014/07*. Retrieved from Manly Vale, New South Wales.

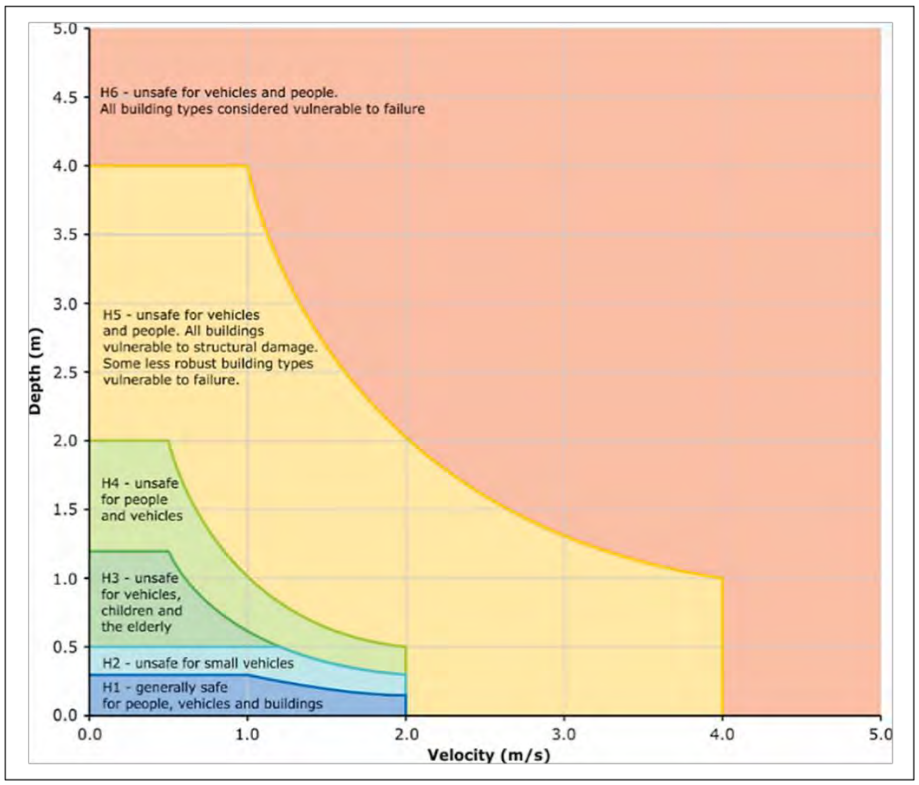

Figure 3.2 Combined flood hazard curves (Figure 6.7.9, ARR 2019)

Table 3.2 Vulnerability thresholds classification limits of flood hazard curves (Tables 6.7.3 and 6.7.4, ARR 2019)

Hazard vulnerability classification	Description of hazard classification	Depth-velocity product (DV) (m^2/s)	Limiting still water depth (m) (Note)	Limiting velocity (m/s)
H1	Generally safe for vehicles, people, and buildings.	≤ 0.3	0.3	2.0
H2	Unsafe for small vehicles.	≤ 0.6	0.5	2.0
H3	Unsafe for vehicles, children, and the elderly.	≤ 0.6	1.2	2.0
H4	Unsafe for vehicles and people.	≤ 1.0	2.0	2.0
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.	≤ 4.0	4.0	4.0
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.	> 4.0	-	-

Table 3.2 Note: The 'limiting still water depth' relates to a zero velocity for the flood hazard curves. It is a boundary value on the flood severity classification.

3.5 Breach locations

The breach location is the location or portion of embankment where the failure originates from. When undertaking a dam breach analysis, the selected breach location has a direct influence on the potential estimated impact. For the dam breach analyses for the Stage 3 and Stage 6 layouts, the breach location was selected considering the following:

- Maximising the potential outflow volume, i.e., typically the location where the embankment is highest.
- Maximising of failure reach length, i.e., proximity to natural watercourses that would carry the outflow the furthest from the facility.

4 Failure scenarios

4.1 Adopted failure scenarios

Two failure modes were adopted in the dam breach analyses:

1 A failure of the main tailings delivery pipeline, leading to erosion of the embankment crest and loss of freeboard, followed by overtopping and further erosion. For a detailed description of this failure simulation, refer to the pipe break assessment[11] completed in 2024 for the Stage 2 layout.

2 For Stage 6, static liquefaction of the upstream raised embankment (Stages 4 to 6), followed by erosion of the downstream raised embankment (Stages 1 to 3).

The scenarios adopted for the dam breach analyses, as outlined in the Basis of Assessment[12] are summarised in Table 4.1.

Table 4.1 Summary of scenarios for the Carrapateena TSF dam breach analyses

Scenario	Breach location	Failure mechanism	Weather condition	Stage and layout (Note 1)	Ponded water
1	TSF Embankment	Slope instability by liquefaction of tailings	Post-flood day	End of Stage 6, flatter tailings beach scenario	72 hr Probable Maximum Precipitation (PMP) **(Note 2)**
2	TSF Embankment	Overtopping by tailings pipe break erosion	Post-flood day	End of Stage 6, flatter tailings beach scenario	72 hr PMP **(Note 2)**
3	TSF Embankment	Overtopping by tailings pipe break erosion	Post-flood day	End of Stage 3, flatter tailings beach scenario	72 hr PMP **(Note 2)**
4	TSF Embankment	Slope instability by liquefaction of tailings	Sunny day	End of Stage 6, flatter tailings beach scenario	Operational pond

Table 4.1 Notes:

(1) Refer to Life of Mine staging and concept layouts[13] and Section 2 of this report.

(2) Assigned an Annual Exceedance Probability of 1 in 10 million in the climate assessment[14]

The weather conditions considered are ‘post-flood-day’ and differ from a flood day assessment as it does not consider the background flood conditions during the breach. The post-flood day for this assessment considers that a background PMP event has passed prior to the breach, leaving a large volume of water in the TSF. The sunny day assessment considered on operational pond sized based on the survey described in the June 2024 capacity assessment[15].

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11 *Tailings Storage Facility - Pipe Break Erosion Assessment*, Carrapateena ref: CA-3630-CIV-REP-1088 Rev0, WSP ref: PS200475-WSP-MEL-MNG-REP-000131 June 2024.

12 Dam Breach Basis of Assessment, WSP ref: Carrapateena ref: CA-3630-CIV-REP-1098 Rev0, PS138057-WSP-MEL-MNG-REP-00004 Rev0, 11 April 2024.

13 *Carrapateena Tailings Storage Facility - Staged Life of Mine Concept Layouts*, Carrapateena ref: CA-3630-CIV-REP-1096, WSP ref: PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

14 *Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment*, Carrapateena Ref: CA-3630-CIV-REP-1071 RevA, WSP Ref: PS138057-WSP-MEL-MNG-REP-00002 Rev0.

15 *Tailings Storage Facility, Capacity Assessment based on June 2024 Beach Facility*, Carrapateena, South Australia, BHP ref: CA-3630-CIV-REP-1113, WSP ref: PS200475-WSP-MEL-MNG-REP-00026 RevA, 17 October 2024.

For each scenario, it was assumed that the Decant Dam has failed due to the background flood prior to the TSF failing and therefore was not considered as part of a cascade failure in the assessment.

Additional sensitivity scenarios are presented in Section 10.

4.2 Failure location

The failure location for this assessment was selected at the TSF embankment based on the point of maximum embankment height above natural ground, i.e. in the region of the eastern watercourse branch of Eliza Creek. This leads to a downstream failure into Eliza Creek to the north of the TSF. The adopted breach location is shown in Figure 4.1. Note, failure of the saddle dams to the south, east, and west of the facility are not considered. Failure toward the south due to a failure of the southern saddle dam and failures of either the west or east saddle dams are discussed further in Section 4.3.

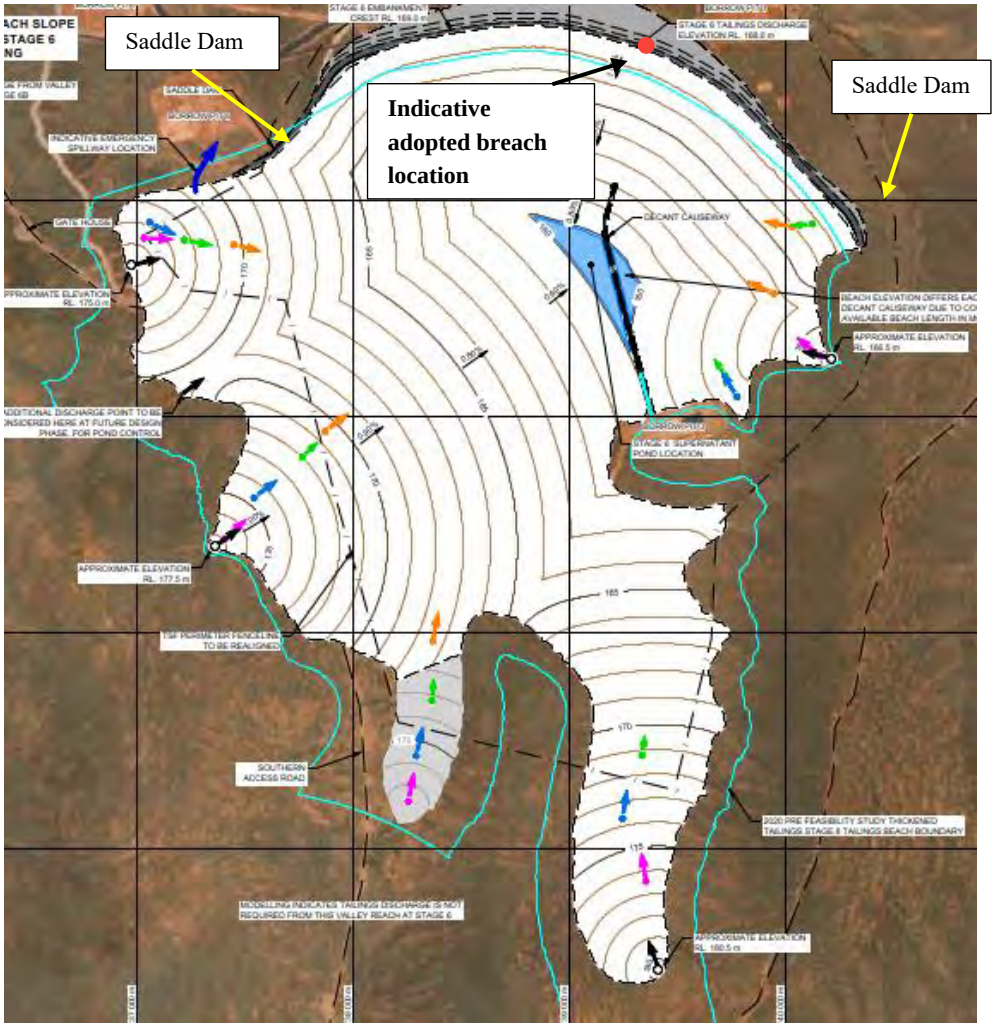

Figure 4.1 Indicative location of adopted failure location for all dam breach scenarios

4.3 Runout paths

The runout path considered in the dam breach assessment is downstream along Eliza Creek with flow to the north, as noted in Figure 4.2. A potential failure path to the south of the TSF, for the future Stage 5 and Stage 6 layouts of the TSF, under the steeper beach slope scenario (which requires the saddle dam) was not considered in the dam breach assessment. The failure path from this possible future saddle dam would be to the south, towards Yeltacowie Creek and then west towards Pernatty Lagoon, as shown in Figure 4.2. This would result in a relatively minor runout due to the expected small volume of tailings adjacent to the saddle dam, however, will be considered in future assessments, if required, subject to beach slope performance. Failure of either the west or east saddle dams (into Eliza Creek tributaries) would also result in relatively minor runouts due to their elevation and small volume of tailings impounded. The location and arrangement of the future saddle dams, which join with the TSF embankment towards the end of the Life of Mine are shown in Figure 4.1.

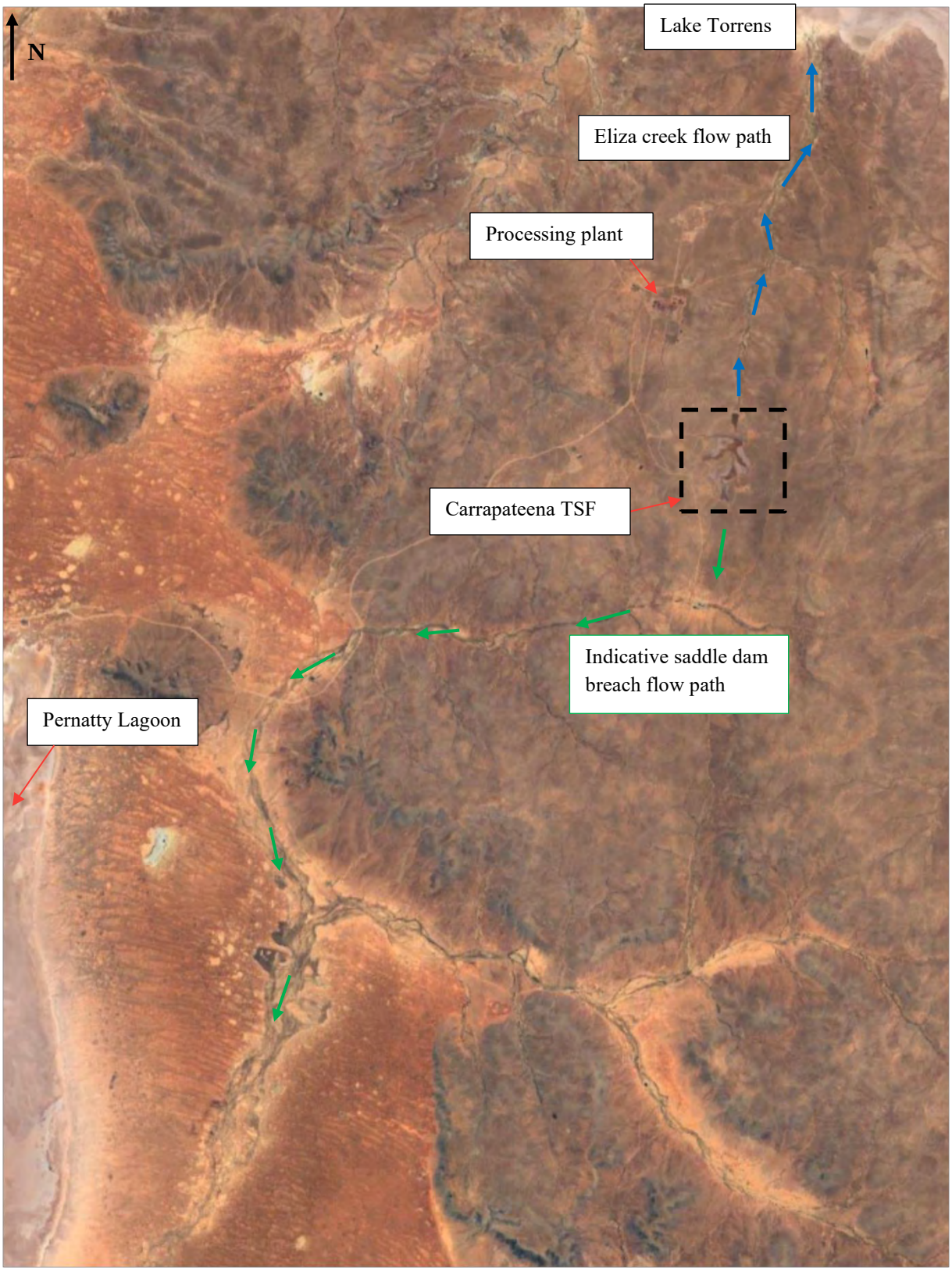

Figure 4.2 Predicted runout flow paths for the TSF (Image source: Google Earth)

4.4 Stored water volumes

The future end of filling layouts for Stage 3 and Stage 6 are both predicted to have storage capacity to store the equivalent runoff from two PMP, 72-hour events below the spillway invert. As a PMP event is considered to be the theoretical maximum rain event, it is assumed for both scenarios that the runoff volume from one PMP 72-hour event is stored in the facility at the time of the breach.

The PMP volume was estimated using rainfall depths as per the climate assessment[16] completed for Carrapateena in 2023, and a catchment size of 1,390 ha. This assessment used guidance from the Bureau of Meteorology which suggests the Generalised Short-Duration Method (GSDM)[17] and the Generalised South-east Australia Method (GSAM)[18] for short and long duration events respectively. The climate assessment defined the PMP as having a 1 in 10 million AEP, i.e., it represents a very rare event. For Stages 3 and 6, this results in an approximate stored water volume of 10.7 Mm^3, assuming 100% runoff.

The supernatant water present in Scenario 4 adopted a pond area of about 7.4 ha based on the June 2024 capacity assessment[19]. When considering the Stage 6 stage storage relationship, this corresponds to a ponded water volume of about 19,000 m^3.

These water volumes were considered in conjunction with the unique pond storage curves of the future Stage 3 and Stage 6 layouts of the TSF during modelling of the breach runout. The pond storage data over the predicted end of filling tailings surface for Stages 3 and 6, in 1 m increments is listed in Table 4.2.

16 *Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment*, Carrapateena Ref: CA-3630-CIV-REP-1071 RevA, WSP Ref: PS138057-WSP-MEL-MNG-REP-00002 Rev0.

17 Bureau of Meteorology. (2003). *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*. Melbourne, Victoria, Australia: Bureau of Meteorology.

18 Bureau of Meteorology. (2006). *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Southeast Australia Method,* October 2006. Melbourne, Victoria, Australia: Bureau of Meteorology.

19 *Tailings Storage Facility, Capacity Assessment based on June 2024 Beach Facility*, Carrapateena, South Australia, BHP ref: CA-3630-CIV-REP-1113, WSP ref: PS200475-WSP-MEL-MNG-REP-00026 RevA, 17 October 2024.

Table 4.2 Pond storage data adopted for the Stage 3 and Stage 6 layouts

Elevation (m RL)	Stage 3 pond storage over end of filling tailings surface (Mm^3)	Elevation (m RL)	Stage 6 pond storage over end of filling tailings surface (Mm^3)
146	-	159	-
147	13,900	160	25,000
148	143,000	161	306,000
149	530,000	162	1,040,000
150	1,293,000	163	2,346,000
151	2,550,000	164	4,323,000
152	4,313,000	165	6,997,000
153	6,607,000	166	10,419,000
154	9,480,000	167	14,602,000
155	12,933,000	168 **(Note)**	19,607,000
156	16,926,000		
156.5 **(Note)**	19,116,000		

Table 4.2 note: storage data to spillway invert elevation, i.e., 1 m below the TSF embankment crest elevation.

5 Tailings characteristics

5.1 Stored tailings characteristics

Parameters for the stored tailings for estimation of outflow volumes and characterisation of the tailings rheology are summarised in Table 5.1. For the dam breach assessment, the stored tailings in the TSF were assumed to have homogeneous properties.

Table 5.1 Adopted stored tailings characteristics for the Stage 3 and 6 layouts

Parameter	Stage 3 TSF layout	Stage 6 TSF layout
Total volume of stored tailings (Mm^3) **(Note 1)**	48.3	118.9
Total mass of stored tailings (Mt) **(Note 2)**	91.8	224.5
Average *in situ* stored dry density (t/m^3) **(Note 3)**	1.9	1.9
Tailings solids particle density (t/m^3) **(Note 1)**	3.5	3.5
Degree of saturation **(Note 4)**	1	1
Stored tailings solids concentration C_m (% w/w) **(Note 5)**	80.6	80.6

Table 5.1 notes:

(1) Particle density based on expected tailings from mid-2025. Refer to Life of Mine concept staging plan[20].

(2) Based on a dry density of 1.9 t/m^3.

(3) Refer Life of Mine basis of assessment[21] and recent capacity assessments[22].

(4) Fully saturated tailings assumed for analysis.

(5) Based on adopted values in Table 5.1.

5.2 Tailings flow characteristics – rheology

For Newtonian fluids, the ratio of shear stress to shear rate is constant, resulting in constant viscosity. For non-Newtonian fluids, and those fluids which do not obey Newton's law of viscosity (e.g., mud), this relationship is not constant, and as such is called apparent viscosity where viscosity changes with shear rate. This is illustrated in Figure 5.1 for four typical fluid types: Newtonian, Bingham plastic, pseudoplastic, and dilatant.

[20] *Carrapateena Tailings Storage Facility - Staged Life of Mine Concept Layouts*, Carrapateena ref: CA-3630-CIV-REP-1096, WSP ref: PS138057-WSP-MEL-MNG-REP-00003 Rev0, 27 March 2024.

[21] *Life of mine Concept Design Update - Basis of Assessment, Carrapateena Tailings Storage Facility*, BHP ref: CA-3630-CIV-REP-1070, WSP ref: PS138057-MEL-MNG-REP-0001 Rev0, 16 January 2024.

[22] *Tailings Storage Facility, Capacity Assessment based on March 2024 Beach Survey*, Carrapateena ref: CA-3630-CIV-REP-1105, WSP ref: PS200475-WSP-MEL-MNG-REP-00024-Rev0, 5 July 2024.

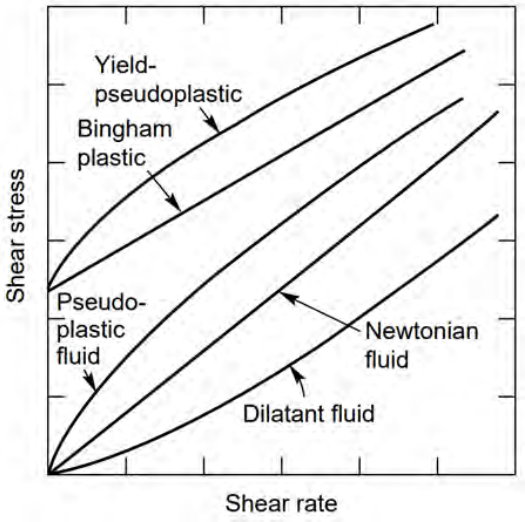

Figure 5.1 Illustration of shear stress as a function of shear rate[23]

Tailings was modelled as a non-Newtonian fluid (changing viscosity with shear rate). Tailings typically exhibit yield-pseudoplastic (shear thinning) behaviour (Blight & Bentel, 1983; Horsley & Snow, 1988), where the apparent viscosity decreases with increasing shear rate[24]. Additionally, these materials require a minimum shear stress (yield stress) before flowing as a fluid. Tailings therefore typically exhibit very different behaviours to water (Newtonian fluid) at increased shear rates and this should be considered for estimating inundation areas when conducting a dam breach runout assessment.

The analyses were performed using numerical software that allows for modelling of both Newtonian and non-Newtonian flow (refer to Section 7.1).

5.3 Tailings rheology data

Tailings rheology test data has become available since the dam breach assessment of 2017. Paterson & Cooke Australia completed a review of historic tailings test work[25] in 2023 to inform the design of the tailings pipeline and pumping system. This report identified 'low' mass concentration (C_m) (easiest pumping duty) and 'High' C_m (highest expected steady state operation) limits for the Stage 2A (up-valley deposition) pumping arrangement. Parameters for these two samples were sourced from the respective test work reports for each sample, completed in March 2019 for the low rheology sample [26] and in September 2022 for the high rheology sample[27]. These two samples are referred to as 'OZM002', and 'SP03 - 40' in their respective reports.

Key slurry parameters adopted for the assessment are summarised in Table 5.2. Note, in this report these samples are subsequently referred to as 'Low C_m tailings' and 'High C_m tailings' respectively. Only the Low C_m tailings parameters were considered in this assessment as they represent the most flowable, and therefore most conservative, case.

[23] Chabbra, R. P., & Richardson, J. F. (1999). *Non-Newtonian Flow in the Process Industries*. Oxford, UK: Butterworth-Heinemann.

[24] Horsley, R. R., & Snow, R. J. (1988). *The rheology of some Australian mine tailings*. In Progress and Trends in Rheology II. Steinkopff, Heidelberg.

[25] Paterson & Cooke Australia Pty Ltd. (2023). *Carrapateena 8.5 MTPA Study: Historical data Analysis* (P&C doc no.: 41-0390-00 HY-TEC-0001 RevB).

[26] Paterson & Cooke Australia Pty Ltd. (2019). *Carrapateena Tailings Pipeline System - Slurry Test Work Report*, (P&C doc no.: OZM-41-0196-TW-REP-001 Rev0).

[27] Paterson & Cooke Australia Pty Ltd. (2022). *Carrapateena Mine Stage Two Slurry Test Work*, (P&C doc no.: OZM-41-0378-00-TW-REP-0002 Rev 0).

Table 5.2 Carrapateena tailings slurry properties for minimum and maximum rheology samples, from Paterson & Cooke testing

Parameter	**Low C_m rheology (OZM002)**	**High C_m rheology (SP03 – 40)**
Sample description	Carrapateena flotation tailings	Tailings flocculated at P&C labs at 40 g/t of flocculant
Solids particle density, ρ_s (kg/m^3)	3650	3302
Process water density, ρ_{pw} (kg/m^3)	1040 **(Note 1)**	1071 **(Note 2)**
Bingham yield stress, τ_0 (Pa)	$\tau_y = 5005\ C_m^{15.5}$	$\tau_y = 16{,}100\ C_m^{13.5}$
Bingham plastic viscosity, μ_{BP} (Pa.s) (**Note 3**)	$\mu_0 = \mu_w + 2.51\ C_m^{11.9}$	$\mu_0 = 2.08\ C_m^{8.45}$
Tested (by Paterson & Cooke) range of slurry solids concentrations, C_m (% w/w)	53.3% to 75.9%	50.4% to 68.8%

Table 5.2 notes:

(1) Simulated process water by P&C (test work completed in 2019).

(2) Density of supplied process water at 20°C (see P&C test work completed in 2022).

(3) μ_w refers to the viscosity of water at 24° C (0.000916 Pa.s).

Rheological properties for each sample were tested by Paterson & Cooke using a rotational viscometer to obtain yield stress (τ_y), and plastic viscosity (μ_0) of the samples over a range of solids concentrations by mass (C_m (% w/w)) and are plotted in Figure 5.2 and Figure 5.3 respectively. The fit lines included in these plots represent the equations noted in Table 5.2 for Bingham yield stress and plastic viscosity respectively.

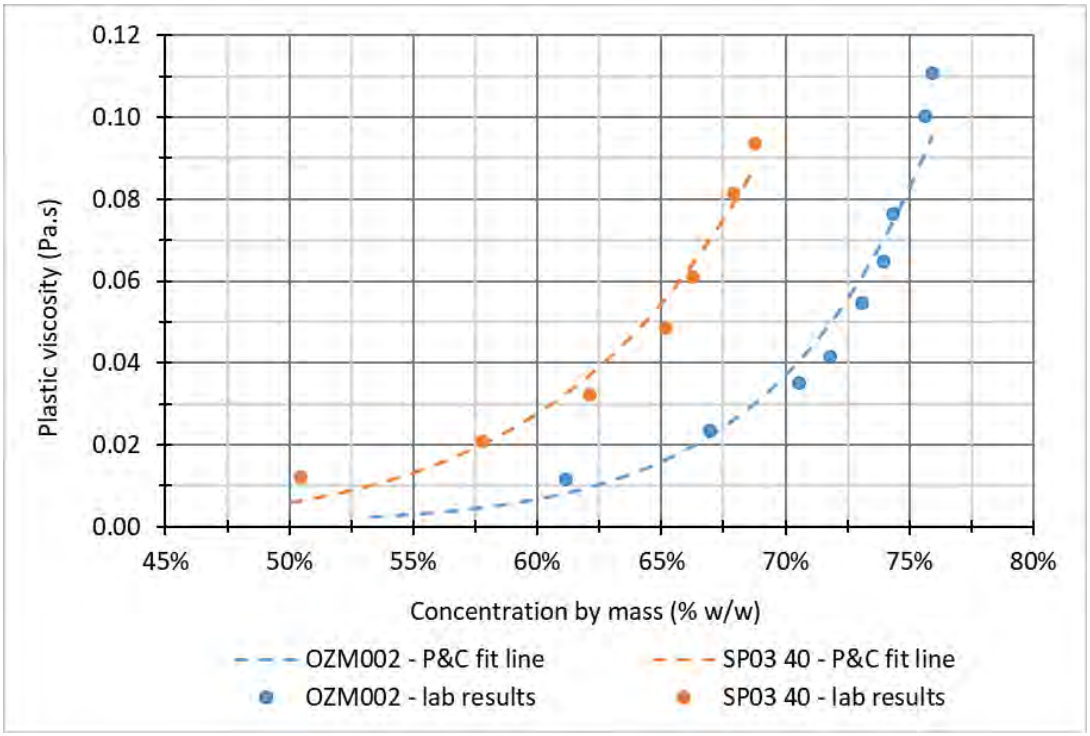

Figure 5.2 Plastic viscosity stress vs. mass concentration for two tailings slurry samples from Paterson & Cooke (P&C) testing

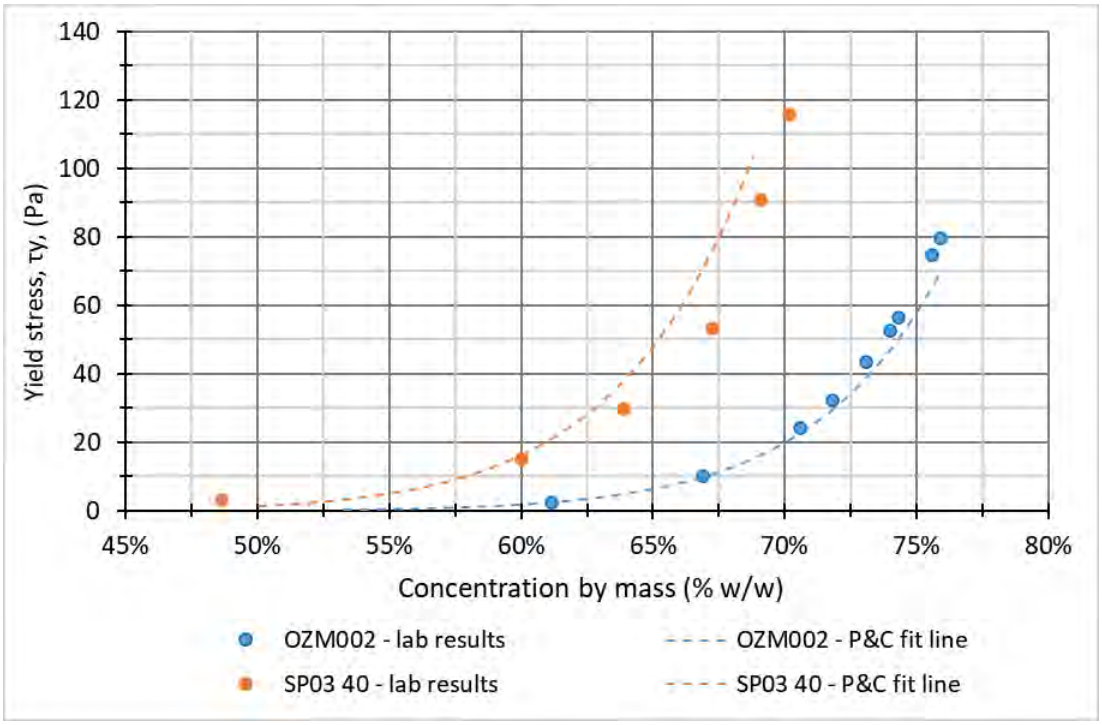

Figure 5.3 Yield stress vs mass concentration for two tailings slurry samples from P&C test work

5.4 Adopted tailings rheology parameters

Tailings parameters from the 'low' tailings rheology sample were adopted for the dam breach assessment, as this sample has the lowest viscosity and yield stress values for a similar solids concentration by mass. This was predicted to result in the largest potential runout area when adopted for the hydraulic model.

This dam breach assessment adopted a Bingham model for the fluid flow behaviour. This model was applied as the software used in this analysis (FLO-2D) incorporates the following empirical equations to compute viscosity and yield stress as functions of the volumetric solids concentration:

$$\tau_y = \alpha_1 e^{\beta_1 C_v}, \qquad and\ \mu = \alpha_2 e^{\beta_2 C_v}$$

A summary of the adopted tailings rheology relationships is provided in Table 5.3. These relationships have been developed based on the data presented in Figure 5.2 and Figure 5.3. Values for yield stress and viscosity are dynamically calculated during the simulation, and as such vary between time, location, and scenario, based on the data presented in Section 5.3 and the relative concentration of tailings and water. Note that FLO-2D requires different units than those provided by Paterson & Cooke. The initial tailings solids concentration by volume is provided (prior to any mixing with ponded water during the breach event), based on the Low C_m rheology tailings sample (refer to Table 5.1 and Section 5.3).

- τ_y: Yield stress (dynes/cm^2) (note 10 dynes/cm^2 = 1 Pa).
- μ: Viscosity (Poises) (note 10 Poises = 1 Pa.s).
- C_v: Solids concentration by volume.

Table 5.3 Adopted tailings rheology parameters for the Low C_m tailings fit line

Parameter	Adopted value
Stored tailings solids concentration C_V (% v/v) **(Note)**	54.3
α_1	0.0462
β_1	21.298
α_2	0.00174
β_2	13.635

Table 5.3 note: Initial tailings solids concentration prior to any mixing with release water.

Note that the introduction of Hydrofloat tailings in 2025 could change the rheology of the tailings and therefore its behaviour in a dam breach scenario. This report assumes that current and future tailings will behave according to currently available, Low C_m rheology data for both the tailings in the future end of filling layouts for Stages 3 and 6.

Also note that some uncertainty is introduced when extrapolating yield stress and viscosity values beyond the range of solids concentrations used for rheology testing.

The relationships discussed above, and the parameters listed in Table 5.3 are presented graphically in Figure 5.4.

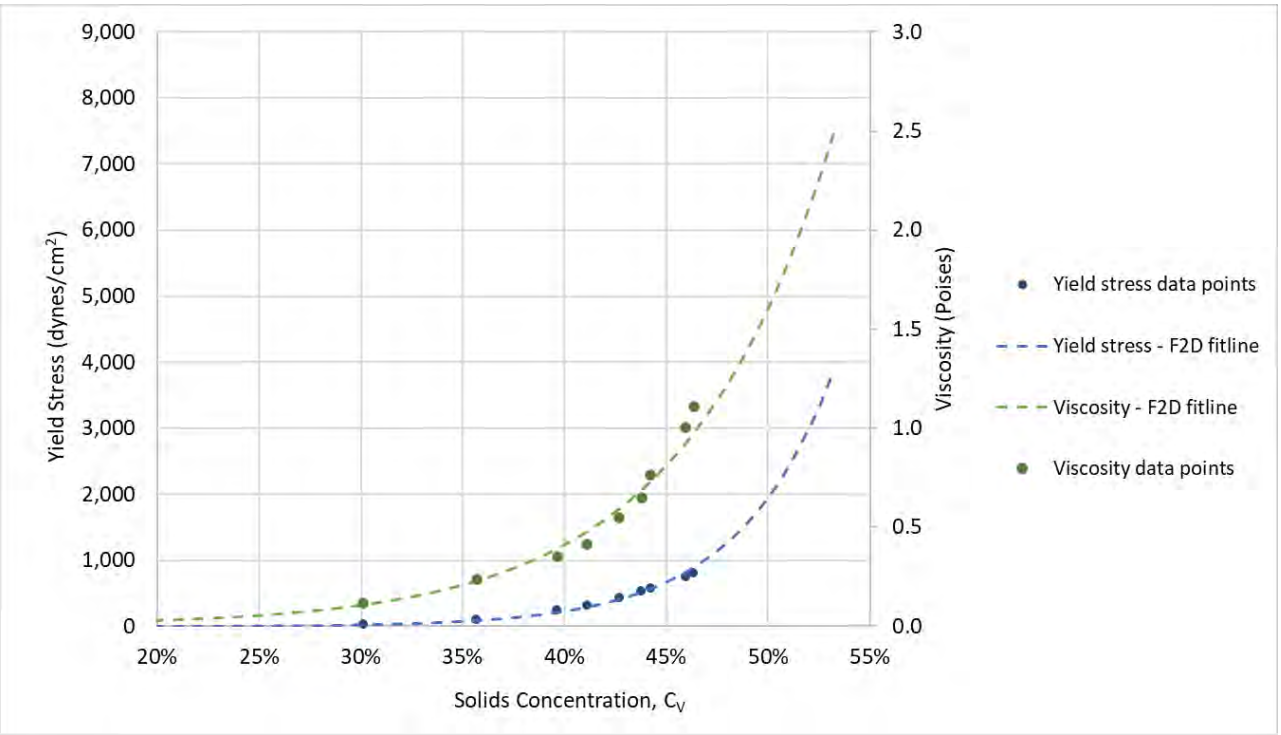

Figure 5.4 Adopted rheology relationships for the low C_m tailings sample

6 Dam breach characterisation

6.1 Breach parameters

The breach parameters including width, side slopes, and formation times were estimated using empirical relationships based on historical failure events, such as those developed by Froelich[28], Xu and Zhang[29], MacDonald & Lanagridge-Monopolis[30], and reviews of historical failures by Wahl[31], and Rana et. al[32].

Froehlich evaluated data from 111 embankment dam failures of various types and failure modes and derived values of parameters described above. Studies by Xu and Zhang also present empirical formulae for predicting dam breach parameters. These formulae were developed considering a database of water and tailings dam failure cases for dams with heights ranging from 5 m to 65 m. Wahl presents a review of historic relations between breach height and average width.

The Canadian Dam Association[33] states that empirical relationships developed for water dams should only be used for erosional type failures (internal erosion and overtopping) and that they may not be applicable for a near instantaneous failure of a tailings dam, e.g., by slope failure caused by liquefaction.

Considering the geometry of the TSF, the expected failure behaviour for an instantaneous breach would result in loss of material above the Stage 3 embankment, i.e., the upstream raised embankments of Stages 4, 5, and 6, followed by erosion of the downstream raised embankment (Stages 1, 2, and 3). For Scenario 1 and 4, the upstream embankment raises (Stages 4, 5, and 6) are assumed to fail instantly from the crest down to the downstream raised embankment (Stages 1, 2, and 3) for the length of embankment breach (breach width) calculated from Froelich's relationships. The downstream raised embankment is then eroded by released tailings slurry and water. The total breach formation time is reduced by the ratio of the height of the downstream raised embankment to the height of the full embankment.

The adopted breach parameters for development of breach hydrographs are summarised in Table 6.1. Parameters are adopted from Froelich's relationships, with the breach formation time of the eroded portion of the embankment scaled in Scenario 1 using the Stage 3 embankment height.

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28 Froehlich, D. (2016). *Empirical model of embankment dam breaching.* Paper presented at the International Conference on Fluvial Hydraulics (River Flow 2016).

29 Xu, Y., & Zhang, L. M. (2009). *Breaching parameters for earth and rockfill dams*. Journal of Geotechnical and Geoenvironmental Engineering, 135(12), 1957-1970.

30 MacDonald, T. C., & Lanagridge-Monopolis, J. (1984). *Breaching Characteristics of Dam Failures*. Journal of Hydraulic Engineering, 110(5), 567-585.

31 Wahl, T. L. (1998). *Prediction of Embankment Dam Breach Parameters: Literature Review and Needs Assessment* (DSO-98-004). Dam Safety Office, US Bureau of Reclamation, Denver, CO.

32 Rana, N. M., Ghahramani, N., Evans, S. G., McDougall, S., Small, A., & Take, W. A. (2021). *Catastrophic mass flows resulting from tailings impoundment failures.* Engineering Geology, 292, 106262.

33 Canadian Dams Association (CDA). (2021*). Technical Bulletin: Tailings Dam Breach Analyses*.

Table 6.1 Adopted breach parameters

Parameter	Value			
	Scenario1	Scenario 2	Scenario 3	Scenario 4
Embankment crest elevation (m RL)	169	169	157.5	169
Elevation of embankment toe at breach location (m RL)	114	114	114	114
Breach bottom elevation (m RL) (**Note 1**)	118	118	118	118
Total breach height (m)	51	51	39.5	51
Bottom breach width (m)	80	80	62	68
Average breach width (m)	130	130	101	120
Top breach width (m)	182	182	141	170
Embankment width (m) **(Note 2)**	92	92	127	92
Formation time (liquefaction of upstream raises) (min)	<1	n/a	n/a	<1
Formation time of full breach (min)	30	39	45	25.6
Breach side slopes (XH:1V)	1	1	1	1
Starter embankment elevation (**Note 3**)	157.5	n/a	n/a	157.5

n/a = not applicable

Table 6.1 notes:

(1) Elevation of natural ground below the embankment crest at the failure location.

(2) Width of embankment at failure location at the middle of the total failure height. Accounts for the cross-sectional geometry of the TSF embankment in each Scenario.

(3) The elevation of the highest downstream raise (Stage 3 crest) is adopted for the starter embankment elevation.

6.2 Outflow volumes

The outflow volume that is mobilised during a TSF failure depends on several factors. These include the geometry of the embankment, the impoundment and its surrounds, the failure mechanism, and pond and weather conditions (i.e., presence of a pond and/or rain event). In this assessment, outflow volume and extent of liquefied tailings was estimated based on conical failure geometry, determined by an estimated failure slope representing an average of the post failure tailings profile.

Studies by Blight and Fourie[34] indicate that failure slope typically varies between 3% and 7% and can be up to 17% to 33% around the perimeter of the cone. Observations from a selection of historical tailings dam breaches by Rourke and Luppnow[35] indicate that post-failure tailings slopes are typically in the range of 5% to 18%. For TSFs with a pond and liquefiable tailings, past failures show the average post-liquefaction slope may range between 3.5% and 9%.

[34] Blight, G. E., & Fourie, A. B. (2003). *A review of catastrophic flow failures of deposits of mine waste and municipal refuse*. Retrieved from Johannesburg, South Africa:

[35] Rourke, H., & Luppnow, D. (2015). *The Risks of Excess Water on Tailings Facilities and Its Application to Dam-break Studies*. Paper presented at the Tailings and Mine Waste Management for the 21st Century, Sydney, Australia.

In addition to the tailings outflow, it was assumed that pond water above the lowest intersection point of the pond and the tailings failure surface (cone) is mobilised. An indicative diagram, simplified for a single embankment without raises, depicting the mobilised tailings volume in the failure cone is presented in Figure 6.1. Note, this approach includes some embankment material due to the presence of upstream raises, however, this volume is expected to be minor compared to the overall release volume of the tailings deposit.

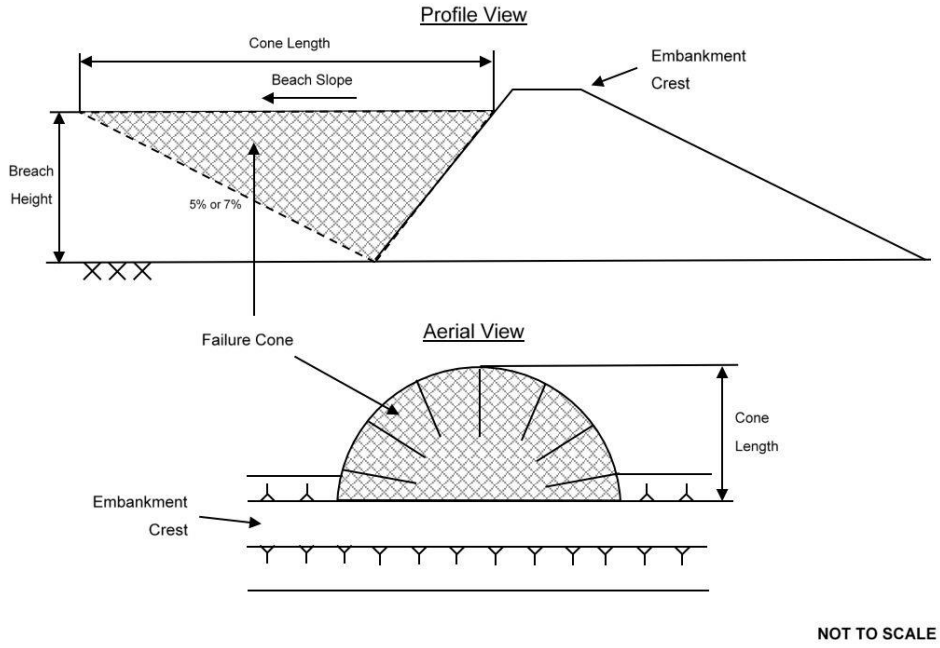

Figure 6.1 Indicative diagram of assumed failure cone

A relatively conservative failure slope of 4% was adopted for the tailings failure slopes in the assessment, following email communication between BHP and WSP on 30 April 2024. A summary of the resulting total outflow volumes for each scenario is presented in Table 6.2.

Table 6.2 Summary of estimated dam breach release volumes

	Volume (Mm^3)			
Parameter	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Forecast total TSF impounded tailings volume **(Note 1)**	118.9	118.9	48.3	118.9
Approximated tailings release volume	29.5	29.5	14.3	29.5
Estimated failed embankment volume **(Note 3)**	0.7	0.7	0.3	0.7
Total ponded water outflow **(Note 4)**	10.7	10.7	10.7	0.02
Total release volume (Note 5)	**40.9**	**40.9**	**25.3**	**30.2**

Table 6.2 notes:

(1) Refer to Life of Mine concept layouts report[36].

(2) Estimated from relationships developed by Froelich (refer Section 6.1)

(3) Separately estimated using approximated breach width.

(4) Refer to volumes in Section 4.4.

(5) Includes released tailings, embankment fill, and water volumes.

An example diagram is presented in Figure 6.2 that shows the 4% failure cone profile through the Stage 6 layout, in addition to the natural ground profile, used to estimate release volumes.

Figure 6.2 Indicative profile of 4% failure cone through the tailings impoundment for the Stage 6 layout

[36] *Tailings Storage Facility, Staged Life of Mine Concept Layouts*, Carrapateena ref: CA-3630-CIV-REP-1096, WSP ref: PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

The estimated release volumes for the failure scenarios in Table 6.2 are plotted against historical release volumes documented in studies undertaken by Rico et. al[37], Larrauri and Lall[38], and Rana et. al.[39] in Figure 6.3**.** Note, estimates of outflow volume and impounded volume (V_F and V_T) for historical tailings dam failures include tailings solids, interstitial water, and ponded supernatant water. The failure scenarios for Carrapateena are shown as orange square symbols in the chart.

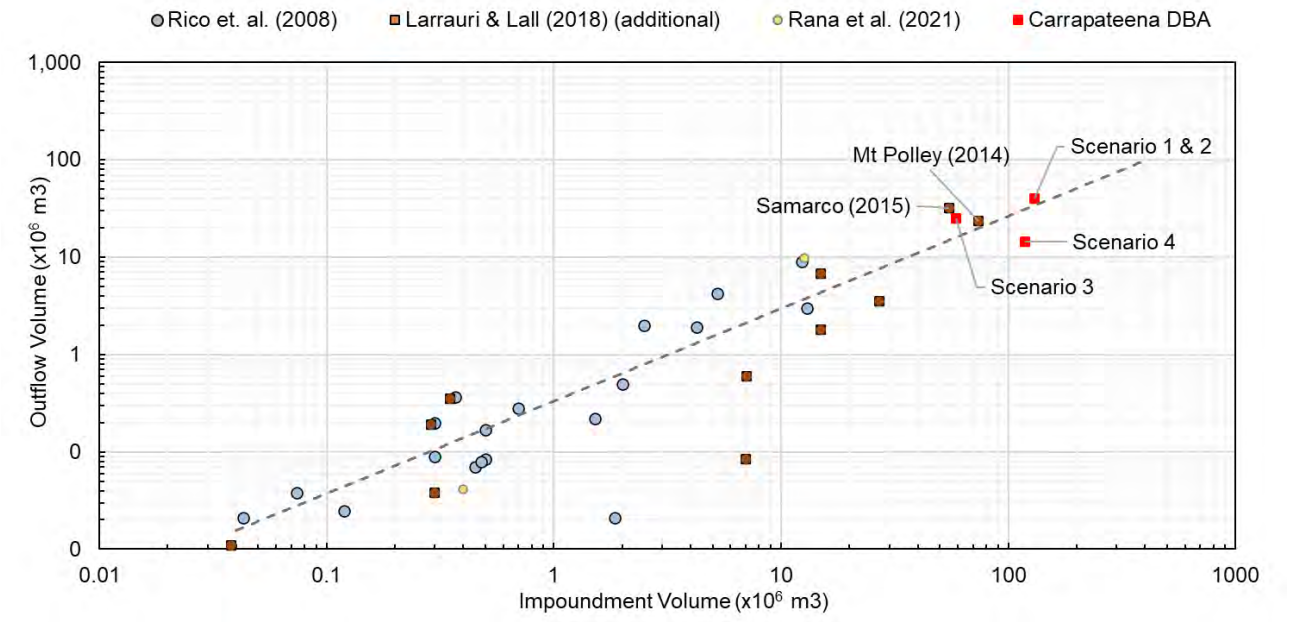

Figure 6.3 Comparison of historical dam failure release volumes and estimated TSF adopted release volumes

6.3 Outflow hydrographs

Outflow hydrographs were derived following standard breach routing equations derived by Fread[40] and utilising the breach parameters presented in Table 6.1 and Table 6.2. Estimation of the hydrographs consider the unique stage-storage relationship of the outflow failure cones presented in Appendix A. These hydrographs are presented in Figure 6.4.

[37] Rico, M. T., Benito, G., & Díez-Herrero, A. (2008). Floods from tailings dam failures. *Journal of Hazardous Materials, 154*, 79-87.

[38] Larrauri, P., & Lall, U. (2018). *Tailings dams failures: updated statistical model for discharge volume and runout*. Environments Journal, 5(28).

[39] Rana, N. M., Ghahramani, N., Evans, S. G., McDougall, S., Small, A., & Take, W. A. (2021). *Catastrophic mass flows resulting from tailings impoundment failures*. Engineering Geology, 292, 106262.

[40] Fread, D. L. (1988). *BREACH: An erosion model for earthen dam failures*.

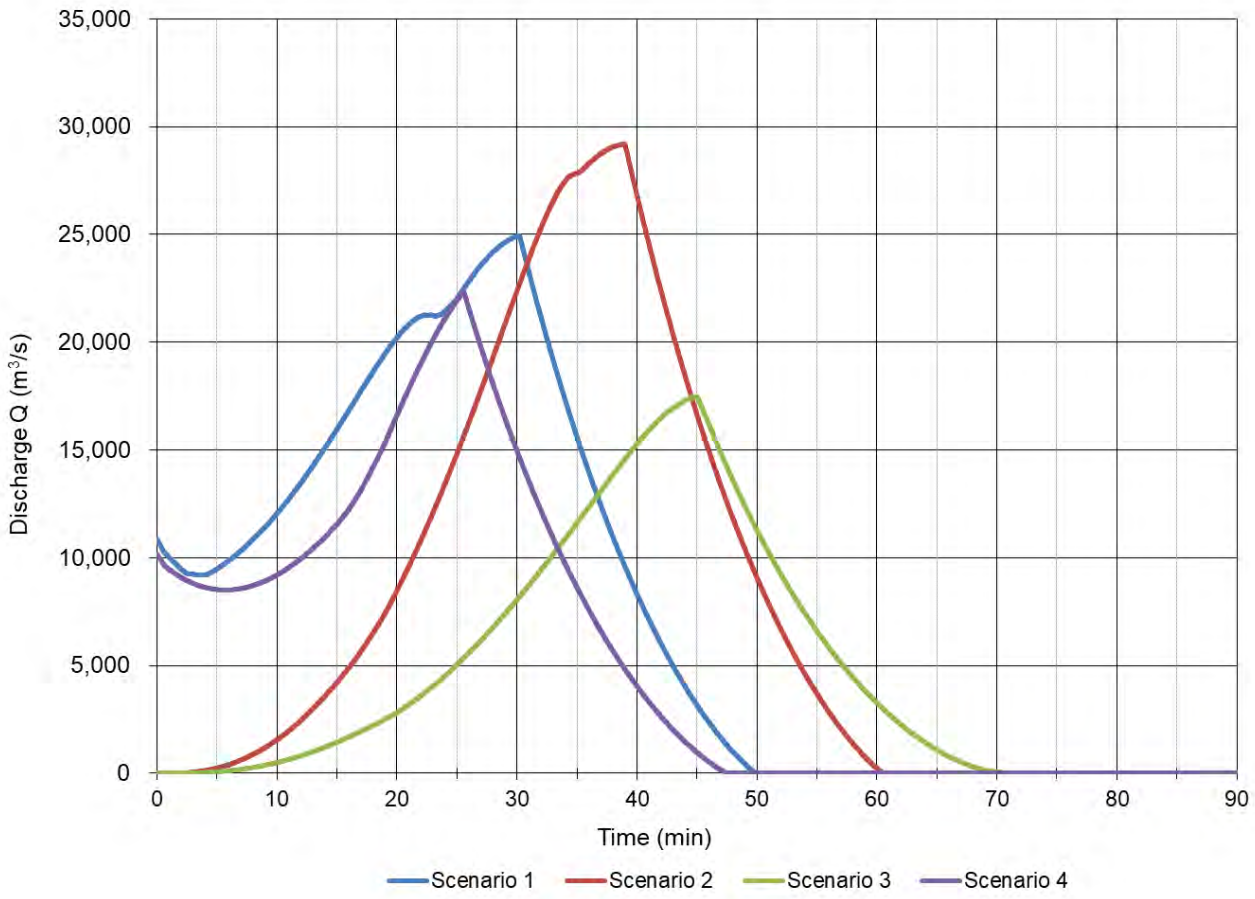

Figure 6.4 Outflow hydrographs for Scenarios 1 to 4

The peak outflow rates of the hydrographs presented in Figure 6.4 is presented below, with the total release volumes of each scenario summarised in Table 6.2.

- Scenario 1 peak outflow rate: 24,900 m^3/s.
- Scenario 2 peak outflow rate: 29,200 m^3/s.
- Scenario 3 peak outflow rate: 17,500 m^3/s.
- Scenario 4 peak outflow rate: 22,350 m^3/s.

Scenario 2 has the highest peak outflow rate which is about 4,500 m^3/s higher than Scenario 1. Despite liquefaction failure of the upstream raises for Scenario 1, this higher peak is attributed to the liquefiable portion of the embankment containing relatively less impounded tailings volume than the downstream raises in the region of the failure cones. If the liquefiable portion of the embankment was greater, then this would shorten the hydrograph and could result in a higher peak outflow rate.

7 Hydraulic modelling

7.1 Software selection

Most of the currently available hydraulic modelling packages are capable of simulating both Newtonian and non-Newtonian flows. The selection of these models is driven by the assumed failure scenarios and background conditions which define the approach to simulating non-Newtonian flows, including single-phase (mixture only) or multi-phase (fluid and solid) approaches up the limit of applicability.

For this assessment, the FLO-2D software package[41] was used to model the dam breach runout extent from the facility. This is a commercially available physics based software package that is equipped to handle both Newtonian and non-Newtonian flows (multi-phase) and can incorporate tailings rheology data for non-Newtonian analysis.

7.2 Terrain data, model extents, results locations

A digital terrain model for the TSF and surrounding area was created based on the following datasets and model extent:

- Tailings beach models as per the staged Life of Mine concept layouts[42].
- A beach survey completed by the BHP Carrapateena survey department (December 2023), covering the TSF and Decant Dam.
- 2016 GRES survey (1 m contours from LiDAR): covers roughly 800 km^2 region including the TSF and runout path to Lake Torrens. This covers most of the terrain between the Decant Dam and Lake Torrens, which forms most of the runout path.
- 2018 Survey from OZ Minerals (CA-33630-ENG-MOD-1000), 25 cm contours, covers roughly 30 km^2 region, includes the TSF and Decant Dam. Extends about 650 m north of the Decant Dam.
- 2021 survey by Aerometrex, about 17 km^2 in region of TSF and Decant Dam, 25 cm contours. Extends about 150 m downstream of the Decant Dam.

The model extents were chosen to extend from the TSF to the point of entry of Eliza Creek into the Carrapateena arm of Lake Torrens, about 16 km to the north of TSF embankment. Other failure paths, e.g., a saddle dam failure and flow to the south were excluded from the assessment, as discussed in Section 4.3. The topographical domain was analysed in FLO-2D using a mesh size of 5 m (gridded points at 5 m spacing).

Topography and model extents as well as locations of interest for model results are shown in Figure 7.1. Model results presented in Section 8.2 are reported for the four locations along the Eliza Creek runout path, these being for the Decant Dam, the Access Road crossing, the small water dam, and at the outflow point into Lake Torrens.

41 FLO-2D Software, I. (2023). *FLO2D PRO,* Version 22.10.24 [Computer Software].

42 *Carrapateena Tailings Storage Facility - Staged Life of Mine Concept Layouts*, Carrapateena ref: CA-3630-CIV-REP-1096 Rev0, WSP ref: PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

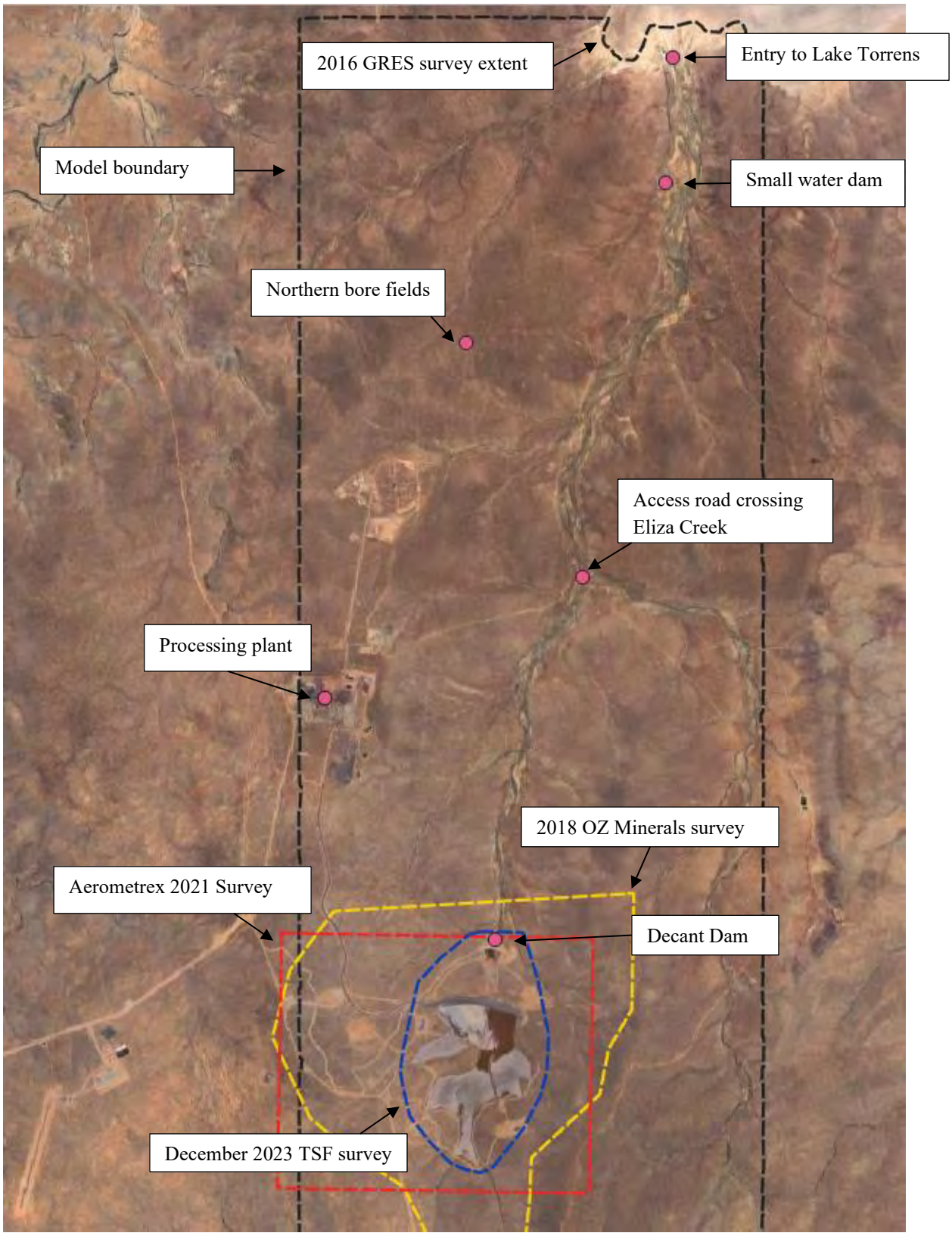

Figure 7.1 Topography extent and model setup

7.3 Boundary conditions

Inflow boundary conditions representing the breach failure hydrographs were assigned at the breach location for each scenario. A free floodplain outflow boundary was assigned based on the extents of available topographical data, at the entry to Lake Torrens at the end of Eliza Creek, which allows the runout to drain from the end of the modelled extent.

Future assessments should consider the runout into Lake Torrens, considering the water level present in the lake during a flood day scenario.

7.4 Surface roughness

The surface roughness parameter (Manning's n) for the ground surface within the model extent was assumed to be constant, at 0.035. This is considered appropriate as the predominant land type surrounding the TSF and in runout path of the TSF is scattered brush based on analysis of aerial images and is consistent with values recommended by Chow[43].

7.5 Other model inputs & assumptions

In addition to the inputs and assumptions noted in previous sections, the following modelling inputs and assumptions were used for the hydraulic modelling:

- Tailings outflow was assumed to behave according to the adopted rheology parameters (refer to Section 5).
- The Decant Dam is assumed to have failed prior to the TSF failing, and as such failure of the Decant Dam is not considered in the analyses.

[43] Chow, V. T. (1964). Handbook of Applied Hydrology: A Compendium of Water-resources Technology: McGraw-Hill.

8 Modelling results

8.1 Inundation mapping

Flood maps were generated from the hydraulic modelling results and are provided in Appendix B. Inundation maps for the sensitivity analyses described in Section 10 are presented in Appendix C. The presented flood inundation maps are listed in Table 8.1 for flows routed through the model terrain**.** The following outputs are provided:

- **Maximum flood depth (m):** Maximum depth of the combined tailings and water outflow.
- **Maximum flood velocity (m/s):** Maximum flood velocity of the combined tailings and water outflows.
- **Flood Severity**: Potential hazard classification (H1 to H6) as defined and described in Section 3.4.

Table 8.1 Summary of presented flood inundation maps

Scenario	Appendix figure number	Flood model output
1	B01	Maximum flood depth
	B02	Maximum flood velocity
	B03	Flood severity classification
2	B04	Maximum flood depth
	B05	Maximum flood velocity
	B06	Flood severity classification
3	B07	Maximum flood depth
	B08	Maximum flood velocity
	B09	Flood severity classification
4	B10	Maximum flood depth
	B11	Maximum flood velocity
	B12	Flood severity classification
Sensitivity A1	C01	Maximum flood depth
	C02	Maximum flood velocity
	C03	Flood severity classification
Sensitivity A2	C04	Maximum flood depth
	C05	Maximum flood velocity
	C06	Flood severity classification
Sensitivity C1	C07	Maximum flood depth
	C08	Maximum flood velocity
	C09	Flood severity classification
Sensitivity C2	C10	Maximum flood depth
	C11	Maximum flood velocity
	C12	Flood severity classification

8.2 Summary of model results

Model results such as maximum flow depth and maximum velocity vary along the flow path for each scenario. Model results at key locations along the Eliza Creek runout path are presented in Table 8.2, Table 8.3, Table 8.4, and Table 8.5 including the Decant Dam, an access track that crosses Eliza creek (about 6.5 km downstream of TSF), a small dam across Eliza creek (about 13 km downstream of TSF), and the entry to Lake Torrens (about 16 km downstream of the TSF embankment). Results are sensitive to the location a cross section is taken and are representative of the maximum depth or velocity across the flow path at each location. As such, values should be considered in conjunction with the flood maps in Appendix B. Refer to Figure 7.1 for results locations. Note that depth velocity product (DV) is calculated as the product of the overall maximum depth and velocity maps presented in the appendices for each scenario.

Table 8.2 Summary of key simulation results: Scenario 1 (Stage 6 layout, slope instability)

Location	Distance from breach location (km) (Note 1)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum depth velocity product (DV) (m^2/s)	Flood severity classification (Note 2)	Flood arrival time (min)
Decant Dam	0.7	21.2	8.3	> 100	H6	< 5
Processing Plant access track	6.5	10.1	7.6	75	H6	25
Small downstream water dam	13	5.9	6.8	40	H6	48
Entry to Lake Torrens	15	3.6	6.9	22	H6	60

Table 8.3 Summary of key simulation results: Scenario 2 (Stage 6 layout, overtopping)

Location	Distance from breach location (km) (Note 1)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum depth velocity product (DV) (m^2/s)	Flood severity classification (Note 2)	Flood arrival time (min)
Decant Dam	0.7	22.9	8.8	> 100	H6	9
Processing Plant access track	6.5	10.3	7.7	77	H6	38
Small downstream water dam	13	6.1	6.6	41	H6	63
Entry to Lake Torrens	15	3.7	6.7	22	H6	72

Table 8.4 Summary of key simulation results: Scenario 3 (Stage 3 layout, overtopping)

Location	Distance from breach location (km) (Note 1)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum depth velocity product (DV) (m^2/s)	Flood severity classification (Note 2)	Flood arrival time (min)
Decant Dam	0.7	17	7.9	> 100	H6	12
Processing Plant access track	6.5	6.6	7	46	H6	46
Small downstream water dam	13	4.3	6.4	30	H6	72
Entry to Lake Torrens	15	3.3	6.6	20	H6	81

Table 8.5 Summary of key simulation results: Scenario 4 (Stage 6 layout, slope instability, sunny day)

Location	Distance from breach location (km) (Note 1)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum depth velocity product (DV) (m^2/s)	Flood severity classification (Note 2)	Flood arrival time
Decant Dam	0.7	21	7.5	> 100	H6	< 5 min
Processing Plant access track	6.5	9.5	3.2	30.4	H6	1.25 hours
Small downstream water dam	13	5.5	0.7	3.9	H6	10.7 hours
Entry to Lake Torrens	15	2.7	0.7	1.9	H5	22.5 hours

Notes for Table 8.2, Table 8.3, Table 8.4, and Table 8.5:

(1) Distance from TSF along runout path

(2) Refer to Section 3.4.

The total inundated area in Eliza Creek for each scenario is summarised in Table 8.6.

Table 8.6 Total inundated area in Eliza Creek for each scenario

Scenario	Total inundated area (km^2) (Note)
1	13.5
2	14.4
3	11.4
4	11.9

Table 8.6 Note: Area in Eliza Creek runout path only.

Reported inundation areas consider model results that adopted an outflow boundary condition at the end of Eliza Creek, and therefore total impacted area may be larger as runout enters the lake.

9 Discussion

The runout extents for Scenarios 1 to 4 were similar, with all scenarios reaching Lake Torrens and presenting large maximum velocities and flow depths between the TSF and Lake Torrens. This was due to little opportunity for flow attenuation in the Eliza Creek watercourse and the large release volume of stored water mixing with the tailings slurry. The flow path downstream of the Decant Dam was on average about 900 m wide, tapering to about 700 m wide near the entry to Lake Torrens. The total width of flow path is narrower near the entrance to Lake Torrens than at the location of the small downstream water dam recorded in Table 8.2, Table 8.3, Table 8.4, and Table 8.5, where the flow spreads out and slows down. In general, however, the maximum recorded flow depth and velocity decreases along the length of the runout path, as tailings gradually come to a stop.

The results presented in Section 8.2 are small snapshots of model results at specific locations, and should be interpreted with the inundation maps presented in Appendix B, as modelled runout depth and velocity are sensitive to changes in underlying topography.

The results of this dam breach analysis indicate a larger inundation extent than that of the assessment[44] completed in 2017. The 2017 assessment considered dam breach and runout for Sunny Day conditions (no significant water pond), whereas this report presents results for a post-Flood Day scenario, and as such large water pond was present at the time of release.

The increase in inundation area relative to the 2017 assessment is attributed to the following key difference in assessment:

- Larger total volume that is released for each scenario, and that a larger proportion of the released volume is water.
- This assessment adopted tailings flow parameters (rheology) from recent test data.
- Tailings were modelled as a Bingham fluid, whereas the previous assessment adopted data from literature, and used the Carreau model for fluid viscosity and yield stress.
- The inclusion of mixing in this assessment, which acts to reduce the overall solids concentration of tailings slurry dynamically as the model progresses. This level of modelling complexity was not available in 2017.

Due to mixing, there is no delineation between which fluid is tailings or water in the runout maps presented in Appendix B and Appendix C.

Generally, the flow path between all scenarios was similar, with Scenario 1 and 2 having a slightly wider flow path compared to Scenario 3 due to the larger release volumes. Model results indicated maximum flow depths were highest near the TSF breach location and reduced towards the end of Eliza Creek. Maximum velocity results followed a similar pattern, generally reducing along Eliza Creek.

Scenario 4 indicated that the tailings flow rate reduces considerably prior to reaching Lake Torrens. By the time the released tailings and supernatant water reaches the end of the model boundary after about 23 hours, the runout volume is moving slowly relative to the post-flood day scenarios. This is attributed to the higher average solids concentration (and therefore yield stress and viscosity) downstream of the breach location due to the lack of supernatant water being released and mixing with the released tailings.

Model results indicated that flood severity classifications remained high at H6 for almost all inundated areas. This is attributed to the flow from the TSF being focussed within Eliza Creek.

The model results did not indicate inundation of significant infrastructure, except for the Decant Dam (which was assumed to have failed prior). However, the runout from all scenarios came within about 300 m to 350 m of inundating the Northern Bore Fields on the western edge of the Eliza Creek valley, between about 8 km and 9.5 km downstream of the TSF.

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[44] Carrapateena Project - *Tailings Storage Facility Dam Break Study*, WSP ref: 1660055-009-M-Rev3, 21 March 2017.

10 Sensitivity analysis

There are many uncertainties in conducting dam failure assessments. A sensitivity analysis was undertaken to inform the sensitivity of the dam breach runout extent to some of the key assumptions and input parameters. Sensitivity analyses were undertaken on the critical failure scenarios, i.e., those for the Stage 6 layout. As Scenario 1 and 2 are considered similar with respect to inundation area, sensitivity was performed on Scenario 1, as there is more uncertainty in the hydraulic modelling of this failure mode of slope instability.

Sensitivity testing of the following key inputs/assumptions was carried out:

- Sensitivity Scenario A: Failure cone tailings slope.
- Sensitivity Scenario B: Breach parameters.

Each of the above parameters are discussed further in the following sections with the resultant flood inundation maps presented in Appendix C.

10.1 Sensitivity A: Failure cone slope

Sensitivity to changes in the final slope of the tailings failure cone was assessed for Scenario 1. A failure cone slope of 4% was adopted for the Scenario 1 base case, and as such slopes of 3% and 5% were assessed for sensitivity. These slopes result in a larger and smaller total runout volume respectively, and therefore result in changes to the outflow hydrograph. The assessed parameters are summarised in Table 10.1, with the respective hydrographs presented in Figure 10.2.

Table 10.1 Sensitivity A – tailings failure cone slope

Scenario	Failure cone slope	Total released volume of tailings solids (Mm^3)	Total released volume (Mm^3) (Note)
Scenario 1 base case	4%	29.5	40.9
Sensitivity A1	3%	45.3	56
Sensitivity A2	5%	17.5	28.2

Table 10.1 note: includes ponded water released (72 hour PMP) and failed embankment volume.

Inundation maps for the above sensitivity scenarios are included in Figures C01 to C06 in Appendix C. The model results indicate that the maximum flood extent is wider for Sensitivity A1, and relatively thinner in Sensitivity A2, as compared to the Scenario 1 base case. Sensitivity A1 indicated slightly larger flooding extent to the east of the access track, and Sensitivity A2 indicated slightly less in the same region. Severity classification reduced in Sensitivity A2 for the small fork in the flow path to the south-west of the small water dam, close to the entry to Lake Torrens. The change to release volume accounts for this variation in inundation extent.

A comparison of the outflow breach hydrographs for Sensitivity A to the base Scenario 1 case is presented in Figure 10.1.

Whilst the breach hydrographs are very sensitive to failure slope and therefore release volume, they do not change the hazard classification meaningfully of the Eliza Creek area (refer to inundation maps in Appendix C) within the range of failure slopes that were tested.

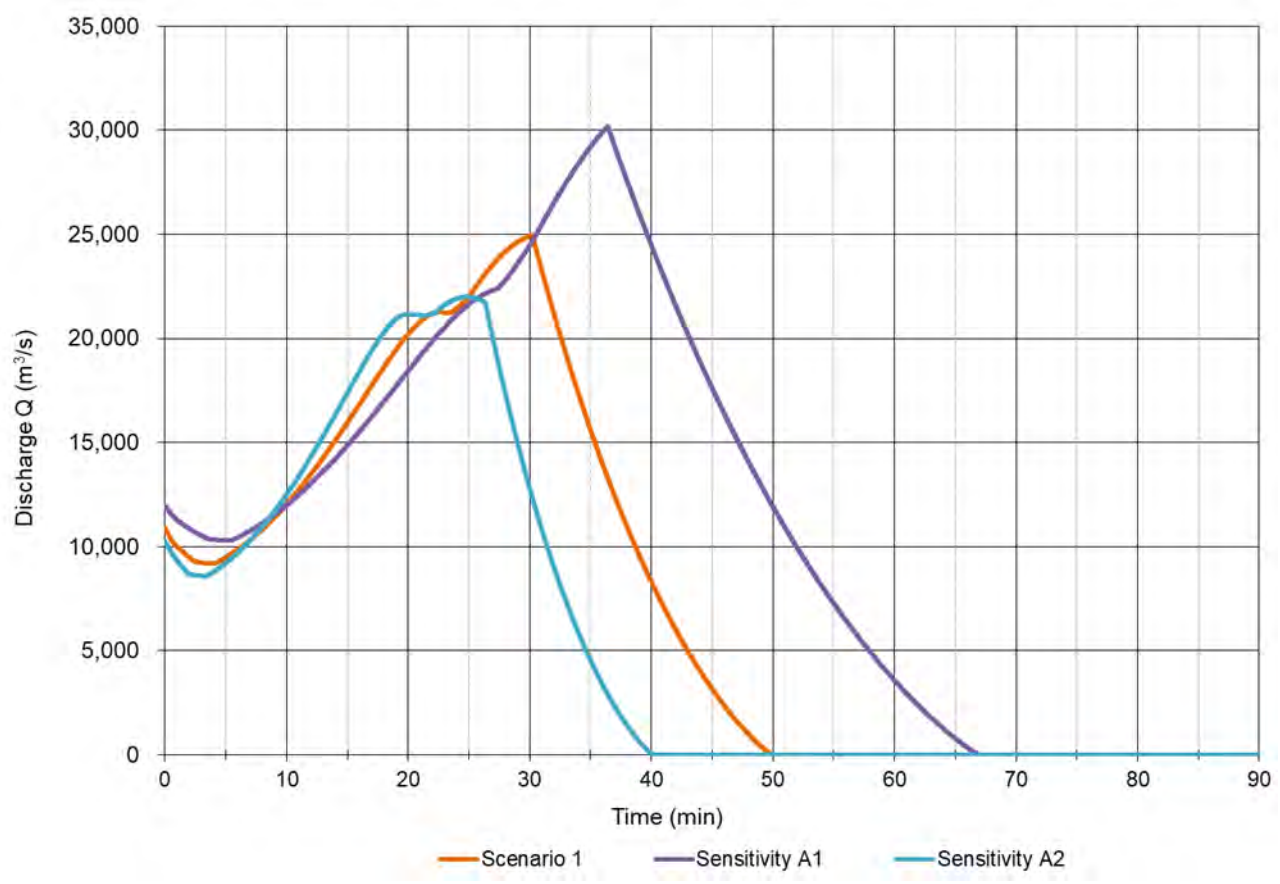


Figure 10.1 Breach hydrographs for Scenario 1 sensitivity to breach cone failure angle

10.2 Sensitivity B: breach parameters

Sensitivity to changes in breach parameters were assessed for Scenario 1. Embankment width at the breach mid-height is an input to the regression equations used for the breach hydrographs developed in Section 6.1 and was selected due to the variability in embankment width due to the nature of the cross-valley embankment construction. Embankment base width was varied by 10 m (wider and narrower). A comparison to the base case for Scenario 1 presented in Table 10.2, with the corresponding hydrograph presented in Figure 10.2.

Table 10.2 Scenario 1 sensitivity to breach parameters (embankment width)

Scenario	Embankment width at breach mid-height
Scenario 1 (base case)	92
Sensitivity B1	102
Sensitivity B2	82

The sensitivity scenarios breach hydrographs are presented in Figure 10.2. The breach hydrographs for these cases are not sensitive to this parameter and given the similarity of the hydrographs for Sensitivity B1 and B1, hydraulic models are not presented for these cases, as the severity classification of the inundated areas is not expected to change meaningfully.

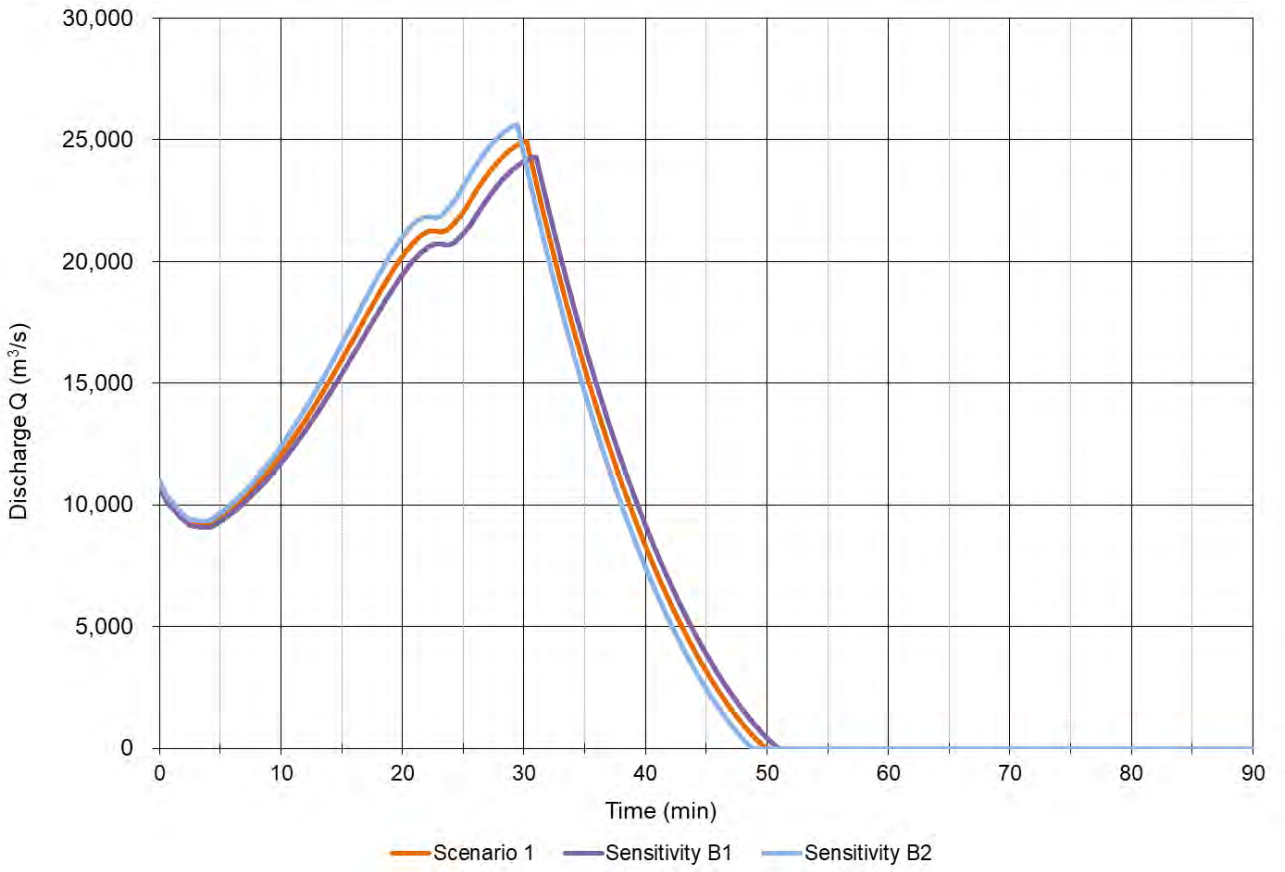


Figure 10.2 Breach hydrograph for Scenario 1 sensitivity to embankment width.

10.3 Sensitivity C: comparison to 2017 study

Two sensitivity scenarios were assessed to provide a comparison to the analyses completed for the previous dam breach assessment[45] (2017). The scenarios assessed are sunny day assessments, that seek to adopt similar parameters to the previous assessment where possible, however adopt current rheology data. A summary of the cases assessed is presented in Table 10.3. Runout figures for Sensitivity scenarios C1 and C2 are provided in Appendix C. The runout extent for the results from the 2017 study are also plotted for comparison, for both the tailings and water runout, refer to Section 2.4 for details on these assessments.

[45] Golder Associates Pty Ltd. (2017). *Carrapateena Project - Tailings Storage Facility Dam Break Study*, WSP ref: 1660055-009-M-Rev3, 21 March 2017.

Table 10.3 Sensitivity C scenario descriptions

Input/scenario description	**2017 Assessment** (Tailings release)	**Sensitivity C1**	**Sensitivity C2**
TSF layout	End of Stage 6 **(Note 1)**	End of Stage 3	End of Stage 6 **(Note 2)**
Ponded water (Mm^3)	0	0	0
Total stored tailings (Mm^3)	72.5	48.3	118.9
Release volume (Mm^3)	21.75	14.5	35.7
Failure mechanism	Internal erosion	Overtopping	Overtopping
Tailings dry density (t/m^3)	1.7	1.9	1.9
Released tailings solids concentration by volume (C_V, %/%)	50	50	50
Tailings rheology sample	Adopted from literature	High rheology tailings **(Note 3)**	High rheology tailings **(Note 3)**
Tailings rheology model	Carreau[46]	Bingham	Bingham

Table 10.3 notes:

(1) Based on the planned total storage volume as of 2017.

(2) Based on the Life of Mine plan[47] as of 2024.

(3) Refer to summary of data in Section 5, and adopted parameters in Section 10.3.2

10.3.1 Release volume

The release volumes assessed in the 2017 assessment considered 30% of the total impounded tailings (then) predicted at the end of Stage 6. This was based on estimates of historical failures, such as those presented in Figure 6.3. This method was adopted for Sensitivity Scenario C.

10.3.2 Adopted tailings rheology

Tailings parameters were adopted form the High Tailings rheology sample described in Section 5. As no ponded water was include in this Scenario, no mixing occurs of tailings downstream of the breach, and there is no dynamic change to tailings rheology parameters as the runout progresses. The fit parameters for the empirical equation required in FLO-2D, for yield stress and viscosity as functions of volumetric solids concentrations are presented in Table 10.4.

$$\tau_y = \alpha_1 e^{\beta_1 C_v}, \qquad and\ \mu = \alpha_2 e^{\beta_2 C_v}$$

[46] Carreau, P. J. (1972). *Rheological Equations from Molecular Network Theories*. Transactions of The Society of Rheology, 16(1), 99-127. doi:10.1122/1.549276

[47] *Life of Mine Concept Design Update - Basis of Assessment, Carrapateena Tailings Storage Facility*, BHP ref: CA-3630-CIV-REP-1070, WSP ref: PS138057-MEL-MNG-REP-0001 Rev0, 16 January 2024.

Table 10.4 Sensitivity Scenario C adopted tailings rheology parameters for High Tailings rheology sample

Parameter	Adopted value
Stored tailings solids concentration C_V (% v/v) **(Note)**	50
α_1	0.484
β_1	18.525
α_2	0.0058
β_2	12.488

10.3.3 Breach outflow hydrograph

Breach hydrographs were developed using the same methods as described in Section 6, for the release volumes presented in Table 10.3. The hydrographs for Sensitivity Scenarios C1 and C2 are presented in Figure 10.3, in addition to the release hydrograph adopted for the tailings release in the 2017 DBA.

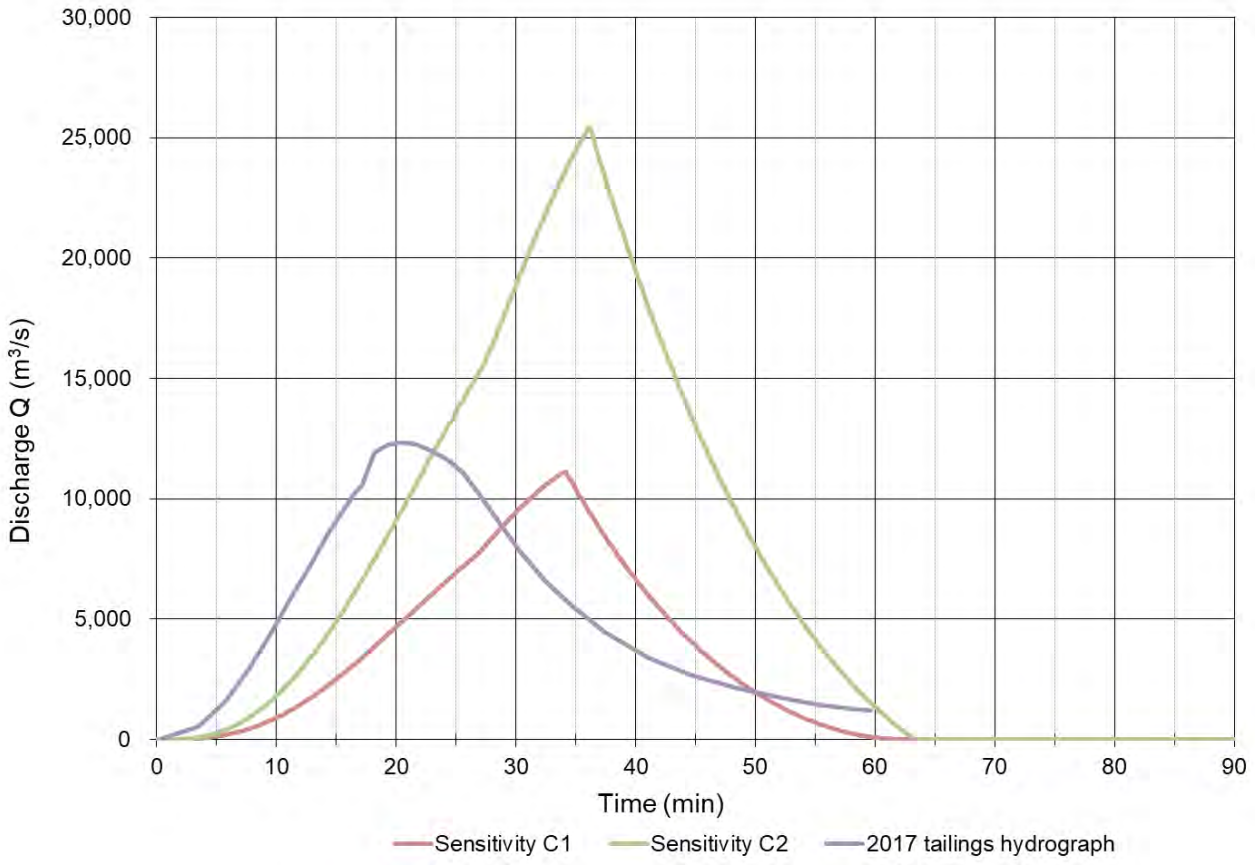


Figure 10.3 Breach outflow hydrographs for Sensitivity Scenarios C1 and C2, and 2017 DBA tailings release.

10.4 Sensitivity scenario results

A summary of the total inundated area in Eliza Creek for each sensitivity Scenarios A and C is presented in Table 10.2.

Table 10.5 Total inundated area in Eliza Creek for Sensitivity Scenario A

Scenario	Total inundated area (km^2)	Maximum runout distance (km)
Scenario 1 (Sensitivity A base case)	13.5	14.8 **(Note 1)**
Sensitivity A1	15.8	14.8 **(Note 1)**
Sensitivity A2	11.8	14.8 **(Note 1)**
2017 assessment (Tailings)	5.5	7.7
2017 assessment (water)	9.4	16 **(Note 2)**
Sensitivity C1	6.5	10.5
Sensitivity C2	13	14.8 **(Note 1)**

Table 10.2 notes

(1) End of simulation outflow boundary for 2024 assessment.

(2) End of simulation outflow boundary for 2017 assessment.

Reported inundation areas consider model results that adopted an outflow boundary condition at the end of Eliza Creek, and therefore total impacted area may be larger as runout enters the lake.

11 Closing and recommendations

This dam breach assessment report documents the methods, assumptions, data analysis and simulation results for four credible failure scenarios for the Carrapateena TSF. The scenarios provide an understanding of potential impacts for the main runout path in the event of a dam breach.

The assessment results provide a visual interpretation of the potential flood inundation and 'flood severity', which are required to establish the Population at Risk (PAR), the Potential Loss of Life (PLL) and environmental impacts as inputs to a consequence category assessment and for emergency response planning.

Extreme flood conditions (and uncontrolled release of ponded runoff from a PMP, 72 hour event) were adopted for all scenarios analysed and these show significant downstream runout extents.

Future assessments should consider the runout into Lake Torrens, considering the water level present in the lake during a flood day scenario.

12 Limitations

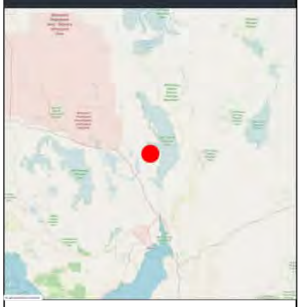
This report summarises the assessment for dam breach runout analysis for the Carrapateena TSF and should be read in conjunction with the limitations statement in Appendix D

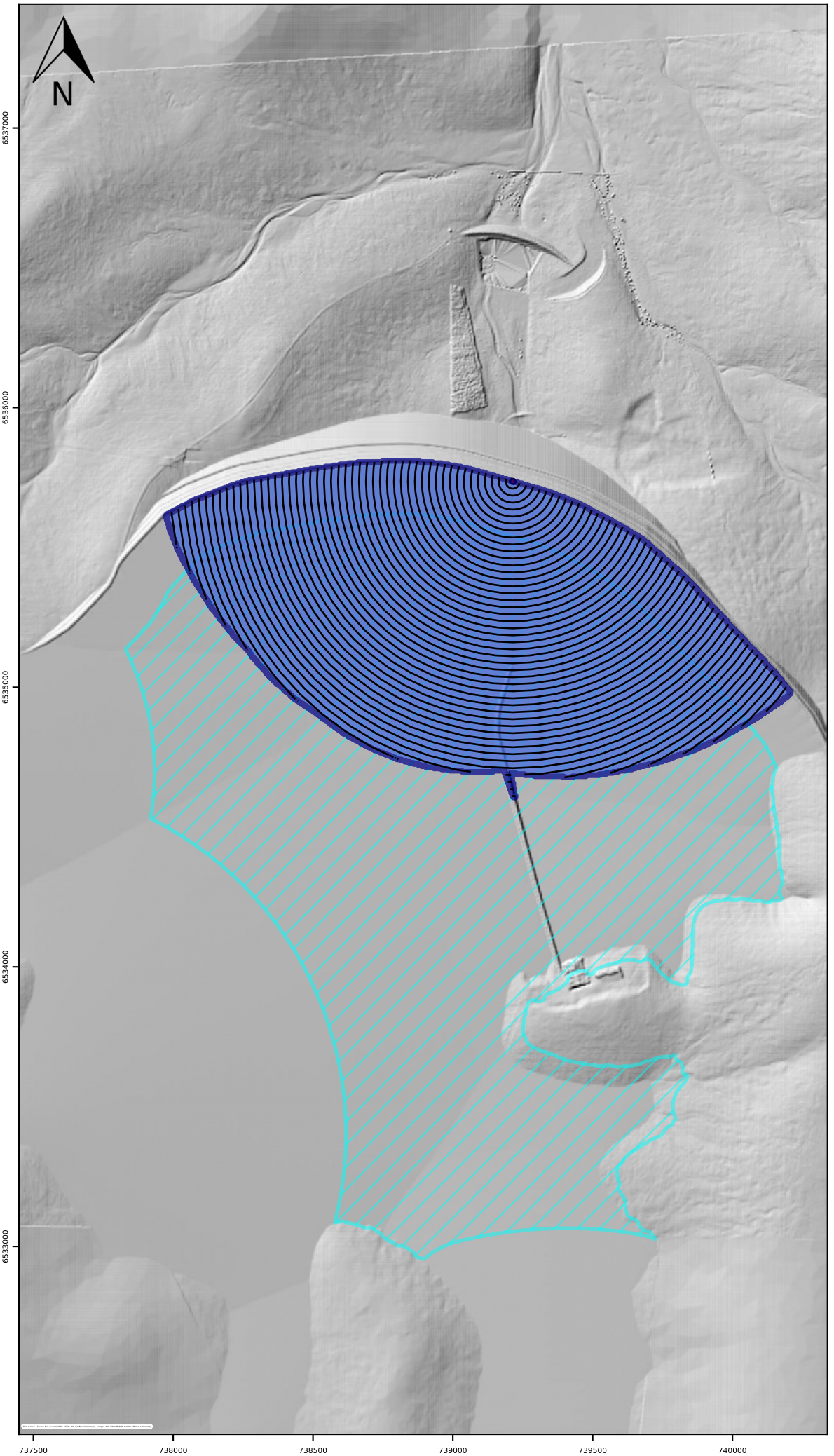
Appendix A

Failure cones

Carrapateena 220 Mt Life of Mine assessment

Scenario 1, 2, and 4 failure cone





LEGEND

- Failure cone contours (1m)
- Failure cone extent
- Supernatant Pond
- Breach Location

1:32000
Scale Bar
500 m

NOTES

1. Base and Key Map: © Open Street Map

Client:	BHP Carrapateena
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	**A01**

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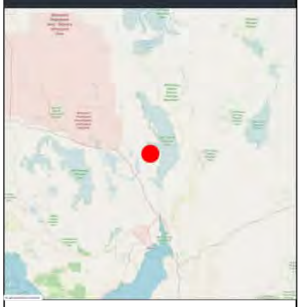
Carrapateena 220 Mt Life of Mine assessment

Scenario 3 failure cone



LEGEND

- Failure cone contours (1m)
- Failure cone extent
- Supernatant Pond
- Breach Location

1:32000
Scale Bar
500 m

NOTES

1. Base and Key Map: © Open Street Map

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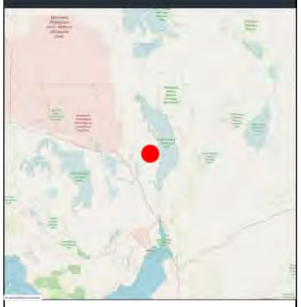
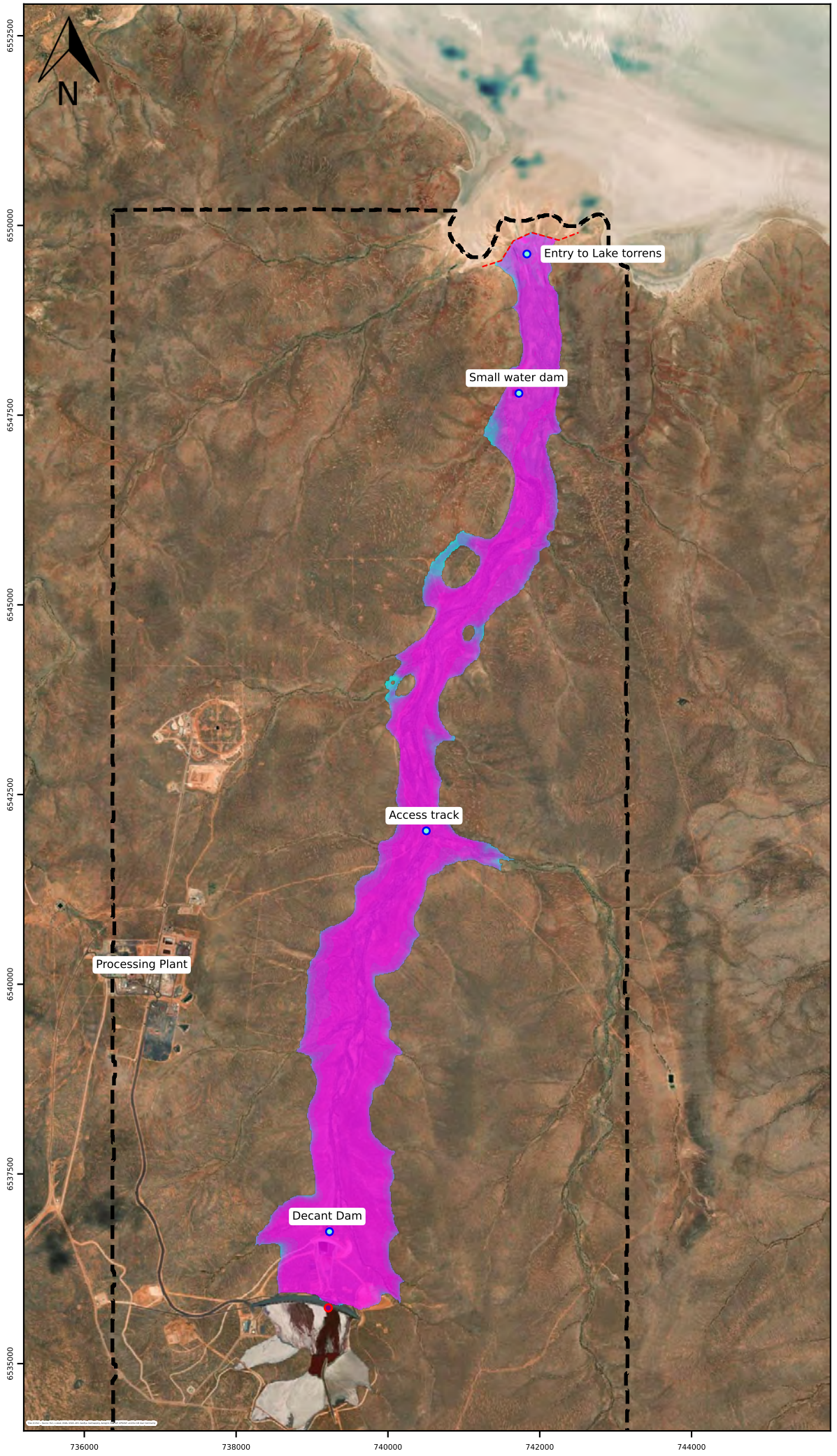
Appendix B

Inundation maps

Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 1: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, Slope instability failure.

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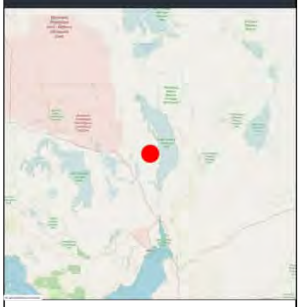
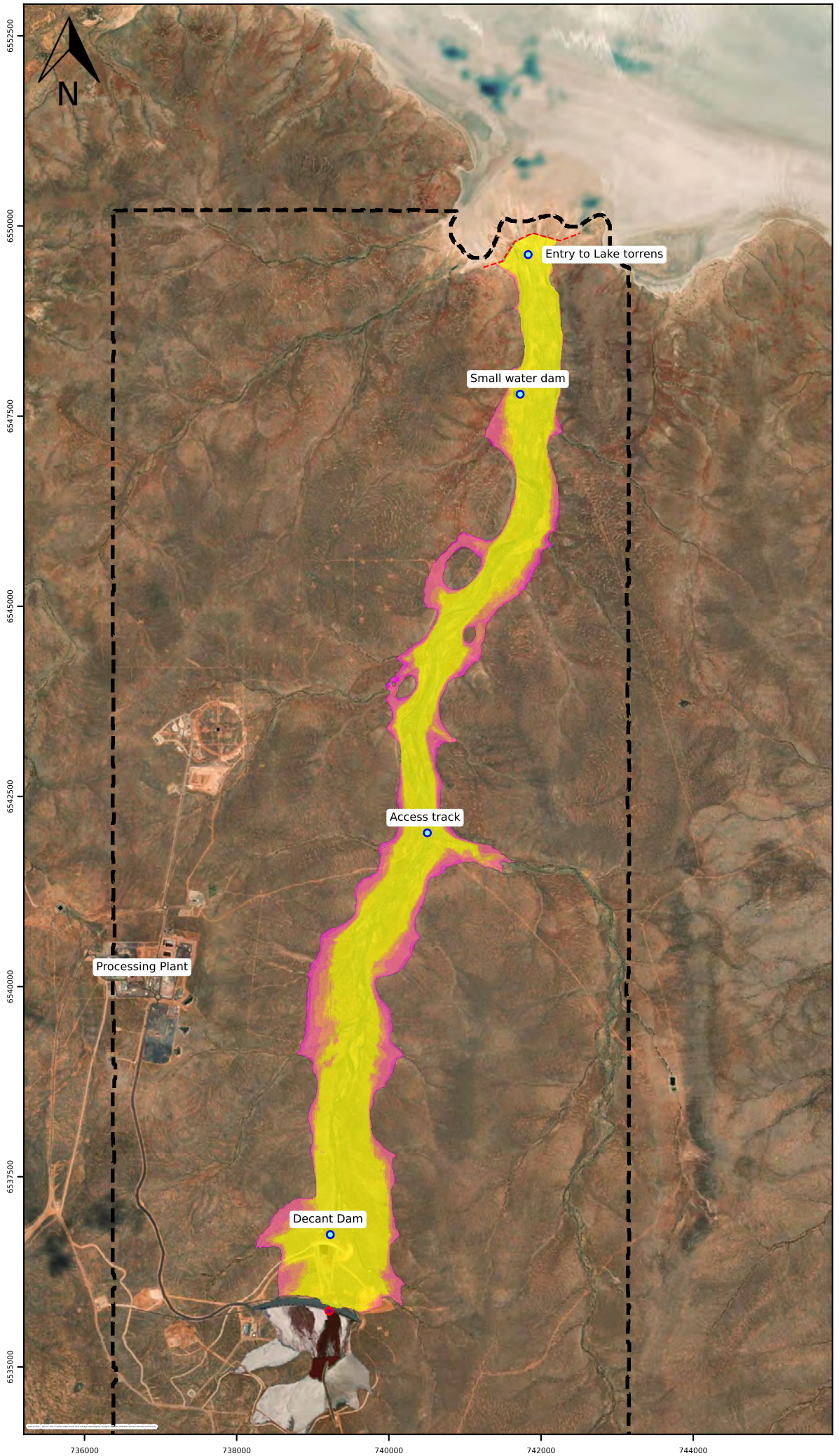
C:\Carrapateena\Dam break figures\Figure Generation runout v2

Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 1: Maximum velocity (m/s)





LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, Slope instability failure.

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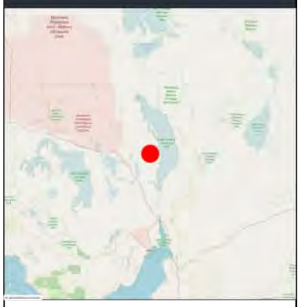
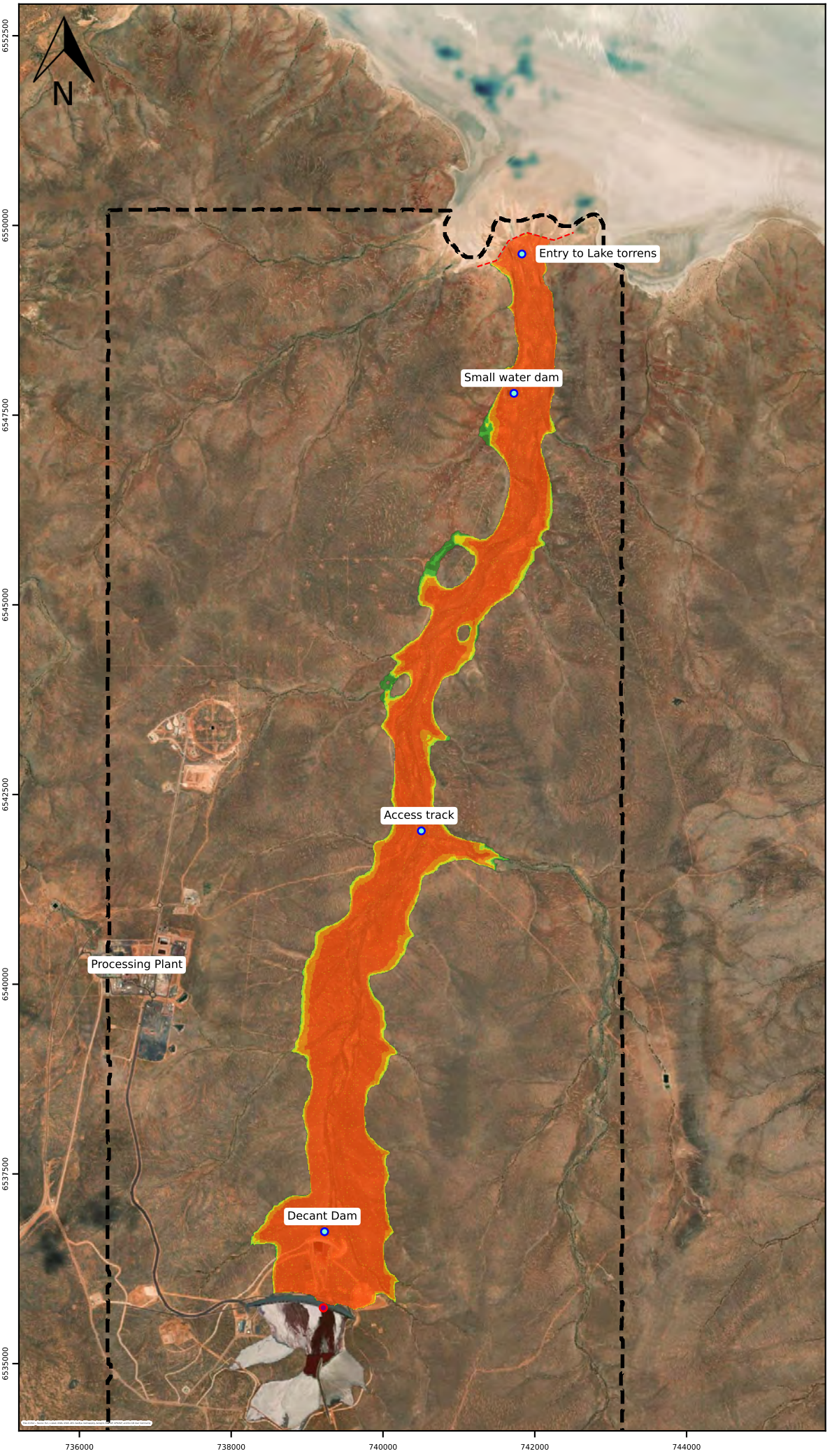
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 1: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

Model boundary
Breach location
Result locations
Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, Slope instability failure.

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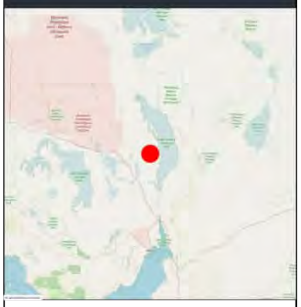
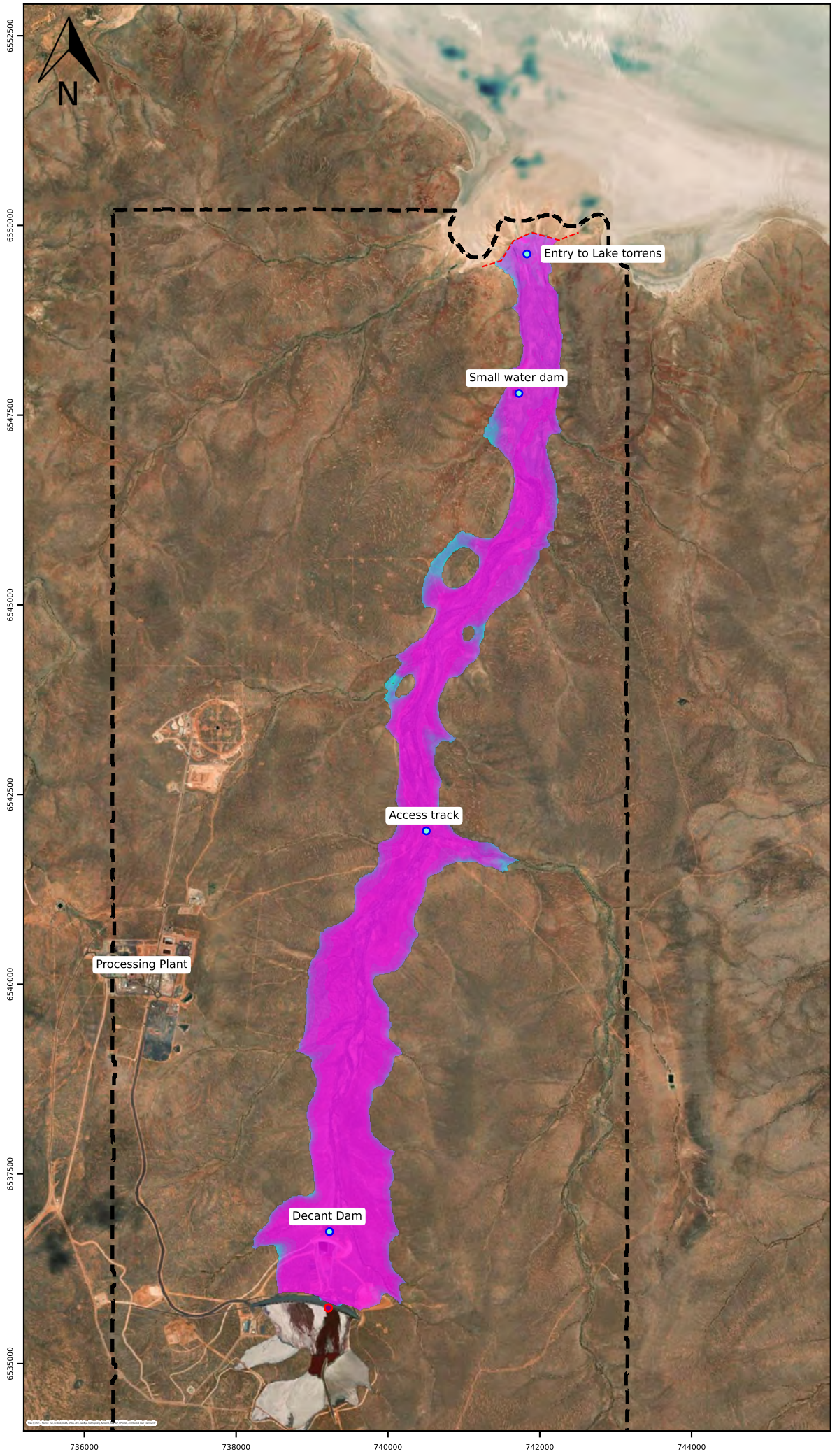
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 2: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, overtopping failure from pipe break.

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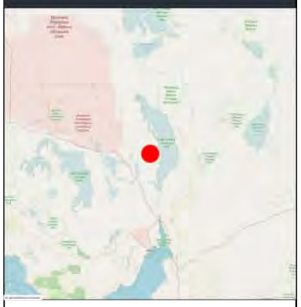
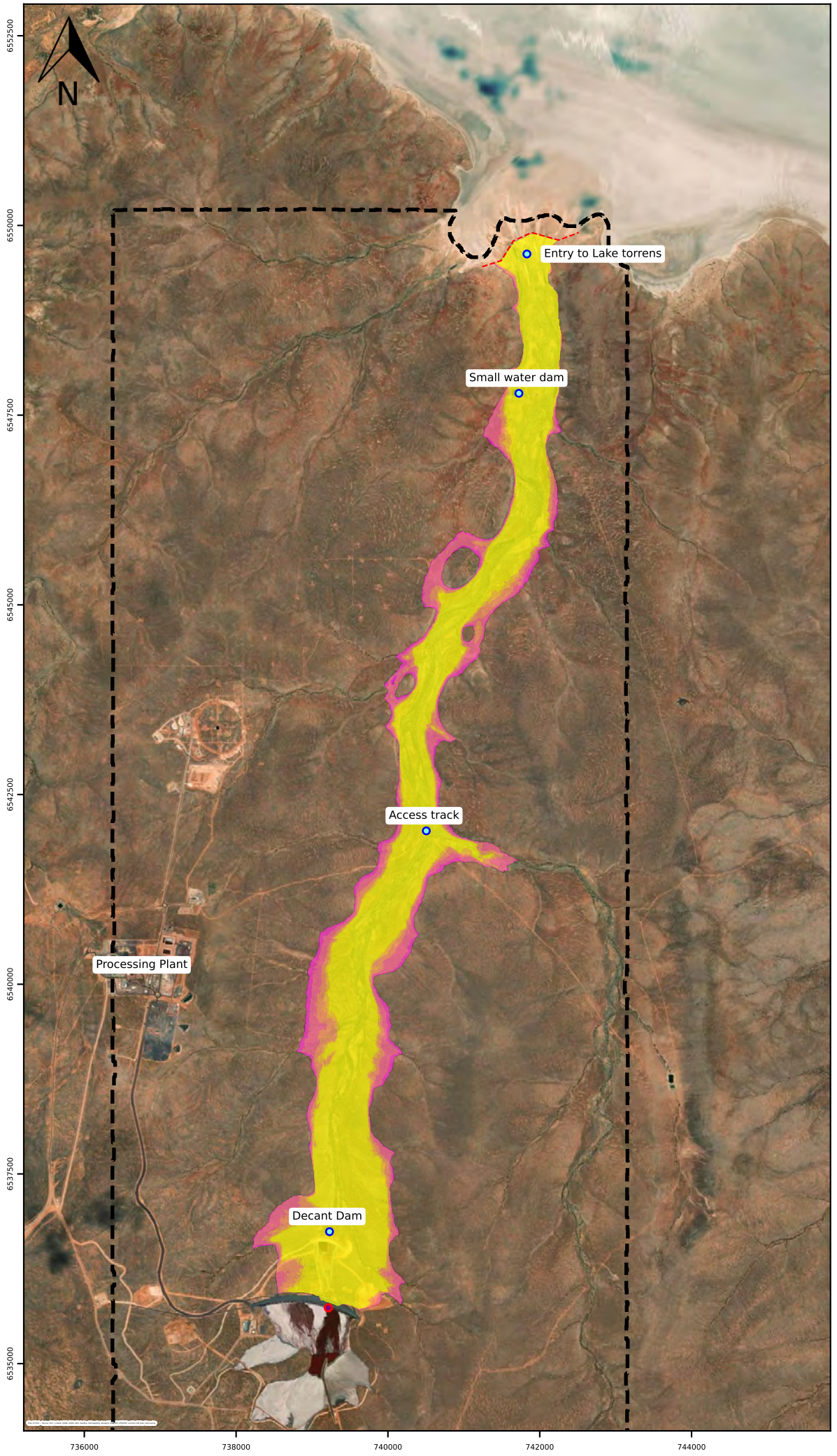
C:\Carrapateena\Dam break figures\Figure Generation runout v2

Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 2: Maximum velocity (m/s)





LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B05

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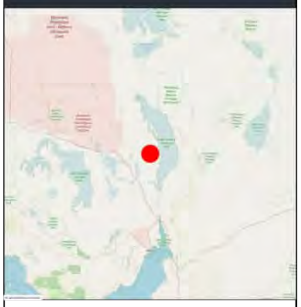
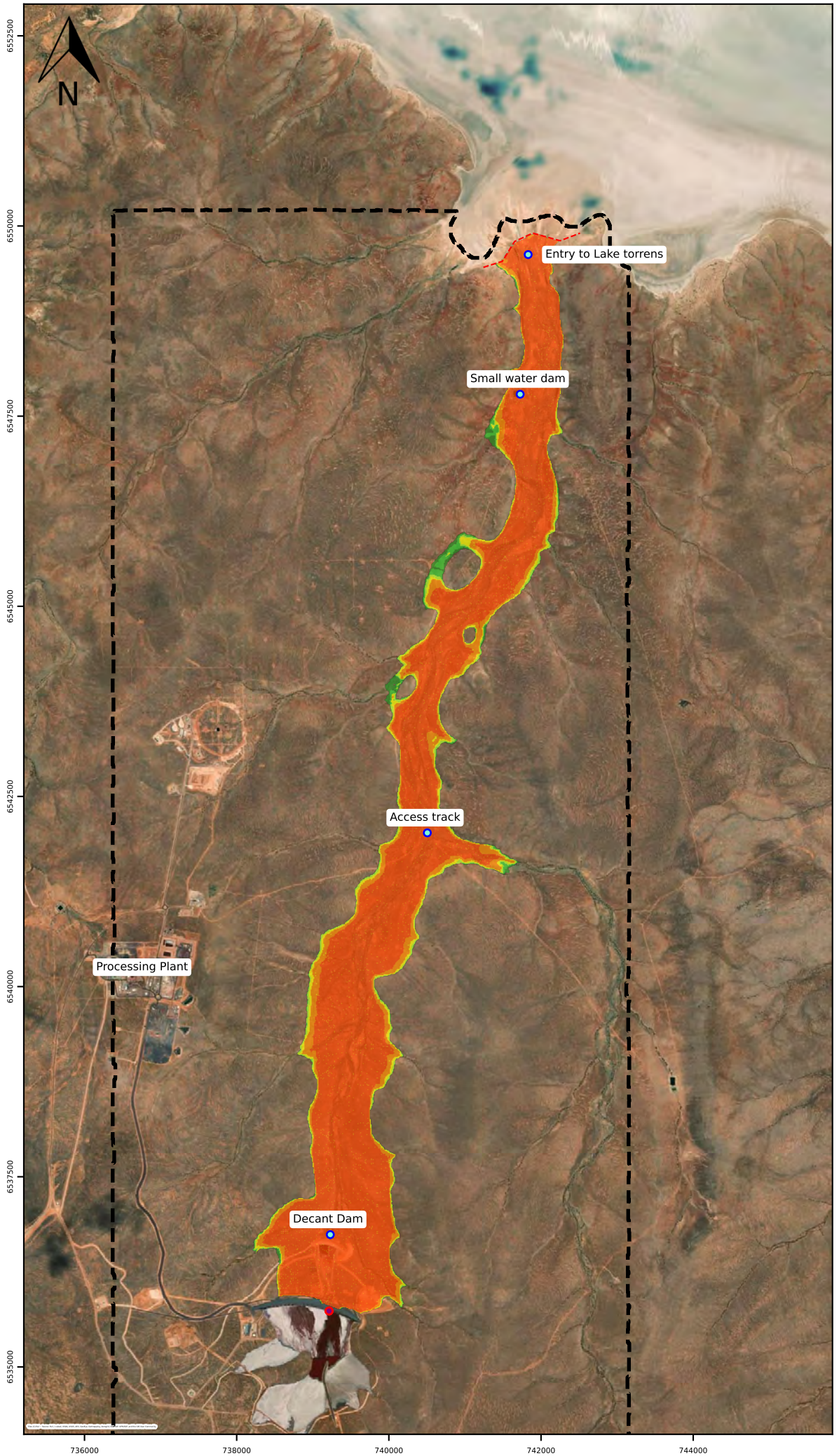
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 2: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

Model boundary
Breach location
Result locations
Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B06

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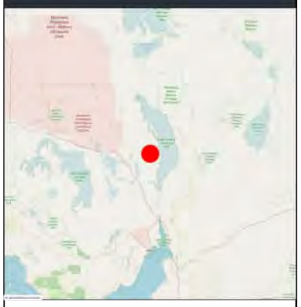
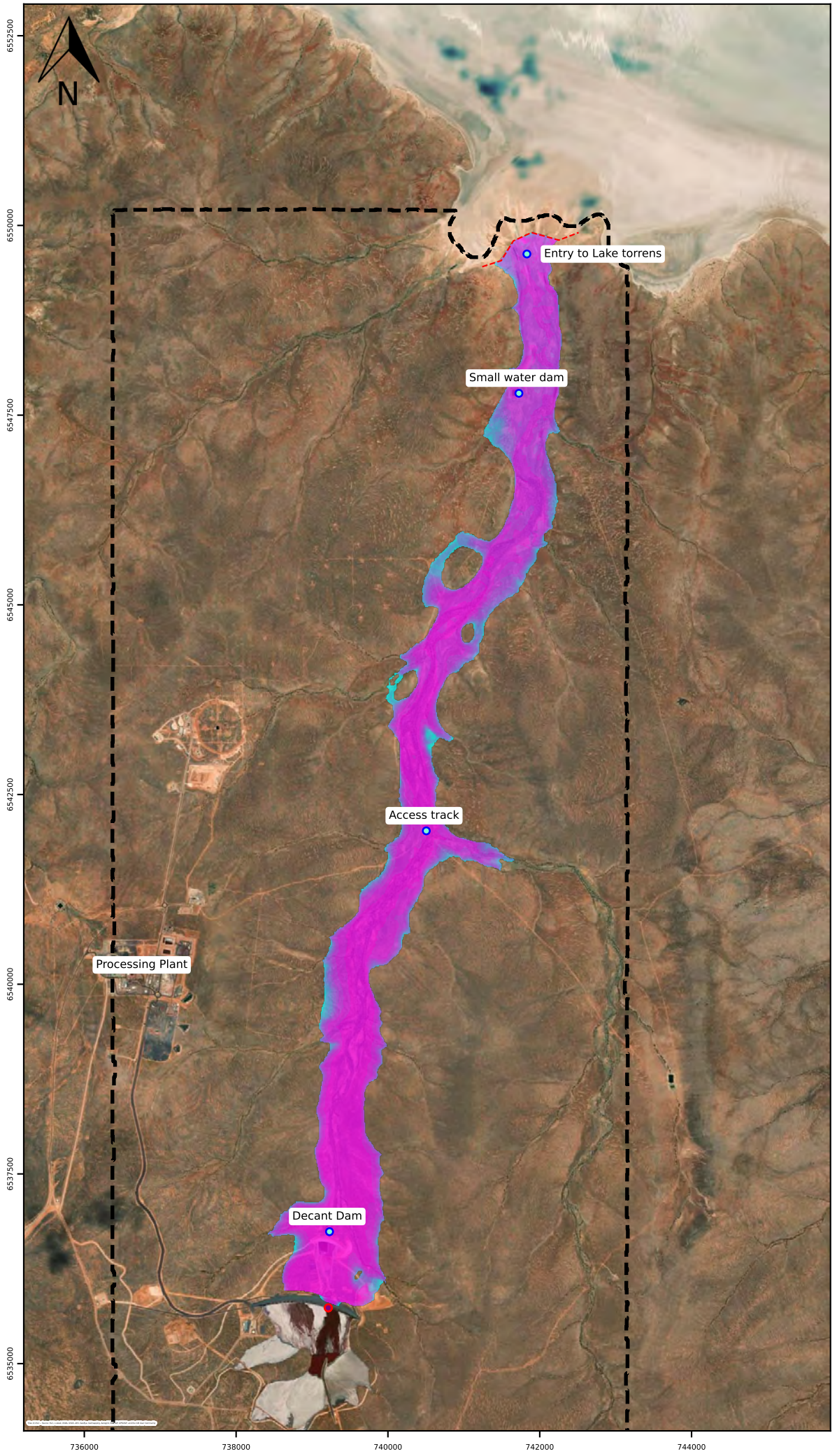
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 3: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 3 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B07

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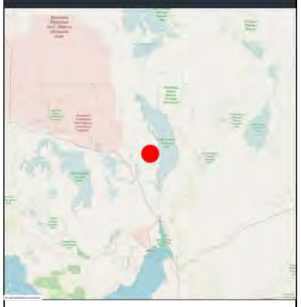
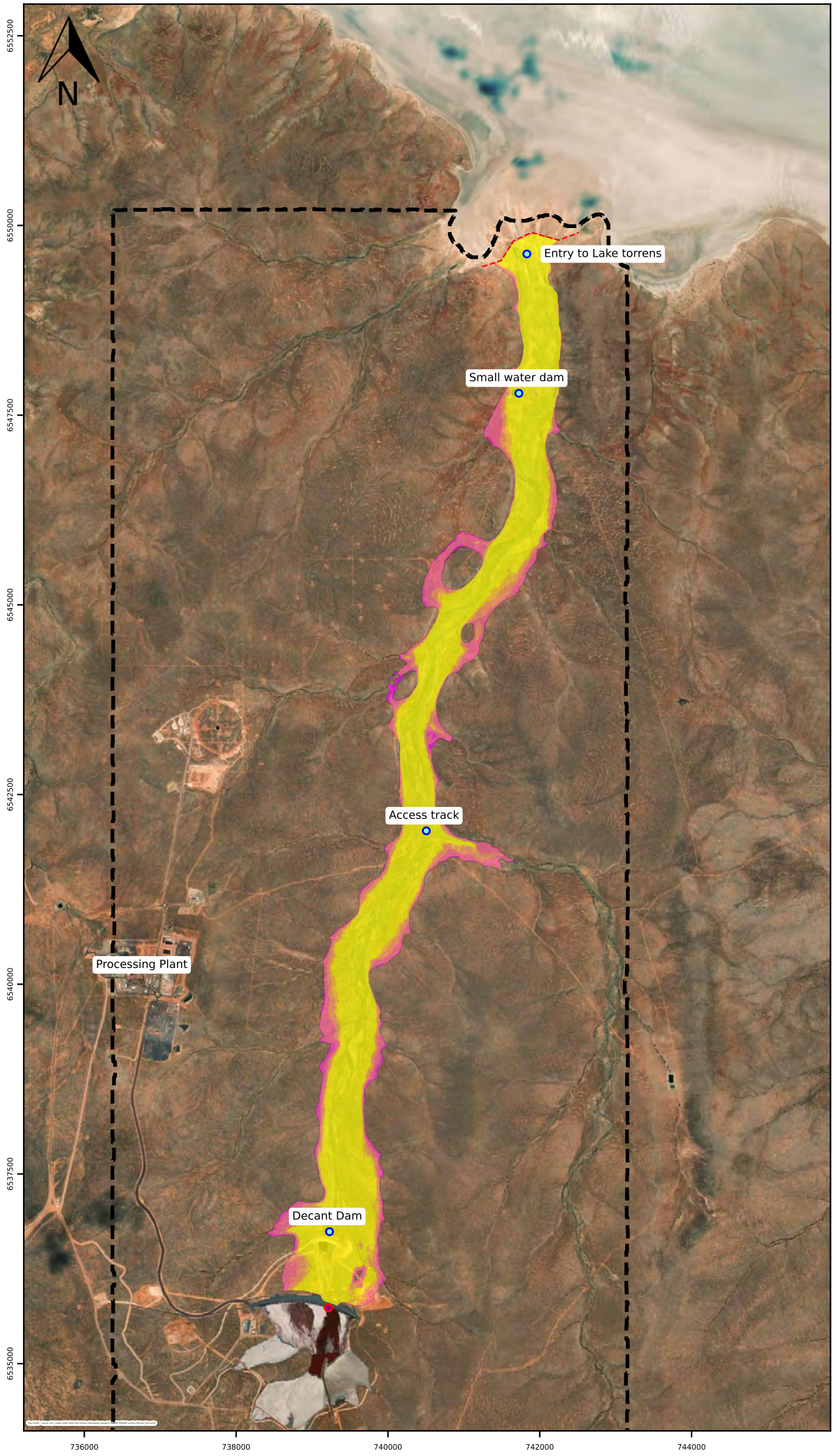
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 3: Maximum velocity (m/s)





LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 3 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B08

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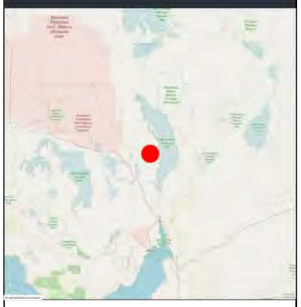
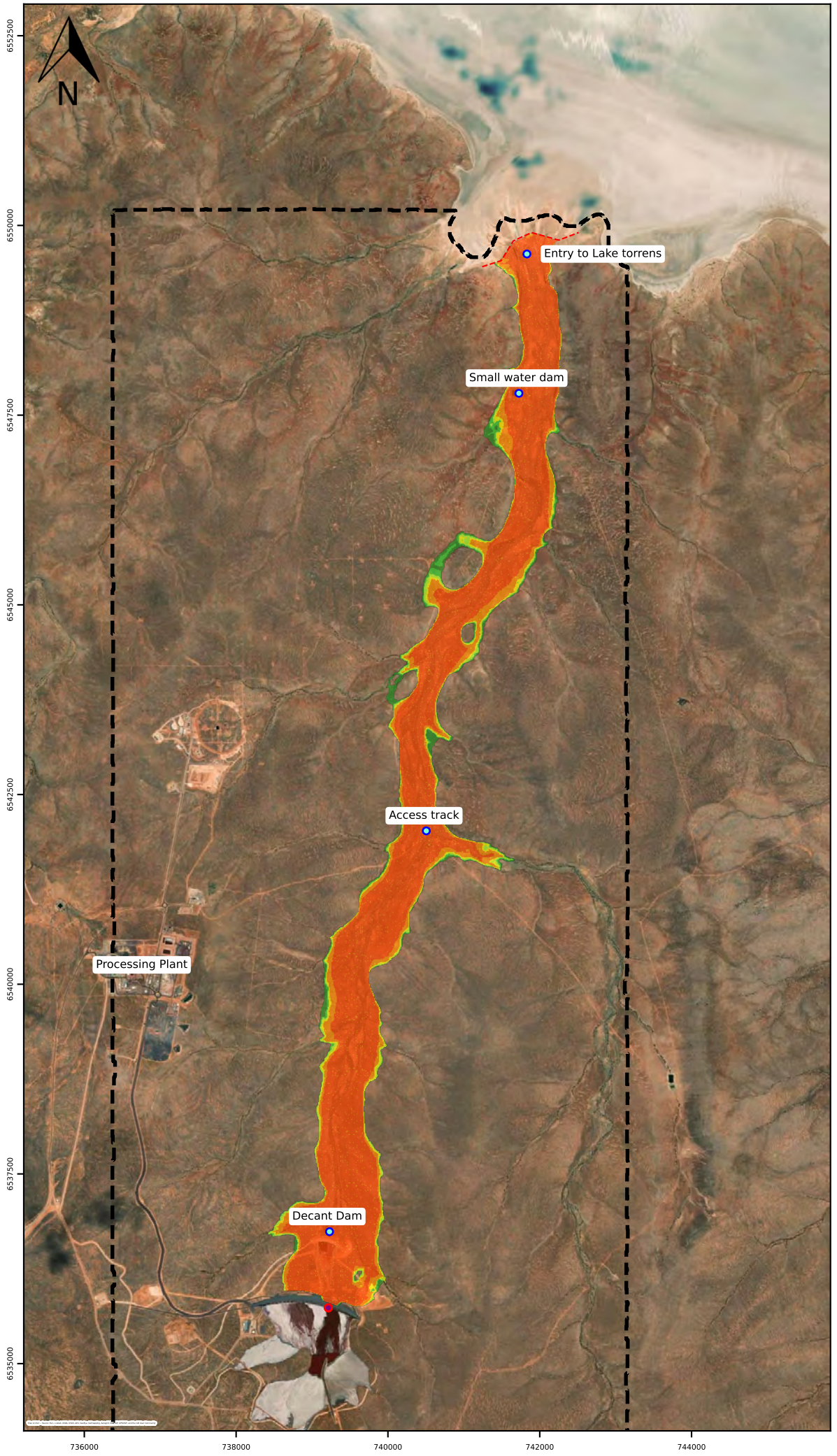
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 3: Flood Severity





LEGEND

Flood Severity

- 6
- 5
- 4
- 3
- 2
- 1

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 3 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B09

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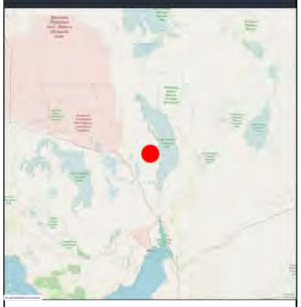
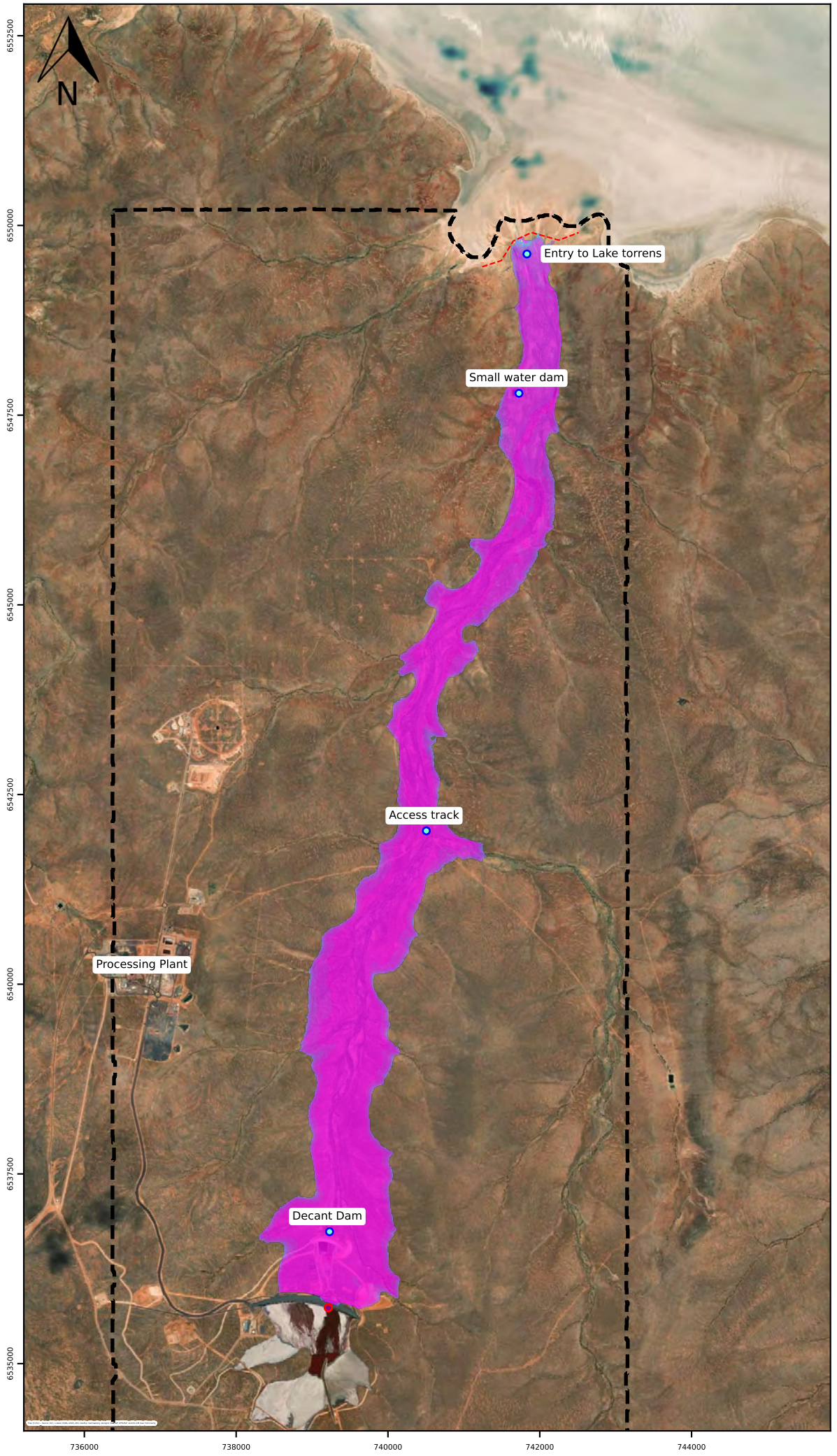
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 4: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final flatter layout, sunny-day, slope instability failure.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	**B10**

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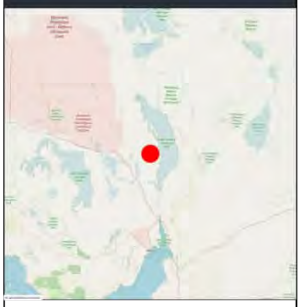
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 4: Maximum velocity (m/s)



LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final flatter layout, sunny-day, slope instability failure.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B11

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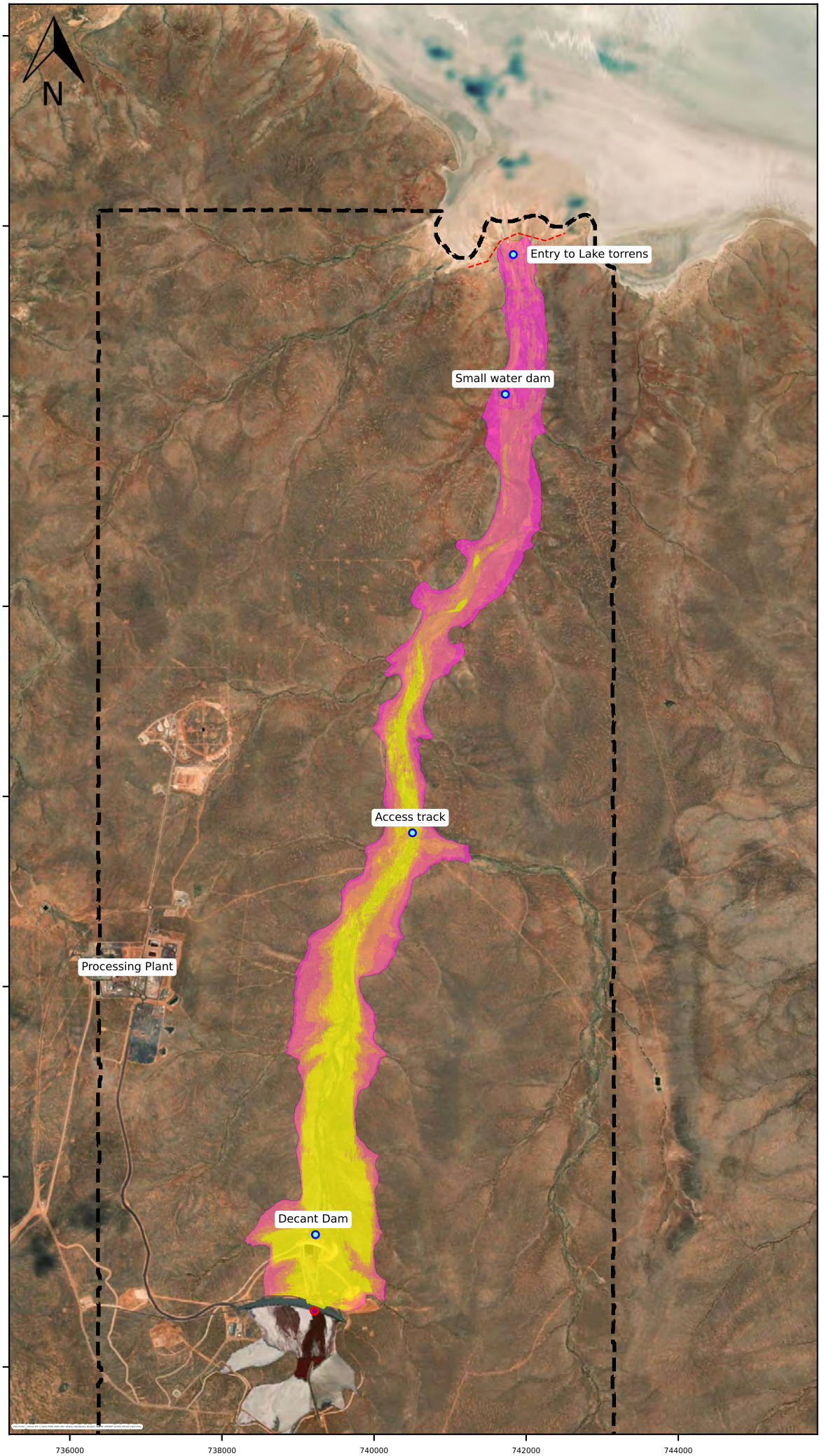
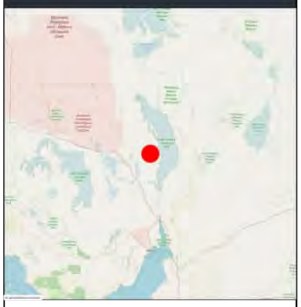
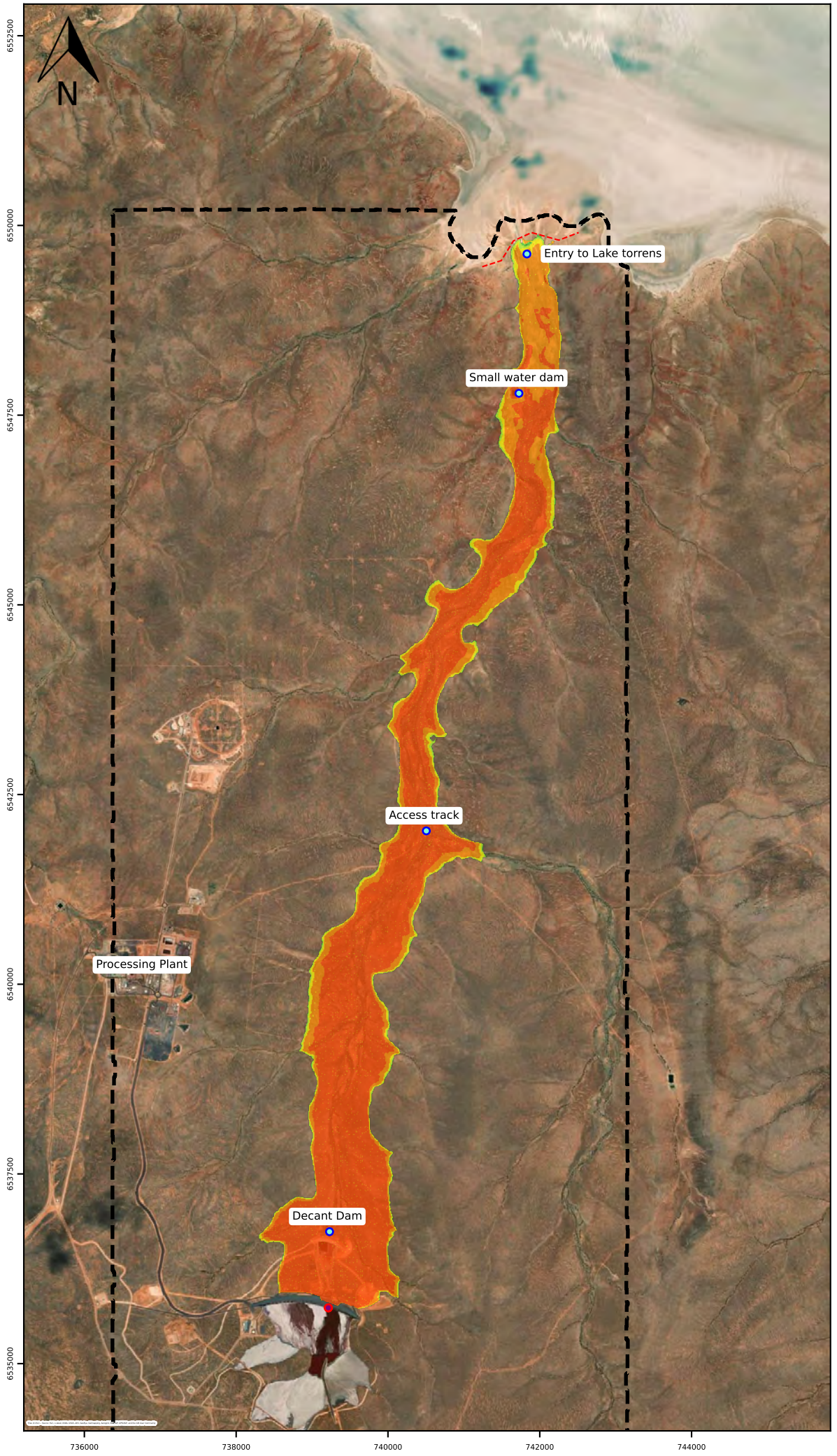


Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 4: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

Model boundary
Breach location
Result locations
Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final flatter layout, sunny-day, slope instability failure.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	B12

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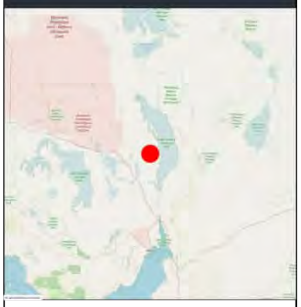
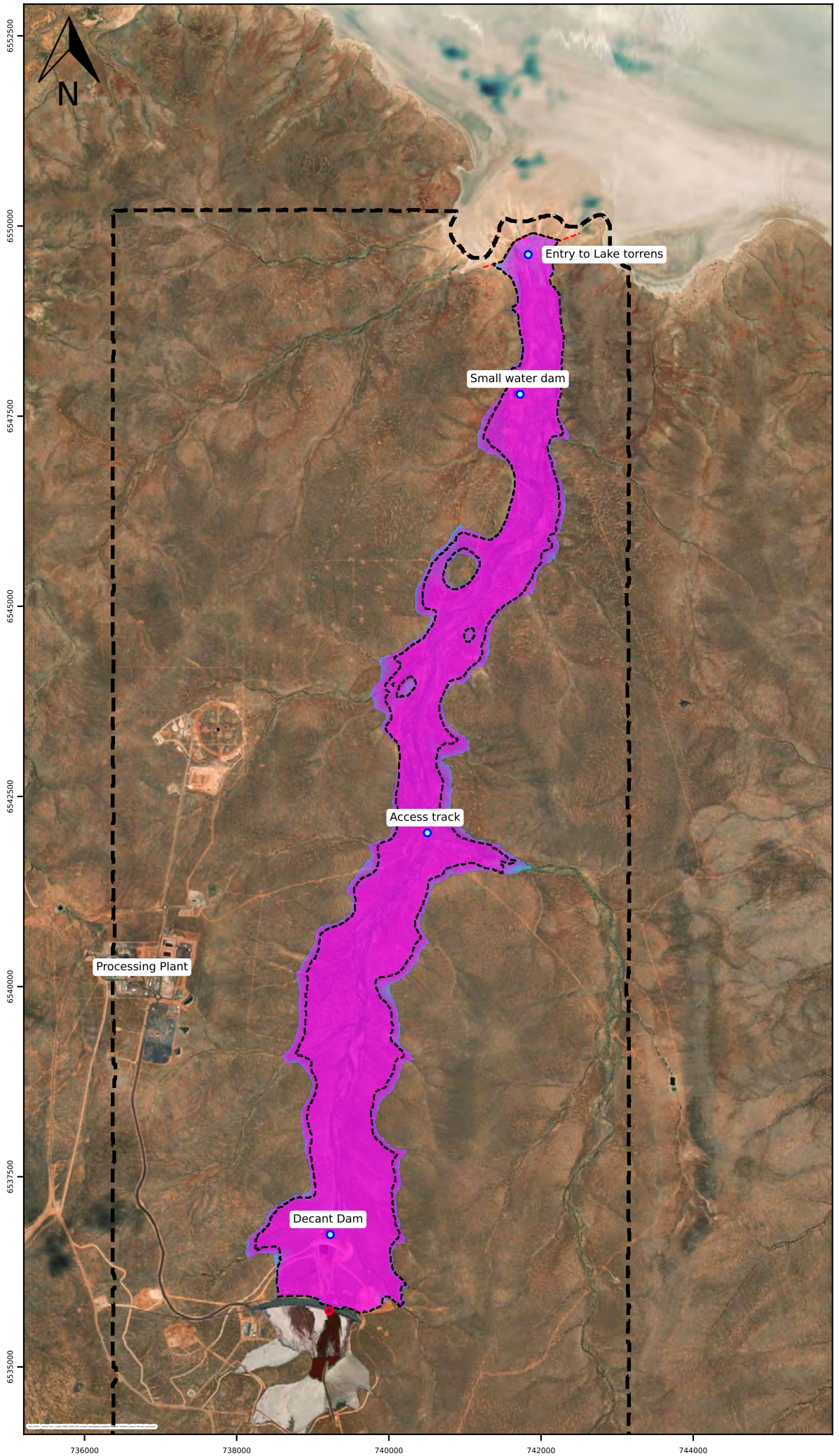
Appendix C

Sensitivity analysis inundation maps

Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity A1: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Scenario 1 base case
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Scenario 1 - Sensitivity to post-failure tailings slope (3%)

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	C01

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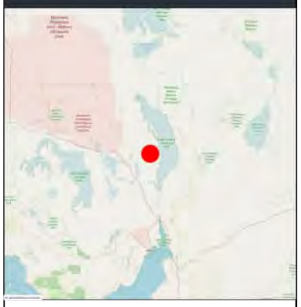
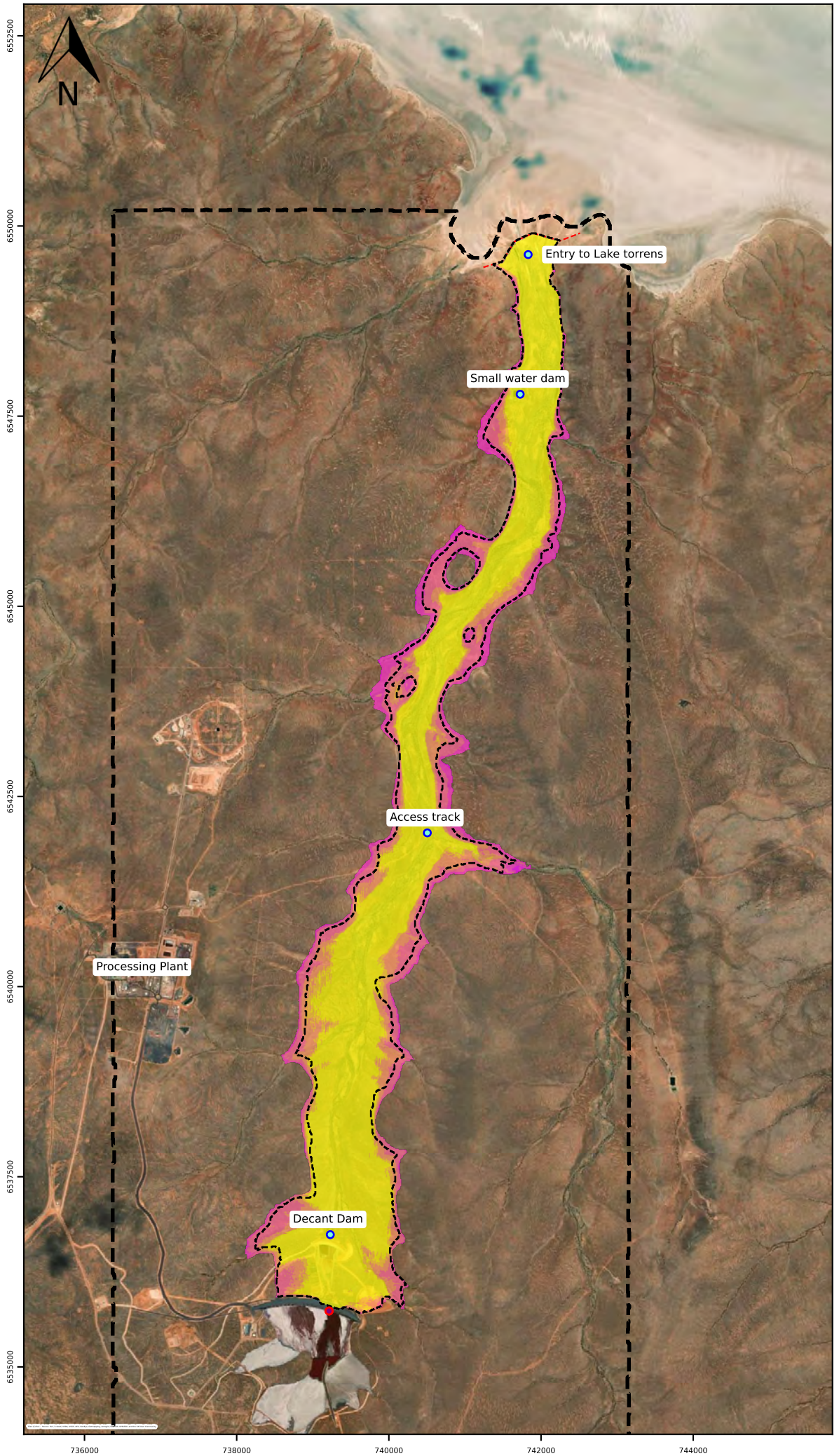
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity A1: Maximum velocity (m/s)





LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Scenario 1 base case
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Scenario 1 - Sensitivity to post-failure tailings slope (3%)

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	C02

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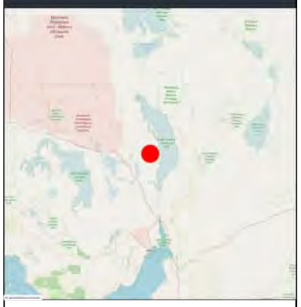
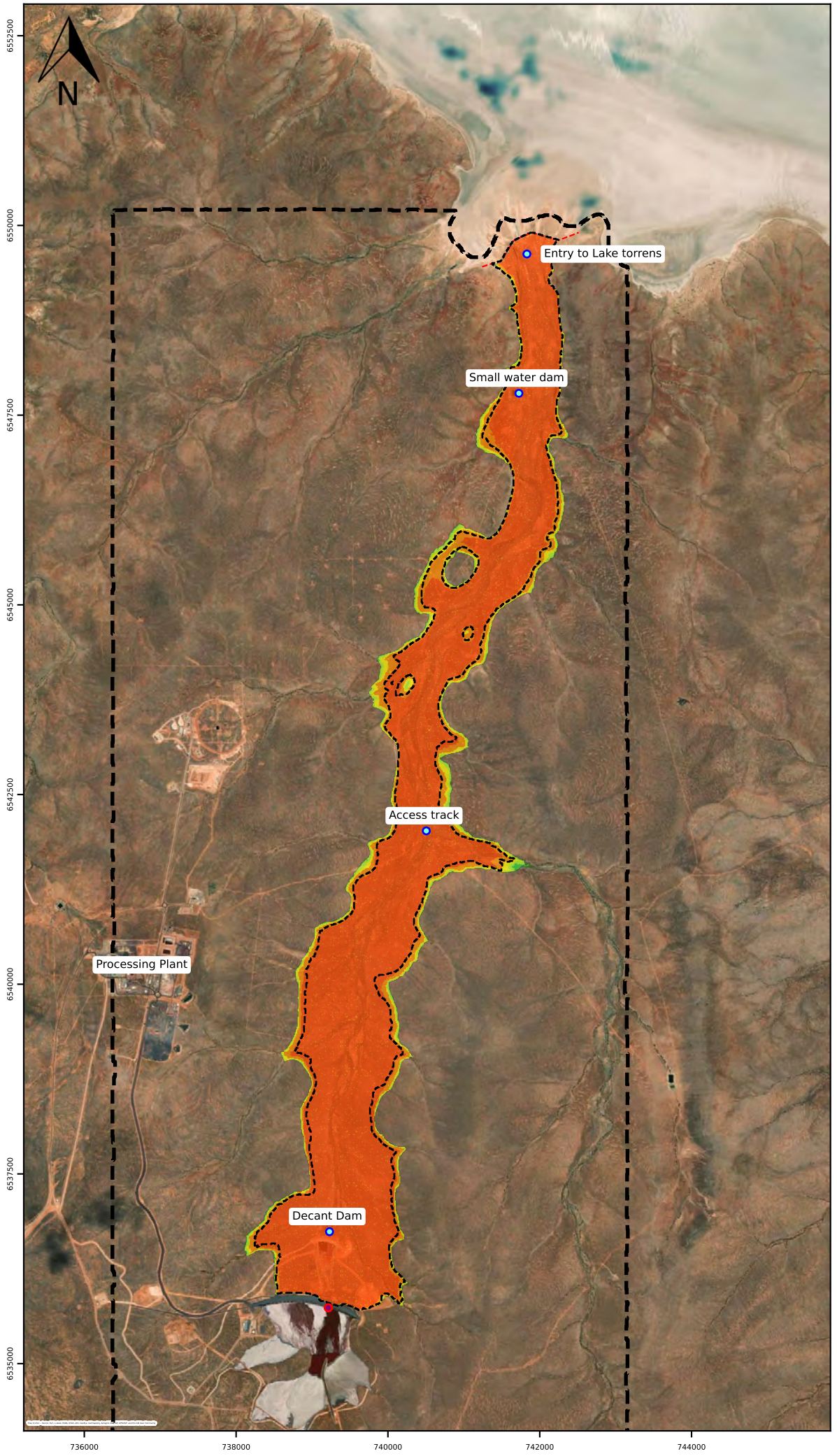
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity A1: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

Model boundary
Breach location
Result locations
Scenario 1 base case
Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Scenario 1 - Sensitivity to post-failure tailings slope (3%)

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	C03

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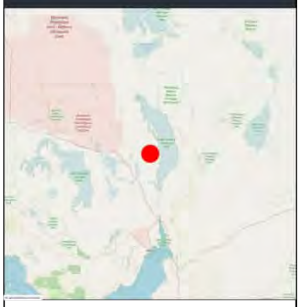
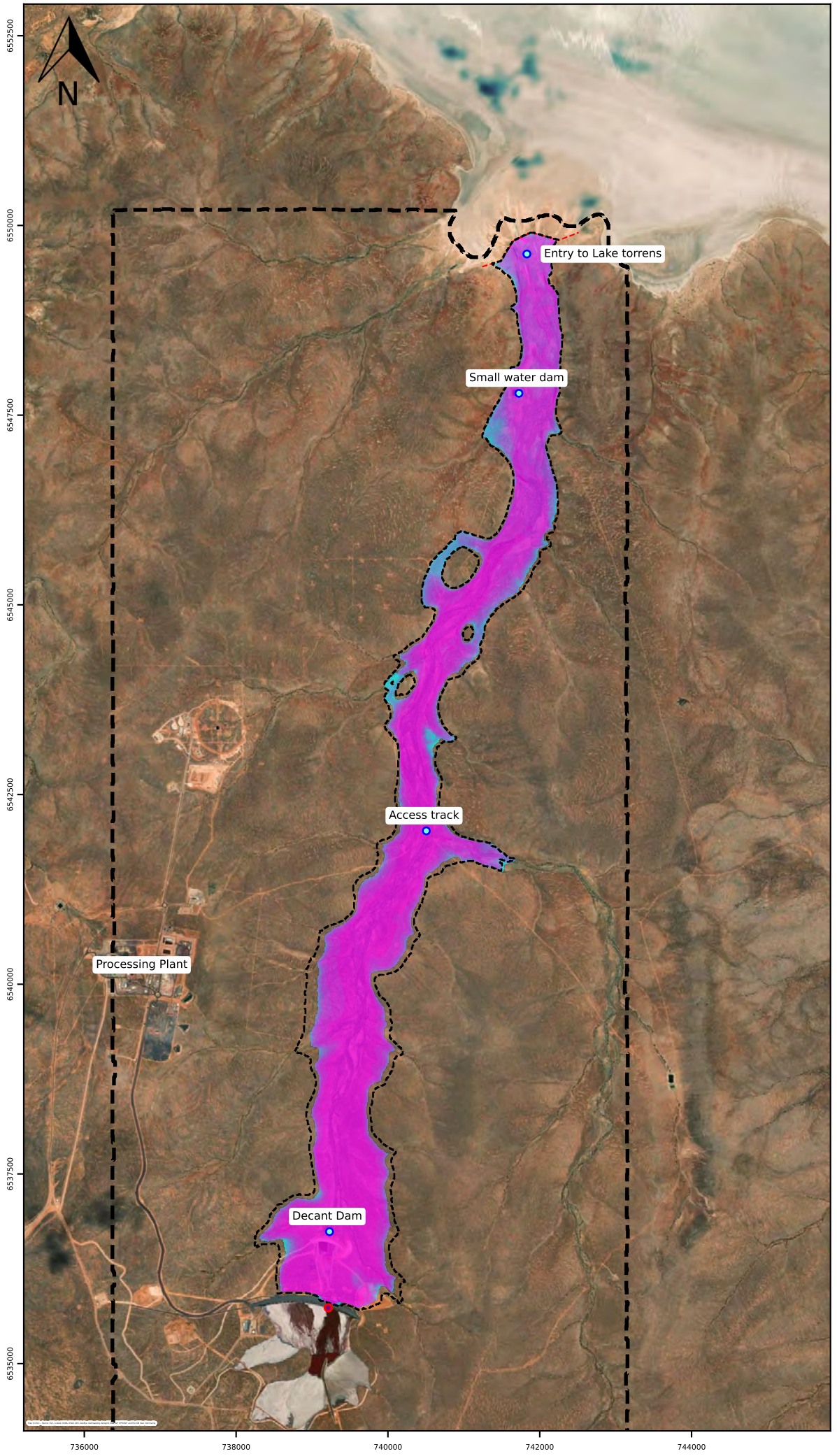
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity A2: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Scenario 1 base case
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Scenario 1 - Sensitivity to post-failure tailings slope (5%)

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
Approved:	GP
Figure No:	C04

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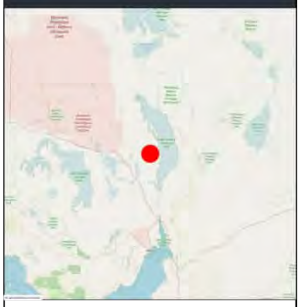
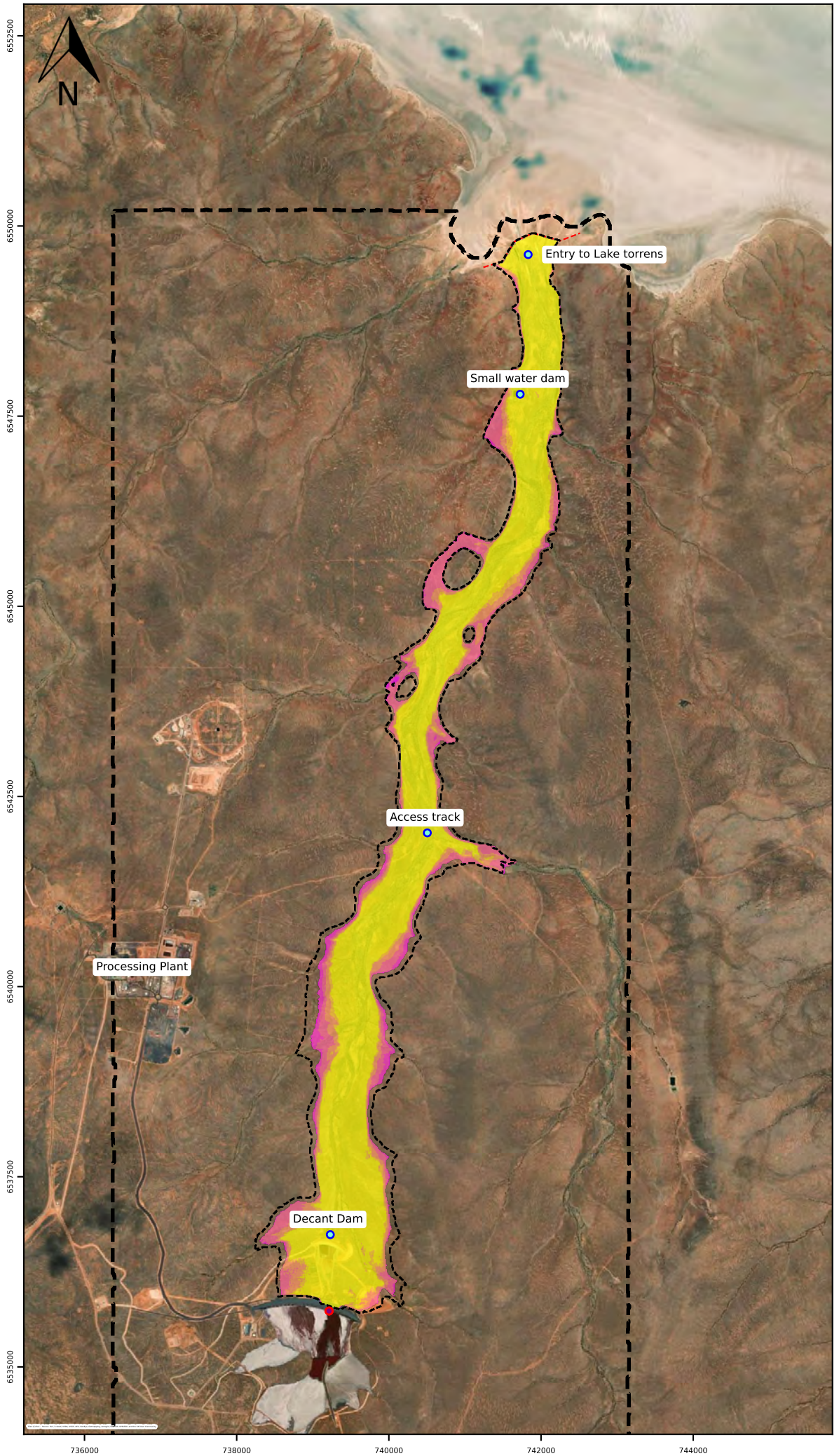
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity A2: Maximum velocity (m/s)





LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Scenario 1 base case
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Scenario 1 - Sensitivity to post-failure tailings slope (5%)

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
Reviewed:	NM
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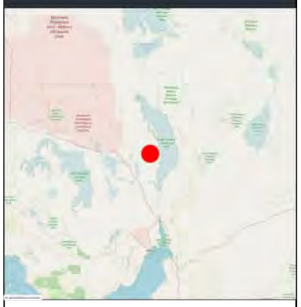
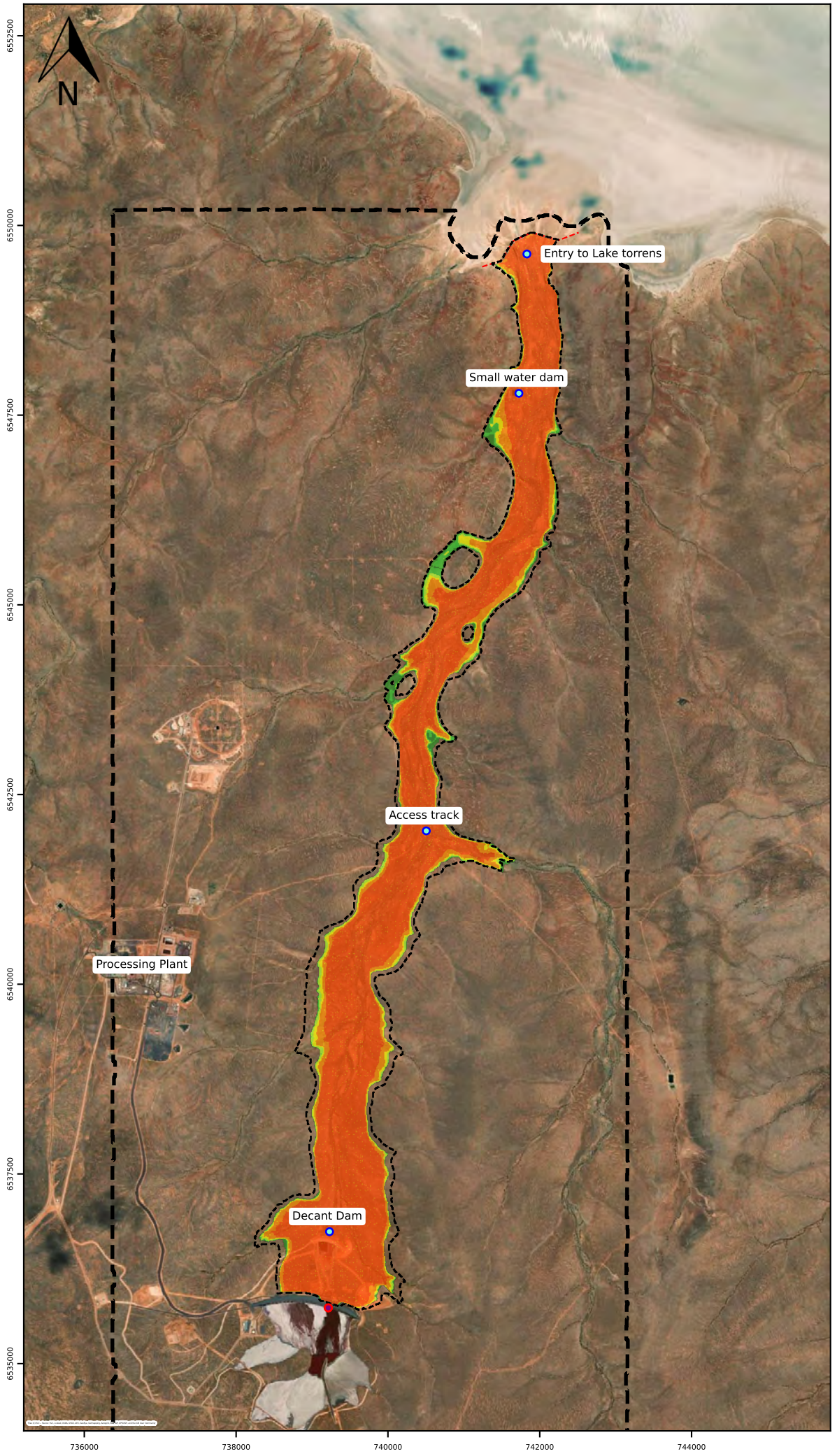
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity A2: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

- Model boundary
- Breach location
- Result locations
- Scenario 1 base case
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Scenario 1 - Sensitivity to post-failure tailings slope (5%)

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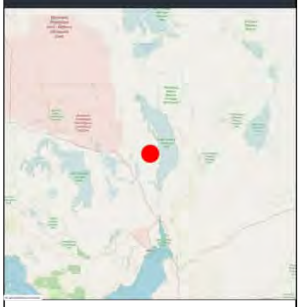
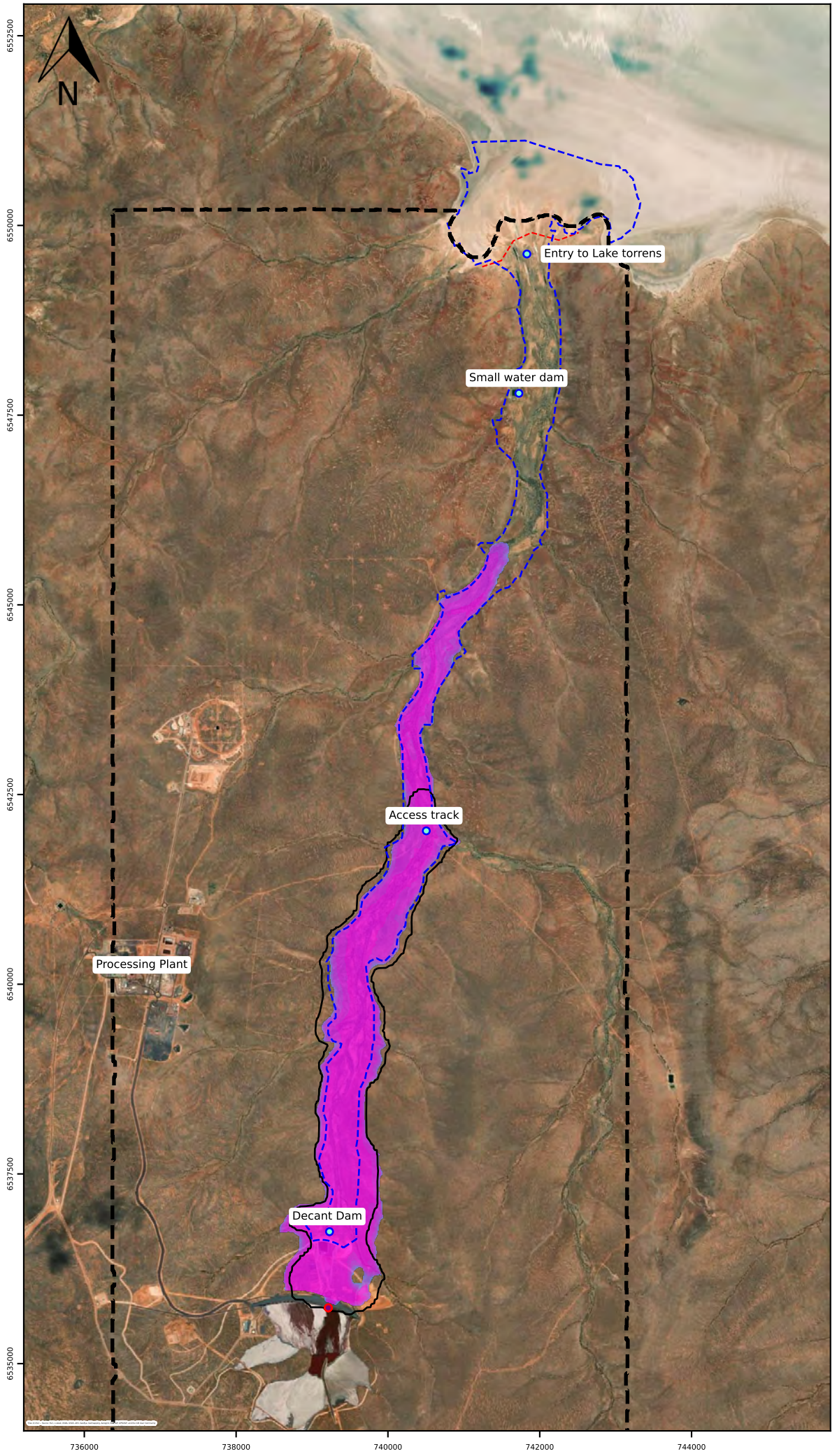
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity C1: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- 2017 Decant Dam runout
- 2017 tailings runout
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Adopts high tailings rheology data (sample SP03 - 40)
3. 30% of total stored tailings released
4. Decant Dam water runout extent (500 ML) from 2017 DBA
5. Stage 3 layout

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
Prepared:	AR
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Approved:	GP
Figure No:	C07

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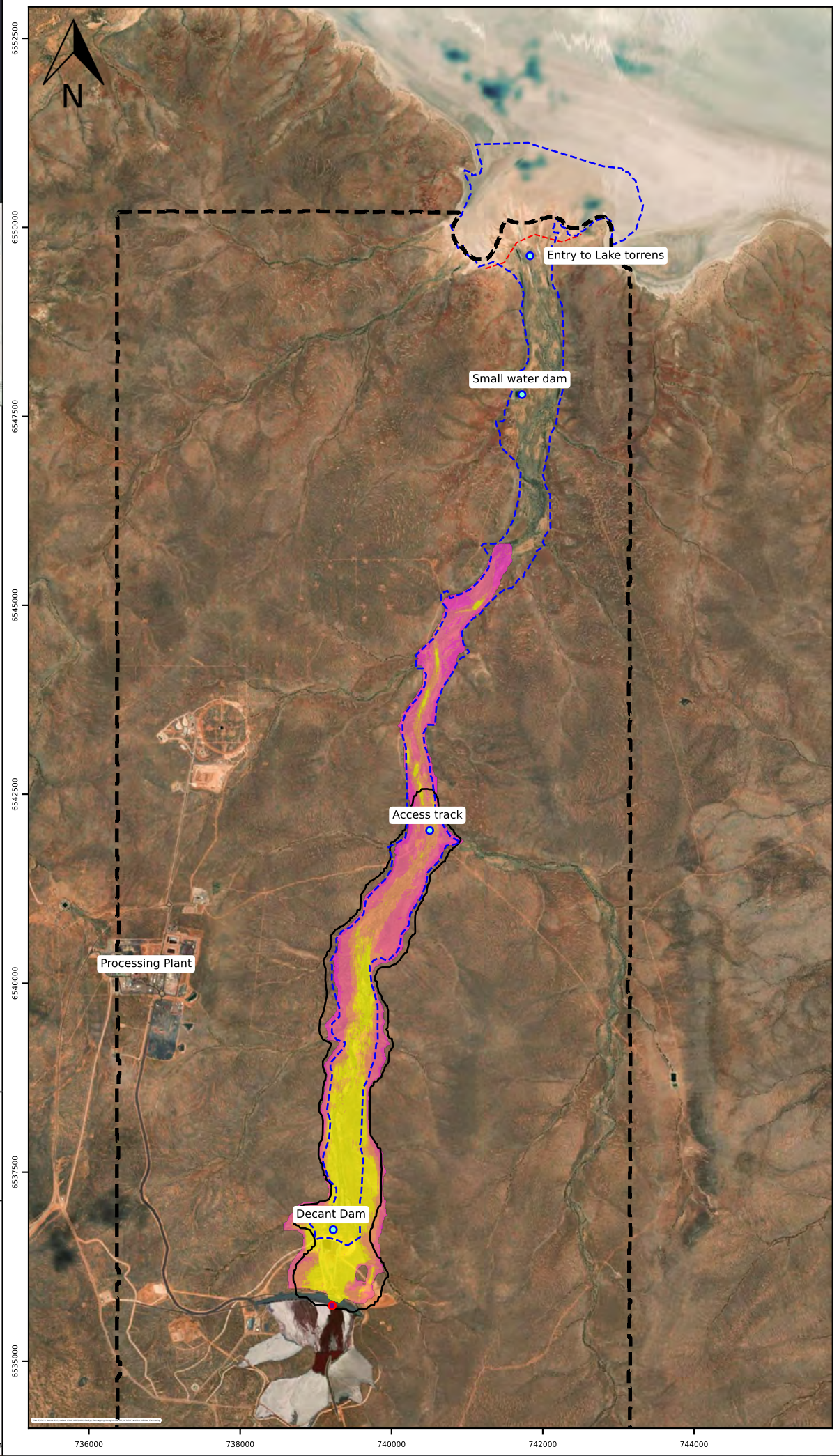
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity C1: Maximum velocity (m/s)



LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- 2017 Decant Dam runout
- 2017 tailings runout
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Adopts high tailings rheology data (sample SP03 - 40)
3. 30% of total stored tailings released
4. Decant Dam water runout extent (500 ML) from 2017 DBA
5. Stage 3 layout

Client:	BHP
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Rev:	0
Date:	2024-11-26
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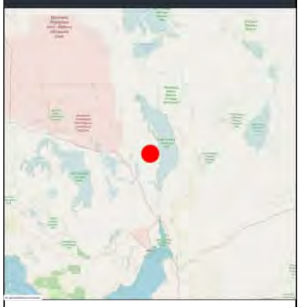
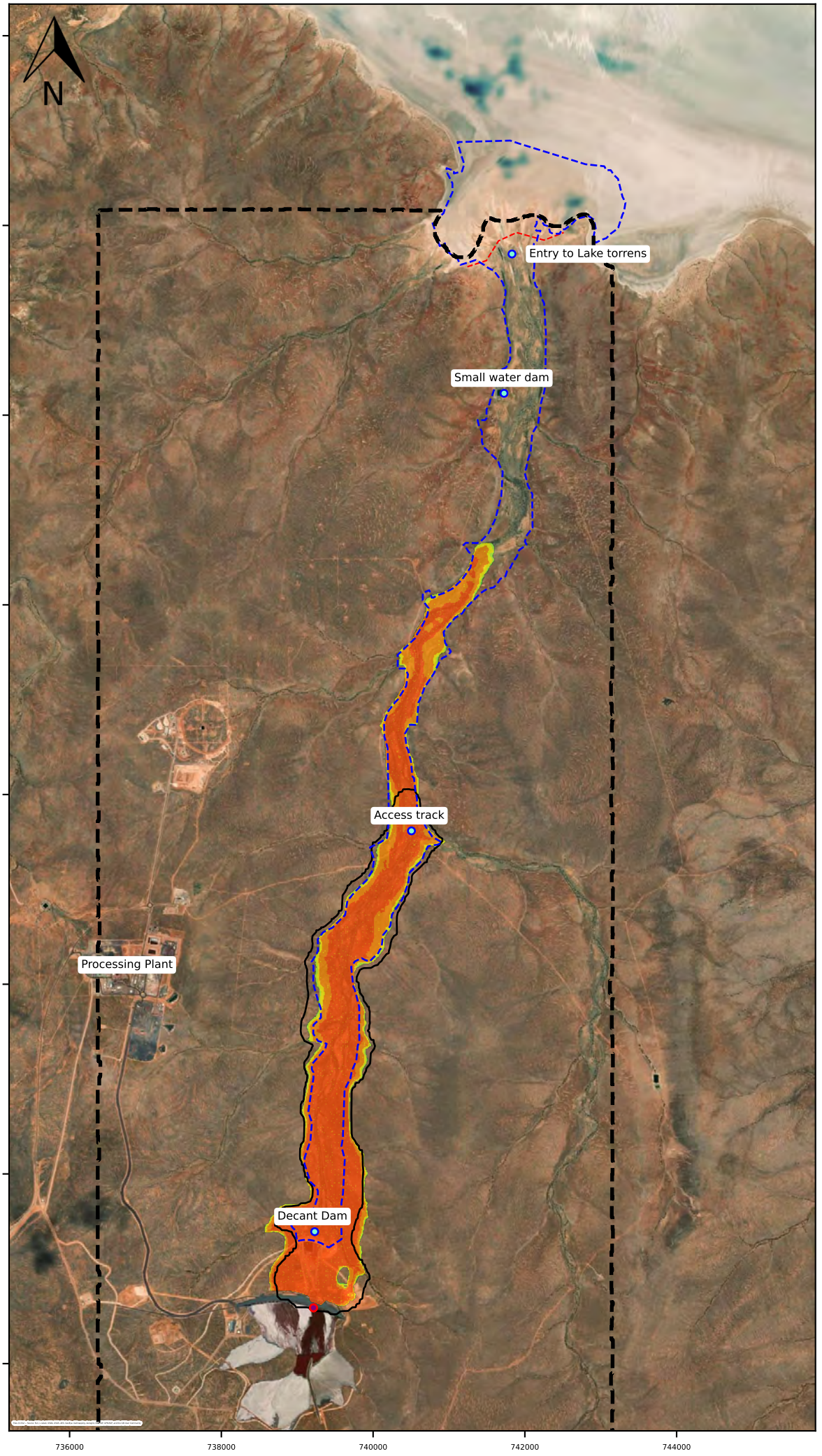
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity C1: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

- Model boundary
- Breach location
- Result locations
- 2017 Decant Dam runout
- 2017 tailings runout
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Adopts high tailings rheology data (sample SP03 - 40)
3. 30% of total stored tailings released
4. Decant Dam water runout extent (500 ML) from 2017 DBA
5. Stage 3 layout

Client:	BHP
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Rev:	0
Date:	2024-11-26
Designed:	AR
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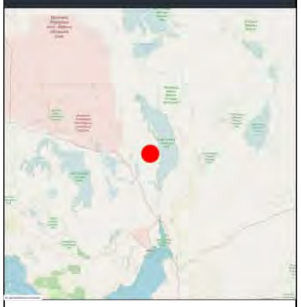
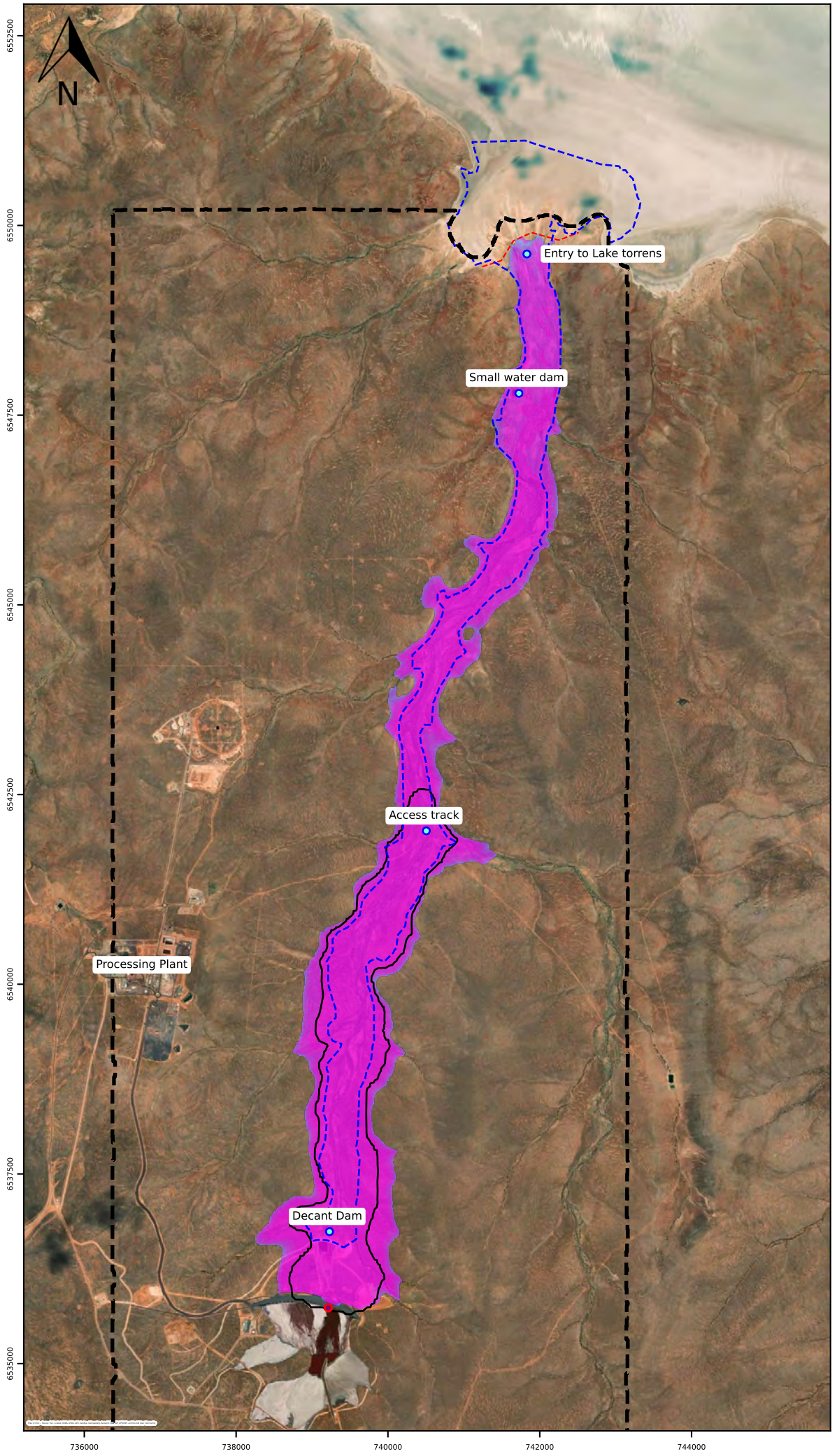
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity C2: Maximum runout depth (m)





LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- 2017 Decant Dam runout
- 2017 tailings runout
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Adopts high tailings rheology data (sample SP03 - 40)
3. 30% of total stored tailings released
4. Decant Dam water runout extent (500 ML) from 2017 DBA
5. Stage 6 layout

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-11-26
Designed:	AR
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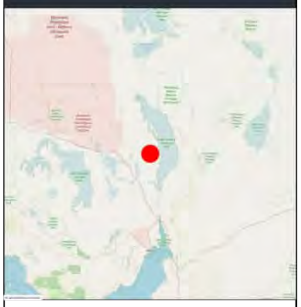
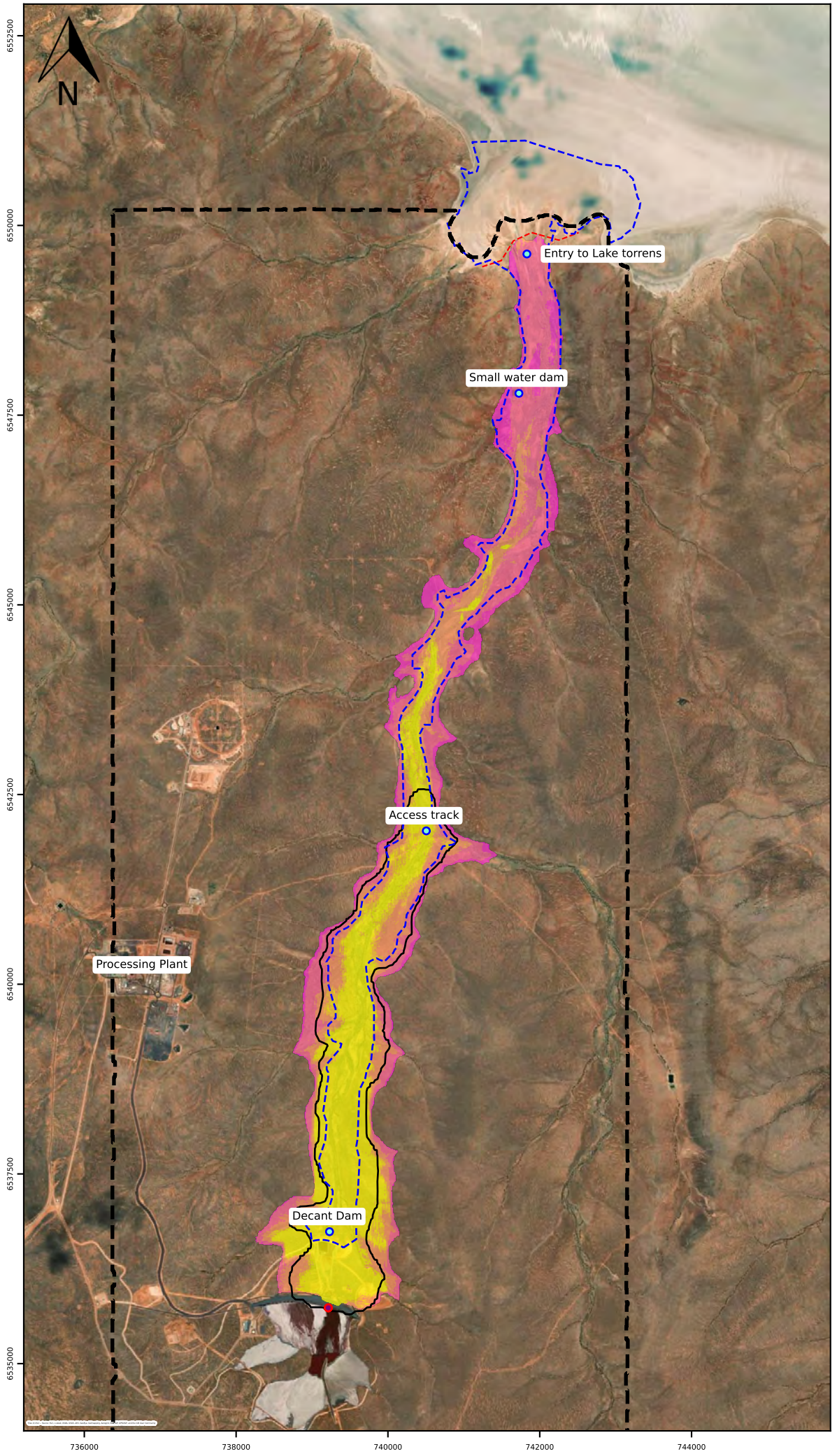
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity C2: Maximum velocity (m/s)





LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- 2017 Decant Dam runout
- 2017 tailings runout
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Adopts high tailings rheology data (sample SP03 - 40)
3. 30% of total stored tailings released
4. Decant Dam water runout extent (500 ML) from 2017 DBA
5. Stage 6 layout

Client:	BHP
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Rev:	0
Date:	2024-11-26
Designed:	AR
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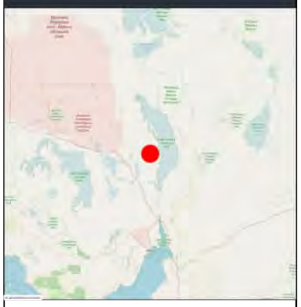
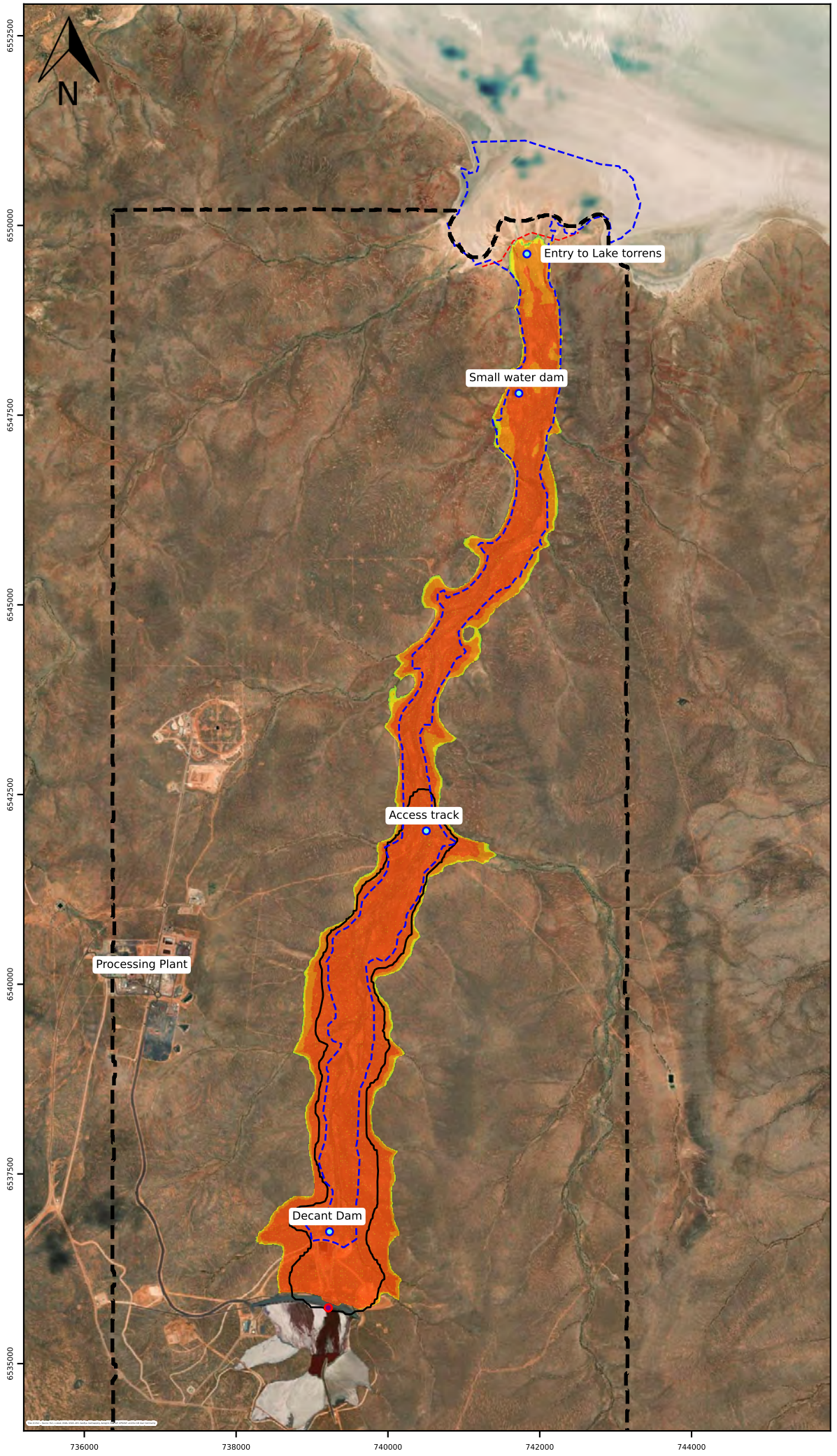
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Sensitivity C2: Flood Severity





LEGEND

Flood Severity

6
5
4
3
2
1

- Model boundary
- Breach location
- Result locations
- 2017 Decant Dam runout
- 2017 tailings runout
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Adopts high tailings rheology data (sample SP03 - 40)
3. 30% of total stored tailings released
4. Decant Dam water runout extent (500 ML) from 2017 DBA
5. Stage 6 layout

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Rev:	0
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Appendix D

Limitations

Limitation Statement

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Appendix I

Consequence category assessment

BHP, owner of OZ Minerals Carrapateena Pty Ltd

Tailings Storage Facility Life of Mine Consequence Category Assessment CA-3630-CIV-REP-1112

Carrapateena, South Australia

November 2024

Question today
Imagine tomorrow
Create for the future

Tailings Storage Facility Life of Mine Consequence Category Assessment
CA-3630-CIV-REP-1112
Carrapateena, South Australia

BHP, owner of OZ Minerals Carrapateena Pty Ltd

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Rev	Date	Details
A	9 July 2024	Draft for comment
B	17 September 2024	Update to address BHP comments
0	27 November 2024	Final

	Name	Date	Signature
Prepared by:	Huiyan Qi	27 November 2024	
Reviewed by:	David Accadia	27 November 2024	
Approved by:	Gareth Philips	27 November 2024	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Appendix B Exposure assessment for estimation of Population at Risk

Appendix C Limitation Statement

1 Introduction

This report presents BHP with the outcomes of consequence category assessment for dam breach failure of the Life of Mine layout of the Tailings Storage Facility (TSF) at Carrapateena. The assessment is based on a dam breach analysis completed in 2024 for the updated Life of Mine layout for storage of about 224 Million dry tonnes (Mdt) of tailings and estimation of Potential Loss of Life based on an exposure assessment completed with representatives of the Carrapateena operation in 2022.

2 Background

2.1 Dam breach analysis completed in 2017

A dam breach runout assessment was undertaken in 2017 for the permit stage and was based on the Stage 6 concept design layout for storage of 145 Mdt of tailings.

Total release volumes of 22 Mm^3 and 0.5 Mm^3 were considered for the TSF and Decant Dam impoundments, respectively. The release volume of 22 Mm^3 for the TSF represented about 30% of the predicted end of Stage 6 storage volume, under the original approved design. Non-Newtonian fluid (viscous) flow for tailings from the TSF and a Newtonian fluid flow for water from the Decant Dam were analysed.

For analysis of tailings flow from the TSF, a solids concentration of 50% by volume was adopted. Flood water in the TSF impoundment was not considered in the analysis. The maximum runout distance was estimated to be less than 8 km from the TSF embankment.

The analysis of water flow from the Decant Dam indicated that a water release would reach Lake Torrens, about 15 km to the north.

Assuming both the TSF and Decant Dam failed, the maximum inundation area, by superimposing the two runout areas, was estimated to be about 11.6 km^2. In accordance with ANCOLDs tailings dam guideline[1], this area resulted in a 'Major' severity rating.

A summary of a dam breach analysis undertaken for the updated Life of Mine for 224 Mdt of tailings is provided in Section 5.

[1] Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure. ANCOLD, July 2019.

2.2 Consequence category assessments for Stages 1 and 2 layouts

The runout assessment completed in 2017 informed consequence category assessments for the Stage 1 and Stage 2 layouts of the TSF. These assessments were undertaken in accordance with methods outlined in consequence category guidelines[2] and tailings dam guidelines[3] of the Australian National Committee on Large Dams (ANCOLD), noting that the tailings dam guidelines were updated between the Stage 1 and Stage 2 designs. A '**Significant**' dam breach consequence category was assigned for both the Stage 1 and Stage 2 layouts. The up to date assessment for the Stage 2 layout is summarised in 2023 annual inspection report[4]. The key ratings that informed the **Significant** category were:

- **Severity of Damage: Major:** A potential breach of the TSF would have a major impact to the downstream environment. It would also stop operation of the Processing Plant due to loss of operational TSF until remedial works (to the embankment as a minimum) are complete.
- **Population at Risk (PAR): <1.** A PAR exposure assessment was undertaken for a Quantitative Risk Assessment[5] for the Stage 2 layout and indicated a PAR of 0.05 for the Decant Dam and a PAR of 0.29 for the TSF. These low ratings were primarily due to:
  - No resident population in the predicted runout zone from a dam breach failure event.
  - Mine personnel are only occasionally present in the downstream inundation zones, and only for short periods of time, e.g., during routine inspections.
  - Station workers and Kokatha people are only occasionally present in the area between the Decant Dam and Lake Torrens.
  - No consideration for additional personnel in TSF area during raise construction campaigns.

2.3 BHP consequence category assessment of 2023

BHP facilitated a consequence category workshop for the TSF in mid-2023 and reported[6] a '**High**' consequence category in accordance with Global Industry Standard on Tailings Management (GISTM) based on potential environmental impacts. The key rating that informed the **High** category was 'environmental loss', as restoration would be *"possible but difficult and could take >5 years"*.

The assessment also noted:

- The PAR was *"considered to be between 1 and 10, depending on whether any construction projects are being undertaken"*.
- The PLL was *"expected to be <1 due to the low number of personnel at the TSF at any one time"*.
- *"The tailings are not acid forming"*.

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2 Guidelines on the Consequence Categories for Dam, ANCOLD, October 2012.

3 Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure. ANCOLD, July 2019.

4 Tailings Storage Facility Annual Inspection Report January 2023 to January 2024. Carrapateena ref. CA-3630-CIV-REP-1094, WSP report ref. PS200475-WSP-MEL-MNG-REP-00019 Rev0, 8 March 2024.

5 Tailings Storage Facility - Stage 2 Quantitative Risk Assessment. Carrapateena ref. CA-3630-CIV-REP-1061, WSP report ref. 19121887-047-R-Rev0, 1 March 2024.

6 GISTM Compliance – Carrapateena TSF Consequence Classification. BHP, 5 December 2023.

2.4 Life of Mine update

BHP intends to increase the Life of Mine storage capacity of the TSF from 145 Mdt of tailings to about 224 Mdt as part of the transition to block-caving mining, through construction of a second downstream raise (Stage 3), followed by a series of upstream raises (Stages 4 to 6). A concept design layout[7] was prepared to accommodate the increased production. Subsequently, a dam breach runout analysis was undertaken based on the revised design layout. This report presents the consequence category assessments based on the methods outlined in ANCOLD and GISTM for the revised design layout.

[7] Tailings Storage Facility Staged Life of Mine Concept Layouts. Carrapateena ref. CA-3630-CIV-REP-1096, WSP report ref. PS138057-WSP-MEL-MNG-REP-00003 Rev1 TSF, September 2024.

3 Overview of TSF

The TSF comprises a tailings storage area and a Decant Dam, with both storages formed by cross valley embankments. Construction of the Stage 1 starter layout occurred between November 2018 and August 2019. For Stage 1 operation, thickened tailings was deposited down-valley towards the Stage 1 embankment by a series of pipe outlets in the valley reaches, referred to as the Stage 1 deposition strategy. Stage 1 deposition occurred between December 2019 and March 2023.

Construction of the Stage 2 layout, including installation of new tailings discharge outlets occurred between November 2021 and January 2023 and operation of the Stage 2 layout commenced in March 2023 with up-valley deposition from the embankment, referred to as the Stage 2A deposition strategy. An aerial photograph of the TSF area taken by BHP in June 2024 is presented in Figure 3.1. The future Stage 2B deposition strategy comprises down-valley tailings deposition towards (but not reaching) the embankment through a series of pipe outlets in the valley reaches. For the Life of Mine, tailings deposition will continue to be switched between up-valley and down-valley phases, with the supernatant pond controlled around the gravity decant tower system, along the Decant Causeway.

Figure 3.1 Aerial image of the TSF as of June 2024 (source: BHP Carrapateena Survey Department)

4 Tailings geochemistry

Geochemical studies[8] for the tailings were undertaken by Environmental Geochemistry Internation (EGi) in 2022 and indicate that the tailings deposited in the TSF will be Non-Acid Forming with an excess of neutralising capacity derived principally from dolomite during the remaining period of sub-level cave mining at Carrapateena.

An additional study has indicated that tailings generated from laboratory flotation of future block cave ore have higher sulphide (pyrite) content than sub-level cave mining and may be representative of tailings produced during processing of ores extracted during block cave mining. The acid forming and acid neutralising capacities of the future block cave tailings were shown to be balanced and therefore the sample was classified as Non-Acid Forming (Uncertain). Further analysis is, however, required to confirm the classification and assess the long-term geochemical behaviour under site-specific conditions.

For consequence category assessments and potential environmental impacts from a dam breach runout, the tailings are classified as Non-Acid Forming. The acid and metalliferous drainage classification will be reviewed based on future geochemical testing of tailings from processing of ore from block cave mining.

[8] Geochemical Kinetic Testing of Flotation Tailings, Environmental Geochemistry International (EGi), ref. S2043/J000663/R1499, 25 May 2022.

5 Dam breach runout assessment

5.1 Flood severity classification

The inundated area from a dam breach can be categorised by flood severity to assess the potential hazard. The flood severity indicates the likely impact/damage caused by the outflow to people, vehicles, and buildings. Guidance on categorisation of the flood severity is provided in the Australian Rainfall and Runoff (ARR) guidelines[9] and is summarised below.

Flood severity is described by six hazard classifications, based on the maximum flood depth, velocity, and depth-velocity product (DV) at a given location. The adopted hazard classifications are presented graphically in Figure 5.1 and are tabulated in Table 5.1 from the ARR guidelines, which were adapted from a report by the UNSW Water Research Laboratory[10].

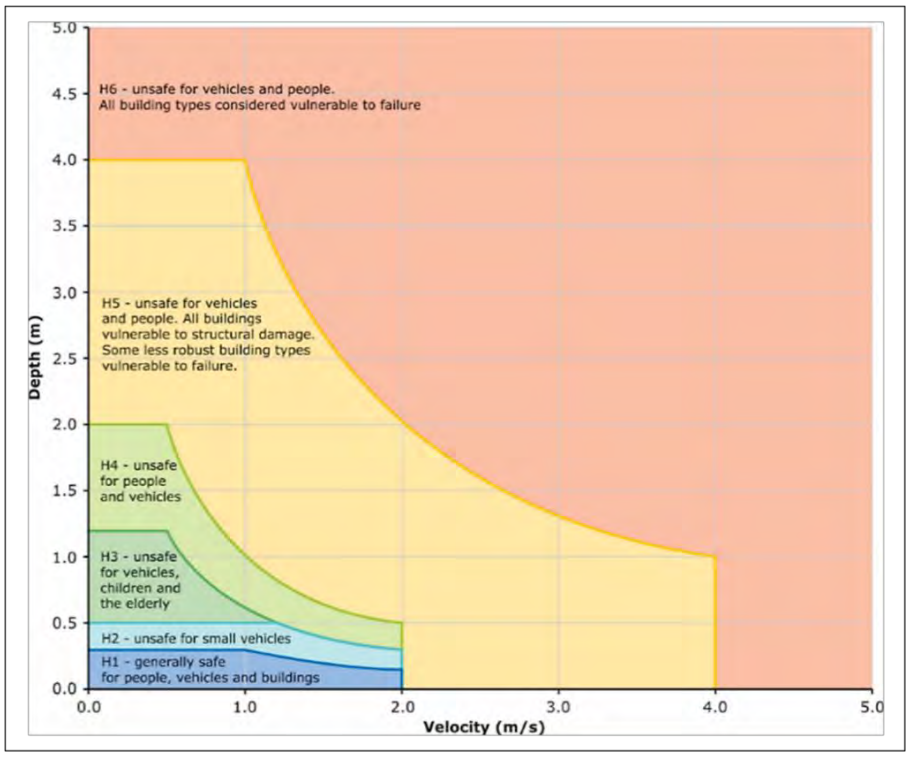

Figure 5.1 Combined flood hazard curves (Figure 6.7.9, ARR 2019)

[9] Ball, J., Babister, M., Nathan, R., Weeks, W., Weinmann, P., Retallick, M., & Testoni, I. (2019). *Australian Rainfall and Runoff – A Guide to Flood Estimation*.

[10] Smith, G. P., Davey, E. K., & Cox, R. J. (2014). *Flood Hazard UNSW Australia Water Research Laboratory Technical Report 2014/07*. Retrieved from Manly Vale, New South Wales:

Table 5.1 Vulnerability thresholds classification limits of flood hazard curves (Tables 6.7.3 and 6.7.4, ARR 2019)

Hazard vulnerability classification	Description of hazard classification	Depth-velocity product (DV) (m^2/s)	Limiting still water depth (m) (Note)	Limiting velocity (m/s)
H1	Generally safe for vehicles, people, and buildings.	≤ 0.3	0.3	2.0
H2	Unsafe for small vehicles.	≤ 0.6	0.5	2.0
H3	Unsafe for vehicles, children, and the elderly.	≤ 0.6	1.2	2.0
H4	Unsafe for vehicles and people.	≤ 1.0	2.0	2.0
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.	≤ 4.0	4.0	4.0
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.	> 4.0	-	-

Table 5.1 note: The 'limiting still water depth' relates to a zero velocity for the flood hazard curves. It is a boundary value on the flood severity classification.

5.2 Scenarios considered

A dam breach runout assessment[11] was completed in November 2024 for future Stages 3 and 6 layouts. The assessment for the TSF was based on the Life of Mine concept design layouts and considered breaches at the point of maximum embankment height above natural ground, i.e. in the region of the watercourse. The breaches lead to failure into the ephemeral Eliza Creek to the north of the TSF and downstream flow to ephemeral Lake Torrens. Note, failure of the Saddle Dams and/or embankment to the south, east, and west of the facility were not considered, due to the small potential release volume of tailings and no potential for release of pond water.

The three dam breach scenarios adopted for analysis are summarised in Table 5.2.

[11] Tailings Storage Facility – Dam Breach Assessment for Life of Mine Study. Carrapateena ref. CA-3630-CIV-REP-1097. WSP report ref. PS138057-WSP-MEL-MNG-REP-00005 Rev0, November 2024.

Table 5.2 Scenarios adopted for the Carrapateena TSF dam breach assessment

Scenario	Breach location	Failure mechanism	Weather condition	Stage and layout (Note 1)	Ponded water
1	TSF Embankment	Slope instability by liquefaction of tailings.	Post-flood day	End of Stage 6, flatter tailings beach scenario.	72 hr Probable Maximum Precipitation (PMP) **(Note 2)**
2	TSF Embankment	Overtopping following scour of embankment crest from tailings pipe break.	Post-flood day	End of Stage 6, flatter tailings beach scenario.	72 hr PMP **(Note 2)**
3	TSF Embankment	Overtopping following scour of embankment crest from tailings pipe break.	Post-flood day	End of Stage 3, flatter tailings beach scenario.	72 hr PMP **(Note 2)**
4	TSF Embankment	Slope instability by liquefaction of tailings	Sunny day	End of Stage 6, flatter tailings beach scenario	Operational pond **(Note 3)**

Table 5.2 notes:

(1) Refer to Life of Mine staging and concept layouts[12].

(2) Assigned an Annual Exceedance Probability of 1 in 10 million in the climate assessment[13].

(3) An operational pond volume of about 20,000 m^3 was adopted, based on the estimated pond volume over the tailings surface in mid-2024, as per the June 2024 capacity assessment[14].

For each scenario, it was assumed that the Decant Dam failed due to the background flood (i.e., the PMP) prior to the TSF failing and therefore was not considered in the assessment.

5.3 Analysis outcomes

Layout plans of the runout areas for dam breach Scenario 2 (the most conservative case) showing the extent of the potential dam breach, maximum flow depth, maximum flow velocity and flood severity are presented in Appendix A.

Dam breach runout simulation results for Scenario 2 are summarised in Table 5.3.

[12] *Carrapateena Tailings Storage Facility - Staged Life of Mine Concept Layouts*. Carrapateena ref. CA-3630-CIV-REP-1096. WSP report ref. PS138057-WSP-MEL-MNG-REP-00003 Rev1, September 2024.

[13] *Carrapateena Tailings Storage Facility, Life of Mine Study - Climate Assessment*. Carrapateena ref. CA-3630-CIV-REP-1071. WSP report ref. PS138057-WSP-MEL-MNG-REP-00002 Rev0, August 2023.

[14] *Tailings Storage Facility, Capacity Assessment based on June 2024 Beach Facility*, Carrapateena ref. CA-3630-CIV-REP-1113. WSP report ref. PS200475-WSP-MEL-MNG-REP-00026 RevA, 17 October 2024.

Table 5.3 Dam breach runout simulation results for Scenario 2 (Stage 6 layout, overtopping)

Location	Distance from breach location (km) (Note 1)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum depth velocity product (DV) (m^2/s)	Flood severity classification (Note 2)	Formation time of full breach of embankment (min)	Flood arrival time (min)
Decant Dam	0.7	22.9	8.8	> 100	H6	39	9
Access track downstream of Decant Dam	6.5	10.3	7.7	77	H6		38
Small stock watering dam near Lake Torrens	13	6.1	6.6	41	H6		63
Entry to Lake Torrens	15	3.7	6.7	22	H6		72

Table 5.3 notes:

(1) Distance from TSF embankment along runout path.

(2) Refer to Section 5.1.

6 Consequence category assessments

6.1 Overview

The consequence category of a TSF is assigned based on the downstream consequences that may be incurred due to an uncontrolled release of tailings and/or water from a beach of the embankment. It can also be assigned based on a large, controlled discharge (i.e., via a spillway), where damage or impacts could occur. ANCOLD refers to these as the 'dam breach failure consequence category' and the 'environmental spill consequence category' respectively. GISTM refer to dam breach failure consequence categories only.

This report presents dam failure consequence category assessments per the ANCOLD, and GISTM methods, and presents the environmental consequence category per the ANCOLD method.

6.2 Population at Risk

'Population at Risk' (PAR) is defined by ANCOLD as:

> '*All people who would be directly exposed to floodwaters within the dam break affected zone, if they took no action to evacuate.*'

The PAR for the TSF was estimated via an exposure assessment in the Quantitative Risk Assessment report[15] completed in March 2023, for the following exposure locations:

- Crest of the TSF embankment.
- Downstream toe of the TSF embankment – including access roads.
- Lined Decant Cell in the Decant Dam.
- Decant Dam pump platform.
- Crest of the Decant Dam embankment.
- Downstream toe of the Decant Dam.
- Monitoring well downstream of the Decant Dam.
- The area between the Decant Dam and Lake Torrens.

The exposure assessment is re-presented in Appendix B and was confirmed by BHP as valid for the Life of Mine assessment. The estimated PAR for the TSF is **0.30**.

[15] *Tailings Storage Facility - Stage 2 Quantitative Risk Assessment, Carrapateena*. Carrapateena ref. CA-3630-CIV-REP-1061. WSP report ref. 19121887-047-R-Rev0, 1 March 2024.

6.3 Potential Loss of Life

'Potential Loss of Life' (PLL) is defined by ANCOLD as:

> '*The part of the population at risk that could lose their lives in the event of a dam breach, including consideration of evacuation warning times and fatality factors, i.e., related to the severity of flow.*'

The PLL can be estimated using the fatality factor (FF) from a chart developed by the US Bureau of Reclamation (USBR) in their Reclamation Consequence Estimating Methodology (RCEM)[16] in 2015 and modified in 2019 by Lang & Foster[17], and using the following equation:

$$PLL = PAR \times FF$$

A fatality factor of 0.7 was adopted based on the following parameters and assumptions and the chart in Figure 6.1.

- No warning would be given to site personnel as the time for dam breach formation and runout arrival time to the Decant Dam is less than 1 hour (refer to Table 5.3). Lang and Foster[17] consider a warning time of less than 1 hour as inadequate for providing sufficient time for evacuation.
- A flood depth and velocity product (DV value) of 100 m^2/s is adopted conservatively based on the dam breach runout assessment for Scenario 2.

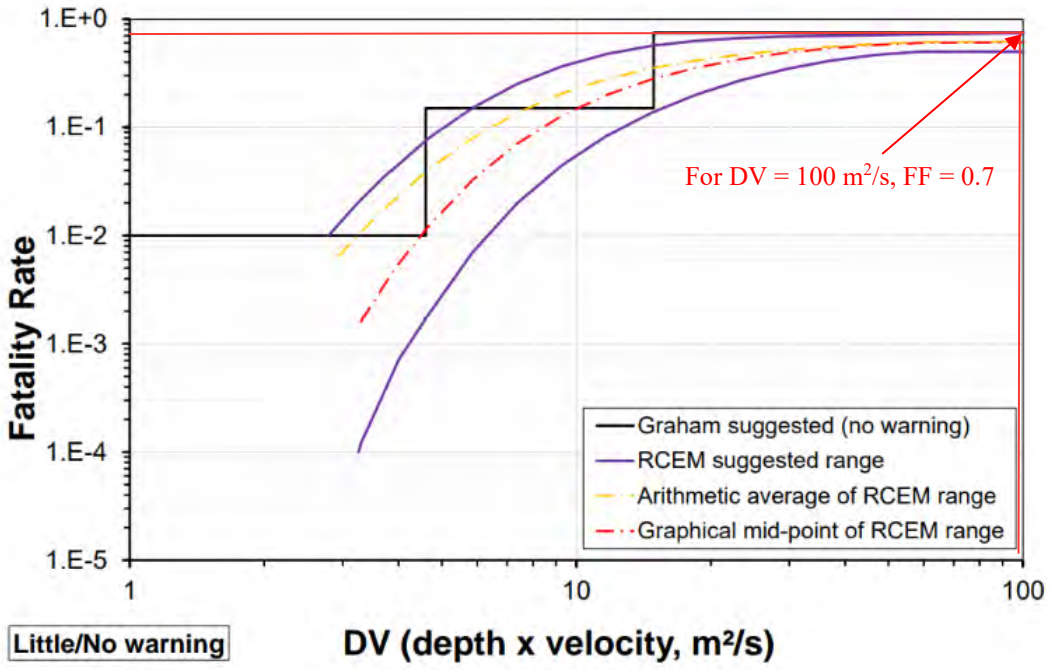

Figure 6.1 Suggested fatality rates from RCEM for Little/No Warning[18]

A PLL of 0.21 was estimated based on the PAR of 0.30 and the FF of 0.7. This estimate is based on the total PAR and the highest DV value in the inundation zone.

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[16] *Reclamation Consequence Estimation Methodology (RCEM), Interim Guidelines for Estimating Life Loss for Dam Safety Risk Analysis*. USBR, 2015.

[17] Lang, S., & Foster, M. (2019). *Estimating the Individual Risk From Dam Failure*. 2019 ANCOLD Conference, 10th-11th October, Auckland, New Zealand, 1–6.

[18] Meneses, C., Lang, S., Hill, P., & Arnold, M. (2015). *Towards consistency in potential loss of lie estimates: Testing the new Reclamation Consequence Estimating Methodology*. 2015 ANCOLD Conference.

6.4 Australian National Committee on Large Dams

6.4.1 Environmental spill consequence category

The environmental spill consequence category is limited to environmental impacts, i.e., potential erosion of the downstream environment and potential contamination due to problematic water. It does not consider the PAR and other impacts.

The severity of the environmental impacts is assessed to be '**Major**' in Table 6.1, indicating that the environmental spill consequence category is likely to be '**Significant**'. The environmental spillway category informs design criteria for the Extreme Storm Storage Allowance under ANCOLD – refer Section 7.

6.4.2 Dam breach failure consequence category

The dam breach failure consequence category assessment method is based on:

- 'Potential Loss of Life' (PLL).
- 'Severity of Damage or Loss', which in addition to environmental impacts, includes social and financial, including impacts to the business.

The ANCOLD consequence category classification system[19] showing the severity level of financial, social, and environmental impacts is presented in Table 6.1. The consequence category assigned to the TSF under the ANCOLD system is '**High C**' as shown in Table 6.2. which is primarily based on:

- The PLL is assessed to be 0.2, i.e., greater than 0.1 and less than 1. Refer Section 6.3.
- A 'Severity of Damage and Loss' rating of '**Major**' is attributed to the impact to the Carrapateena operation, as a dam breach would result in a significant loss of revenue from shutdown of the Processing Plant due to inoperable TSF, remediation costs and regulator fines for potential breach of license and impact the local habitats.

[19] *Guidelines on the consequence categories for dams*. Australian National Committee on Large Dams (ANCOLD), October 2012.

Table 6.1 Severity of damages and losses assessment (Table 2 of ANCOLD 2012)

Damage and loss		Severity level				Comments
		Minor	Medium	Major	Catastrophic	
Total infrastructure costs	Cost estimate					
Residential	$0					Commercial: There is a small water dam downstream of the TSF which is within the dam breach inundation. zone. Repair costs expected to be less than $1M. Community infrastructure: Access track to the process plant downstream of the TSF may need to be repaired. Repair costs expected to be less than $1M. TSF and Decant Dam replacement or repair cost: Dam remediation costs could be in the order of $200M.
Commercial	<$1M					
Community infrastructure	<$1M					
Dam replacement or repair cost	~$200M					
Total estimated cost	~$200M			×		Major: $100M to $1B
Impact on dam owner's business						
Importance to the business				×		Major impact to the business in terms of financial, social, and legal aspects.
Effect on services provided by the owner				×		Major impact to the mining operation as ore processing would cease without an operable TSF. Mining and stockpiling of ore may continue at a potentially reduced rate subject to available stockpile areas.
Effect on continuing credibility			×			Credibility and reputation impacted.
Community reaction and political implications			×			Potential for community concern due to damage to local environment surrounding TSF.
Impact on financial viability				×		BHP would likely continue to be financially viable, considering the cost of remedial works.
Value of water in the storage		×				Water in the Decant Dam is not relied upon for the ore processing plant.

Damage and loss	Severity level				Comments
	Minor	Medium	Major	Catastrophic	
Health and social impacts					
Public health	×				Eliza creek in the inundation zone of the TSF and Lake Torrens could become contaminated, however, these ephemeral and saline systems are not relied on by the public for water.
Loss of Service to the community	×				TSF failure may result in some temporary loss of jobs.
Cost of emergency management	×				No residences or mine infrastructure downstream of the TSF that would require emergency management.
Dislocation of people	×				No resident population in inundation zones.
Dislocation of business	×				A dam failure would primarily result in a dislocation to the Carrapateena operation. The dams would likely be remediated and returned to operation within 20 months.
Employment affected		×			Mine personnel would be affected, particularly those who work in the processing plant.
Loss of heritage			×		The area surrounding the TSF is the traditional country of the Kokatha people.
Loss of recreational facility	×				No recreational area or facilities of great local significance are in the downstream inundation zones.

Damage and loss		Severity level				Comments
		Minor	Medium	Major	Catastrophic	
Environmental impacts						
Area of impact				×		The inundated area is less than 20 km^2.
Duration of impact				×		Habitats may take time to recover, due to scour erosion from tailings and water outflow. The recovery time would likely to be within 5 years to 10 years.
Stock and fauna			×			The receiving environment is used for marginal grazing. Potential for contamination of stock watering dam.
Ecosystems			×			Sparsely vegetated in the downstream inundation zones.
Rare and endangered species			×			The area around the TSF is identified to have ecological communities of vulnerable species, namely the Plains Mouse[20]. Losses are expected to be recovered over about five years based on the published recovery plan.
Highest level of severity of damage and loss				×		Highest level of severity of damage and loss is 'Major'.

[20] Carrapateena Operation PEPR Compliance Report 2023, Carrapateena ref. CA-0000-ENV-REP-1038, March 2024.

Table 6.2 Consequence categories based on PLL (Table 4 of ANCOLD 2012)

Potential Loss of Life	Severity of Damage and Loss				Comments
	Minor	Medium	Major	Catastrophic	
<0.1	Very low	Low	Significant	High C	Major: as identified in Table 6.1. PLL = 0.2. Refer Section 6.3.
≥0.1 to <1	Significant	Significant	High C	High B	
≥1 to <5	**(Note 1)**	High C	High B	High A	
≥5 to <50		High A **(Note 2)**	High A	Extreme	
≥50		**(Note 1)**	Extreme	Extreme	

Table 6.2 notes (directly from ANCOLD):

1. *With a PLL equal to or greater than one (1), it is unlikely Damage will be minor. Similarly with a PLL in excess of 50 it is unlikely Damage will be classified as Medium*
2. *Where PLL is in the range ≥5 to < 10, the Category level can be reduced to High B.*

6.5 GISTM

The GISTM consequence category classification system[21] is presented in Table 6.3. The assigned consequence category under this classification system is '**Very High'** based on incremental losses for Environment.

[21] *Global Industry Standard on Tailings Management*, Global Tailings Review, August 2020.

Table 6.3 GISTM consequence classification matrix (Table 1 of GISTM, 2020)

Dam failure consequence classification	Incremental losses					Comments
	Potential Population at Risk	Potential Loss of Life	Environment	Health, social and cultural	Infrastructure and economics	
Low	<1	None expected	Minimal short-term loss or deterioration of habitat or rare and endangered species.	Minimal effects and disruption of business and livelihoods. No measurable effect on human health. No disruption of heritage, recreation, community or cultural assets.	Low economic losses: area contains limited infrastructure or services. <US$1M.	PAR and PLL <1: Refer Sections 6.2 and 6.3.
Significant	1 to 10	Unspecified	No significant loss or deterioration of habitat. Potential contamination of livestock/fauna water supply with no health effects. Process water low potential toxicity. Tailings not potentially acid generating and have low neutral leaching potential. Restoration possible within 1 to 5 years.	Significant disruption of business, service or social dislocation. Low likelihood of loss or regional heritage, recreation, community, or cultural assets. Low likelihood of health effects.	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes. <US$10M.	A potential breach of the TSF would likely be remediated within 5 years. Disruption to regional heritage would likely occur as the area surrounding the TSF is the traditional country of the Kokatha people.

Dam failure consequence classification	Incremental losses					Comments
	Potential Population at Risk	Potential Loss of Life	Environment	Health, social and cultural	Infrastructure and economics	
High	10 to 100	Possible (1 to10)	Significant loss or deterioration of critical habitat or rare and endangered species. Potential contamination of livestock/fauna water supply with no health effects. Process water moderately toxic. Low potential for acid rock drainage or metal leaching effects of released tailings. Potential area of impact 10 km^2 to 20 km^2. Restoration possible but difficult and could take >5 years.	500 to 1,000 people affected by disruption of business, services or social dislocation. Disruption of regional heritage, recreation, community or cultural assets. Potential for short term human health effects.	High economic losses affecting infrastructure, public transportation, and commercial facilities, or employment. Moderate relocation/compensation to communities. <US$100M.	The tailings is classified as NAF.

Dam failure consequence classification	Incremental losses					Comments
	Potential Population at Risk	Potential Loss of Life	Environment	Health, social and cultural	Infrastructure and economics	
Very High	100 to 1,000	Likely (10 to 100)	Major loss or deterioration of critical habitat or rare and endangered species. Process water highly toxic. High potential for acid rock drainage or metal leaching effects from released tailings. Potential area of impact >20 km^2. Restoration or compensation possible but very difficult and requires a long time (5 years to 20 years).	1,000 people affected by disruption of business, services or social dislocation for more than one year. Significant loss of national heritage, community or cultural assets. Potential for significant long-term human health effects.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities, for dangerous substances), or employment. High relocation/compensation to communities. <US$1B.	Reported inundation areas are less than 20 km^2, however, a boundary condition was adopted at Lake Torrens in the dam breach analyses, and therefore impact areas may be greater than 20 km^2.

Dam failure consequence classification	Incremental losses					Comments
	Potential Population at Risk	Potential Loss of Life	Environment	Health, social and cultural	Infrastructure and economics	
Extreme	>1,000	Many (>100)	Catastrophic loss of critical habitat or rare and endangered species. Process water highly toxic. Very high potential for acid rock drainage or metal leaching effects from released tailings. Potential area of impact >20 km^2. Restoration or compensation in kind impossible or requires a very long time (>20 years).	5,000 people affected by disruption of business, services or social dislocation for years. Significant National heritage or community facilities or cultural assets destroyed. Potential for severe and/or long-term human health effects.	Extreme economic losses affecting critical infrastructure or services, (e.g., hospital, major industrial complex, major storage facilities for dangerous substances) or employment. Very high relocation/compensation to communities and very high social readjustment costs. >US$1B.	Ratings not applicable.

7 Design criteria for consequence classification systems

Applicable design criteria under each of the guidelines/standards and consequence category systems are summarised in Table 7.1.

Table 7.1 Consequence category and design criteria summary by guideline/standard

Guideline/standard	Consequence category	Design criteria	
		Flood management	**Earthquake**
ANCOLD Guidelines on Tailings Dams, July 2019	**High C** (dam breach failure)	Flood discharge (based on dam failure category) — 1:100,000 AEP rain event and 1:10 AEP wind for wave runup freeboard, or — Probable Maximum Flood (PMF).	Operational design earthquake (Safety Evaluation Earthquake) — 1:2,000 AEP earthquake event. Post closure design earthquake, larger of: — Maximum Credible Earthquake. — 1:10,000 AEP earthquake event.
	Significant (environmental spill)	Environmental flood storage (Extreme Storm Storage Allowance, based on environmental spill category) — 1:100 AEP, 72-hour rain event. — 1:10 AEP wind for wave runup freeboard. — 0.5 m contingency freeboard.	Not applicable.
Global Industry Standard on Tailings Management, August 2020	**Very High**	Operations and Closure (Active care) — 1:5,000 AEP rain event. Passive-Closure (Passive care) — 1:10,000 AEP rain event.	Operations and Closure (Active care) — 1:5,000 AEP earthquake event. Passive-Closure (Passive care) — 1:10,000 AEP earthquake event.
	Extreme (Note 1)	Operations and Closure (Active care) — 1:10,000 AEP rain event.	Operations and Closure (Active care) — 1:10,000 AEP event.

Guideline/standard	Consequence category	Design criteria	
		Flood management	**Earthquake**
ICMM Tailings Management Good Practice Guide, May 2021	**Extreme (Note 2)**	Maximum Design Flood (MDF) — Rainfall with return period of 1 in 10,000 years (1 in 10,000 AEP rain event). or: — Probable Maximum Flood, if recommended by the Engineer of Record or required in jurisdiction.	Maximum Design Earthquake (MDE) — Return period of 1 in 10,000 years (1 in 10,000 AEP event). or: — Maximum Credible Earthquake.

Table 7.1 notes:

(1) GISTM notes for Requirement 4.2 that designs should be implemented for a higher consequence category or the '**Extreme**' consequence category external loading criteria.

(2) ICMM does not advocate a consequence category system, but rather to adopt robust design based on conservative criteria with the goal of preventing catastrophic failures. It recommends adopting conservative design criteria that generally align with the '**Extreme**' consequence category of GISTM.

8 Closing

This report summarises the consequence category assessments for the TSF under ANCOLD guidelines and GISTM. The assessments indicate:

- A **'Significant'** environmental spill consequence category under ANCOLD.
- A '**High C**' dam breach consequence category under ANCOLD.
- A '**Very High'** dam breach consequence category under GISTM.

In addition to these assessments, ICMM notes that a new TSF or an upgrade to an existing TSF should be designed for criteria equivalent to that required for an '**Extreme**' consequence category facility under GISTM. GISTM notes for 'Requirement 4.2', that designs should be implemented for a higher consequence category or the '**Extreme'** consequence category external loading criteria.

The Life of Mine concept design for the TSF is based on compliance with the most conservative applicable design criteria identified across ANCOLD, GISTM and ICMM.

The adopted flood design criteria for the Life of Mine operational layouts are:

- TSF flood management capacity: 1:100,000 AEP critical duration rain event and 1:10 AEP wind for wave runup freeboard, as per spillway design criteria of ANCOLD for a **'High C'** dam failure category. Note, each Life of Mine layout for the TSF is shown to have surge capacity that exceeds the estimated flood volume from a PMP, 72-hour event. Considering the large surge capacity and adopting an emergency spillway as good practice, the TSF spillway for each Life of Mine layout was conservatively sized[22] (based on the Stage 3 layout) for a 1 in 1000 AEP critical duration design rain event, assuming water at the spillway invert prior to the event, and allowing for 0.5 m freeboard above the height of peak outflow.
- Decant Dam flood storage capacity: 1 in 100 AEP, 72-hour design rain event, as per the 'Extreme Storm Storage Allowance' of ANCOLD for a **'Significant'** environmental spill category.
- Decant Dam emergency spillway: 1:100,000 AEP critical duration rain event and 1:10 AEP wind for wave runup freeboard. Although a smaller rain event could be justified based on storage of water (and not tailings) in the Decant Dam, the capacity of the existing spillway was demonstrated[22] to have capacity for this rain event and wave freeboard.

The 1 in 10,000 AEP earthquake event was adopted for design. The following were undertaken/adopted for geotechnical assessment[23]:

- Rockfill embankment settlement analysis for the peak ground acceleration for this design event.
- Residual strength was adopted for clay in the foundation of the embankments, for slope stability analyses.
- Post-liquefaction strength was adopted for tailings, for slope stability analyses.

A Limitation Statement is provided in Appendix C.

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[22] Tailings Storage Facility – Life of Mine Concept Design Update for 224 Mdt, Carrapateena ref. CA-3630-CIV-REP-1109, WSP report ref, PS138057-WSP-MEL-MNG-REP-00010 Rev 0, November 2024.

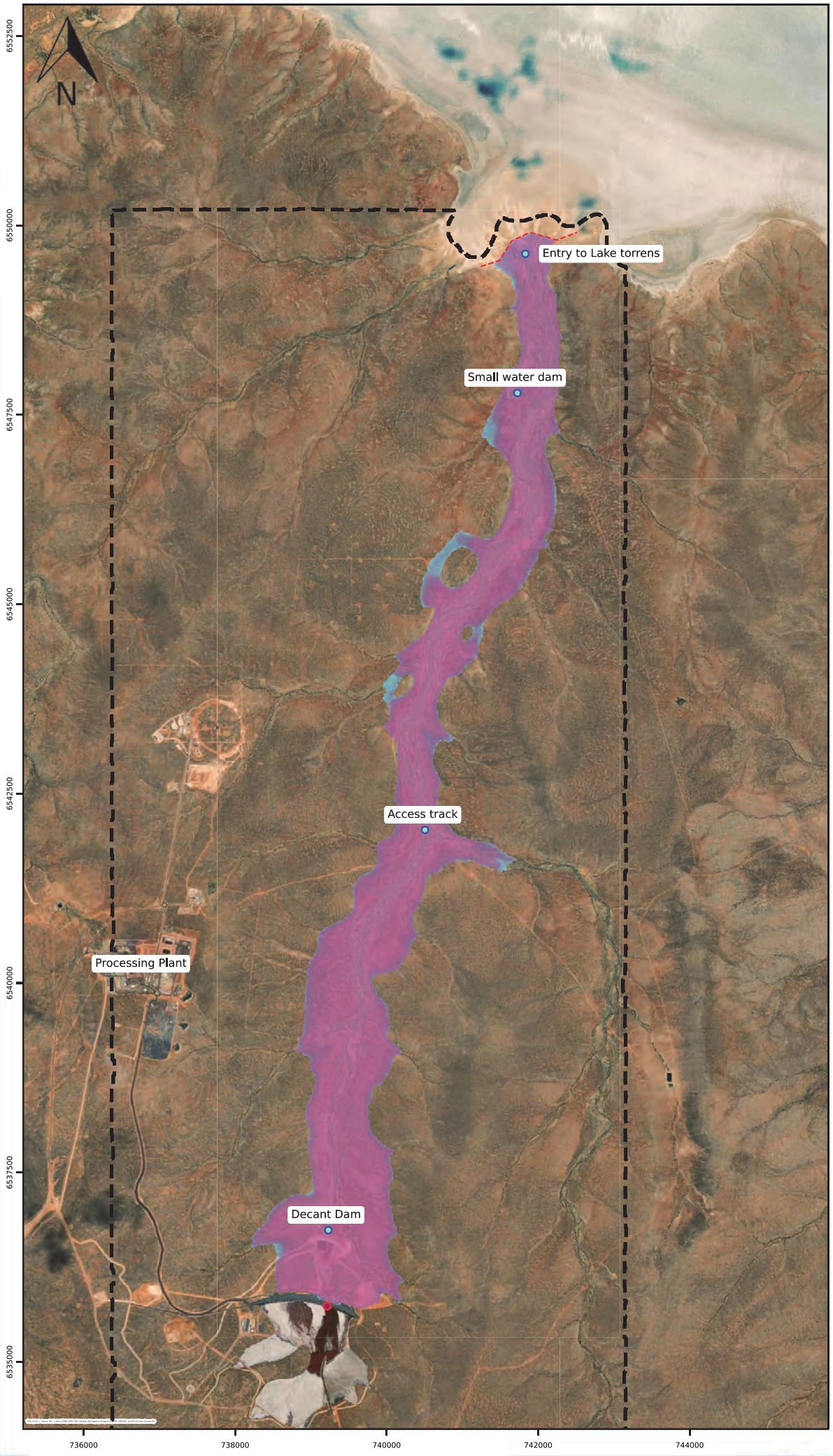
[23] Tailings Storage Facility – Life of Mine Concept Design Update Slope Stability Assessment, Carrapateena ref. CA-3630-CIV-REP-1106, WSP report ref. PS138057-WSP-MEL-MNG-REP-00007 Rev0, November 2024.

Appendix A

Dam breach inundation maps

Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 2: Maximum runout depth (m)



LEGEND

Maximum runout depth (m)

- 5.00
- 3.00
- 2.00
- 1.50
- 1.00
- 0.75
- 0.50
- 0.30
- 0.20
- 0.10

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-10-21
Designed:	AR
Prepared:	AR
Reviewed:	RS
Approved:	GP
Figure No:	B04

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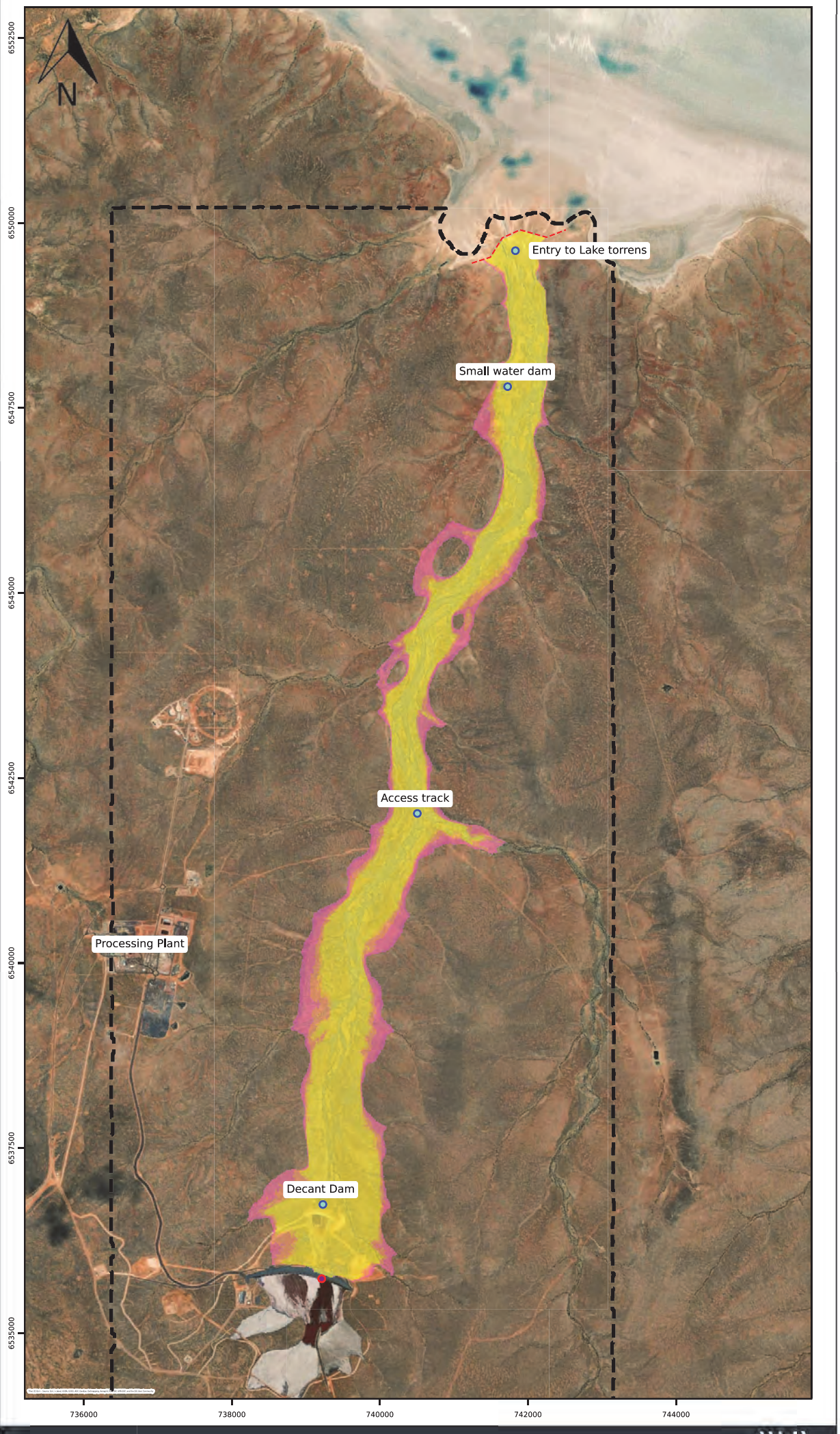
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 2: Maximum velocity (m/s)



LEGEND

Maximum velocity (m/s)

- 3.0
- 2.5
- 1.5
- 0.5
- 0.1

- Model boundary
- Breach location
- Result locations
- Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-10-21
Designed:	AR
Prepared:	AR
Reviewed:	RS
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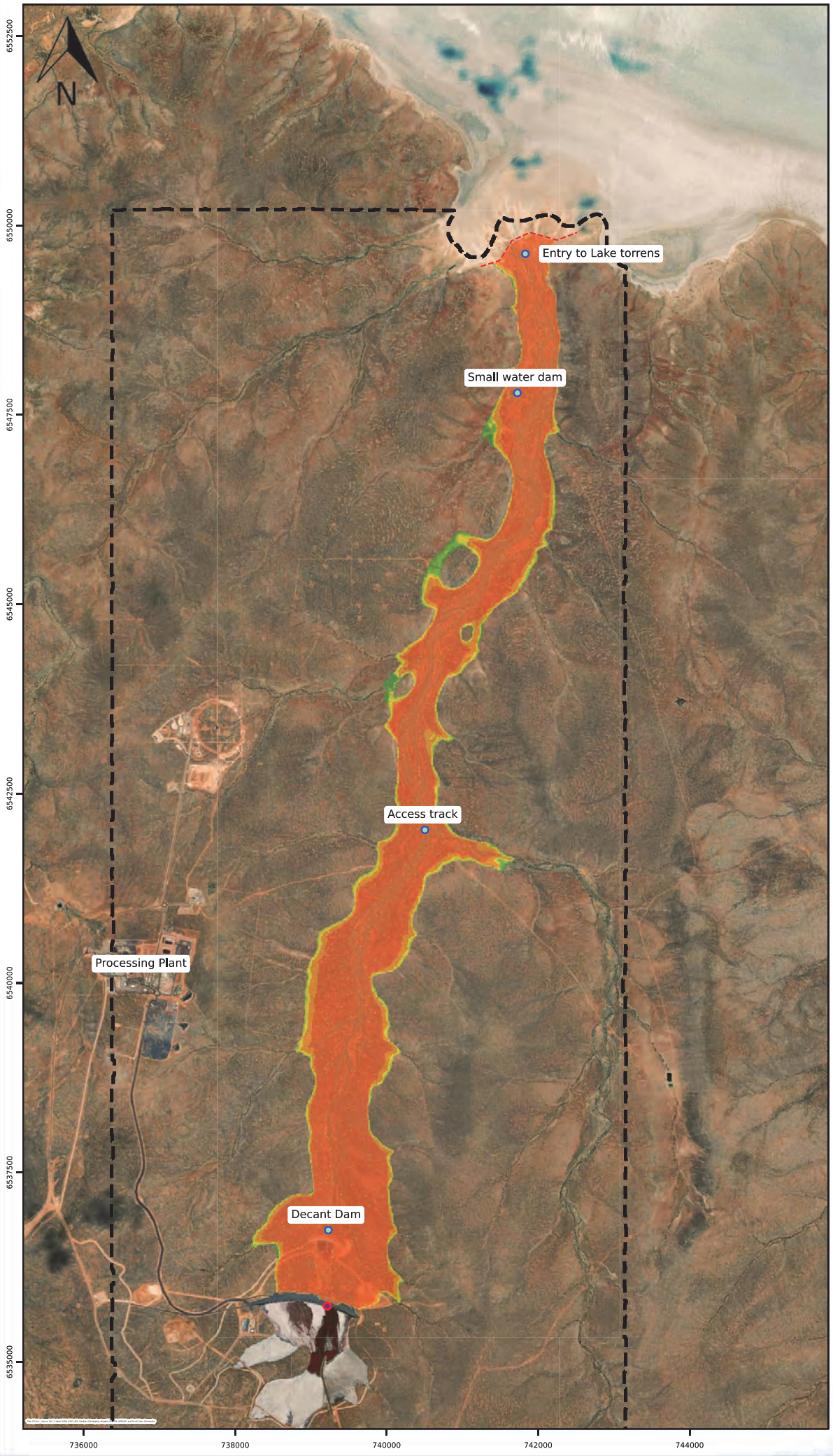
Carrapateena TSF Dam Breach Assessment for 224 Mdt Life of Mine

Scenario 2: Flood Severity



LEGEND

Flood Severity

6
5
4
3
2
1

Model boundary
Breach location
Result locations
Model outflow boundary

1:111000
Scale Bar
1650 m

NOTES

1. Base and Key Map: © Open Street Map
2. Stage 6 final layout, post-flood day, overtopping failure from pipe break.

Client:	BHP
Proj #:	PS138057
Rev:	0
Date:	2024-10-21
Designed:	AR
Prepared:	AR
Reviewed:	RS
Approved:	GP
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Appendix B

Exposure assessment for estimation of Population at Risk

Table 1 PAR by exposure locations on and downstream of the Decant Dam embankment

Location	Period	Frequency (Days/year)	Number of people per visit	Number of visits per day	Exposure time per visit (hours)	PAR
Decant Dam crest	Day shift	365	1	3	0.08	0.01
	Night shift	365	1	3	0.08	0.01
	Weekly inspections	52	1	1	0.25	<0.01
	Quarterly inspections	4	2	1	2.00	<0.01
Decant Dam downstream toe	Day shift	365	1	3	0.08	0.01
	Night shift	365	1	3	0.08	0.01
	Weekly inspections	52	1	1	0.17	<0.01
	Quarterly inspections	4	2	1	0.33	<0.01
Between Decant Dam and Lake Torrens	Indicative quarterly visits (Note)	4	1	1	13.00	<0.01
Total PAR						0.05

Table 2 PAR by exposure locations on and downstream of the TSF embankment (to the Decant Dam)

Location	Period	Frequency (Days/year)	Number of people per visit	Number of visits per day	Exposure time per visit (hours)	PAR
TSF Embankment crest	Day shift	365	1	3	0.17	0.02
	Night shift	365	1	3	0.17	0.02
	Weekly inspections	52	1	1	1.00	0.01
	Weekly maintenance	52	3	1	2.00	0.04
	Weekly miscellaneous visits	52	1	2	1.00	0.01
	Quarterly inspections	4	2	1	2.00	<0.01
TSF downstream toe	Day shift	365	1	3	0.25	0.03
	Night shift	365	1	3	0.25	0.03
	Weekly inspections	52	1	1	0.50	<0.01
	Quarterly road maintenance	4	2	1	3.00	<0.01
	Quarterly inspections	4	1	1	1.00	<0.01

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Location	Period	Frequency (Days/year)	Number of people per visit	Number of visits per day	Exposure time per visit (hours)	PAR
Lined Decant Cell	Weekly inspections	52	1	1	0.25	<0.01
	Quarterly inspections	4	2	1	0.50	<0.01
Decant Dam pump platform	Day shift	365	1	3	0.25	0.03
	Night shift	365	1	3	0.25	0.03
	Weekly inspections	52	1	1	0.08	<0.01
	Weekly maintenance (refuelling)	52	1	1	0.50	<0.01
	Weekly maintenance (general)	52	2	1	0.50	0.01
	Quarterly inspections	4	2	1	0.17	<0.01
	Quarterly moving pumps	4	2	1	3.00	<0.01
	Quarterly servicing pumps	4	2	3	0.50	<0.01
Decant Dam PAR	Refer Table 1 for exposure assessment on and downstream of the Decant Dam					0.05
Total PAR						0.30

Appendix C

Limitation Statement

Limitation Statement

PERMITTED PURPOSE

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Appendix J

Slope Stability Assessment

BHP, owner of OZ Minerals Carrapateena Pty Ltd

Tailings Storage Facility
Life of Mine Concept Design Update
Slope Stability Assessment

Carrapateena, South Australia
CA-3630-CIV-REP-1106

November 2024

Question today
Imagine tomorrow
Create for the future

Tailings Storage Facility
Life of Mine Concept Design Update
Slope Stability Assessment
Carrapateena, South Australia
CA-3630-CIV-REP-1106

BHP, owner of OZ Minerals Carrapateena Pty Ltd

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Rev	Date	Details
A	19 June 2024	Draft for comment
B	11 September 2024	Update to address BHP comments
0	13 November 2024	Final

	Name	Date	Signature
Prepared by:	Huiyan Qi	13 November 2024	
Reviewed by:	David Accadia	13 November 2024	
Approved by:	Gareth Phillips	13 November 2024	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Appendix A Output of Slope Stability Assessment

Appendix B Limitation Statement

1 Introduction

This report presents BHP with an embankment slope stability assessment for the proposed Life of Mine embankment raises for the Tailing Storage Facility (TSF) at Carrapateena. The stability analyses are based on the Life of Mine staging plan[1] for Stages 3 to 6 of the TSF, i.e., a downstream raise for Stage 3 and upstream raises for Stages 4 to 6. The analyses include stability improvement measures where necessary, to meet minimum Factors of Safety for compliance with best practice guidelines.

2 Minimum factors of safety for embankment slope stability

The minimum Factors of Safety adopted for the slope stability analyses are those outlined in the Australian National Committee on Large Dams (ANCOLD) tailings dam guidelines[2], and summarised in Table 2.1.

Table 2.1 Minimum Factors of Safety for assessment of embankment slope stability

Loading Condition	Minimum Factor of Safety
Static – Short term undrained and long-term drained strength parameters and loss of containment	1.5
Post-seismic/post liquefaction strength **(Note)**	1.1

Table 2.1 note: liquified strength applies to susceptible material, i.e., tailings that may liquify due to either seismic or static loading.

3 Stability analyses

3.1 Method and embankment section

Stability analyses were undertaken using Rocscience's Slide 2 software with the GLE/Morgenstern-Price method.

The embankment cross-section selected for analysis is shown on Figure A006 in the TSF Staged Life of Mine Concept Layout report[3] and is re-presented in Figure 3.1. The embankment raise configuration for the relatively flat tailings beach scenario (1% to 0.6% beach slopes) was adopted for this assessment as it would result in relatively more tailings beneath the upstream raises and therefore less embankment fill, relative to the steep beach scenario. For the selected cross section, each stage embankment was progressively analysed for slope stability. The raise configurations for Stage 3 and for Stages 4 to 6 are summarised in Sections 3.2 and 3.3, and the scenarios for analysis are described in Section 5.

1 Tailings Storage Facility Staged Life of Mine Concept Layout report. Carrapateena ref. CA-3630-CIV-REP-1096. WSP report ref. PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

2 Guidelines on Tailings Dams – Planning, design, construction, operation and closure. Revision 1. ANCOLD, July 2019.

3 Tailings Storage Facility Staged Life of Mine Concept Layout report. Carrapateena ref. CA-3630-CIV-REP-1096. WSP report ref. PS138057-WSP-MEL-MNG-REP-00003 Rev1, 13 September 2024.

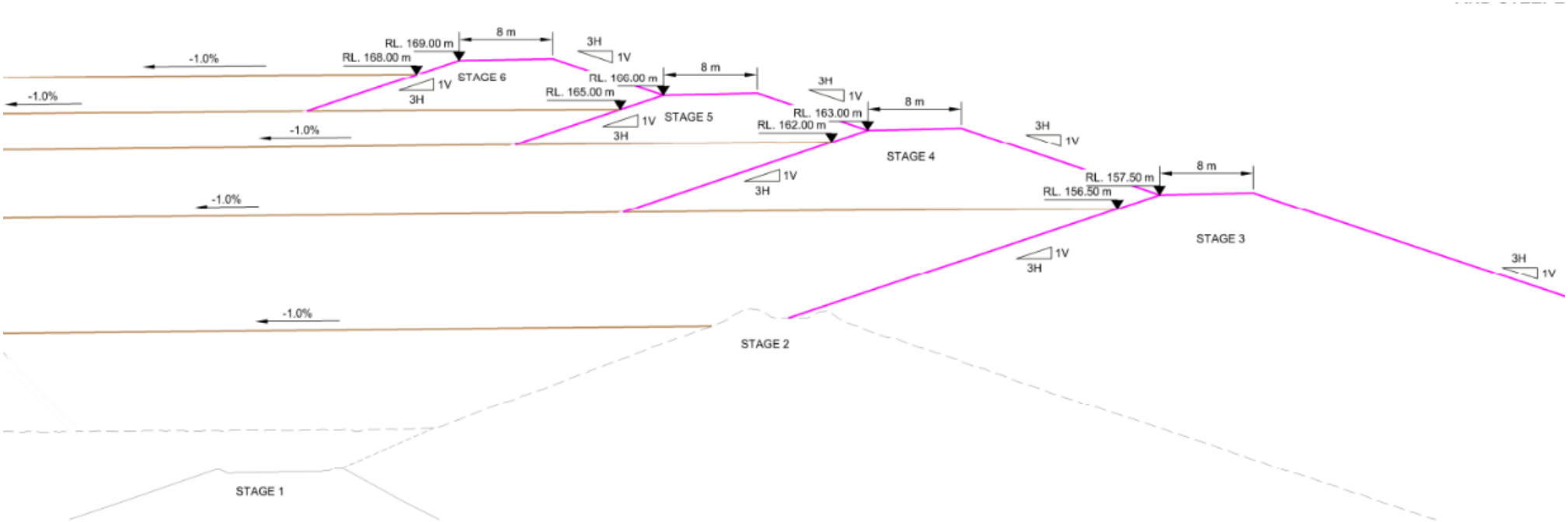

Figure 3.1 Selected Life of Mine TSF embankment cross-section for stability analysis

3.2 Stage 3 downstream raise

The Stage 3 downstream raise will be formed with compacted rockfill and will increase the embankment height by about 10.8 m.

The adopted crest width for the Stage 3 embankment is 8 m and the gradient of the upstream and downstream slopes is 3H:1V. A 5 m wide berm will be retained at the upstream side of the Stage 2 embankment to facilitate anchoring of a geosynthetic liner on the upstream face.

3.3 Stages 4 to 6 upstream raises

The Stages 4 to 6 upstream raises will be formed with compacted rockfill. The raise heights relative to the crest of the previous stage embankments are 5.5 m, 3 m and 3 m respectively. The crest width for each raise is 8 m and the gradient of the upstream and downstream slope is 3H:1V. Each raise projects from the upstream crest edge of the previous raise, thereby leaving an 8 m wide berm at the downstream toe of each raise, to facilitate operational access and to allow for future slope modifications, if required.

4 Material strength parameters

The material strength parameters adopted in the analyses are summarised in Table 4.1. The parameters are as per those adopted for the analyses undertaken for the Stage 3 raise options assessment[4] in 2023, as derived from the geotechnical site investigation[5] undertaken in 2017 and laboratory testwork[6] undertaken on bench scale tailings samples in 2016.

[4] Stage 3 embankment raise options assessment, Carrapateena Tailings Storage Facility. Carrapateena ref. CA-3630-CIV-REP-1079. WSP report ref. PS207335-WSP-MEL-MNG-REP-00002-Rev0, November 2023.

[5] Geotechnical Investigation for Tailings Storage Facility Design, Carrapateena Project. Golder Associates (Now WSP), report ref. 1660055-004-R-Rev0, March 2017.

[6] Carrapateena Project – Summary of Results from Tailings Testwork – Sample A and Sample B. Golder Associates (now WSP), report ref. 1660055-001-M, March 2017.

Table 4.1 Material parameters adopted in the stability analyses

Material	Colour	Unit weight (kN/m³)	Cohesion (kPa)	Friction angle (Deg)	Vertical strength ratio (s_u/σ'_V)	Minimum shear strength (kPa)	Source
Moderately Weathered to Fresh Quartzite bedrock		22	20	40	-	-	Assumed based on field observations and conservative based on literature.
Extremely to Moderately Weathered Quartzite bedrock		22	20	40	-	-	
In situ gravelly clay and clay (Residual Soil and Colluvium)		17	-	-	0.25	50	Measured from laboratory testwork undertaken on clay samples collected during the 2017 geotechnical investigation[7]. Residual strength with strength ratio reduction of 20% adopted to account for a potential post-seismic condition.
Stored tailings (undrained)		22	-	-	0.24	20	Measured from laboratory strength tests[8] on bench scale samples prepared in 2016.
Stored tailings (liquified)		22	-	-	0.11	0	
Embankment fill: Compacted Weathered Rockfill **(Note)**		22	0	33	-	-	Assumed based on observations made during geotechnical investigations and conservative based on literature.
Shear key, upstream toe berm erosion protection and platform: Coarse Rockfill and Compacted Weathered Rockfill **(Note)**		22	0	33	-	-	
Upstream toe berm fill: Compacted Tailings		22	0	30	-	-	Measured from laboratory standard compaction tests undertaken on bench scale samples prepared in 2016.

Table 4.1 note: includes rockfill sourced from site borrow pits/quarries and from mine waste rock stockpiles.

7 Geotechnical Investigation for Tailings Storage Facility Design, Carrapateena Project. Golder Associates (Now WSP), report ref. 1660055-004-R-Rev0, March 2017.

8 Carrapateena Project – Summary of Results from Tailings Testwork – Sample A and Sample B. Golder Associates (now WSP), report ref. 1660055-001-M, March 2017.

5 Scenario analysed

5.1 Stage 3 – downstream failure surfaces

Downstream failure surfaces were analysed for the downstream embankment raise of Stage 3, for a condition at completion of Stage 3 tailings deposition from the embankment. The following scenarios were analysed, with undrained conditions adopted for foundation clay, where present:

1. The *in situ* clay is retained in the Stage 3 embankment raise foundation.
2. The *in situ* clay is completely removed from the Stage 3 embankment raise foundation, i.e., replaced with compacted rockfill for the embankment.
3. A shear key is excavated to the base of the *in situ* clay backfilled with rockfill. The adopted base width for the shear key was 30 m, with an average excavation depth of 2 m into *in situ* clay.

5.2 Stages 4 to 6 – upstream failure surfaces

Upstream failure surfaces were analysed for the upstream embankment raises of Stages 4 to 6, for conditions prior to tailings deposition, i.e., at the end of raise construction. Undrained and liquefied tailings conditions were analysed for the Stage 4 raise. For Stages 5 and 6, only the liquefied tailings condition was analysed for upstream failure surfaces, as this represents the critical condition. For liquefied tailings conditions, it was conservatively assumed that all tailings are liquefiable and had liquefied.

The analyses indicated an upstream toe berm is required for each upstream raise to achieve the required Factor of Safety under liquefied tailings conditions. For each upstream raise, the toe berm was considered in conjunction with a rockfill platform, which may be required to facilitate access of earthmoving equipment. For the purpose of analysis, the platform would be formed by excavation into the tailings and replacement with rockfill or by pushing rockfill into the tailings. (Subject to the condition of the tailings prior to construction, a layer may be placed over the tailings or may not be required.) The extents of the upstream toe berm were modified until a minimum Factor of Safety of 1.1 was achieved for each raise. The adopted sizes for toe berms are presented in Section 6.

5.3 Stages 4 to 6 – downstream failure surfaces

Downstream failure surfaces were analysed for the upstream raises of Stages 4 to 6, for conditions at the end of tailings deposition adjacent to each embankment raise. The upstream toe berms adopted for the upstream slope failure scenarios were included in the analyses.

The analyses indicated a shear key is required below the downstream toe of each upstream raise, except for the final Stage 6 raise, however, a shear key should also be adopted for this raise, to accommodate a possible future upstream raise beyond Stage 6 if required. The extents of the shear keys were modified until a minimum Factor of Safety of 1.1 was achieved for the Stage 6 raise. The adopted sizes for the shear keys are included in Section 6.

6 Results and outputs

The adopted sizes for the upstream toe berms and the shear keys are presented in Table 6.1. Consideration was given to using Compacted Tailings in the toe berms where practical, with a layer of overlying Compacted Weathered Rockfill for erosion protection.

The scenarios and Factors of Safety are summarised in Table 6.2. The outputs are presented in Appendix A.

Table 6.1 Sizes for toe berms and shear keys

Stage	Toe berms			Shear keys
	Compacted Weathered Rockfill platform (Note)	**Compacted Tailings**	**Compacted Weathered Rockfill erosion protection layer**	**Coarse Rockfill**
Stage 4	2 m thick by 50 m wide, extending from the upstream toe	2 m thick by 50 m wide	0.5 m thick by 50 m wide	1 m deep by 10 m wide
Stage 5	0.5 m thick by 35 m wide, extending from the upstream toe	0.5 m thick by 35 m wide	0.5 m thick by 35 m wide	0.5 m thick by 5 m wide
Stage 6	0.5 m thick by 15 m wide, extending from the upstream toe	1 m thick by 15 m wide	0.5 m thick by 15 m wide	0.5 m thick by 5 m wide

Table 6.1 note: The Compacted Weathered Rockfill platform extends over the Coarse Rockfill shear key for each stage.

Table 6.2 Summary of outputs

Scenario No.	Stage	Scenario	Figure ref.	Minimum Factor of Safety for compliance with ANCOLD	Achieved Factor of Safety	Compliant (Y/N)
1.1	Stage 3	— Downstream slope failure — With clay in Stage 3 foundation	Figure A1	1.5	1.43	N (refer Scenarios 1.2 and 1.3)
1.2		— Downstream slope failure — Without clay in Stage 3 foundation — Phreatic surface at Stage 3 tailings surface	Figure A2	1.5	1.61	Y
1.3		— Downstream slope failure — With rockfill shear key in in the Stage 3 foundation	Figure A3	1.5	1.60	Y

Scenario No.	Stage	Scenario	Figure ref.	Minimum Factor of Safety for compliance with ANCOLD	Achieved Factor of Safety	Compliant (Y/N)
2.1	Stage 4	— Upstream slope failure — Stage 3 tailings surface — Undrained tailings strength — Phreatic surface at Stage 3 tailings surface	Figure A4	1.5	1.20	N (refer Scenario 2.4)
2.2		— As above, except with liquified tailings strength	Figure A5	1.1	0.54	N (refer Scenario 2.3)
2.3		— As above (Scenario 2.2), with upstream toe berm	Figures A6 & A7	1.1	1.11	Y
2.4		— Upstream slope failure — Stage 3 tailings surface — Undrained tailings strength — Phreatic surface at Stage 3 tailings surface — With upstream toe berm (sized for liquefied tailings scenario)	Figure A8	1.5	2.13	Y
3.1		— Downstream slope failure **(Note 1)** — Failure surface exits at downstream toe of Stage 4 raise — Stage 4 end of filling tailings surface — Liquified tailings strength — Phreatic surface at Stage 4 tailings surface	Figure A9	1.1	2.31	Y

Scenario No.	Stage	Scenario	Figure ref.	Minimum Factor of Safety for compliance with ANCOLD	Achieved Factor of Safety	Compliant (Y/N)
4.1	Stage 5	— Upstream slope failure — Stage 4 tailings surface — Liquified tailings strength — Phreatic surface at Stage 4 tailings surface	Figure A10	1.1	0.54	N (refer Scenario 4.2)
4.2		— As above, with upstream toe berm	Figures A11 & A12	1.1	1.10	Y
4.3		— Downstream slope failure **(Note 1)** — Rockfill shear key for Stage 4 embankment, sized based on analysis for Stage 6 downstream failure — Failure surface exits at downstream toe of Stage 5 raise **(Note 2)** — Stage 5 end of filling tailings surface — Liquified tailings strength — Phreatic surface at Stage 5 tailings surface	Figure A13	1.1	2.29	Y

Scenario No.	Stage	Scenario	Figure ref.	Minimum Factor of Safety for compliance with ANCOLD	Achieved Factor of Safety	Compliant (Y/N)
5.1	Stage 6	— Upstream slope failure — Stage 5 tailings surface — Liquified tailings strength — Phreatic surface at Stage 5 tailings surface	Figure A14	1.1	0.57	N (refer Scenario 5.2)
5.2		— As above, with upstream toe berm	Figures A15 & A16	1.1	1.12	Y
6.1		— Downstream slope failure — Failure surface exits at downstream toe of Stage 4 raise — Stage 6 end of filling tailings surface — Undrained tailings strength — Phreatic surface at Stage 6 tailings surface	Figure A17	1.5	1.58	Y
6.2		— As above, except with liquified tailings strength	Figure A18	1.1	1.01	N (refer Scenario 6.4)
6.3		— Downstream slope failure — Rockfill shear keys for Stage 4 and Stage 5 embankments — Failure surface exits at downstream toe of Stage 4 raise — Stage 6 end of filling tailings surface — Undrained tailings strength — Phreatic surface at Stage 6 tailings surface	Figure A19	1.5	1.76	Y
6.4		— As above, except with liquified tailings strength	Figure A20	1.1	1.20	Y
6.5		— As above, with upstream toe berm and downstream toe shear key	Figure A21 & A22	1.1	1.22	Y

Scenario No.	Stage	Scenario	Figure ref.	Minimum Factor of Safety for compliance with ANCOLD	Achieved Factor of Safety	Compliant (Y/N)
6.6		— Downstream slope failure — Failure surface exits at downstream toe of Stage 5 raise — Stage 6 end of filling tailings surface — Liquified tailings strength — Phreatic surface at Stage 6 tailings surface — with upstream toe berm and downstream toe shear key	Figure A23	1.1	1.27	Y

Table 6.2 notes:

1. Upstream slope failure for Stage 4 and Stage 5 with end of filling tailings surfaces were not analysed, as the upstream slope is buttressed against instability by the tailings.
2. Critical failure surface would exit at downstream toe of Stage 4 embankment, if a shear key wasn't considered for the Stage 4 embankment.

7 Closing

This report summaries embankment slope stability analyses for the updated Life of Mine raises for the TSF. The analyses identified the following improvement measures:

- Stage 3 downstream raise: *In situ* clay downstream of the Stage 2 embankment should either be removed or a rockfill shear key should be formed through the clay, to provide resistance to downstream failure surfaces.
- Stage 4 to 6 upstream raise: an upstream toe berm and shear key is required for each raise to provide resistance to upstream and downstream failure surfaces respectively.

A limitation statement is provided in Appendix B.

Appendix A

Output of Slope Stability Assessment

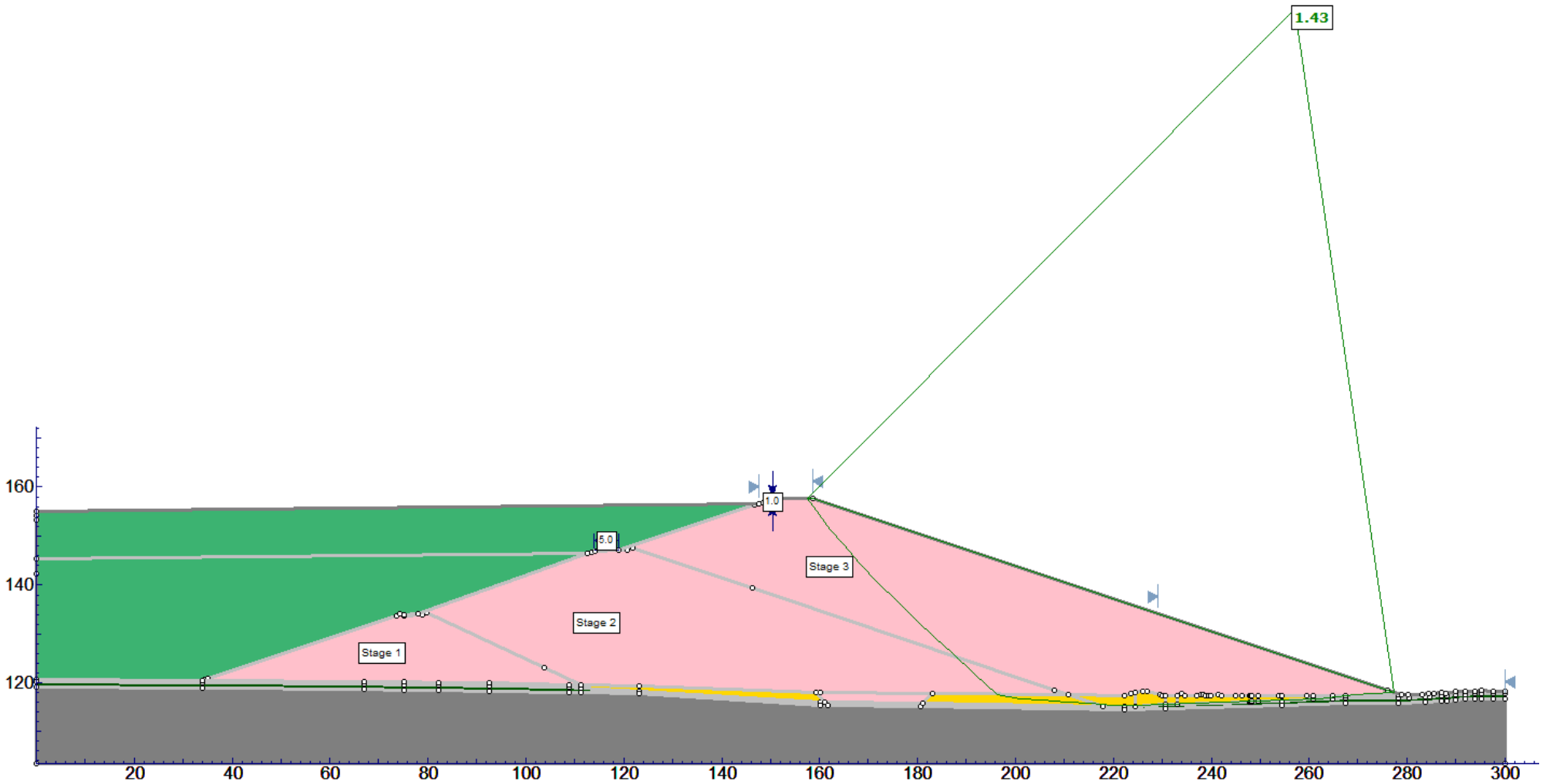

Figure A.1 Scenario 1.1

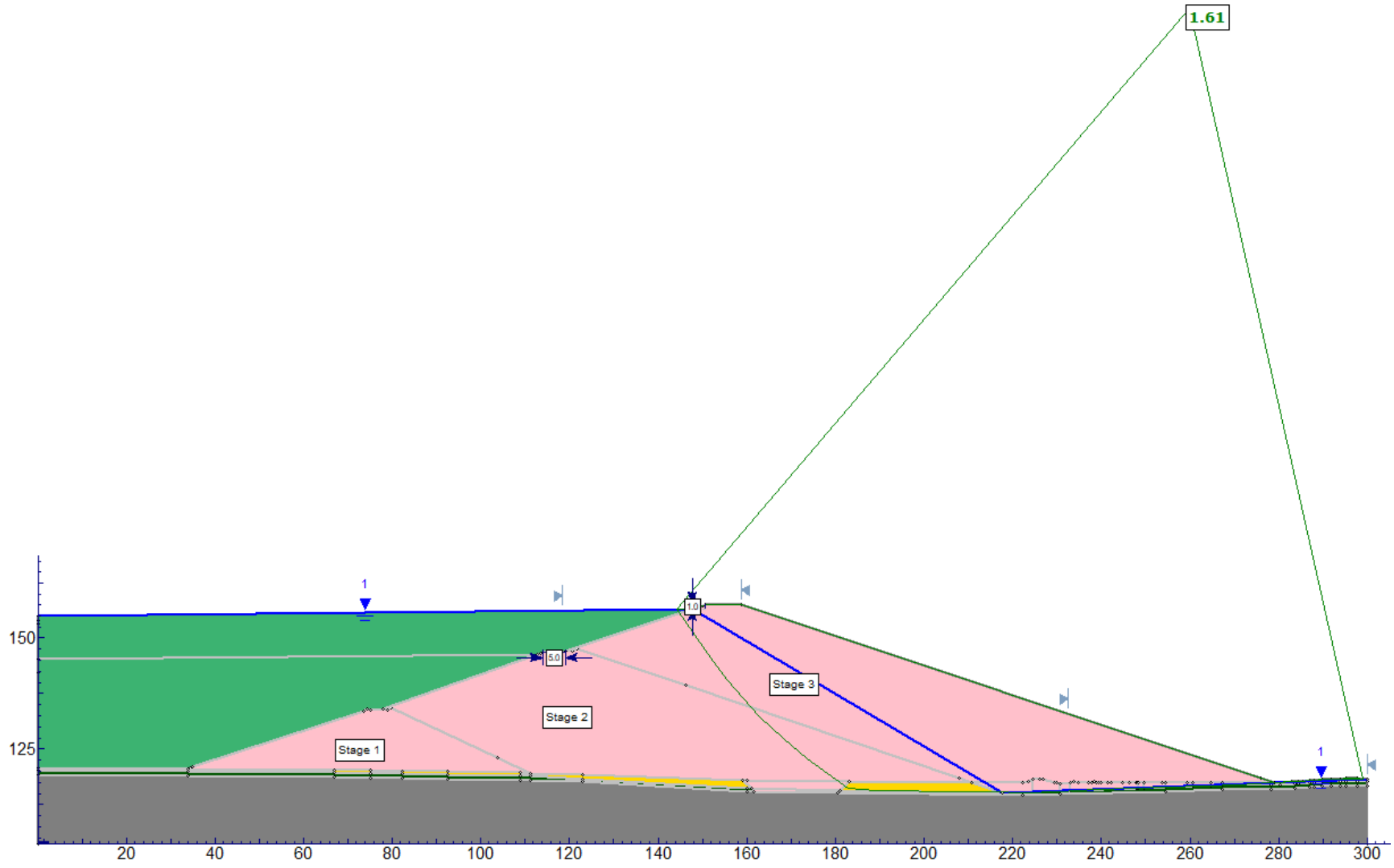

Figure A.2 Scenario 1.2

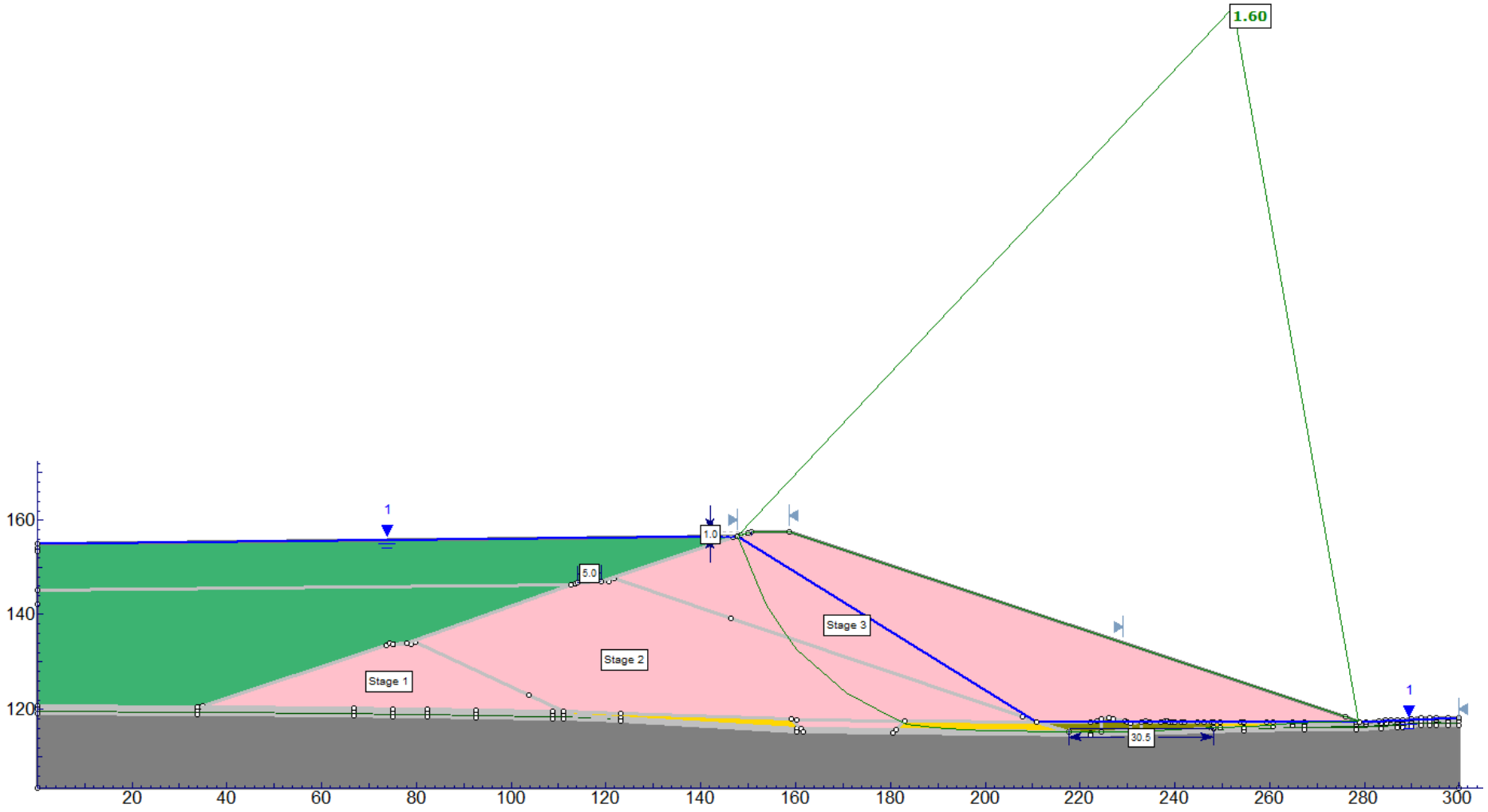

Figure A.3 Scenario 1.3

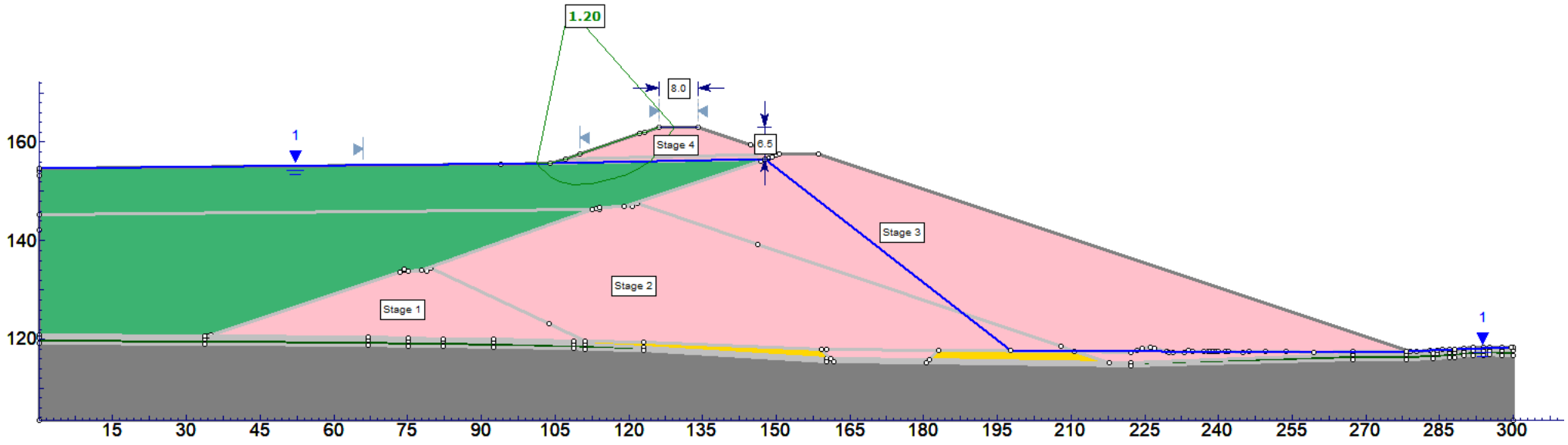

Figure A.4 Scenario 2.1

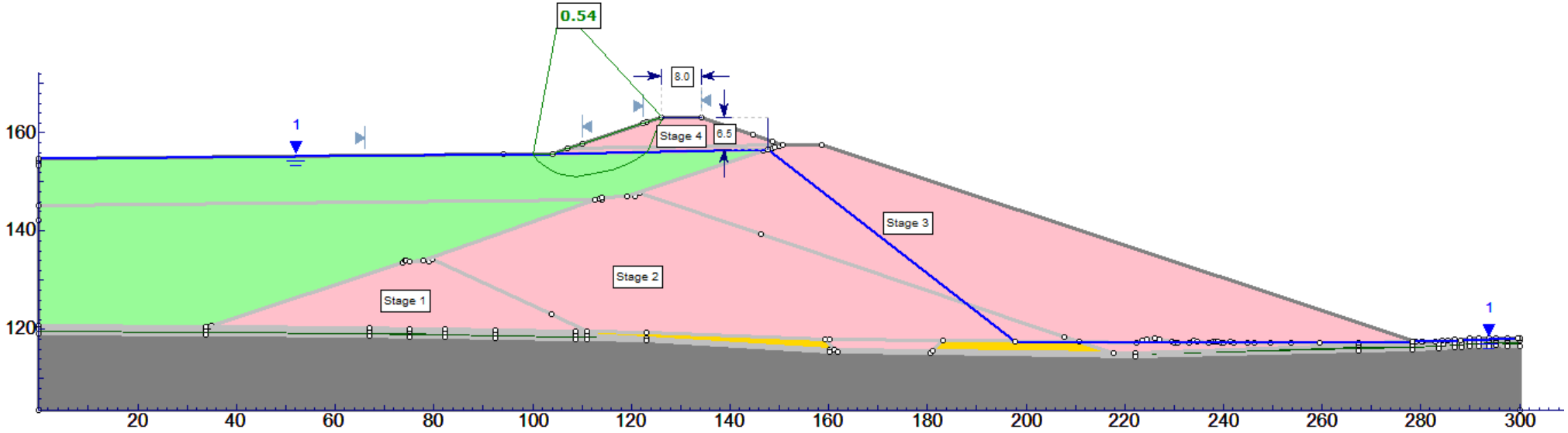

Figure A.5 Scenario 2.2

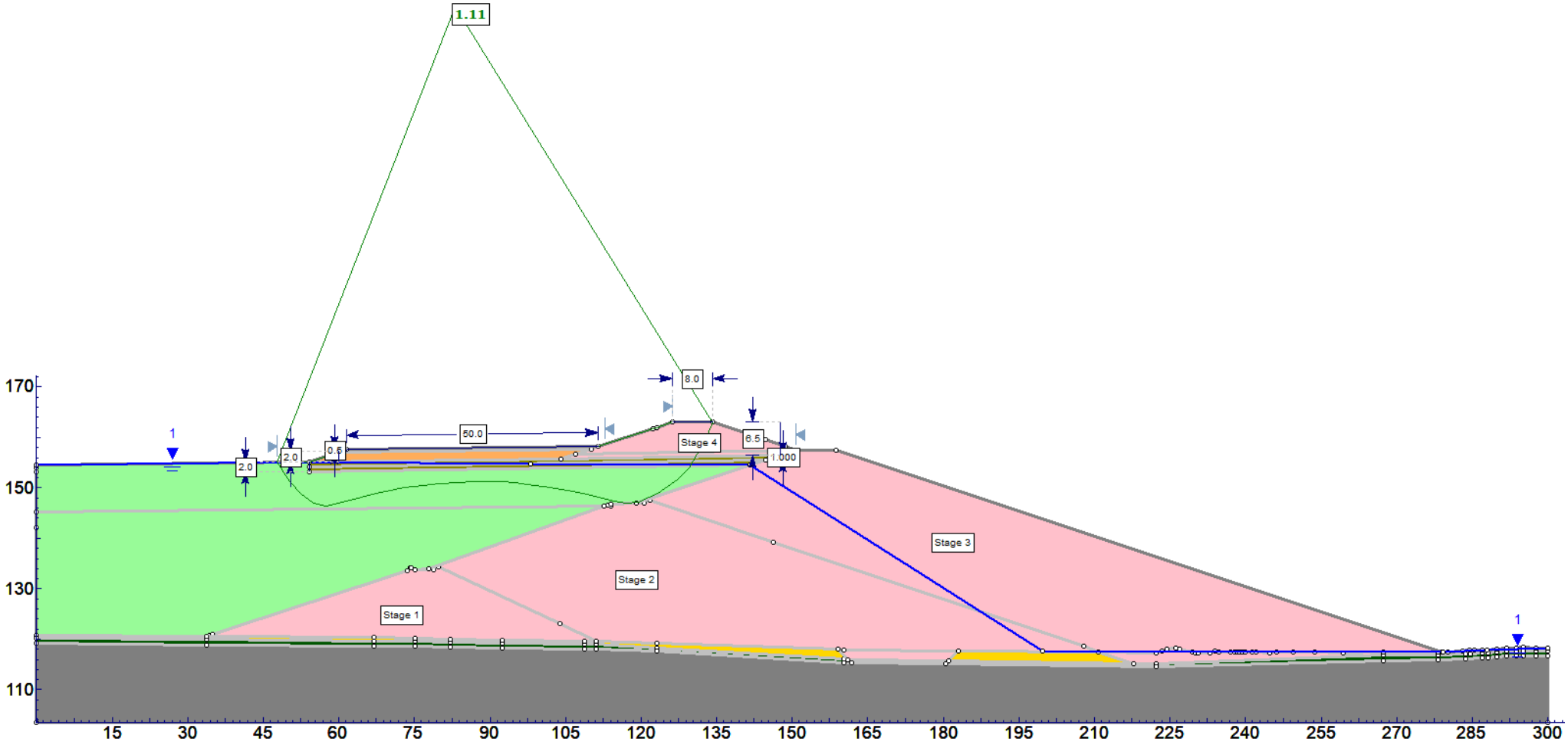

Figure A.6 Scenario 2.3

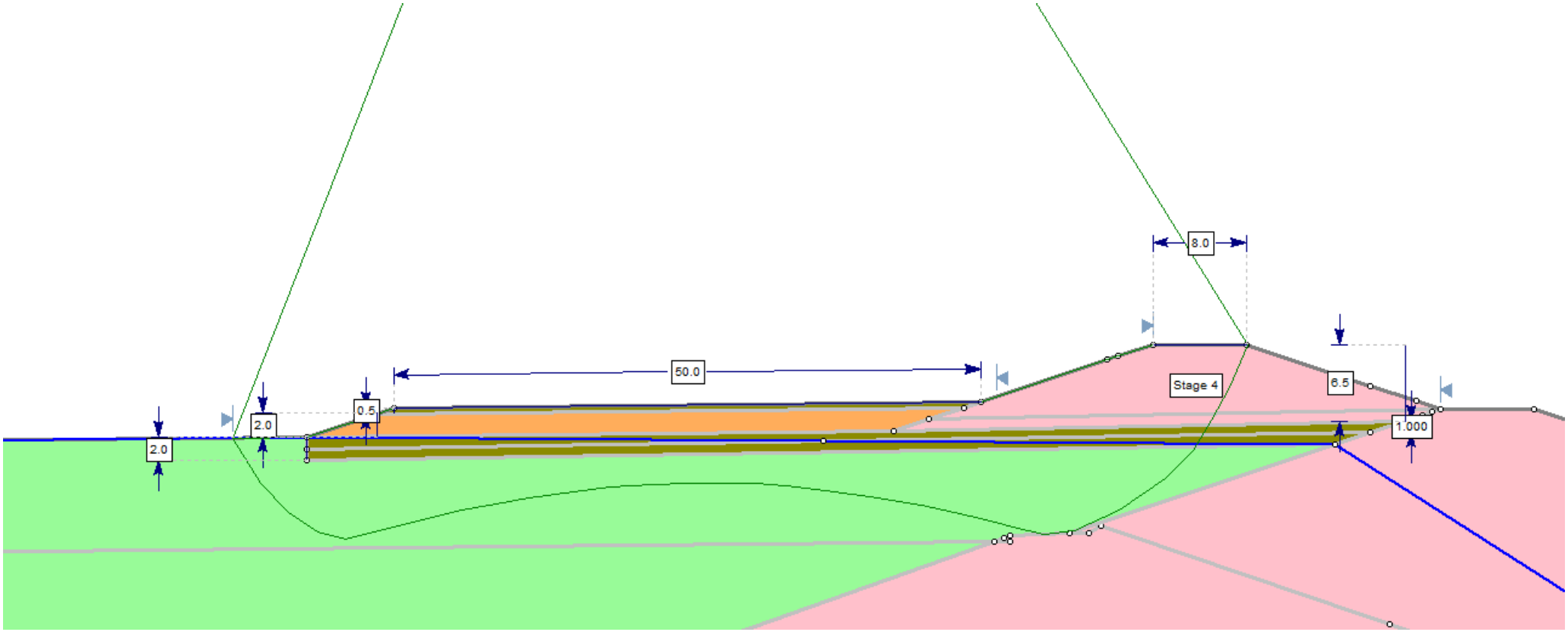

Figure A.7 Scenario 2.3 - toe berm

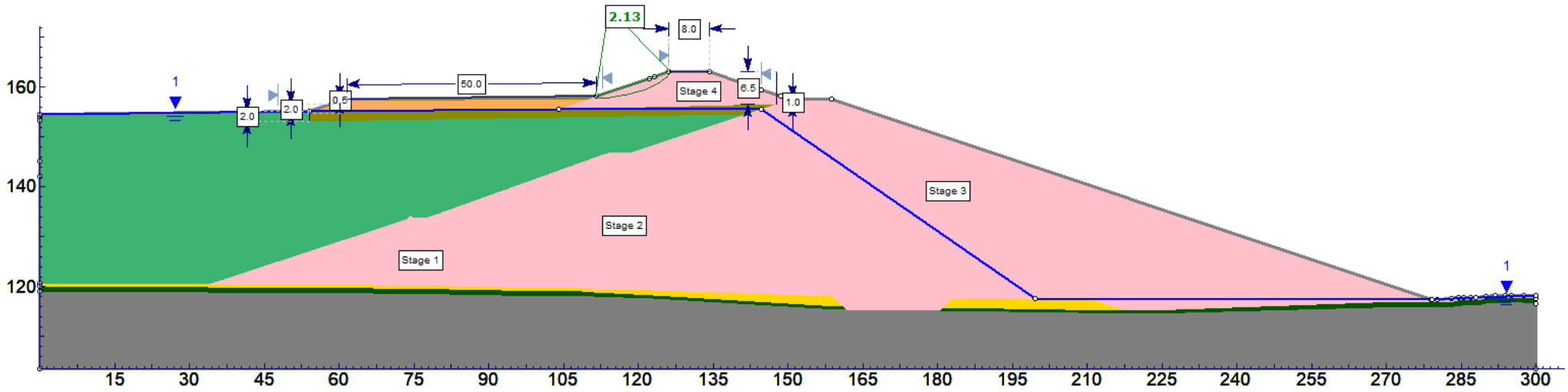

Figure A.8 Scenario 2.4

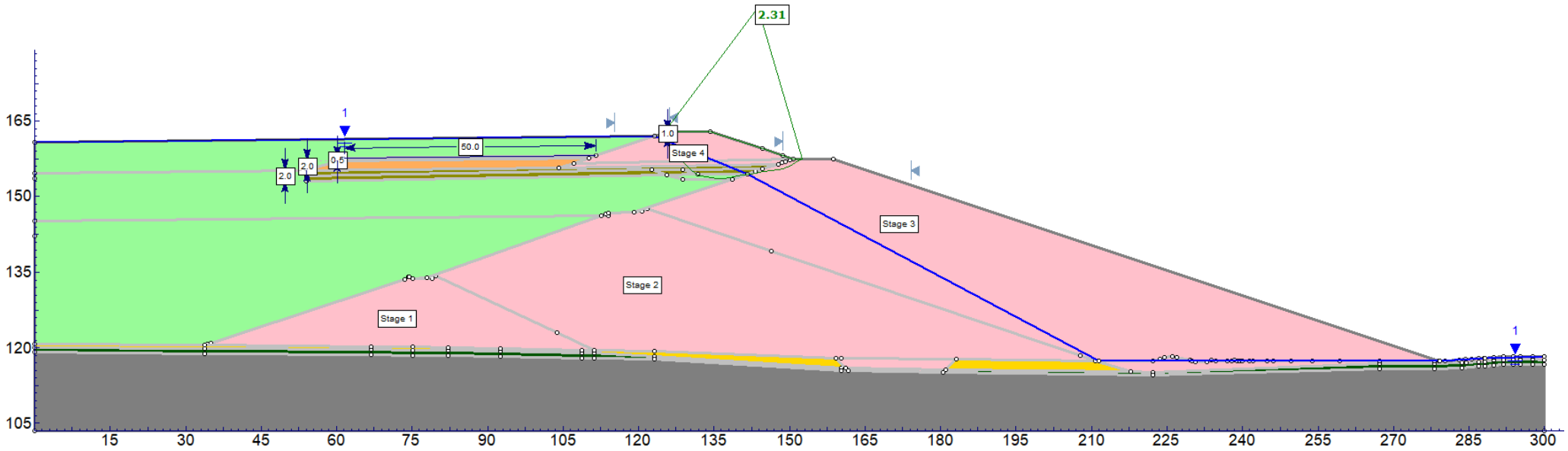

Figure A.9 Scenario 3.1

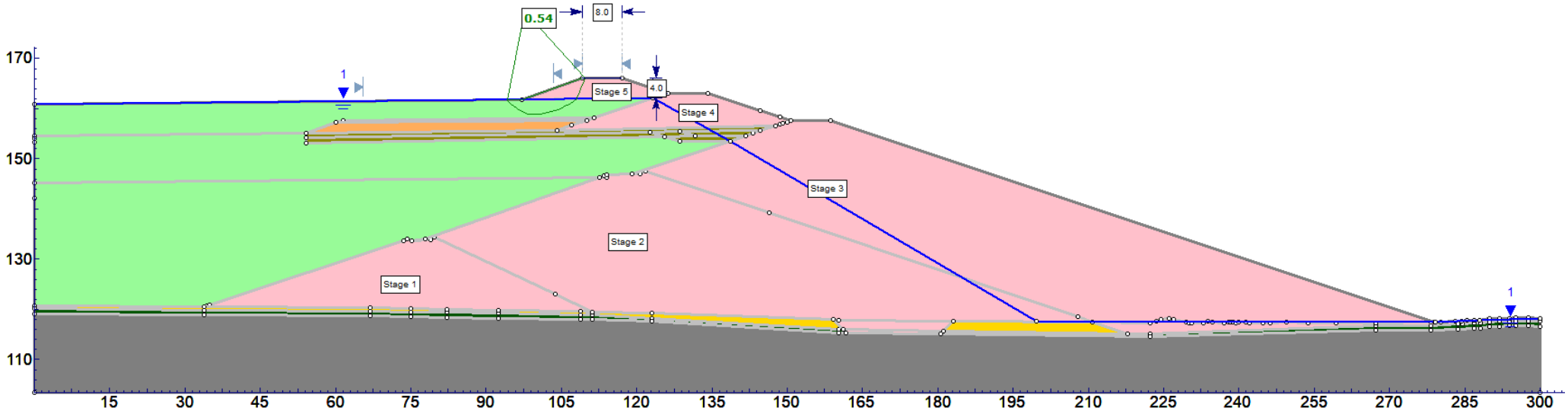

Figure A.10 Scenario 4.1

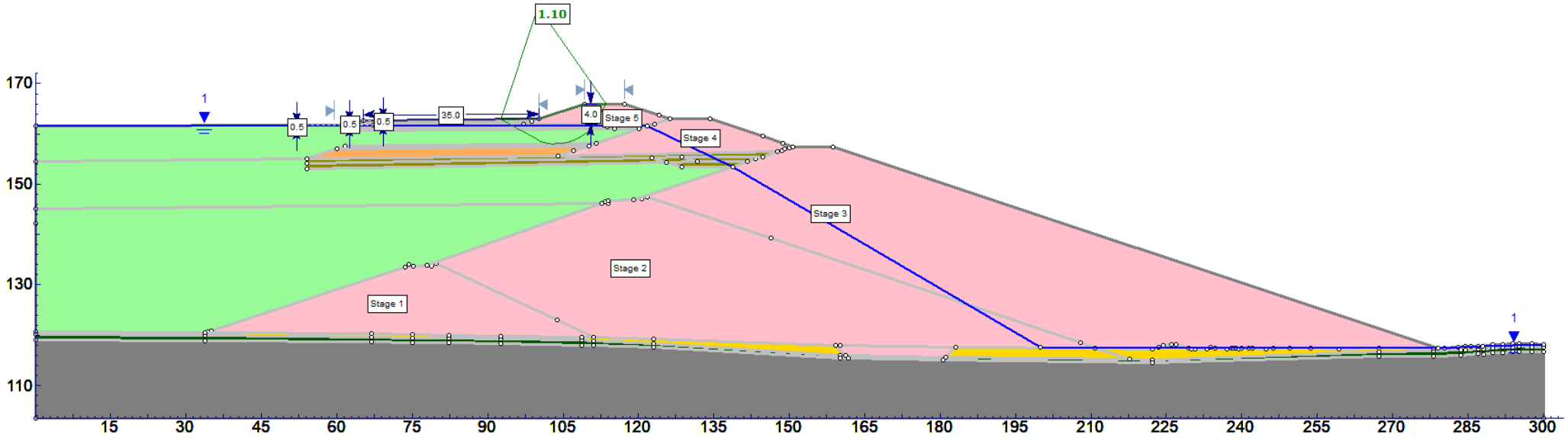

Figure A.11 Scenario 4.2

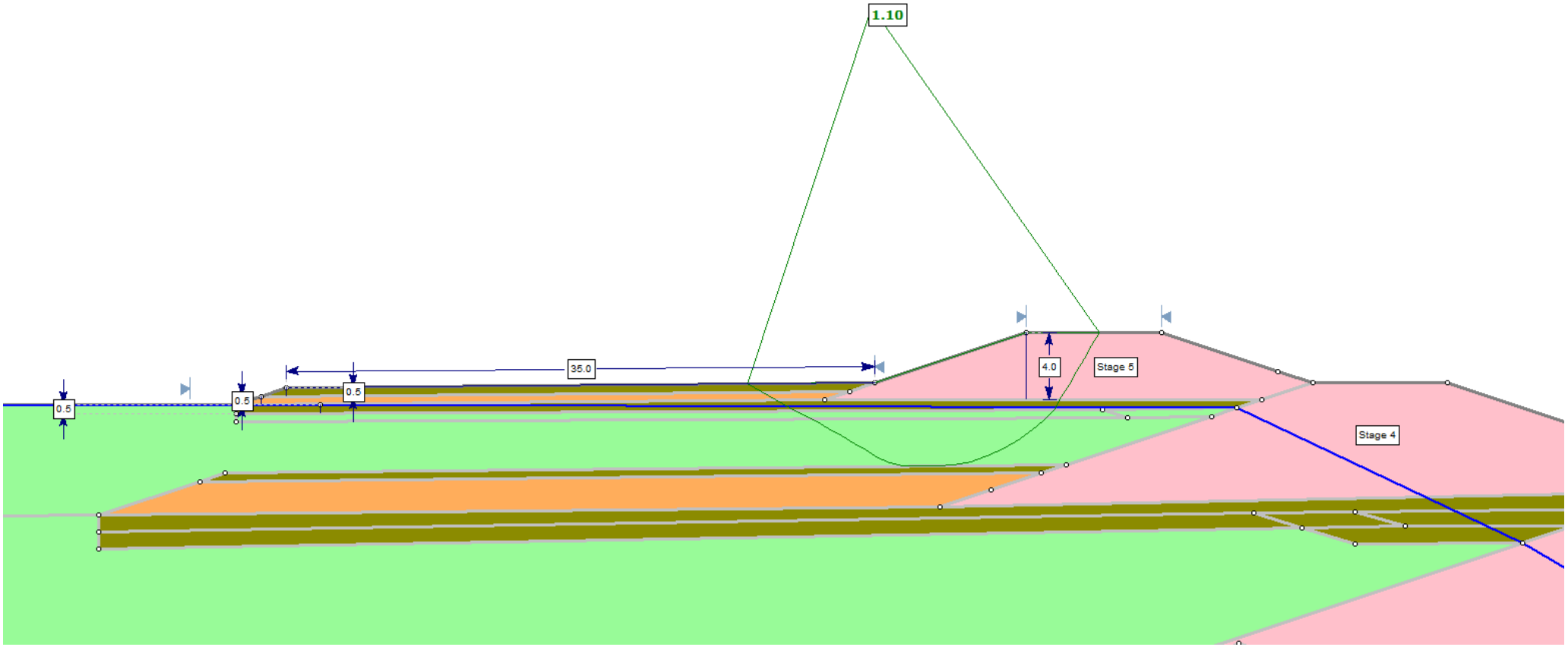

Figure A.12 Scenario 4.2 -toe berm enlargement

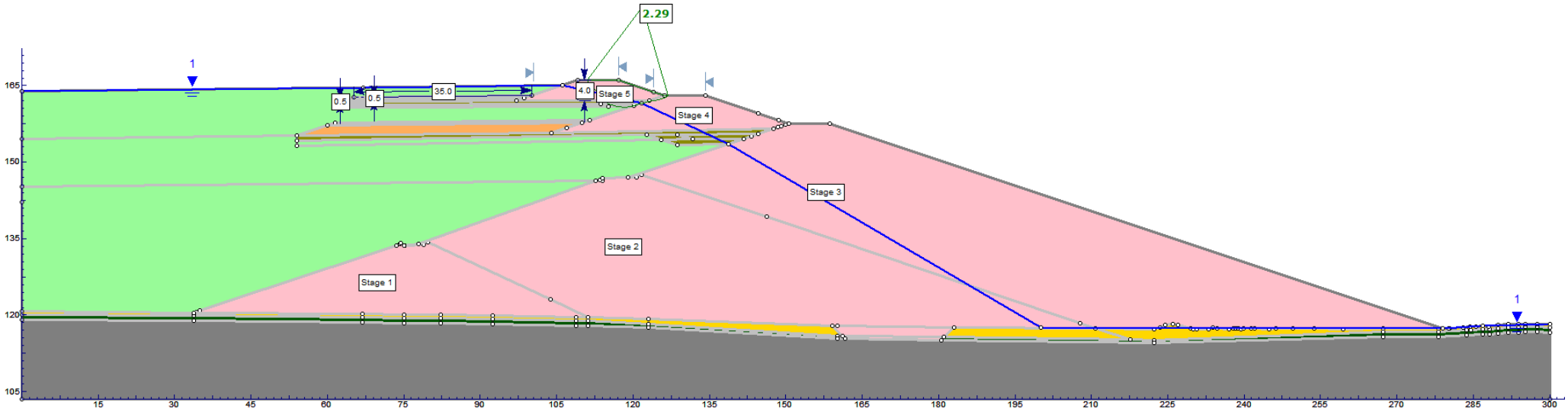

Figure A.13 Scenario 4.3

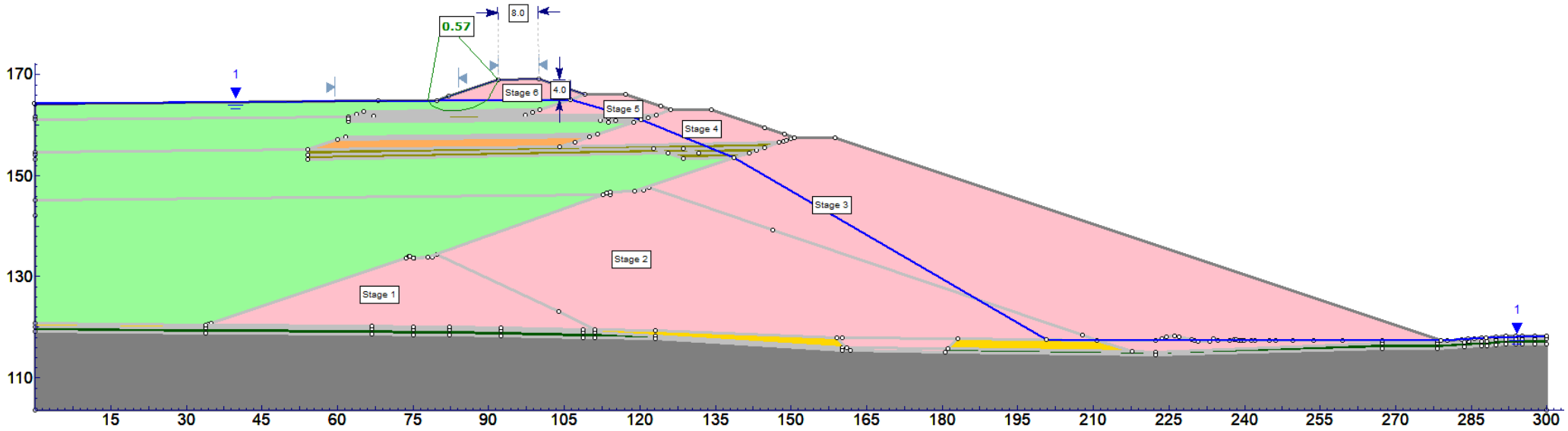

Figure A.14 Scenario 5.1

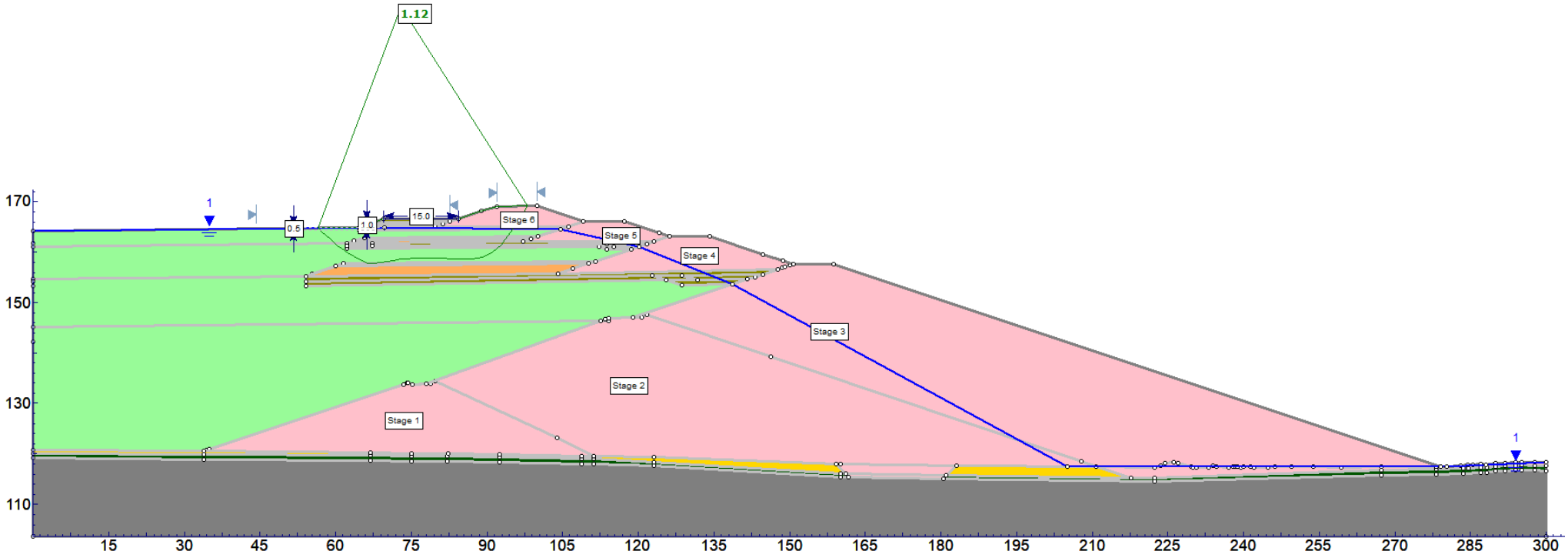

Figure A.15 Scenario 5.2

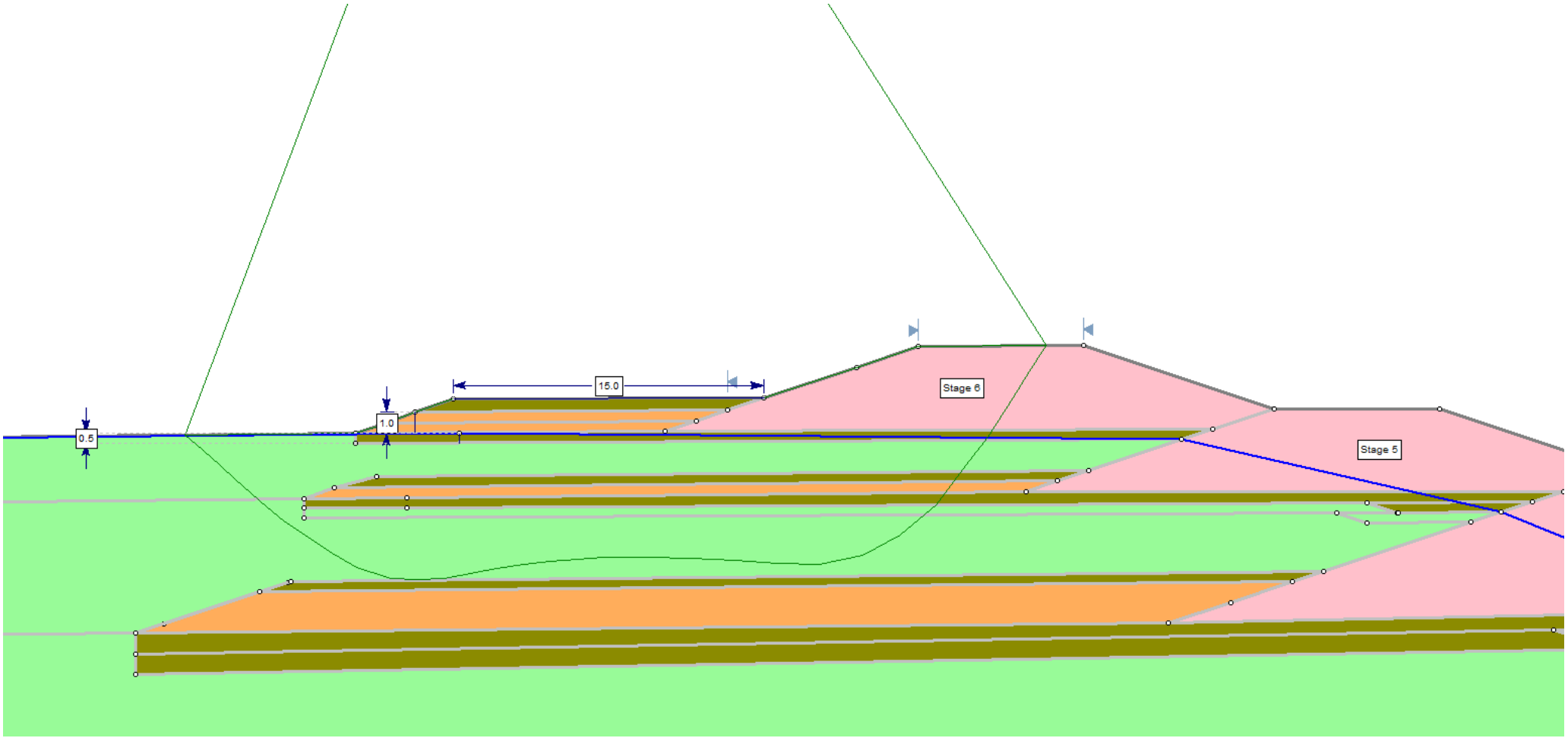

Figure A.16 Scenario 5.2 – toe berm

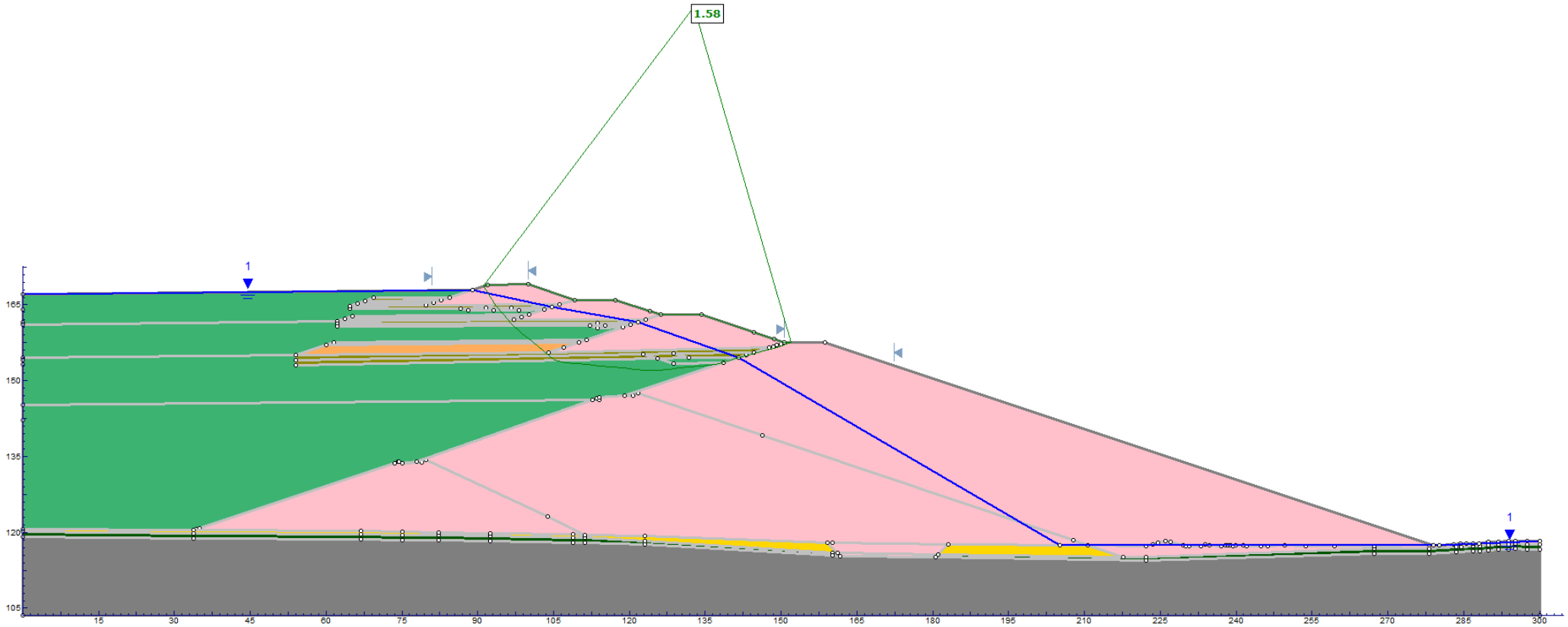

Figure A.17 Scenario 6.1

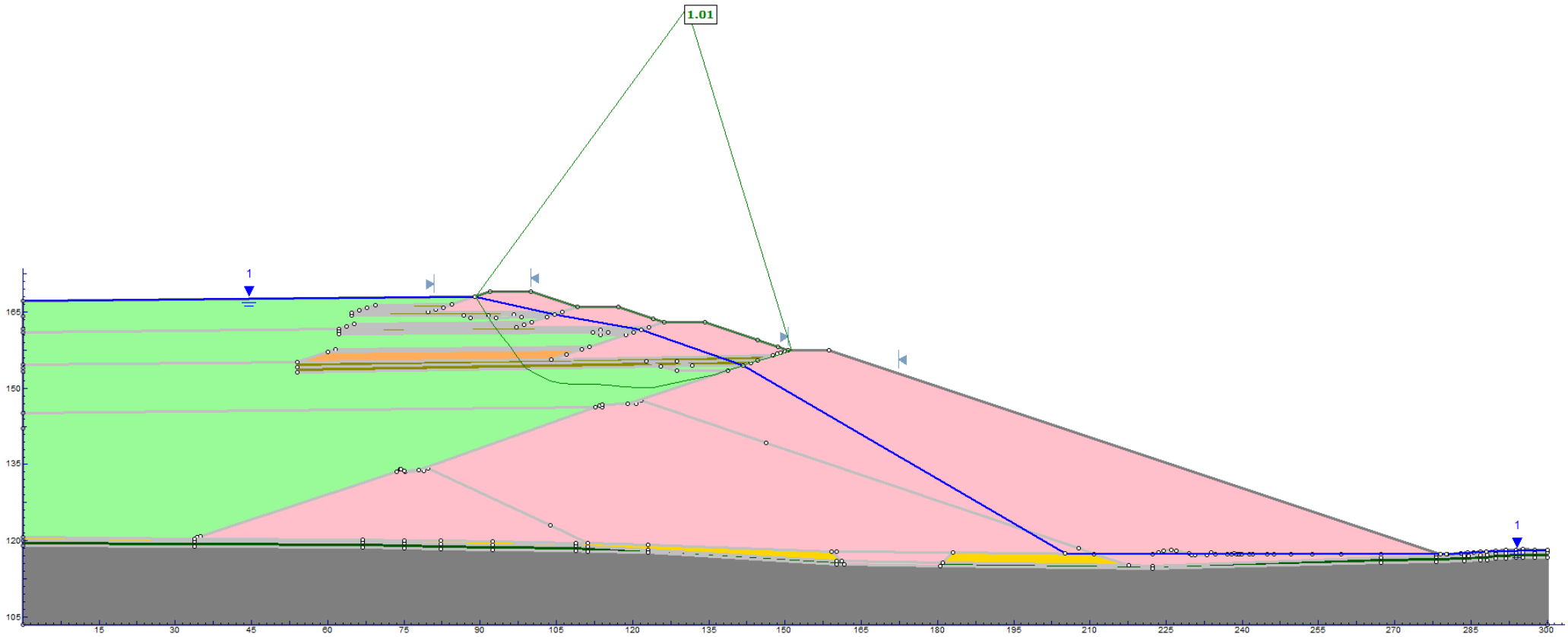

Figure A.18 Scenario 6.2

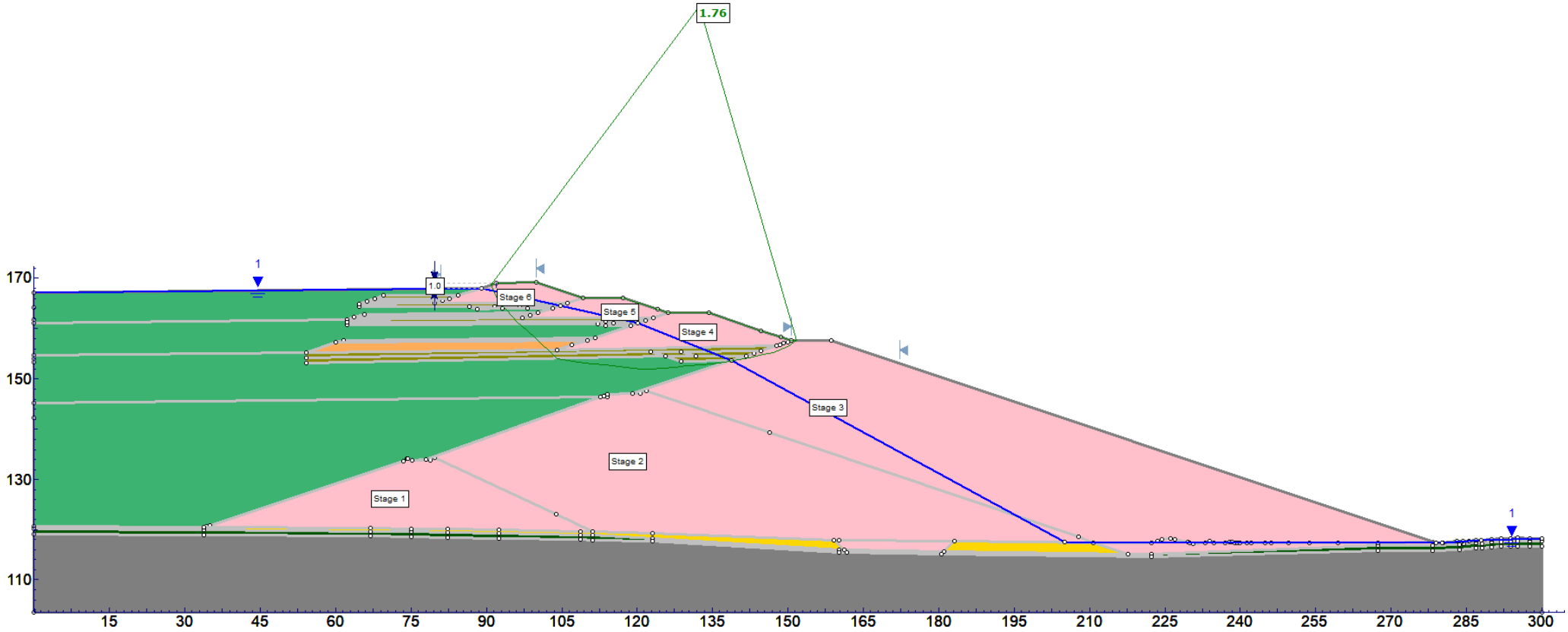

Figure A.19 Scenario 6.3

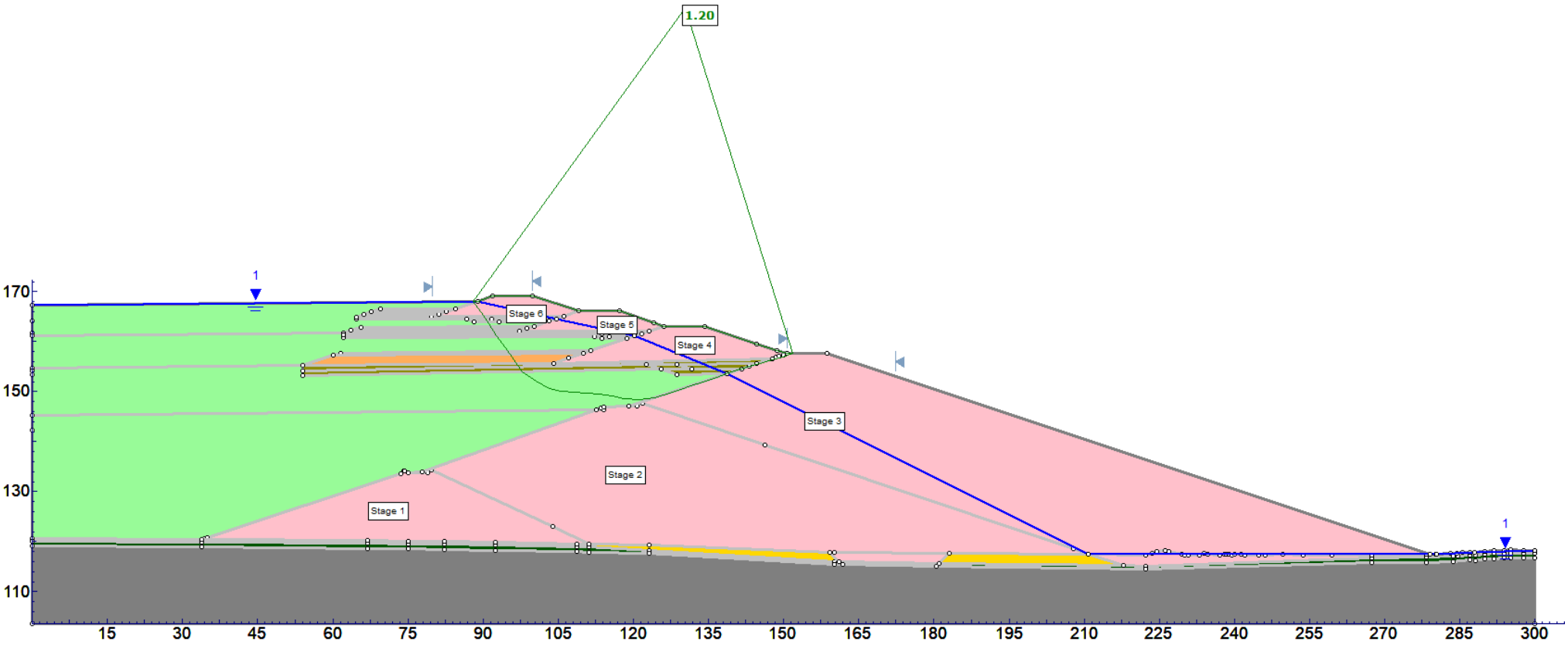

Figure A.20 Scenario 6.4

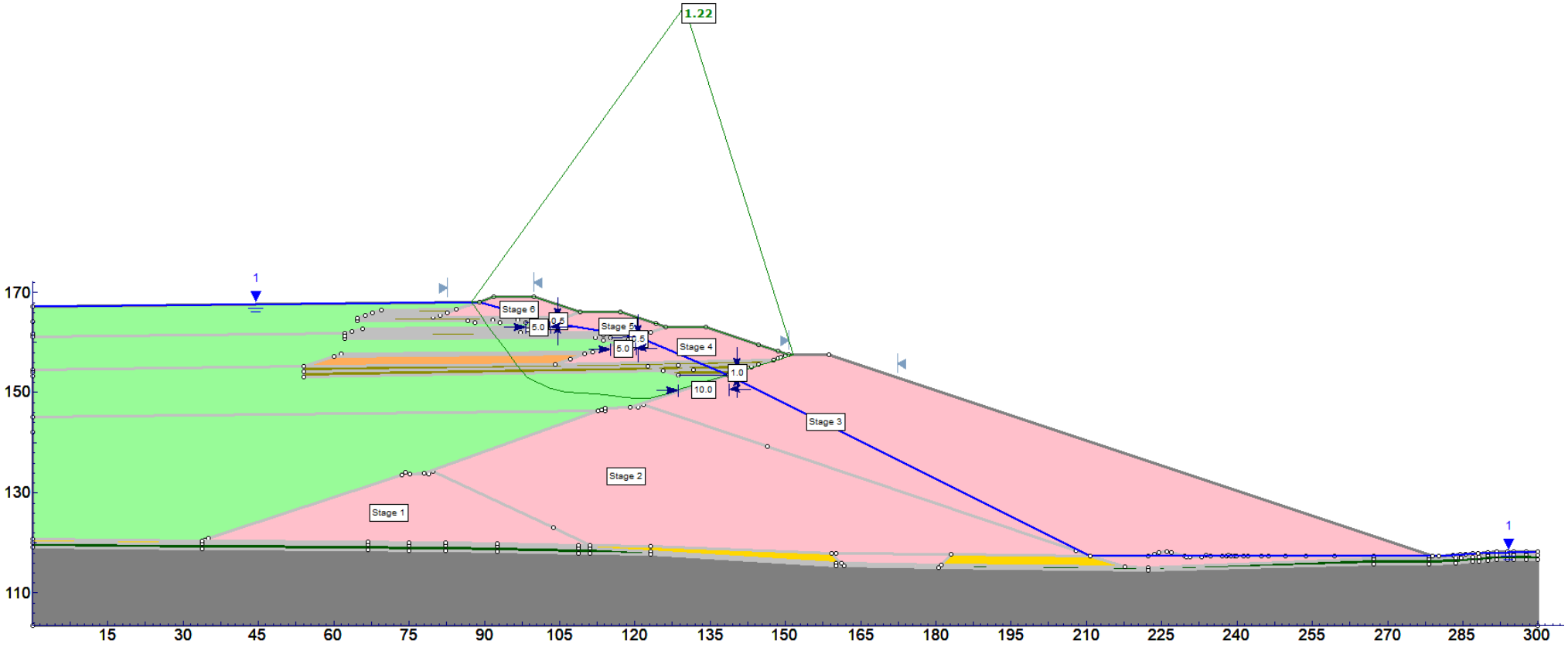

Figure A.21 Scenario 6.5

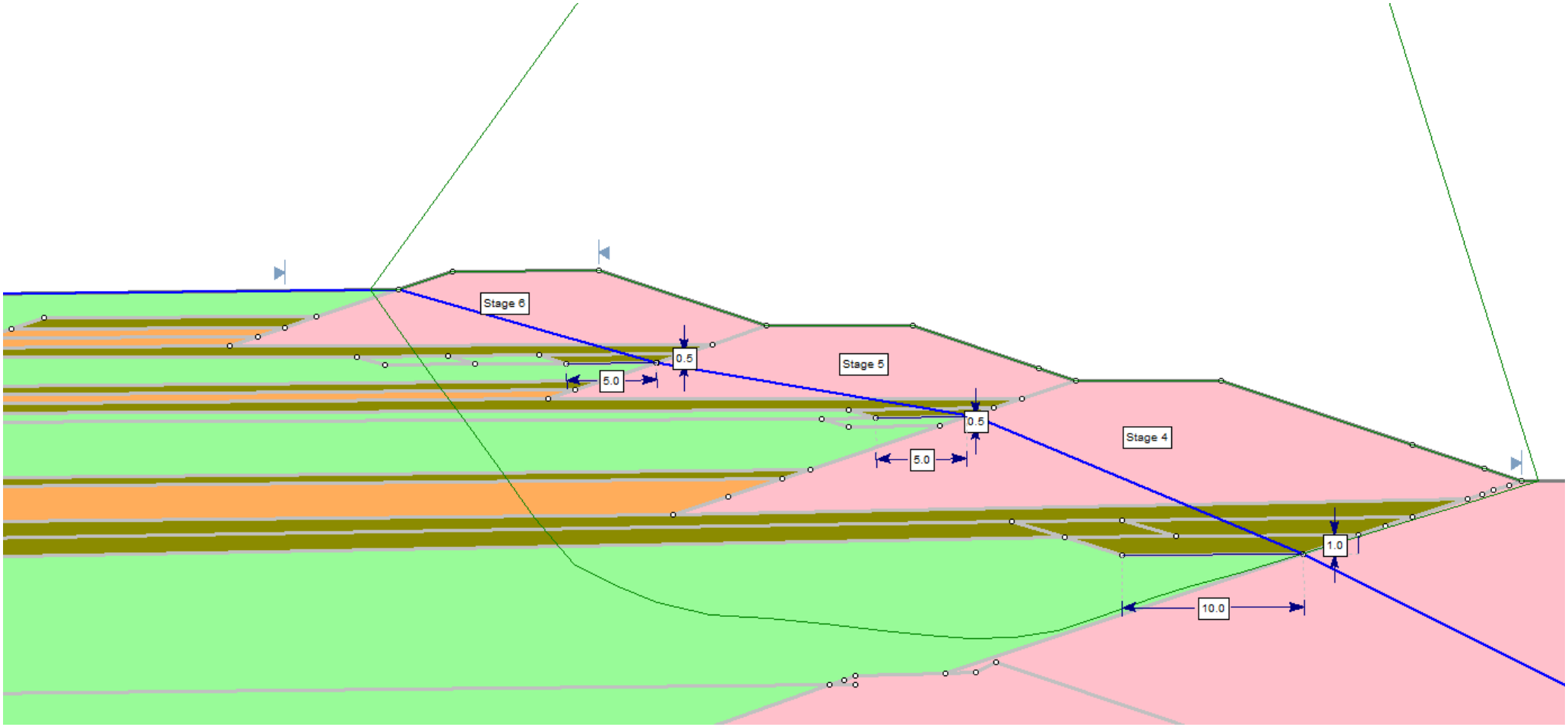

Figure A.22 Scenario 6.5 – shear key

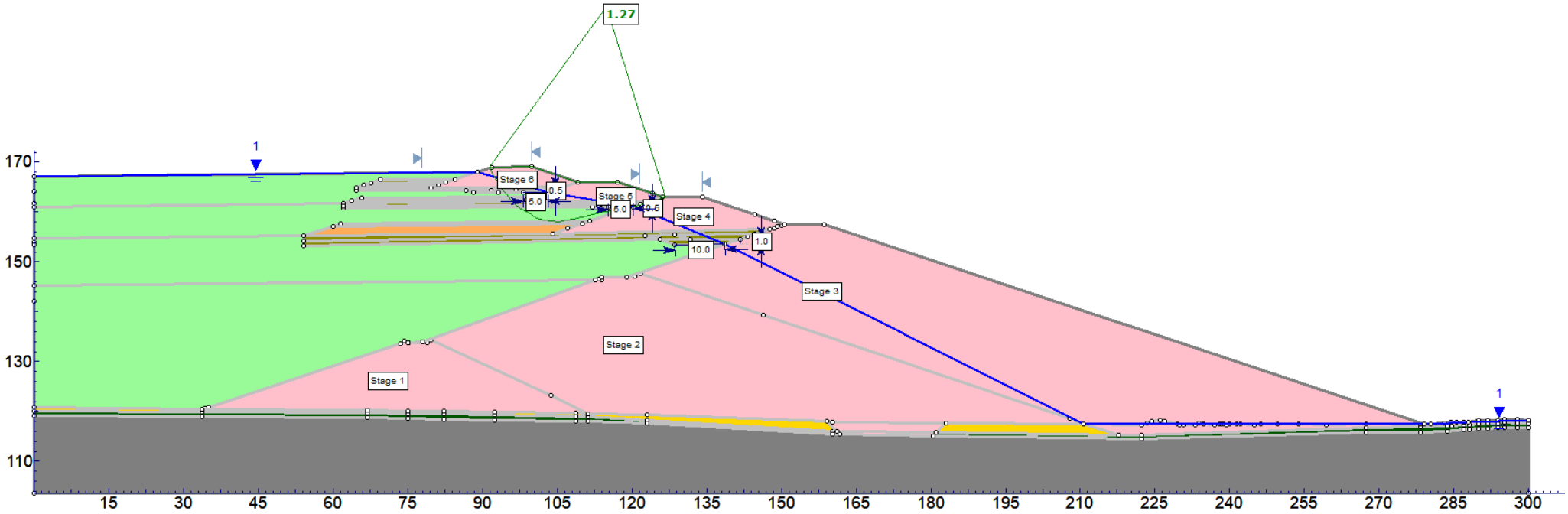

Figure A.23 Scenario 6.6

Appendix B

Limitation Statement

Limitation Statement

PERMITTED PURPOSE

This Report is provided by WSP for the purpose described in the Agreement and no responsibility is accepted by WSP for the use of the Report in whole or in part, for any other purpose (*Permitted Purpose*).

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Appendix K

Schedule of quantities for Stages 3 to 6

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Our ref: PS138057-WSP-MEL-MNG-LTR-00008 Rev0

25 November 2024

BHP, owner of OZ Minerals Carrapateena Pty Ltd
2 Hamra Drive
Adelaide Airport, SA 5950

Carrapateena - Tailings Storage Facility Life of Mine - Schedule of Quantities

1. Introduction

This document presents the Schedule of Quantities for construction of the Stage 3 downstream raise and the Stages 4 to 6 upstream raises for the Tailings Storage Facility (TSF) embankment. The schedules are based on the concept designs presented in the Life of Mine Concept Design Update report[1] and include emergency spillways and the centreline raises to the Decant Causeway.

2. Preamble to Schedule of Quantities

The following items are to be considered/included in the unit rates in the schedules:

- For the purpose of this schedule of quantities, the term ‘quarry’ refers to the Borrow Pit 3 extension unless otherwise specified.
- The rates for materials from the Borrow Pit 3 extension are to assume an average haulage distance of 3 km. The following materials are to be excavated from the Borrow Pit 3 extension, and crushed (as required) and screened:
  - Moderately to Slightly Weathered Rockfill, with maximum particle size of 250 mm, to form the embankment raise.
  - Screened Weathered Rockfill, well graded with maximum particle size of 50 mm, to form a bedding layer for a liner on the upstream slope of the embankment and a wearing course at the crest.
  - Drainage Aggregate, 10 mm to 20 mm particle size, for upstream toe drain extensions. To produce this material, rock from the quarry is to be crushed and screened.
  - Coarse Rockfill, 50 mm to 300 mm particle size, to form an erosion protection layer on the downstream slope of the embankment.
- The cost of developing the Borrow Pit 3 extension is to be inclusive of quarry surface preparation (removal of topsoil and clay) and drill and blast.
- The cost of crushing and screening material, as required.
- The cost of procurement and haulage of commercial materials to site, whether by supplier or Contractor. Temporary stockpiling (as required) of commercial materials is to be included in the rates.

[1] Tailings Storage Facility, Staged Life of Mine Concept Design Update for 224 Mdt, Carrapateena ref. CA-3630-CIV-REP-1109 Rev0, WSP report ref. PS138057-WSP-MEL-MNG-REP-00010 Rev0, November 2024.

WSP | Calibre acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

- All commercially sourced materials delivered to site are to include manufacturer quality control (QC) documentation.
- The cost of haulage of waste materials to temporary stockpiles (designated location(s) by the Principal within 1 km of TSF perimeter) and/or site waste disposal facilities. Waste materials comprise but are not limited to:
  - Debris from clearing of the Works area.
  - Trees, shrubs, and roots cleared from the Works area.
  - Surface cobbles.
  - Topsoil, i.e., upper portion of soil profile with tree and shrub roots.
  - *In-situ* clay.
- The minimum methods for placement, moisture conditioning and compaction of earthen materials as outlined in schedules. These describe maximum loose layer thickness and minimum number of passes for compaction by a certain type and size of roller.
- All fill quantities provided in the schedules are nett as shown on the Drawings, i.e., they do not allow for wastage. Allowance is to be made for overbuild and trimming, where applicable.
- The quantities provided for geosynthetics in the schedules are nett as shown on the Drawings, i.e., they do not allow for wastage and/or panel overlap.
- The cost for supply of concrete and cement stabilised sand, is to assume on-site batching, using existing facilities that will be made available by BHP, including transportation of concrete and cement stabilised sand to the Works area.
- Note, items for relocation of existing dam monitoring instruments and logging systems are excluded from the schedules. Items for new instruments are also excluded.

3. Summary

The following table summarises the cost components for Life of Mine raise construction presented in this schedule of quantities.

Table 3.1 Summary of cost components

Item	Reference	Amount ($)
Stage 3 downstream raise		
Stage 3 embankment	Section 4.1	
Stage 3 emergency spillway	Section 4.2	
Stage 3 Decant Causeway	Section 4.3	
Total		
Stage 4 upstream raise		
Stage 4 embankment	Section 5.1	
Stage 4 emergency spillway	Section 5.2 (refer Section 4.2)	
Stage 4 Decant Causeway	Section 5.3	
Total		
Stage 5 upstream raise		
Stage 5 embankment	Section 6.1	
Stage 5 west saddle dam	Section 6.2	
Stage 5 south saddle dam	Section 6.3	
Stage 5 emergency spillway	Section 6.4 (refer Section 4.2)	
Stage 5 Decant Causeway	Section 6.5	
Total		
Stage 6 upstream raise		
Stage 6 embankment	Section 7.1	
Stage 6 south saddle dam	Section 7.2	
Stage 6 emergency spillway	Section 7.3 (refer Section 4.2)	
Stage 6 Decant Causeway	Section 7.4	
Total		

4. Stage 3 downstream raise

4.1 Stage 3 embankment

Table 4.1 Schedule of Quantities for Stage 3 downstream raise option

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, stripping, foundation preparation, and miscellaneous**				
1.1	**Downstream slope of Stage 2 embankment**				
1.1.1	Excavate (strip) the Coarse Mine Rockfill layer (1 m thick) from the downstream face of the Stage 2 embankment and the Stage 2 safety bund from the downstream crest edge, and stockpile at location(s) designated by the Principal.	m^3	86,000		
1.2	**Abutments**				
1.2.1	Clear debris from the footprint area between the Stage 2 embankment and Stage 3 abutments and stockpile within 1 km at location(s) designated by the Principal. Assume negligible vegetation within footprint, i.e., no requirement for clearing and grubbing.	m^2	22,000		
1.2.2	Excavate (strip) topsoil and loose gravel and cobbles from the footprint area between the Stage 2 and Stage 3 abutments, and stockpile within 1 km at location(s) designated by the Principal. Assume average thickness of topsoil is about 0.5 m within the east abutment footprint area and 0.3 m within the west abutment footprint area.	m^3	9,000		
1.2.3	Scarify *in situ* clay between the Stage 2 embankment abutment and the Stage 3 abutment to a depth of 0.3 m, moisture condition and compact with a minimum 6 single directional passes of a 20 tonne padfoot roller on vibratory mode.	m^2	22,000		
1.3	**Downstream toe area – stripping and foundation preparation**				
1.3.1	Excavate (strip) topsoil and loose gravel and cobbles from the footprint area downstream of the Stage 2 embankment, within the Stage 3 footprint, and stockpile within 1 km at location(s) designated by the Principal. Assume average thickness of topsoil is about 0.3 m within the footprint area.	m^3	32,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.3.2	Excavate (strip) coarse mine rockfill layer (0.5 m thick) from the surface drains downstream of the Stage 2 embankment, within the Stage 3 footprint. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	18,000		
1.3.3	Excavate clay (to expose bedrock) downstream of the Stage 2 embankment, within the Stage 3 footprint. Assume average thickness of clay is about 0.9 m within the footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	95,000		
2.0	**Downstream toe areas – pipe extensions**				
2.1	Extend the existing DN225 HDPE seepage outfall pipes from the pipe junction pit to a new junction pit downstream of the projected Stage 3 embankment. Item inclusive of supply and connection of pipes, supply of encapsulation sand and compacted weathered rockfill causeway extensions.	Lump sum	1		
2.2	Extend the existing slotted DN160 HDPE seepage collection pipes from the collection sump at the downstream toe of the Stage 2 embankment to a new sump downstream of the projected Stage 3 embankment. Item inclusive of supply, slotting and connection of pipes, and trenched installation with drainage aggregate and filter geotextile encapsulation, and rockfill backfill above the drains.	Lump sum	1		
2.3	Supply and install a new seepage collection sump for the seepage collection pipe extensions. Assume 1.5 m diameter × 4 m deep reinforced concrete tower with reinforced concrete base, as per the sump for the existing system, with penetrations for three DN160 HDPE drainage pipes.	Lump sum	1		
2.4	Decommission the DN450 and DN560 decant outfall pipe valves and close the top of the DN560 HDPE pipe at the pipe junction pit.	Lump sum	1		
2.5	Supply and install a new pipe junction pit for the DN225 HDPE seepage outfall pipes and the DN560 HDPE decant outfall pipe, with inspection ports for the pipes where they pass through the pit. Assume 2 m diameter × 3 m deep reinforced concrete tower, similar to the existing pipe junction pit.	Lump sum	1		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
3.0	**Embankment raise, including downstream erosion protection**				
3.1	Excavate Moderately to Slightly Weathered rock from quarry, screen as required (for maximum 250 mm particle size), load, haul, place, moisture condition and compact to form the Stage 3 embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	2,580,000		
3.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in two equal thickness layers to form a 0.5 m thick bedding layer for the Bituminous Geomembrane liner on the upstream slope of the embankment. Assume 8 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode for compaction of each layer.	m^3	30,000		
3.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape to form a 1 m thick erosion protection layer on the downstream slope of the embankment.	m^3	145,000		
3.4	Excavate the surface drain at the downstream toe of the embankment and stockpile within 1 km at location(s) designated by the Principal. Quantity approximated based on erosion protection layer.	m^3	27,000		
3.5	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape to form a 0.5 m thick layer on the surface drains at the downstream toe of the embankment. Quantity estimated based on 150% of the volume used for the Stage 2 drains.	m^3	27,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
4.0	**Liner installation**				
4.1	Supply and install Bituminous Geomembrane liner (Coletanche ES4 or equivalent) on the upstream slope of the embankment. Inclusive of crest and toe anchor trenches, with cement stabilised sand backfill.	m^2	73,000		
4.2	Supply and install ballast tubes over the Bituminous Geomembrane liner. Inclusive of anchoring at the crest of the embankment. Ballast tubes to be placed at 5 m spacing and down to 60% of the Stage 3 slope length with a weight of 100 kilogram per meter length. Tubes to be formed by 1 mm thick textured (on outside) and smooth (on inside) LLDPE geomembrane and filled with sand.	m^2	60,000		
5.0	**Upstream toe drain extensions**				
5.1	Supply and install a 4 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the portion of the Bituminous Geomembrane liner that will be covered by the upstream toe drain extensions.	m^2	2,300		
5.2	Supply and install non-woven Geotextile (Bidim A39 or equivalent) for the upstream toe drain extensions.	m^2	3,900		
5.3	Supply and install perforated DN160 HDPE PN10 SDR17 PE100 pipes to form the upstream toe drain extensions.	m	560		
5.4	Source and supply Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry. Load, haul, place and shape to form upstream toe drain extensions. Assume upstream toe drain is 2.5 m wide by 0.5 m thick.	m^3	700		
5.5	Supply and install an additional 1.5 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the Bituminous Geomembrane liner at the upstream toe of the embankment to provide protection against the overlying erosion protection layer.	m^2	900		
5.6	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form a 0.25 m thick erosion protection layer over the upstream toe drain extensions. Assume loose layer thickness of 0.3 m and 4 single direction passes of a 20 tonne tracked excavator or equivalent, to limit damage to the underlying geotextile and drain.	m^3	700		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
6.0	**Embankment crest works**				
6.1	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the Stage 3 embankment to form a 0.3 m thick wearing course. Additional 1 m thickness to be formed near upstream crest edge over 3 m width to facilitate Bituminous Geomembrane liner anchor trench. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode.	m^3	11,100		
6.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the Stage 3 embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	2,700		
6.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge of the embankment to form a safety bund.	m^3	2,700		

4.2 Stage 3 emergency spillway

The emergency spillway assessment for the Stage 3 indicates dimensions consistent to the Stage 2 spillway. The following quantities are as per those estimated for the Stage 2 spillway prior to its construction.

Table 4.2 Schedule of Quantities for Stage 3 emergency spillway

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	Clear debris from the emergency spillway footprint area and stockpile within 1 km at location(s) designated by the Principal. Assumes negligible vegetation within footprint, i.e., no requirement for clearing and grubbing.	m^2	8,300		
2.0	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the emergency spillway footprint area and stockpile within 1 km at location(s) designated by the Principal. Assume average topsoil thickness is about 0.5 m within footprint area.	m^3	4,200		
3.0	Excavate clay (to expose bedrock) to form the shape of the emergency spillway and stockpile within 1 km at location(s) designated by the Principal. Excavation quantity based on average 0.7 m thickness of *in situ* clay below topsoil.	m^3	5,800		
4.0	Excavate *in situ* weathered rock to form the shape of the emergency spillway, and stockpile within 1 km at location(s) designated by the Principal. (Provisional)	m^3	3,000		
5.0	Excavate *in situ* clay to form the camber drain at eastern side of the spillway, and stockpile and stockpile within 1 km at location(s) designated by the Principal.	m^3	220		
6.0	Excavate *in situ* weathered rock at the emergency spillway for the sill beam, and stockpile within 1 km at location(s) designated by the Principal.	m	38		
7.0	Supply and cast fibre reinforced concrete to form the sill beam at the emergency spillway. Assume average depth of sill beam is about 0.5 m and width is 0.5 m.	m	38		
8.0	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape to form safety bunds at the crest of the spillway side slopes.	m^3	500		

4.3 Stage 3 Decant Causeway raise

The following schedule is based on the end of Stage 2 tailings beach model for the flat beach slope scenario. The Stage 3 causeway raise height varies between about 5 m and 10 m. Sub-staging will be considered for detailed design.

Table 4.3 Schedule of Quantities for Stage 3 Decant Causeway raise

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, grubbing, stripping and miscellaneous**				
1.1	Clear debris from the causeway footprint area over natural ground and stockpile within 1 km at location(s) designated by the Principal.	m^2	1,200		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the causeway footprint area over natural ground and stockpile within 1 km at location(s) designated by the Principal.	m^3	400		
1.3	Scarify natural ground (clay) within the causeway raise footprint to a nominal depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	1,200		
1.4	Scarify tailings within the causeway raise footprint (if practical) to a nominal depth of 0.3 m, moisture condition (if required) and compact. Assume 4 single direction passes of a 20 tonne pad foot roller on static mode.	m^2	19,900		
1.5	Supply and install geosynthetic reinforcement (Combigrid 60/60 or equivalent) over the tailings surface within the footprint of the causeway raise. (provisional)	m^2	19,900		
1.6	Remove Stage 2 safety bunds from causeway crest and temporarily stockpile for reuse (as practical) on the Stage 3 causeway crest.	m^3	1,000		
2.0	**Decant Causeway pioneer layer and outfall pipe extension**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry. Load, haul, place, and spread to form a 1 m thick pioneer layer over the tailings surface within the causeway raise footprint.	m^3	19,900		
2.2	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to construct a strip pad for subsequent trench excavation and installation of decant outfall pipe extension. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	1,700		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
2.3	Excavate trench into strip pad for decant outfall pipe extension and temporarily stockpile spoil adjacent to the strip pad for reinstatement in the causeway raise. Item inclusive of exposing southern end of the Stage 2 decant outfall pipe.	m^3	600		
2.4	Supply and install DN560 PN16 SDR 11 HDPE pipe to extend the decant outfall pipe to the south. Item inclusive of welding of the new HDPE pipe to the Stage 2 outfall pipe.	m	80		
2.5	Supply, place and nominally compact Clean Sand in the base of the trench and around the DN560 HDPE pipe.	m^3	400		
2.6	Excavate rockfill from trench spoil stockpile, haul, place, moisture condition and compact in a single layer to cover the top of the sand encasement.	m^3	200		
3.0	**Decant tower installation**				
3.1	Supply and cast concrete, including steel reinforcement, to form the Decant Tower concrete base (for Decant Tower 6).	Lump sum	1		
3.2	Supply and stockpile DN450 HDPE riser pipe control rings (collars) for Decant Towers 1 to 6. Items inclusive of lifting handles and ballast.	No.	130		
3.3	Supply and install 1.8 m diameter by 1.2 m high precast slotted decant tower units to raise the existing (Stage 2) Decant Towers 1 to 5 and to form Decant Tower 6.	No.	30		
4.0	**Decant Causeway raise**				
4.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to raise the causeway. Item inclusive of causeway extension to the south. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	117,000		
4.2	Supply and install geosynthetic reinforcement (TenCate Miragrid GX130/30 or equivalent) at a height of 1 m above the Stage 2 causeway, to the width of the causeway.	m^2	27,000		
4.3	Excavate Moderately to Slightly Weathered rock from quarry, crush, and screen to produce stockpile(s) of Filter Rock (50 mm to 150 mm particle size). Load from stockpile, haul, place and shape around the raises to Decant Towers 1 to 6.	m^3	36,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
4.4	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpile(s) of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the causeway crest to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode.	m^3	2,500		
4.5	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the crest edges of the causeway to form safety bunds.	m^3	1,000		

5. Stage 4 upstream raise

5.1 Stage 4 embankment

Table 5.1 Schedule of Quantities for Stage 4 upstream raise option

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, stripping, foundation preparation, and miscellaneous**				
1.1	**Upstream crest of Stage 3 embankment**				
1.1.1	Excavate (remove) safety bund from the upstream crest edge of the Stage 3 embankment. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	2,700		
1.2	**Abutments**				
1.2.1	Clear debris from the footprint area between the Stage 3 and Stage 4 abutments and stockpile within 1 km at location(s) designated by the Principal. Assume negligible vegetation within the footprint, i.e., no requirement for clearing and grubbing.	m^2	17,700		
1.2.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the footprint area between the Stage 3 and Stage 4 abutments. Assume average thickness of topsoil is about 0.5 m within footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	8,900		
1.2.3	Scarify *in situ* clay (between the Stage 3 and Stage 4 abutments) to a depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	17,700		
1.3	**Foundation, shear key and toe berm preparation**				
1.3.1	Excavate tailings from the Stage 3 tailings surface to form a trench for the shear key adjacent to the upstream crest edge of the Stage 3 embankment. Retain 0.5 m thickness of tailings over the Stage 2 Bituminous Geomembrane liner to avoid damage to the Geomembrane.	m^3	25,000		
1.3.2	Supply and install a layer of non-woven Geotextile (Bidim A39 or equivalent) at the base of the shear key trench to form a separation layer between the shear key backfill and the tailings surface.	m^2	21,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.3.3	Excavate clay from the Stage 4 embankment footprint (outside of tailings footprint) to form a trench for the shear key. Provisional item, assuming 5 m^2 cross-sectional area for shear key, to allow for foundation drainage.	m^3	1,900		
1.3.4	Construct the shear key drain over the extent of the shear key in the tailings, including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	1,910		
1.3.5	Construct the shear key drain in trenches approaching the abutments, including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	380		
1.3.6	Supply and install DN315 HDPE PN8 SDR11 pipes (2 x 6 m joined lengths each) to form seepage extraction pipes at 100 m centres for the shear key drain. (Extraction pipes are not proposed for the drains near the abutments.)	No.	20		
1.3.7	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to backfill the trench (Items 1.3.1 and 1.3.3).	m^3	27,000		
1.3.8	Excavate Moderately to Slightly Weathered rock from quarry. Load, haul, moisture condition and spread by a dozer (or tracked equipment) to form a 2 m thick platform (pioneer layer) for embankment and toe berm construction. Platform may be formed by pushing rockfill into the tailings or excavating tailings and replacing with rockfill.	m^3	349,000		
2.0	**Embankment raise, including downstream erosion protection**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form the Stage 4 embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	401,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
2.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in two equal thickness layers to form a 0.5 m thick bedding layer for the Bituminous Geomembrane liner on the upstream slope of the embankment. Assume loose layer thickness of 0.3 m and 8 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode for compaction of each layer.	m^3	26,000		
2.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape to form a 1 m thick layer on the downstream slope of the embankment.	m^3	39,000		
3.0	**Liner installation**				
3.1	Supply and install Bituminous Geomembrane liner (Coletanche ES4 or equivalent) on the upstream slope of the embankment. Inclusive of crest and toe anchor trenches, with cement stabilised sand backfill.	m^2	62,000		
3.2	Supply and install ballast tubes over the Bituminous Geomembrane liner. Inclusive of anchoring at the crest of the embankment. Ballast tubes to be placed at 5 m spacing and to 60% of the Stage 4 slope length with a weight of 100 kilogram per meter length. Tubes to be formed by 1 mm thick textured (on outside) and smooth (on inside) LLDPE geomembrane and filled with sand.	m^2	52,000		
4.0	**Upstream toe berm (over tailings)**				
4.1	Excavate tailings from nominated borrow pit within the TSF impoundment, load, haul, place, moisture condition and compact in layers to form the upstream toe berm. Assume loose layer thickness of 0.3 m and 6 single direction passes of a 20 tonne pad foot roller on vibratory mode. Assume average 500 m haulage distance from borrow. Rate to be inclusive of borrow pit preparation, e.g., advance scarification for drying and/or blading for moisture conditioning.	m^3	205,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
4.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact in two layers to form a 0.5 m thick scour protection layer over the upstream toe berm. Assume loose layer thickness of 0.3 m and 6 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	52,000		
4.1	**Upstream toe drain (between abutments)**				
4.1	Supply and install a 4 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the portion of the Bituminous Geomembrane liner that will be covered by the upstream toe drain extensions.	m^2	1,200		
4.1	Supply and install non-woven Geotextile (Bidim A39 or equivalent) for the upstream toe drain extensions.	m^2	2,100		
4.1	Supply and install perforated DN160 HDPE PN10 SDR17 PE100 pipes to form the upstream toe drain extensions.	m	290		
4.1	Source and supply Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry. Load, haul, place and shape to form upstream toe drain extensions. Assume upstream toe drain is 2.5 m wide by 0.5 m thick.	m^3	400		
4.1	Supply and install an additional 1.5 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the Bituminous Geomembrane liner at the upstream toe of the embankment to provide protection against the overlying erosion protection layer.	m^2	500		
4.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form a 0.25 m thick erosion protection layer over the upstream toe drain extensions. Assume loose layer thickness of 0.3 m and 4 single direction passes of a 20 tonne tracked excavator or equivalent, to limit damage to the underlying geotextile and drain.	m^3	400		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
5.0	**Embankment crest works**				
5.1	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the Stage 4 embankment to form a 0.3 m thick wearing course. Additional 1 m thickness to be formed near upstream crest edge over 3 m width to facilitate liner anchor trench. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two layers on vibratory mode and the remainder on static mode.	m^3	12,600		
5.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the Stage 4 embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	3,100		
5.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge to form a safety bund.	m^3	3,100		

5.2 Stage 4 emergency spillway

The concept design for the Stage 4 emergency spillway is as per Stage 3. Refer quantities presented in Table 4.2.

5.3 Stage 4 Decant Causeway raise

The following schedule is based on the end of Stage 3 tailings beach model for the flat beach slope scenario. The Stage 4 causeway raise height varies between about 4 m and 7 m. Sub-staging will be considered for detailed design.

Table 5.2 Schedule of Quantities for Stage 4 Decant causeway raise

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, grubbing, stripping and miscellaneous**				
1.1	Clear debris from the causeway footprint area over natural ground and stockpile within 1 km at location(s) designated by the Principal.	m^2	200		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the causeway footprint area over natural ground and stockpile within 1 km at location(s) designated by the Principal.	m^3	60		
1.3	Scarify natural ground (clay) within the causeway raise footprint to a nominal depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	200		
1.4	Scarify tailings within the causeway raise footprint (if practical) to a nominal depth of 0.3 m, moisture condition (if required) and compact. Assume 4 single direction passes of a 20 tonne pad foot roller on static mode.	m^2	22,000		
1.5	Supply and install geosynthetic reinforcement (Combigrid 60/60 or equivalent) over the tailings surface within the footprint of the causeway raise. (provisional)	m^2	22,000		
1.6	Remove Stage 3 safety bunds from causeway crest and temporarily stockpile for reuse (as practical) on the Stage 4 causeway crest.	m^3	1,000		
2.0	**Decant Causeway pioneer layer and outfall pipe extension**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry. Load, haul, place, and spread to form a 1 m thick pioneer layer over the tailings surface within the causeway raise footprint.	m^3	22,000		
2.2	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to construct a strip pad for subsequent trench excavation and pipe installation. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	1,100		
2.3	Excavate trench into strip pad for decant outfall pipe extension and temporarily stockpile spoil adjacent to the strip pad for reinstatement in the causeway raise. Item inclusive of exposing southern end of Stage 3 decant outfall pipe.	m^3	400		
2.5	Supply and install DN560 PN16 SDR 11 HDPE pipe to extend the decant outfall pipe to the south. Item inclusive of welding of the new HDPE pipe to the Stage 3 outfall pipe.	m	50		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
2.6	Supply, place and nominally compact Clean Sand in the base of the trench and around the DN560 HDPE pipe.	m^3	300		
2.7	Excavate rockfill from trench spoil stockpile, haul, place, moisture condition and compact in a single layer to cover the top of the sand encasement.	m^3	200		
3.0	**Decant tower installation**				
3.1	Supply and stockpile DN450 HDPE riser pipe controls rings (collars) for Decant Towers 1 to 6. Items inclusive of lifting handles and ballast.	No.	100		
3.2	Supply and install 1.8 m diameter by 1.2 m high precast slotted decant tower units to raise Decant Towers 1 to 6.	No.	30		
4.0	**Decant Causeway raise**				
4.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to raise the causeway. Item inclusive of causeway extension to the south, over natural ground. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	83,000		
4.2	Supply and install geosynthetic reinforcement (TenCate Miragrid GX130/30 or equivalent) at a height of 1 m above the Stage 3 causeway, to the width of the causeway.	m^2	29,000		
4.3	Excavate Moderately to Slightly Weathered rock from quarry, crush, and screen to produce stockpile(s) of Filter Rock (50 mm to 150 mm particle size). Load from stockpile, haul, place and shape around the raises to Decant Towers 1 to 6.	m^3	25,000		
4.4	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpile(s) of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the causeway crest to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode.	m^3	2,900		
4.5	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the crest edges of the causeway to form safety bunds.	m^3	1,100		

6. Stage 5 upstream raise

6.1 Stage 5 embankment

Table 6.1 Schedule of Quantities for Stage 5 downstream raise option

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, stripping, foundation preparation, and miscellaneous**				
1.1	**Upstream crest of Stage 4 embankment**				
1.1.1	Excavate (remove) safety bund from the upstream crest edge of the Stage 4 embankment. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	3,100		
1.2	**Abutments**				
1.2.1	Clear debris from the footprint area between the Stage 4 and Stage 5 abutments and stockpile within 1 km at location(s) designated by the Principal. Assume negligible vegetation within the footprint, i.e., no requirement for clearing and grubbing.	m^2	25,000		
1.2.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the footprint area between the Stage 4 and Stage 5 abutments. Assume average thickness of topsoil is about 0.5 m within footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	12,100		
1.2.3	Scarify *in situ* clay (between the Stage 4 and Stage 5 abutments) to a depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	25,000		
1.3	**Foundation, shear key and toe berm preparation**				
1.3.1	Excavate tailings from the Stage 4 tailings surface to form a trench for the shear key adjacent to the upstream crest edge of the Stage 4 embankment. Retain 0.5 m thickness of tailings over the Stage 4 Bituminous Geomembrane liner to avoid damage to the Geomembrane.	m^3	7,200		
1.3.2	Supply and install a layer of non-woven Geotextile (Bidim A39 or equivalent) at the base of the shear key trench to form a separation layer between the shear key backfill and the tailings surface.	m^2	12,200		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.3.3	Excavate clay from the Stage 5 embankment footprint (outside of tailings footprint) to form a trench for the shear key. Provisional item, assuming 5 m^2 cross-sectional area for shear key, to allow for foundation drainage.	m^3	4,100		
1.3.4	Construct the shear key drain over the extent of the shear key in the tailings, including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	2,210		
1.3.5	Construct the shear key drain in trenches approaching the abutments, including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	805		
1.3.6	Supply and install DN315 HDPE PN8 SDR11 pipes (2 × 6 m joined lengths each) to form seepage extraction pipes at 100 m centres for the shear key drain. (Extraction pipes are not proposed for the drains near the abutments.)	No.	23		
1.3.7	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to backfill the trench (Items 1.3.1 and 1.3.3).	m^3	11,300		
1.3.8	Excavate Moderately to Slightly Weathered rock from quarry. Load, haul, moisture condition and spread by a dozer (or tracked equipment) to form a 0.5 m thick platform (pioneer layer) for embankment and toe berm construction. Platform may be formed by pushing rockfill into the tailings or excavating tailings and replacing with rockfill.	m^3	72,000		
2.0	**Embankment raise**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form the Stage 5 embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	206,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
2.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in two equal thickness layers to form a 0.5 m thick bedding layer for the Bituminous Geomembrane liner on the upstream slope of the embankment. Assume loose layer thickness of 0.3 m and 8 single direction passes of a 20 tonne smooth drum roller with the first two passes on vibratory mode and the remainder on static mode for compaction of each layer.	m^3	21,000		
2.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape to form a 1 m thick layer on the downstream slope of the embankment.	m^3	33,000		
3.0	**Liner installation**				
3.1	Supply and install Bituminous Geomembrane liner (Coletanche ES4 or equivalent) on the upstream slope of the embankment. Inclusive of crest and toe anchor trenches, with cement stabilised sand backfill.	m^2	51,000		
3.2	Supply and install ballast tubes over the Bituminous Geomembrane liner. Inclusive of anchoring at the crest of the embankment. Ballast tubes to be placed at 5 m spacing and to 60% of the Stage 5 slope length with a weight of 100 kilogram per meter length. Tubes to be formed by 1 mm thick textured (on outside) and smooth (on inside) LLDPE geomembrane and filled with sand.	m^2	41,000		
4.0	**Upstream toe berm (over tailings)**				
4.1	Excavate tailings from nominated borrow pit within the TSF impoundment, load, haul, place, moisture condition and compact in layers to form the upstream toe berm. Assume loose layer thickness of 0.3 m and 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^3	41,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
4.2	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact in two layers to form a 0.5 m thick scour protection layer over the upstream toe berm. Assume loose layer thickness of 0.3 m and 6 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	41,000		
5.0	**Upstream toe drain (between abutments) (Provisional)**				
5.1	Supply and install a 4 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the portion of the Bituminous Geomembrane liner that will be covered by the upstream toe drain extensions.	m^2	900		
5.2	Supply and install non-woven Geotextile (Bidim A39 or equivalent) for the upstream toe drain extensions.	m^2	1,600		
5.3	Supply and install perforated DN160 HDPE PN10 SDR17 PE100 pipes to form the upstream toe drain extensions.	m	230		
5.4	Source and supply Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry. Load, haul, place and shape to form upstream toe drain extensions. Assume upstream toe drain is 2.5 m wide by 0.5 m thick.	m^3	300		
5.5	Supply and install an additional 1.5 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the Bituminous Geomembrane liner at the upstream toe of the embankment to provide protection against the overlying erosion protection layer.	m^2	400		
5.6	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form a 0.25 m thick erosion protection layer over the upstream toe drain extensions. Assume loose layer thickness of 0.3 m and 4 single direction passes of a 20 tonne tracked excavator or equivalent, to limit damage to the underlying geotextile and drain.	m^3	300		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
6.0	**Embankment crest works**				
6.1	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the Stage 5 embankment to form a 0.3 m thick wearing course. Additional 1 m thickness to be formed near upstream crest edge over 3 m width to facilitate liner anchor trench. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two layers on vibratory mode and the remainder on static mode.	m^3	16,600		
6.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the Stage 5 embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	4,000		
6.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge to form a safety bund.	m^3	4,000		

6.2 Stage 5 west saddle dam

Table 6.2 Schedule of Quantities for Stage 5 west saddle dam

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.1	Clear debris from the footprint area of the saddle dam and stockpile within 1 km at location(s) designated by the Principal. Assume negligible vegetation within the footprint, i.e., no requirement for clearing and grubbing.	m^2	6,800		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the footprint area of the west saddle dam. Assume average topsoil thickness is about 0.5 m within footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	3,400		
1.3	Scarify *in situ* clay from the footprint area of the west saddle dam to a depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode. (Provisional, subject to shear key)	m^2	6,800		
1.4	Excavate clay from the saddle dam footprint (outside of tailings footprint) to form a trench for the shear key. Provisional item, assuming 5 m^2 cross-sectional area for shear key, to allow for foundation drainage.	m^3	1,600		
1.5	Construct the shear key drain along the toe of the upstream face of the saddle dam including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	310		
1.6	Supply and install DN315 HDPE PN8 SDR11 pipes (2 x 6 m joined lengths each) to form a seepage extraction pipe for the shear key drain.	No.	1		
1.7	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to backfill the trench.	m^3	1,600		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.8	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form the saddle dam embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	13,600		
1.9	Supply and install non-woven Geotextile layer (Bidim A39 or equivalent) on the upstream face of the saddle dam.	m^2	3,000		
1.10	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact in two equal thickness to form a 0.5 m thick layer over the non-woven geotextile layer on the upstream face of the saddle dam. Assume 8 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode for each layer.	m^3	1,200		
1.11	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the saddle dam embankment to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two layers on vibratory mode and the remainder on static mode.	m^3	730		
1.12	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the saddle dam embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	400		
1.13	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge to form a safety bund.	m^3	400		

6.3 Stage 5 south saddle dam

Table 6.3 Schedule of Quantities for Stage 5 south saddle dam

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.1	Clear debris from the footprint area of the saddle dam and stockpile within 1 km at location(s) designated by the Principal. Assume negligible vegetation within the footprint, i.e., no requirement for clearing and grubbing.	m^2	35,000		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the footprint area of the saddle dam. Assume average topsoil thickness is about 0.5 m within footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	18,000		
1.3	Scarify *in situ* clay from the footprint area of the south saddle dam to a depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode. (Provisional, subject to shear key).	m^2	35,000		
1.4	Excavate clay from the saddle dam footprint (outside of tailings footprint) to form a trench for the shear key. Provisional item, assuming 5 m^2 cross-sectional area for shear key, to allow for foundation drainage.	m^3	4,600		
1.5	Construct the shear key drain along the toe of the upstream face of the saddle dam including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	905		
1.6	Supply and install DN315 HDPE PN8 SDR11 pipes (2 x 6 m joined lengths each) to form a seepage extraction pipe for the shear key drain.	No.	1		
1.7	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to backfill the trench.	m^3	4,600		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.8	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form the saddle dam embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	133,000		
1.9	Supply and install non-woven Geotextile layer (Bidim A39 or equivalent) on the upstream face of the saddle dam.	m^2	16,100		
1.9	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact in two equal thickness to form a 0.5 m thick layer over the non-woven geotextile layer on the upstream face of the saddle dam. Assume 8 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode for each layer.	m^3	7,200		
1.10	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the saddle dam embankment to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two layers on vibratory mode and the remainder on static mode.	m^3	2,200		
1.11	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the saddle dam embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	1,200		
1.12	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge to form a safety bund.	m^3	1,200		

6.4 Stage 5 emergency spillway

The concept design for the Stage 5 emergency spillway is as per Stage 3. Refer quantities presented in Table 4.2.

6.5 Stage 5 Decant Causeway raise

The following schedule is based on the end of Stage 4 tailings beach model for the flat beach slope scenario. The Stage 5 causeway raise height varies between about 3 m and 5 m.

Table 6.4 Schedule of Quantities for Stage 5 Decant causeway raise

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, grubbing, stripping and miscellaneous**				
1.1	Clear debris from the causeway footprint area over natural ground and stockpile within 1 km at location(s) designated by the Principal.	m^2	500		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the causeway footprint area and stockpile within 1 km at location(s) designated by the Principal.	m^3	200		
1.3	Scarify natural ground (clay) within the causeway raise footprint to a nominal depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	500		
1.4	Scarify tailings within the causeway raise footprint (f practical) to a nominal depth of 0.3 m, moisture condition (if required) and compact within the causeway raise footprint. Assume 4 single direction passes of a 20 tonne pad foot roller on static mode.	m^2	21,000		
1.5	Supply and install geosynthetic reinforcement (Combigrid 60/60 or equivalent) over the tailings surface within the footprint of the causeway raise. (provisional)	m^2	21,000		
1.6	Remove Stage 4 safety bunds from causeway crest and temporarily stockpile for reuse (as practical) on the Stage 5 causeway crest.	m^3	1,100		
2.0	**Decant Causeway pioneer layer and outfall pipe extension**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry. Load, haul, place, and spread to form a 1 m thick pioneer layer over the tailings surface within the causeway raise footprint.	m^3	21,000		
2.2	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to construct a strip pad for subsequent trench excavation and pipe installation. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	2,300		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
2.3	Excavate trench into strip pad for decant outfall pipe extension and temporarily stockpile spoil adjacent to strip pad for reinstatement in the causeway raise. Item inclusive of exposing southern end of Stage 4 decant outfall pipe.	m^3	800		
2.4	Supply and install DN560 PN16 SDR 11 HDPE pipe to extend the decant outfall pipe to the south. Item inclusive of welding of the new HDPE pipe to the Stage 4 outfall pipe.	m	110		
2.5	Supply, place and nominally compact Clean Sand in the base of the trench and around the DN560 HDPE pipe.	m^3	500		
2.6	Excavate rockfill from trench spoil stockpile, haul, place, moisture condition and compact in a single layer to cover the top of the sand encasement.	m^3	300		
3.0	**Decant tower installation**				
3.1	Supply and install DN450 HDPE riser pipe control rings (collars) for Decant Towers 1 to 6. Items inclusive of lifting handles and ballast.	No.	70		
3.2	Supply and install 1.8 m diameter by 1.2 m high precast slotted decant tower units to raise Decant Towers 1 to 6.	No.	20		
4.0	**Decant Causeway raise**				
4.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to raise the causeway. Item inclusive of causeway extension to the south over natural ground. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	73,000		
4.2	Supply and install geosynthetic reinforcement (TenCate Miragrid GX130/30 or equivalent) at a height of 1 m above the Stage 4 causeway, to the width of the causeway.	m^2	30,000		
4.3	Excavate Moderately to Slightly Weathered rock from quarry, crush, and screen to produce stockpile(s) of Filter Rock (50 mm to 150 mm particle size). Load from stockpile, haul, place and shape around the raises to Decant Towers 1 to 6.	m^3	11,400		
4.4	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpile(s) of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the causeway crest to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode.	m^3	2,700		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
4.5	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the crest edges of the causeway to form safety bunds.	m^3	1,200		

7. Stage 6 upstream raise

7.1 Stage 6 embankment

Table 7.1 Schedule of Quantities for Stage 6 downstream raise option

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, stripping, foundation preparation, and miscellaneous**				
1.1	**Upstream crest of Stage 5 embankment**				
1.1.1	Excavate (remove) safety bund from the upstream crest edge of the Stage 5 embankment. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	4,000		
1.2	**Abutments**				
1.2.1	Clear debris from the footprint area between the Stage 5 and Stage 6 abutments and stockpile within 1 km at location(s) designated by the Principal. Assume negligible vegetation within the footprint, i.e., no requirement for clearing and grubbing.	m^2	7,700		
1.2.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the footprint area between the Stage 5 and Stage 6 abutments. Assume average thickness of topsoil is about 0.5 m within footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	3,900		
1.2.3	Scarify *in situ* clay (between the Stage 5 and Stage 6 abutments) to a depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	7,700		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.3	**Foundation, shear key and toe berm preparation**				
1.3.1	Excavate tailings from the Stage 5 tailings surface to form a trench for the shear key adjacent to the upstream crest edge of the Stage 5 embankment. Allow for 0.5 m thickness of tailings to be retained over the Stage 5 Bituminous Geomembrane liner to avoid damage to the Geomembrane.	m^3	11,100		
1.3.2	Supply and install a layer of non-woven Geotextile (Bidim A39 or equivalent) at the base of the shear key trench to form a I layer between the shear key backfill and the tailings surface.	m^2	17,100		
1.3.3	Excavate clay from the Stage 6 embankment footprint (outside of tailings footprint) to form a trench for the shear key. Provisional item, assuming 5 m^2 cross-sectional area for shear key, to allow for foundation drainage.	m^3	900		
1.3.4	Construct the shear key drain over the extent of the shear key in the tailings, including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	3,400		
1.3.5	Construct the shear key drain in trenches approaching the abutments, including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	180		
1.3.6	Supply and install DN315 HDPE PN8 SDR11 pipes (2 × 6 m joined lengths each) to form seepage extraction pipes at 100 m centres for the shear key drain. (Extraction pipes are not proposed for the drains near the abutments).	No.	34		
1.3.7	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to backfill the trench (Items 1.3.1 and 1.3.3).	m^3	12,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.3.8	Excavate Moderately to Slightly Weathered rock from quarry. Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to form a 0.5 m thick platform (pioneer layer) for embankment and toe berm construction. Platform may be formed by pushing rockfill into the tailings or excavating tailings and replacing with rockfill.	m^3	67,000		
2.0	**Embankment raise**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form the Stage 6 embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	226,000		
2.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in two equal thickness layers to form a 0.5 m thick bedding layer for the Bituminous Geomembrane liner on the upstream slope of the embankment. Assume loose layer thickness of 0.3 m and 8 single direction passes of a 20 tonne smooth drum roller with the first two passes on vibratory mode and the remainder on static mode for compaction of each layer.	m^3	25,000		
2.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape to form a 1 m thick layer on the downstream slope of the embankment.	m^3	38,000		
3.0	**Liner installation**				
3.1	Supply and install Bituminous Geomembrane liner (Coletanche ES4 or equivalent) on the upstream slope of the embankment. Inclusive of crest and toe anchor trenches, with cement stabilised sand backfill.	m^2	62,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
3.2	Supply and install ballast tubes over the Bituminous Geomembrane liner. Inclusive of anchoring at the crest of the embankment. Ballast tubes to be placed at 5 m spacing and to 60% of the Stage 6 slope length with a weight of 100 kilogram per meter length. Tubes to be formed by 1 mm thick textured (on outside) and smooth (on inside) LLDPE geomembrane and filled with sand.	m^2	49,000		
4.0	**Upstream toe berm (over tailings)**				
4.1	Excavate tailings from nominated borrow pit within the TSF impoundment, load, haul, place, moisture condition and compact in layers to form the upstream toe berm. Assume loose layer thickness of 0.3 m and 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^3	47,000		
4.2	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form a 0.5 m thick scour protection layer over the upstream toe berm. Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact in two layers to form a 0.5 m thick scour protection layer over the upstream toe berm. Assume loose layer thickness of 0.3 m and 6 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	24,000		
5.0	**Upstream toe drain (between abutments) (Provisional)**				
5.1	Supply and install a 4 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the portion of the Bituminous Geomembrane liner that will be covered by the upstream toe drain extensions.	m^2	2,400		
5.2	Supply and install non-woven Geotextile (Bidim A39 or equivalent) for the upstream toe drain extensions.	m^2	4,200		
5.3	Supply and install perforated DN160 HDPE PN10 SDR17 PE100 pipes to form the upstream toe drain extensions.	m	600		
5.4	Source and supply Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry. Load, haul, place and shape to form upstream toe drain extensions. Assume upstream toe drain is 2.5 m wide by 0.5 m thick.	m^3	750		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
5.5	Supply and install an additional 1.5 m wide strip of non-woven Geotextile (Bidim A39 or equivalent) over the Bituminous Geomembrane liner at the upstream toe of the embankment to provide protection against the overlying erosion protection layer.	m^2	900		
5.6	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form a 0.25 m thick erosion protection layer over the upstream toe drain extensions. Assume loose layer thickness of 0.3 m and 4 single direction passes of a 20 tonne tracked excavator or equivalent, to limit damage to the underlying geotextile and drain.	m^3	680		
6.0	**Embankment crest works**				
6.1	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the Stage 5 embankment to form a 0.3 m thick wearing course. Additional 1 m thickness to be formed near upstream crest edge over 3 m width to facilitate liner anchor trench. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two layers on vibratory mode and the remainder on static mode.	m^3	19,500		
6.2	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the Stage 5 embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	4,700		
6.3	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge to form a safety bund.	m^3	4,700		

7.2 Stage 6 south saddle dam

Table 7.2 Schedule of Quantities for Stage 6 south saddle dam

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	Excavate (remove) safety bund from the upstream crest edge of the Stage 5 south saddle dam embankment. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	2,400		
1.1	Clear debris from the footprint area of the saddle dam and stockpile within 1 km at location(s) designated by the Principal. Assumes negligible vegetation within the footprint, i.e., no requirement for clearing and grubbing.	m^2	3,100		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the footprint area of the saddle dam. Assume average topsoil thickness is about 0.5 m within footprint area. Assume material is to be stockpiled within 1 km, at locations designated by the Principal.	m^3	1,600		
1.3	Scarify *in situ* clay from the footprint area of the saddle dam to a depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode. (Provisional, subject to shear key).	m^2	3,100		
1.4	Excavate clay from the saddle dam footprint (outside of tailings footprint) to form a trench for the shear key. Provisional item, assuming 5 m^2 cross-sectional area for shear key, to allow for foundation drainage.	m^3	4,700		
1.5	Construct the shear key drain along the toe of the upstream face of the saddle dam including supply and installation of non-woven Geotextile (Bidim A39 or equivalent), perforated DN160 HDPE PN10 SDR17 PE100 pipes and Drainage Aggregate (10 mm to 20 mm particle size) from a commercial quarry.	m	940		
1.6	Supply and install DN315 HDPE PN8 SDR11 pipes (2 x 6 m joined lengths each) to form a seepage extraction pipe for the shear key drain.	No.	1		
1.7	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, moisture condition and spread by a dozer (or equivalent tracked equipment) to backfill the trench.	m^3	4,700		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.8	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form the saddle dam embankment. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	18,000		
1.9	Supply and install non-woven Geotextile layer (Bidim A39 or equivalent) on the upstream face of the saddle dam.	m^2	3,400		
1.10	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact in two equal thickness to form a 0.5 m thick layer over the non-woven geotextile layer on the upstream face of the saddle dam. Assume 8 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode for each layer.	m^3	1,700		
1.11	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the crest of the south saddle dam embankment to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two layers on vibratory mode and the remainder on static mode.	m^3	2,300		
1.12	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and shape at the at the upstream crest edge of the saddle dam embankment to form a safety bund over the tailings delivery pipeline. (Note, placement of Coarse Rockfill is not practical over the pipe.)	m^3	1,300		
1.13	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the downstream crest edge to form a safety bund.	m^3	1,300		

7.3 Stage 6 emergency spillway

The concept design for the Stage 6 emergency spillway is as per Stage 3. Refer quantities presented in Table 4.2.

7.4 Stage 6 Decant Causeway raise

The following schedule is based on the end of Stage 5 tailings beach model for the flat beach slope scenario. The Stage 6 causeway raise height varies between about 3 m and 5 m. Sub-staging will be considered for detailed design.

Table 7.3 Schedule of Quantities for Stage 6 Decant causeway raise

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
1.0	**Clearing, grubbing, stripping and miscellaneous**				
1.1	Clear debris from the causeway footprint area over natural ground and stockpile within 1 km at location(s) designated by the Principal.	m^2	500		
1.2	Excavate (strip) topsoil and loose sand, gravel, and cobbles from the causeway footprint area and stockpile within 1 km at location(s) designated by the Principal.	m^3	200		
1.4	Scarify natural ground (clay) within the causeway raise footprint to a nominal depth of 0.3 m, moisture condition and compact. Assume 6 single direction passes of a 20 tonne pad foot roller on vibratory mode.	m^2	500		
1.4	Scarify tailings within the causeway raise footprint (if practical) to a nominal depth of 0.3 m, moisture condition (if required) and compact within the causeway raise footprint. Assume 4 single direction passes of a 20 tonne pad foot roller on static mode.	m^2	13,500		
1.5	Supply and install geosynthetic reinforcement (Combigrid 60/60 or equivalent) over the tailings surface within the footprint of the causeway raise. (provisional)	m^2	13,500		
1.6	Remove Stage 5 safety bunds from causeway crest and temporarily stockpile for reuse (as practical) on the Stage 6 causeway crest.	m^3	1,100		
2.0	**Decant Causeway pioneer layer and outfall pipe extension**				
2.1	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and spread to form a 1 m thick pioneer layer over the tailings surface within the causeway raise footprint.	m^3	13,500		
2.2	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to form a strip pad for subsequent trench excavation and pipe installation. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	300		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
2.3	Excavate trench into strip pad for decant outfall pipe extension and temporarily stockpile spoil adjacent to strip pad for reinstatement in the causeway raise. Item inclusive of exposing southern end of Stage 5 decant outfall pipe.	m^3	100		
2.4	Supply and install DN560 PN16 SDR 11 HDPE pipe to extend the decant outfall pipe to the south. Item inclusive of welding of the new HDPE pipe to the Stage 5 outfall pipe.	m	10		
2.5	Supply, place and nominally compact Clean Sand in the base of the trench and around the DN560 HDPE pipe.	m^3	100		
2.5	Excavate rockfill from trench spoil stockpile, haul, place, moisture condition and compact in a single layer to cover the top of the sand encasement.	m^3	100		
3.0	**Decant tower installation**				
3.1	Supply and install DN450 HDPE riser pipe control rings (collars) for Decant Towers 1 to 6. Items inclusive of lifting handles and ballast.	No.	70		
3.1	Supply and install 1.8 m diameter by 1.2 m high precast slotted decant tower units to raise Decant Towers 1 to 6.	No.	20		
4.0	**Decant Causeway raise**				
4.1	Excavate Moderately to Slightly Weathered rock from quarry, load, haul, place, moisture condition and compact to raise the causeway. Item inclusive of causeway extension to the south. Assume loose layer thickness of 0.4 m and 8 single direction passes of a 20 tonne smooth drum roller on vibratory mode.	m^3	51,000		
4.2	Supply and install geosynthetic reinforcement (TenCate Miragrid GX130/30 or equivalent) at a height of 1 m above the Stage 5 causeway, to the width of the causeway.	m^2	33,000		
4.3	Excavate Moderately to Slightly Weathered rock from quarry, crush, and screen to produce stockpile(s) of Filter Rock (50 mm to 150 mm particle size). Load from stockpile, haul, place and compact around the raises to Decant Towers 1 to 6.	m^3	9,600		
4.4	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpile(s) of Screened Rockfill (well graded with maximum particle size of 50 mm). Load, haul, place, moisture condition and compact in layers at the causeway crest to form a 0.3 m thick wearing course. Assume maximum loose layer thickness of 0.2 m and 6 single direction passes of a 20 tonne smooth drum roller, with the first two passes on vibratory mode and the remainder on static mode.	m^3	3,000		

Item	Description	Unit	Quantity	Rate ($)	Amount ($)
4.5	Excavate Moderately to Slightly Weathered rock from quarry, and screen to produce stockpiles of Coarse Rockfill (50 mm to 300 mm particle size). Load, haul, place, and shape at the crest edges of the causeway to form safety bunds.	m^3	1,200		

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Appendix L

Limitation Statement

Limitation Statement

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Appendix B2.
Tailings geochemical update

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Expansion Project Tailings Geochemical Update 2024

Carrapateena

J000863 / R1681

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Expansion Project Tailings Geochemical Update 2024

CARRAPATEENA

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LIST OF ABBREVIATIONS

ABBREVIATIONS USED IN GEOCHEMICAL ASSESSMENT

ARD	Acid Rock Drainage
AMD	Acid, Metalliferous and Saline Drainage
NMD	Neutral and Metalliferous Drainage
ABA	Acid Base Account
$pH_{1:2}$	pH of a sample slurry with a solid to water ratio of 1:2 (by weight)
$EC_{1:2}$	Electrical Conductivity of a sample slurry with a solid to water ratio of 1:2 (by weight)
ESP	Exchangeable Sodium Percentage
ECEC	Effective Cation Exchange Capacity
S	Sulphur
CRS	Chromium Reducible Sulphur
KCl	Potassium Chloride
H_2SO_4	Sulphuric Acid
SO_4	Sulphate
$CaCO_3$	Calcium Carbonate
ANC	Acid Neutralising Capacity in kg H_2SO_4/t
ANC_{ABCC}	Acid Neutralising Capacity in kg H_2SO_4/t estimated from ABCC testing
CNV	Carbonate Neutralising Value in kg H_2SO_4/t
MPA	Maximum Potential Acidity, calculated from total S in kg H_2SO_4/t
NAPP	Net Acid Producing Potential, calculated from ANC and total S (or MPA) in kg H_2SO_4/t.
NAG	Net Acid Generation (test)
NAGpH	pH of NAG solution before titration
$NAG_{(pH4.5)}$	NAG acidity titrated to pH 4.5 in kg H_2SO_4/t
$NAG_{(pH7.0)}$	NAG acidity titrated to pH 7.0 in kg H_2SO_4/t
ABCC	Acid Buffering Characteristic Curve
GAI	Geochemical Abundance Index based on multi-elements of solids
PAF	Potentially Acid Forming
PAF-LC	Potentially Acid Forming - Low Capacity
NAF	Non-Acid Forming
UC	Uncertain
AC	Acid Consuming

UNITS OF MEASUREMENTS

%	Percentage
°C	Degrees Celsius
dS	Deci Siemen
µm	Micrometre
mm	Millimetre
m	Metre
mg	Milligram
g	Gram
kg	Kilogram
t	Tonne
L	Litre
ml	Millilitre

OTHER ABBREVIATIONS

ALS	Australian Laboratory Services
BC	Block Cave
Bn	Bornite
BV	Bureau Veritas
Cpy	Chalcopyrite
EGi	Environmental Geochemistry International Pty Ltd
Project	Carrapateena
LOM	Life of Mine
ROM	Run-of-Mine
SLC	Sub-level Caving

EXECUTIVE SUMMARY

As a part of the Carrapateena Expansion project, BHP Carrapateena engaged Environmental Geochemistry International (EGi) to undertake a review of geochemical assessments of process plant tailings that have been undertaken to date. This review is designed to update and collate the current understanding of potential acid rock drainage (ARD), neutral mine drainage (NMD) or saline drainage (SD) risks associated with storage of tailings in the tailings storage facility (TSF).

A number of geochemical studies have been conducted on flotation tailings generated from processing of Carrapateena ores. These have ranged from static and kinetic testing of tailings produced from metallurgical test work conducted on ore types representing ores which have been extracted during sub-level caving (SLC) operations, plant and metallurgical test tailings from processing of chalcopyrite (Cpy), bornite (Bn) and future block cave (FBC) ores, to recent plant tailings.

The key findings from these studies can be summarised as follows:

- Tailings generated from laboratory and plant flotation of Cpy and Bn ores are representative of tailings produced during processing of ores extracted during SLC mining and have low sulphide content and moderate ANC principally derived from dolomite. These tailings are classified as NAF, generally with a high ANC/MPA ratio indicating a low risk of ARD generation.
- Tailings generated from laboratory flotation of FBC ore have, as expected, higher sulphide (pyrite) content than SLC tailings and may therefore be representative of tailings produced during processing of ores extracted during BC mining. However, this requires further testing for confirmation. The balance between the acid forming and acid neutralising capacities of the FBC tailings studied to date were evenly balanced and consequently the sample was classified as Uncertain (NAF).
- Leach column testing of all tailings samples tested to date, including both SLC and BC tailings, have provided leachates with neutral pH and excess alkalinity, suggesting the risk of ARD generation from oxidation of tailings on exposure to air is low.
- Leaching of SLC and FBC tailings with hypersaline process water under kinetic leach column conditions resulted in significantly elevated concentrations of a number of metals (Ag, Co, Cu, Mn, Ni, Tl, U, Zn) in leachates, with solution speciation modelling suggesting increased metal solubility at neutral pH is likely due to the high chloride concentration in process water.
- Leaching of SLC and FBC tailings with DI water under kinetic leach column conditions resulted in leachates for all tailings samples containing metals at concentrations near or below the detection limit, with the exception of Mn, possibly reflecting Mn-carbonate dissolution. Uranium was present at elevated concentrations in both process and DI water leachates.
- ABA analysis of plant tailings sampled over 15 months during 2022 and 2023 demonstrated that tailings produced during flotation of SLC ore are NAF with a substantial excess of ANC, and consequently low risk of ARD generation.

Together the results of these studies indicate that tailings generated during processing of SLC ore using hypersaline groundwater for flotation will produce neutral pH seepage with elevated concentrations of a number of metals if exposed to air on dried beaches. Should saline process water be replaced with fresh water, or post closure when the only water input of the TSF is rainwater/runoff, then the concentrations of metals in tailings pore water is expected to decrease substantially. When ore from BC mining becomes the dominant feed to the flotation plant, it is expected that tailings geochemical properties will remain similar to tailings produced during SLC mining, but with the increased possibility of lower pH seepage and possible increased metal concentrations. However, further testing is required to refute or verify the increased risk of ARD.

The following recommendations are made to support the results of tailings geochemical characterisation studies undertaken to date:

- Routine ABA testing of plant tailings should be continued, and the results evaluated on a regular basis. Should the ARD properties of plant tailings change significantly, sampling frequency should be increased, and samples should be kept for more detailed geochemical testing.
- Monitoring of groundwater bores downgradient of the TSF should be continued to establish if seepage from the TSF is affecting groundwater quality.
- Further flotation tailings samples should be generated from BC ore samples obtained from drill core and subjected to geochemical testing to confirm if a range of BC ores will produce NAF tailings, as was the case for the single BC tailings sample tested to date.
- Sampling of longer-term exposed TSF beach (if existing) should be undertaken and pore water and solids examined to supplement findings from leach column testing of SLC tailings using hypersaline process water.

1. INTRODUCTION

BHP's Carrapateena mine currently uses sub-level caving (SLC) to extract copper-gold ore. Copper mineralisation is principally associated with bornite (Bn) and chalcopyrite (Cpy) which is upgraded using a bulk flotation process involving flotation at natural (circum-neutral) pH. Flotation tailings are dewatered using a high-rate thickener, with the underflow deposited in a valley fill tailings storage facility (TSF). The Carrapateena Expansion will build upon the existing SLC mining operation to access additional mineralisation within the deposit through Block Cave (BC) development to increase production up to 12 million tonnes per annum (Mtpa). Resource definition drilling suggests that during this time the nature of the ore will evolve, with a decrease in copper-sulphur ratio (Cu:S) corresponding to decreasing bornite and chalcopyrite and increasing pyrite in the plant feed. When "Future block cave" (FBC) ore is processed, the current bulk flotation process may be modified to include liming to facilitate pyrite depression. Under these conditions sulphur deportment to the tailings may increase, potentially changing the acid rock drainage (ARD) potential of the tailings in the TSF.

As a part of the Carrapateena Expansion project, BHP Carrapateena engaged Environmental Geochemistry International (EGi) to undertake a review of geochemical assessments of process plant tailings that have been undertaken to date. This review is designed to update and collate the current understanding of potential acid rock drainage (ARD), neutral mine drainage (NMD) or saline drainage (SD) risks associated with storage of tailings in the TSF.

2. TAILINGS GEOCHEMICAL STUDIES

A number of geochemical studies have been conducted on flotation tailings generated from processing of Carrapateena ores. These have ranged from static (EGi, 2008) and kinetic (EGi, 2018) testing of tailings produced from metallurgical test work conducted on ore types representing ores which have been extracted during SLC operations, recent plant tailings (EGi, 2022 , EGi, 2024a), to plant and metallurgical test tailings from processing of chalcopyrite (Cpy), bornite (Bn) and future block cave (FBC) ores (EGi, 2024b). A list of these studies is provided in Table 1.

Flotation plant tailings collected between 2022 and 2023 generated from ore extracted using SLC all plot in the non-acid forming (NAF) region of an acid-base accounting (ABA) plot (Figure 1), with the majority providing ANC/MPA ratios (acid neutralising capacity to maximum potential acidity ratio) above 2, indicating a high likelihood of excess neutralising capacity. Also shown in the ABA plot are the ABA characteristics of the samples used for each of the tailings geochemical studies (Figure 1). The plot shows that materials used for initial static and kinetic testing of flotation tailings from processing of SLC ore, appear to be representative of the geochemical properties of recent plant tailings. Results from the more recent geochemical test program (EGi, 2024b) indicate that the Cpy and Bn tailings represent lower and upper sulphur content of the recent plant tailings, respectively, with both classifying as NAF. As expected, the FBC tailings contained considerably more sulphur than tailings produced from processing of SLC ore. ABA results suggest that geochemical testing undertaken to date has been conducted using tailings that are representative of tailings produced by the flotation plant at Carrapateena while processing ore extracted during SLC and are likely to be representative of tailings produced from processing of future BC ore.

A high level summary of each of the geochemical assessment studies listed in Table 1 is provided in Table 2.

Table 1: Process tailings geochemical testing reports for the Carrapateena project

Report Title	Authors/Date
Preliminary ARD Assessment of the Carrapateena Project	EGi, September 2008
Geochemical Characteristics of Flotation Tailings and Process Residues	EGi, November 2018
ABA Analysis of Tailings Composites	EGi, October 2022
ARD Analysis of Carrapateena Tailings 2022/2023	EGi, March 2024
Geochemical Testing of Flotation Tailings	EGi, June 2024

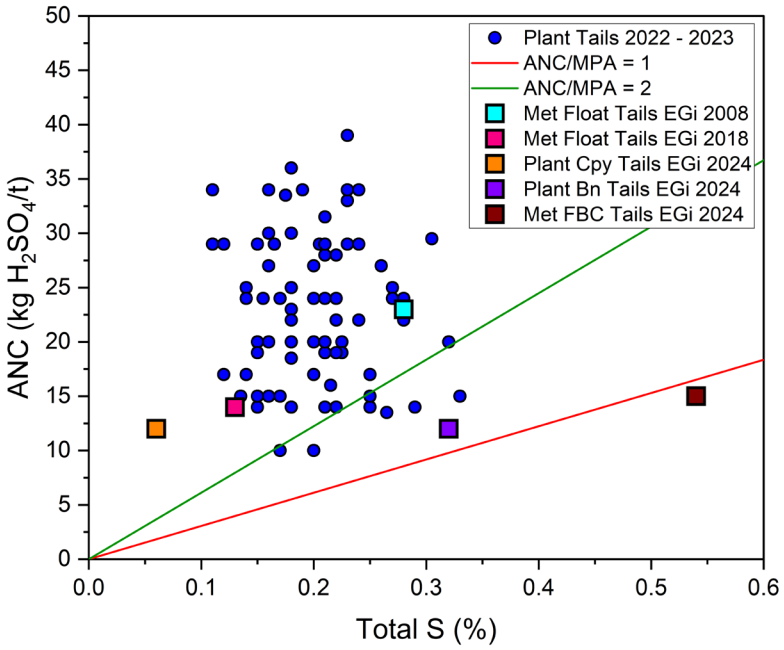

Figure 1: ABA plot for plant tailings samples produced between 2002 and 2023 and ABA characteristics of samples used for the studies shown in Table 1.

Table 2: Summary of process tailings geochemical studies for the Carrapateena project

Study	Test Program	Results	Recommendations/Implications
Preliminary ARD Assessment of the Carrapateena Project: EGi, September 2008	Program focused principally on waste rock and ore, but included one laboratory generated tailings sample, representing a combined rougher/cleaner flotation tailings from a blend of relatively high grade bornite and chalcopyrite mineralisation. Testing included: • standard static ARD testing including ABA and NAG • ABCC • batch water extraction.	• Tailings were classified as NAF • Total S, ANC and NAGpH were typical of subsequent plant tailings • DI Water extraction provided neutral pH low salinity leachates with very low metal concentrations	• Carry out testing of representative tailings samples when processing options and methods are at a more advanced stage
Geochemical Characteristics of Flotation Tailings and Process Residues: EGi, November 2018	Examined the geochemical properties of residues from various processing options which were being examined, including bulk flotation. Testing conducted on laboratory flotation tailings included: • standard static ARD testing including ABA and NAG • sulphur and carbon speciation • multi-element assay • kinetic column leach testing	• Tailings were classified as NAF • Total S, ANC and NAGpH were typical of subsequent plant tailings • Leach column testing (DI water) provided neutral pH leachates across 40 weeks with moderate salinity and slightly elevated concentrations of Co, Cu, Mn, Mo, U.	• The sulphide contents of flotation tailings will be low, and corresponding acid potentials negligible. • Based on the test sample, acid potential will not be a consideration for how flotation tailings residues are managed. • Results are probably more relevant to closure, when there is no longer tailings discharge, and the final beached tailings across the TSF are left to dry out and periodically flushed by incident rain, or if fresh water is used in the future for processing.
Geochemical Testing of Flotation Tailings: EGi, June 2024	Examined the geochemical properties of flotation tailings, including plant tailings from processing of Cpy and Bn ores and lab flotation of FBC ore. Testing included:	• Cpy and Bn tailings were classified as NAF, with FBC tailings classified as Uncertain (NAF) • Total S, ANC and NAGpH of Cpy and Bn tailings were typical of plant tailings	• The sulphide contents of flotation tailings from SLC ore will be low, and corresponding acid potentials negligible. • However, during the operational phase, if hypersaline groundwater is

	• standard static ARD testing including ABA and NAG • sulphur and carbon speciation • multi-element assay • ABCC • mineralogy (QXRD) • kinetic column leach testing leached using process and DI water	• FBC tailings contained ANC typical of plant ANC, but with higher Total S and lower NAGpH • Leaching with hypersaline process water provided neutral pH leachates across 24 weeks with elevated concentrations of Ag, Co, Cu, Mn, Ni, Tl, U, Zn • Leaching with DI water provided neutral pH leachates across 24 weeks with slightly elevated concentrations of Mn and U	used for processing, then elevated concentrations of metals may occur in TSF seepage. • Monitoring of groundwater bores downgradient of the TSF should be continued to establish if seepage from the TSF is affecting groundwater quality. • Based on the sample used, tailings generated from processing of FBC ore will provide circum-neutral pH seepage, with elevated metal concentrations similar to SLC tailings. • However, plant tailings should be monitored for their ARD properties to ascertain if the materials tested during the current study are representative of the plant tailings in general. • In the post-operational period, or if lower salinity process water is used, metals concentrations in seepage (if any) can be expected to decrease.
ABA Analysis of Tailings Composites: EGi, October 2022	ABA (Total S and ANC) testing conducted on daily plant tailings composite samples over a four week period between June and July 2022.	• All samples were classified as NAF	• Four daily composite samples should be selected monthly for Total S, ANC and NAG analysis.
ARD Analysis of Carrapateena Tailings 2022/2023: EGi, March 2024	ABA (Total S and ANC) and NAG testing conducted weekly using daily plant tailings composite samples over a 14 month period between early October 2022 and late November 2023.	• All samples were classified as NAF with >90% samples giving an ANC/MPA ratio above 2	• One daily composite sample should be selected monthly for Total S, ANC and NAG analysis.

3. TAILINGS GEOCHEMICAL STUDY DETAILS

3.1. Preliminary ARD Assessment of the Carrapateena Project

A preliminary ARD study of the Carrapateena Project was undertaken in 2008 by Environmental Geochemistry International (EGi, 2008). This study focused principally on waste rock and ore, but included one laboratory generated tailings sample, representing a combined rougher/cleaner flotation tailings from a blend of relatively high grade bornite and chalcopyrite mineralisation. The findings from this study relating to waste rock and ore are summarised in EGi 2024c, with a brief summary of the study relating to tailings provided in Table 3.

Table 3: Summary of geochemical testing of Carrapateena tailings, EGi 2008

Study Design
Conduct a geochemical characterisation of waste rock, ore and tailings, and highlight any potential ARD issues associated with development of the project
Samples and Testing
A laboratory generated tailings sample representing a combined rougher/cleaner flotation tailings from a blend of relatively high grade bornite and chalcopyrite mineralisation representing SLC ore was used for the test program. Testing included: • Standard static ARD testing including ABA, $pH_{1:2}$ and $EC_{1:2}$ and single stage NAG • ABCC • Multi-element assay • Batch water extraction
Key Findings
• The single tailings sample tested had a relatively low sulphur content, moderate ANC and NAGpH of 7.7. The tailings sample was classified as NAF with a high degree of safety. • Most of the total ANC is available for buffering, principally from ferroan dolomite, but at slow reaction rates. • However, it was noted that the majority of the ore samples may be PAF which implies that the resulting tailings might be mainly PAF also (assuming most pyrite reports to the tailings). • Extraction with DI water gave an extract with neutral pH (7.5), low salinity (EC 220 µS/cm) with no elevated metals concentrations.
Implications and Recommendations
• Carry out testing of representative tailings samples when processing options and methods are at a more advanced stage, to define ARD management requirements for tailings handling and storage facility design.

3.2. Geochemical Characteristics of Flotation Tailings and Process Residues

A study examining the geochemical properties of flotation tailings and process residues was undertaken in 2018 by Environmental Geochemistry International (EGi, 2018). The report from this study is reproduced in Appendix A. At the

time, an investigation was underway to assess the feasibility of a Concentrate Treatment Plant (CTP) to upgrade the flotation concentrates to 50 – 60% copper, producing an iron calcium precipitate (ICP). The study examined the geochemical characteristics of flotation tailings, ICP residue, blends of flotation tailings and ICP and flotation tailings slurried with barren CTP liquor. As the CTP was not taken forward, only the results for geochemical assessment of flotation tailings are summarised below in Table 4.

Table 4: Summary of geochemical testing of Carrapateena tailings, EGi 2018

Study Design
The main objectives of the geochemical testing program were to: • Assess the acid forming characteristics of the flotation tailings using static testing procedures, including sulphide content and speciation, and the availability and reactivity of any carbonate mineralisation. • Identify any elements that are potentially of environmental importance within the flotation tailings. • Quantify the leachability of any such elements using laboratory-scale kinetic leach tests.
Samples and Testing
A tailings sample generated from laboratory flotation of ore representing SLC ore was used for the test program. Testing included: • Standard static ARD testing including ABA, $pH_{1:2}$ and $EC_{1:2}$ and single stage NAG • Sulphur and carbon speciation • Multi-element assay • Batch water extraction • Kinetic leach column testing using DI water over a 40 week period
Key Findings
• The flotation tailings solids as provided were slightly alkaline (pH 7.6) and slightly saline (EC 583 µS/cm). • The total sulphur content of the flotation tailings solids was relatively low at 0.17 %S with a sulphide-S content of 0.13 %S. • The tailings had a modest ANC of 14 kg H_2SO_4/t, and the CNV based on inorganic carbon (i.e. carbonate) content was approximately the same at 16 kg H_2SO_4/t. • NAG liquor remained alkaline with a pH of 7.6. • Based on the ABA and NAG test results the flotation tailings sample was classified NAF with an ANC/MPA ratio above 3. • The sample was significantly enriched in Co, Cu, Mo, U. • Kinetic leach column testing provided leachates with neutral pH (median pH 7.1, median alkalinity 47 mg $CaCO_3$/L), moderate salinity (median TSD 770 mg/L) after an initial saline flush (TDS 3125 mg/L) and slightly elevated metals (Co, Cu, Mn, Mo, U) concentrations.
Implications and Recommendations
• The sulphide contents of flotation tailings generated from flotation of SLC ore will be low, and corresponding acid potentials negligible. • Based on the test sample, the acid potential of tailings produced during processing of SLC ore will not be a consideration and there should not be any need for specific ARD related management or prevention measures (e.g. sub-aqueous deposition) to be incorporated into the overall design and operation of the TSF at Carrapateena. • Results are probably more relevant to closure, when there is no longer tailings discharge, and the final beached tailings across the TSF are left to dry out and periodically flushed by incident rain, or if fresh water is used in the future for processing.

3.3. Geochemical Kinetic Testing of Flotation Tailings

A study examining the geochemical properties of tailings generated from flotation of both SLC and FBC ores was reported in 2024 by Environmental Geochemistry International (EGi, 2024b). The report from this study is reproduced in Appendix B. The study used kinetic leach column testing to understand the geochemical properties of beached tailings (exposed to the air and therefore susceptible to oxidation) during both operational and closure phases of the project.

Process water at Carrapateena is sourced from hypersaline groundwater with a salinity of around 90 g/L. Consequently, pore and supernatant water in the TSF currently has a salinity of around 100 g/L which appears to be increasing as evaporation concentrates salt within the TSF. If there is continued use of hypersaline water for processing, salinity may increase to LOM and beyond as the tailings dry out. Under these hypersaline conditions, there is potential for pyrite oxidation and metal leaching to show modified behaviour in comparison with freshwater conditions.

Post closure, when water input to the TSF will include only rainfall and run-off, the tailings will dry out further due to the large negative water balance prevailing at Carrapateena. Under these conditions it can be expected that tailings will become undersaturated with decreased seepage from the base of the tailings, and capillary rise bringing saline pore water to the surface where evaporation will likely leave salt deposits. These salt deposits will potentially contain secondary minerals resulting from sulphide oxidation which, on contact with incident rainfall and run-off, may produce acidic and metalliferous drainage.

To investigate the influence of the conditions described above on the geochemical behaviour of the tailings, leach column testing was conducted using both hypersaline process water and DI water, with examination of the salt deposits found on the surface of the columns at the end of the leaching period to understand the potential for these materials to generate ARD. The results from this study are summarised below in Table 5.

Table 5: Summary of geochemical testing of Carrapateena tailings, EGi 2024b

Study Design
As a part of the Carrapateena Expansion project, which will result in an increase in the tailings deposited in the TSF, an updated study of tailings geochemistry was conducted. The Carrapateena Expansion will build upon the existing SLC mining operation to access additional mineralisation within the deposit through Block Cave (BC) development to increase production up to 12 million tonnes per annum (Mtpa). During this time, the nature of the ore will evolve, with a decrease in copper-sulphur ratio (Cu:S) corresponding to decreasing bornite and chalcopyrite and increasing pyrite in the plant feed. When future block cave (FBC) ore is processed, the current bulk flotation process may be modified to include liming to facilitate pyrite depression. Under these conditions sulphur deportment to the tailings may increase, potentially changing the acid rock drainage (ARD) potential of the tailings in the TSF. The aim of this study was to: • Understand the geochemical properties of tailings that will represent the materials which will be deposited in the TSF to LOM. • Use this understanding of tailings geochemistry to determine any operational issues for the TSF during both the operational and closure phases of the project.
Samples and Testing
Two tailings samples obtained from plant flotation of Cpy and Bn ores (SLC ores) and a third FBC ore from laboratory flotation were used for the test program. Testing included: • Standard static ARD testing including ABA, $pH_{1:2}$ and $EC_{1:2}$ and single stage NAG • Sulphur and carbon speciation

- ABCC
- Kinetic NAG
- Multi-element assay
- PSD analysis
- Mineralogy (QXRD)
- Kinetic leach column testing using process and DI waters over a 24 week period

Key Findings

Static geochemical and mineralogical testing found:

- Increasing pyrite content in the order Cpy<Bn<FBC tailings, with ANC provided principally derived from dolomite (Cpy<Bn<FBC tailings).
- The total sulphur content of the flotation tailings solids was relatively low to moderate, increasing in the order of Cpy (0.012%)<Bn (0.039%)<FBC (0.67%) with the majority present as sulphide-S.
- The tailings have modest ANC of 12 - 15 kg H_2SO_4/t, with the readily available fraction as measured by ABCC essentially the same as the measured ANC.
- The NAGpH of Cpy (7.8) and Bn (7.7) tailings was slightly alkaline, in contrast to the NAGpH (4.6) of the FBC tailings.
- Based on the static geochemical test results the SLC (Cpy and Bn) flotation tailings samples were classified NAF. The FBC sample was classified as Uncertain (NAF).
- The Cpy, Bn and FBC tailings samples were significantly enriched in Ag, Co, Cu, Mo, Se, U, W.

Kinetic leach column testing found:

- Cpy, Bn and FBC tailings leached with process water gave leachates with circum-neutral pH (6 – 7), with moderate alkalinity (20 – 50 mg $CaCO_3$/L).
- Leaching with hypersaline process water provided leachates with elevated concentrations of Ag, Co, Cu, Mn, Ni, Tl, U, Zn, with solution speciation modelling suggesting increased metal solubility at neutral pH is likely due to the high chloride concentration in process water.
- DI water leachates for all tailings samples maintained a pH above neutral (7 -8) with an excess of alkalinity (30 – 50 mg $CaCO_3$/L).
- DI water leachates for all tailings samples contained metals at concentrations near or below the detection limit, with the exception of Mn, possibly reflecting Mn-carbonate dissolution. U was present at elevated concentrations in both process and DI water leachates.
- Analysis of salt crusts formed during leaching with process water demonstrated that these salts comprised principally of halite and gypsum. Significantly, the amount of heavy metal salts is calculated to comprise less than 0.1 wt. % of the salt crust.

Implications and Recommendations

- Tailings produced from processing of ore extracted during the remaining period of sub-level cave mining at Carrapateena will likely be NAF, with an excess of neutralising capacity derived principally from dolomite.
- Tailings produced during processing of ore extracted during the future period of block cave mining at Carrapateena will likely have higher pyrite content than tailings produced from flotation of SLC ore, and the balance between the potential acidity generated from pyrite oxidation and the acid neutralising capacity in the tailings (principally from dolomite) will be more evenly balanced than in the NAF SLC tailings.
- Evidence to date suggests that tailings generated through the LOM are a low risk of producing low pH seepage/pore water as a result of oxidation after exposure to air. Nevertheless, while hypersaline water is used for ore processing, the likelihood of elevated metal concentrations in TSF seepage/pore water is increased.
- Post closure when the only input of water to the TSF is rainfall/runoff, tailings pore water salinity may decrease which will likely result in a decrease in pore water metal concentrations.

- Tailings should be monitored for their ARD properties to ascertain if the materials tested during the current study are representative of the plant tailings in general and that therefore the conclusions drawn from this work will be applicable to the tailings deposited in the TSF.
- Monitoring of groundwater bores downgradient of the TSF should be continued to establish if seepage from the TSF is impacting groundwater quality.

3.4. ABA Analysis of Plant Tailings 2022

To confirm the NAF classification of tailings produced during flotation of SLC ore is more generally applicable to the Carrapateena processing plant tailings, a study was undertaken to evaluate the ABA properties of daily composite final tailings samples collected from the plant (EGi, 2022). The report from this study is reproduced in Appendix C.

Testing was conducted by the Bureau Veritas (BV) laboratory at Wingfield in South Australia. To provide quality control for the test program, a split of the samples tested by BV was sent to EGi's laboratory where duplicate ABA testing was conducted. In addition to ANC testing, ABCC analysis was also conducted by EGi to confirm the standard ANC method provided a satisfactory measure of the readily available neutralising capacity of the tailings. The results from this study are summarised below in Table 6.

Table 6: Summary of geochemical testing of Carrapateena flotation plant tailings, EGi 2022

Study Design
Undertake ABA analysis of representative final tailings samples from the Carrapateena flotation plant to determine if tailings generated from processing of SLC ores are more generally NAF and therefore reasonably represented by the SLC tailings used in previous tailings geochemical studies.
Samples and Testing
Daily plant tailings composite samples were collected over a four week period between mid-June and mid-July 2022. Testing included: • Total S • ANC • ABCC (selected samples)
Key Findings
• All plant tailings samples collected during the test period were NAF, with an average ANC/MPA ratio of 3.6. • Results showed relatively little variation in either Total S or ANC in the tailings samples, indicating consistent acid forming characteristics for the tailings during the study period. • The results from inter-laboratory testing of duplicate samples demonstrated good reproducibility. • ABCC testing demonstrated that the standard ANC method provides a good estimate of readily available neutralising capacity in the tailings.
Implications and Recommendations
• These results demonstrated the very low risk of acid generation if tailings deposited in the TSF were oxidised on exposure to air. It was recommended that four daily composite samples are selected monthly for Total S, ANC and NAG analysis and sent to the BV laboratory for routine testing.

3.5. ABA Analysis of Plant Tailings 2022 - 2023

To confirm the NAF classification of tailings produced during flotation of SLC ore is more generally applicable to the Carrapateena processing plant tailings over the longer-term, the previous study involving evaluation of the ABA properties of daily composite final tailings samples collected from the plant was extended to a period of 14 months. ABA testing of a daily composite tailings sample collected weekly was undertaken (EGi, 2024a). The report from this study is reproduced in Appendix D.

Testing was conducted by the Bureau Veritas (BV) laboratory at Wingfield in South Australia. The results from this study are summarised below in Table 7.

Table 7: Summary of geochemical testing of Carrapateena flotation plant tailings, EGi 2024a

Study Design
Undertake ABA analysis of final tailings samples from the Carrapateena flotation plant to determine if tailings generated from processing of SLC ores are more generally NAF over the longer-term.
Samples and Testing
Daily plant tailings composite samples were collected weekly over a 14 month period between the beginning of October 2022 and the end of November 2024. Testing included: • Total S • ANC • NAG
Key Findings
• All plant tailings samples collected during the test period were NAF, with >90% of samples testing giving an ANC/MPA ratio >2. • All but one sample gave a NAGpH >7 and for this one sample the NAG capacity to pH 7 was only 1 kg H_2SO_4/t. • Results showed relatively little variation in either Total S or ANC in the tailings samples, indicating consistent acid forming characteristics for the tailings during the study period.
Implications and Recommendations
• These results demonstrated the very low risk of acid generation if SLC tailings deposited in the TSF were oxidised on exposure to air. • It was recommended that one daily composite sample is selected monthly for Total S, ANC and NAG analysis and sent to the BV laboratory for routine testing.

4. SUMMARY OF STUDY RESULTS

The key findings from a number of studies conducted to characterise the geochemical properties of bulk flotation tailings generated from flotation of both SLC and BC ore can be summarised as follows:

- Tailings generated from laboratory and plant flotation of Cpy and Bn ores are representative of tailings produced during processing of ores extracted during SLC mining and have low sulphide content and moderate ANC principally derived from dolomite. These tailings are classified as NAF, generally with a high ANC/MPA ratio indicating a low risk of ARD generation.
- Tailings generated from laboratory flotation of FBC ore have, as expected, higher sulphide (pyrite) content than SLC tailings and may therefore be representative of tailings produced during processing of ores extracted during BC mining. However, this requires further testing for confirmation. The balance between the acid forming and acid neutralising capacities of the FBC tailings studied to date were evenly balanced and consequently the sample was classified as Uncertain (NAF).
- Leach column testing of all tailings samples tested to date, including both SLC and BC tailings, have provided leachates with neutral pH and excess alkalinity, suggesting the risk of ARD generation from oxidation of tailings on exposure to air is low.
- Leaching of SLC and FBC tailings with hypersaline process water under kinetic leach column conditions resulted in significantly elevated concentrations of a number of metals (Ag, Co, Cu, Mn, Ni, Tl, U, Zn) in leachates, with solution speciation modelling suggesting increased metal solubility at neutral pH is likely due to the high chloride concentration in process water.
- Leaching of SLC and FBC tailings with DI water under kinetic leach column conditions resulted in leachates for all tailings samples containing metals at concentrations near or below the detection limit, with the exception of Mn, possibly reflecting Mn-carbonate dissolution. Uranium was present at elevated concentrations in both process and DI water leachates.
- ABA analysis of plant tailings sampled over 15 months during 2022 and 2023 demonstrated that tailings produced during flotation of SLC ore are NAF with a substantial excess of ANC, and consequently low risk of ARD generation.

5. REFERENCES

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EGi (2024b). Geochemical Kinetic Testing of Flotation Tailings. Environmental Geochemistry International Document No. S2043 / J000663 / R1499, June 2024.

EGi (2024c). Expansion Project Waste Rock and Ore Geochemical Update 2024. Environmental Geochemistry International Document No. J000863 / R1683, July 2024.

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APPENDIX A
Geochemical Characteristics of Flotation Tailings and Process Residues

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Carrapateena Project

Geochemical Characteristics of Flotation Tailings and Process Residues

November 2018

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1.0 Introduction

Environmental Geochemistry International Pty Ltd (EGi) was commissioned by OZ Minerals to geochemically characterise samples representing flotation tailings and process residues that will be produced during the Carrapateena Project, located in South Australia, approximately 160 km north of Port Augusta.

The Carrapateena Project will involve mining of a copper-gold resource by underground sub-level caving, comminution of ore by a sequence of primary crushing and secondary SAG and ball milling, and ore processing using conventional flotation producing a concentrate containing copper and gold minerals. Copper occurs predominantly as chalcopyrite and bornite, with minor occurrence of chalcocite, digenite and covellite. The project will have a life of 20 years at a production rate of 4.23 Mtpa.

In addition to the flotation circuit, OZ Minerals are assessing the feasibility of a Concentrate Treatment Plant (CTP) to upgrade concentrates to 50-60% copper and remove impurities. The CTP is being developed as a separate project and will have the capacity to treat concentrates from projects other than Carrapateena.

Tailings from the flotation circuit will be thickened to around 60 to 65% solids then discharged to a valley fill tailings storage facility (TSF) by way of sub-aerial spigot discharge points either at the head or sides of the valley or along the upstream crest of the TSF embankment. The main residue from the CTP will be an iron calcium precipitate (ICP).

The geochemical assessment carried out by EGi involved samples of the following material types:

- Flotation tailings solids
- ICP solids
- Blended flotation tailings and ICP solids
- Flotation tailings slurried with CTP barren liquor

The blend of the tailings and ICP solids and the slurry of flotation tailings with CTP barren liquor were included in the test program as OZ Minerals are evaluating options for co-disposal of ICP residues with tailings into the TSF. The tailings/ICP blend comprised 88% flotation tailings and 12 % ICP, consistent with the ratio of the weights of the two waste types that will be produced.

The main objectives of the geochemical testing program were to:

- assess the acid forming characteristics of the flotation tailings and ICP solids using static testing procedures, including sulphide content and speciation, and the availability and reactivity of any carbonate mineralisation;
- identify any elements that are potentially of environmental importance within the flotation tailings and residue solids, and
- quantify the leachability of any such elements using laboratory-scale kinetic leach tests.

The geochemical investigation involved two stages: the first involved geochemical characterisation of the material solids using static testing methods, and the second involving long-term kinetic testing using the column leach method.

2.0 Methodology

2.1 Sample Preparation

The four samples representing flotation tailings and process residues were provided by SGS Minerals Metallurgy (Perth). Approximately 10 kg of solids of each sample were provided. The samples were provided in the following moisture states:

- flotation tailings - dry solids
- ICP solids - slightly moist pulp
- flotation tailings / ICP blend - dry solids
- flotation tailings / CTP barren liquor - slurry

The moist ICP sample was slowly dried in a fan-forced oven at a low temperature (50°C) for 24 hours.

The liquor fraction of the slurry of flotation tailings with barren CTP liquor was initially sub-sampled (~ 1 litre) for analysis then the slurry was thoroughly mixed and allowed to settle overnight. Most of the liquor was then decanted to a separate container and the remaining solids were re-mixed prior to taking a sub-sample (~1 kg) of the solids that was slowly dried in a fan-forced oven. The decanted liquor was returned to the remaining solids pending inclusion in stage 2 kinetic testing.

All dried sub-samples were passed through a 2 mm screen and thoroughly mixed to produce a homogenous powder, then sealed in air-tight plastic bags pending geochemical analysis.

2.2 Geochemical Assessment Program

The geochemical assessment program included analysis or calculation of the following:

- Multi-element analysis of solids
- Multi-element analysis of liquor (flotation tailings/CTP mix only)
- Water-leachable elements (flotation tailings, ICP solids, and tailings/ICP blend)
- Existing pH and electrical conductivity (EC)
- Sulphur content and speciation
- Carbon content and speciation
- Carbonate neutralising value (CNV)
- Acid neutralising capacity (ANC)
- Maximum potential acidity (MPA)
- Net acid producing potential (NAPP)
- Net acid generation (NAG) capacity
- Kinetic column leach testing

The analytical methods used by EGi for geochemical characterisation of the tailings and ICP solids are described below.

2.3 Static Analytical Procedures

The methodologies were based on test procedures commonly adopted for the prediction of ARD potential as documented by:

> ***AMIRA International (2002)***. *ARD Test Handbook. Project P387A Prediction & Kinetic Control of Acid Mine Drainage. Prepared by Ian Wark Research Institute & Environmental Geochemistry International Pty Ltd, May 2002.*
>
> ***INAP (2009)***. *The Global Acid Rock Drainage (GARD) Guide. Produced by the International Network for Acid Prevention http://www.gardguide.com*

Multi-Element Analysis of Solids

Elemental analysis of solids was carried out by ALS (Brisbane), which is a NATA registered laboratory. Samples were digested by multi-acid addition (*i.e.* hydrofluoric, nitric, perchloric and hydrochloric acids) and the digests were analysed using inductively coupled plasma mass spectrometry (ICPMS) for the following suite of elements: Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, S, Sb, Se, Sn, U and Zn. Mercury was also assayed by aqua regia digestion to minimise volatilisation followed by ICPMS analysis.

Water Soluble Elements

The liquor fraction of the flotation tailings/CTP barren liquor sample that was provided as a slurry was analysed directly. For the other three samples that were provided as dry or moist pulps, the water-soluble components were determined by ALS (Sydney) using the Australian Standard Leaching Procedure (ASLP). This method involved extraction of a sub-sample of material with deionised water at a solid:liquid ratio of 1:20 for 24 hours. At completion, the pH, EC and alkalinity of the extract were recorded then the liquor fraction was filtered through 0.45 micron membrane filters and analysed using a combination of ICPMS, and ICP atomic emission spectrometry (ICPAES). The analysis of extracts included Al, As, Ba, Ca, Cd, Cl, Co, Cr, Cu, Fe, Hg, K, Pb, Mg, Mn, Mo, Na, Ni, Sb, Se, Si, Sn, SO_4, U, Zn.

Existing pH and EC

The existing pH and EC of the slurry sample involving tailings and CTP barren liquor were measured directly on the liquor fraction. For all other samples the pH and EC were determined by measurements of a suspension comprising 50 g of sample in 100 mL of deionized water. The suspensions were mixed for a period of at least 1 hour to ensure equilibration prior to pH and EC measurements.

Sulphur and Carbon Speciation

The following sulphur and carbon speciation analyses were carried out by ALS in Brisbane:

- *Total sulphur* - Measured by direct high temperature combustion, oxidation and infra-red detection using Leco induction furnace.
- *Sulphate-sulphur* - Samples were leached with hot HCl to remove acid-soluble sulphates. The amount of sulphate within the leachate was then determined by ICPAES.
- *Sulphide-sulphur* - Calculated as the difference between Total-S and Sulphate-S values.

- C*hromium Reducible Sulphur* - Inorganic sulphur was reduced to H_2S by hot acidic $CrCl_2$ solution and the evolved H_2S gas trapped in zinc acetate solution as ZnS. The concentration of ZnS was subsequently quantified by idiometric titration. This method is designed to be selective for pyritic-sulphur, but may also include some elemental sulphur if present in a sample.
- *Total carbon* - Measured by direct high temperature combustion, oxidation and infra-red detection using Leco induction furnace.
- *Organic-carbon* - Samples were digested with hot HCl to remove any acid soluble carbonates, then rinsed with distilled/deionised water to remove residual chloride. The acid-insoluble carbon remaining in the residue (which is predominantly organic-carbon) was then measured by Leco.
- *Inorganic-carbon* - Calculated as the difference between Total-C and Organic-C values.

Maximum Potential Acidity

The MPA is the amount of acid (expressed as kg H_2SO_4/t) that theoretically can be generated by a sample when all sulphur occurs as reactive pyrite and there is complete oxidation of the pyrite. The initial reaction products of pyrite oxidation are dissolved sulphate, iron and hydrogen ions, but at pHs greater than about 3.5 the solubility of iron (as ferric) is low, and some or all of the iron may precipitate as ferric hydroxide under atmospheric conditions. This process results in further generation of hydrogen ions, although the "acidity" of the reactant solution remains the same, as the precipitation of iron simply represents a transfer of solution "acidity" from dissolved iron to free hydrogen. The overall stoichiometry of pyrite oxidation reaction under atmospheric conditions can be expressed as follows:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \Rightarrow Fe(OH)_{3\ (ppt)} + 4H^+ + 2SO_4^{2-} \quad (1)$$

Based on the stoichiometry for this reaction, four hydrogen ions (or two molecules of H_2SO_4) are produced per molecule of FeS_2 oxidised, which means a material containing 1 %S as pyrite could generate the equivalent of 30.6 kg H_2SO_4 per tonne of material. MPA is commonly calculated using the total sulphur content, however if a significant portion of the sulphur occurs as sulphate the MPA will be over-estimated as sulphate does not contribute to acid forming potential. For the Carrapateena samples more accurate estimates of MPA were obtained by multiplying the sulphide-sulphur contents (as %S) by a factor of 30.6.

Acid Neutralising Capacity

ANC was determined using a modified Sobek Method[1]. This method provides a direct measurement of the amount of acid that can be consumed by carbonate and other gangue minerals within a sample. A fizz test was initially carried out to provide a qualitative indication of the magnitude of neutralisation capacity. This involved the addition of one or two drops of 1:3 HCl (approximately 8% HCl) to approximately 0.5 g of pulverised sample. The degree of "fizzing" was assessed and a fizz rating between 0 and 5 was assigned, where 0 signifies no visible reaction and 5 signifies very strong reaction. The fizz rating was then used to determine the strength and amount of acid required in the Sobek method to produce a suspension with a pH in the range 1 to 2. Acid additions ranged from 4 mL of 0.5 M HCl for a fizz rating of zero up to 60 mL of 1.0 M HCl for a fizz rating of 5. The sample-acid suspensions were allowed to react for approximately 1 to 2 hours, then the flasks were placed on a hot-plate and the suspensions heated to 80 to 90°C for another 1 or

[1] The most widely used method for assessing the inherent acid neutralising capacity (ANC) of a sample is the modified Sobek method (*Sobek, A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith (1978). Field and Laboratory Methods Applicable to Overburdens and Minesoils. U.S. Environmental Protection Agency 600/2-78-054, Washington DC*).

2 hours to complete the reaction. The amount of acid remaining after the reaction stage was determined by back-titration with sodium hydroxide. The amount of acid consumed by the sample (expressed in terms of kg H_2SO_4/t) was subsequently determined by difference.

Carbonate Neutralising Value

The carbonate neutralising value (CNV) is an indirect measure of the neutralisation capacity within a sample based on the inorganic-carbon content of a sample. The calculation assumes the inorganic carbon occurs exclusively as carbonate, and CNV is commonly expressed in terms of the amount of sulphuric acid that theoretically could be neutralised by the carbonate within a sample per unit weight (kg H_2SO_4/t). The calculation of CNV is based on the stoichiometry of the following reaction:

$$CaCO_3 + H_2SO_4 \Rightarrow Ca^{2+} + SO_4^{2-} + H_2O + CO_2\,(g)$$

where the main reaction products are calcium, sulphate, water and carbon dioxide gas. This reaction indicates that one mole of carbon (as carbonate) will neutralise one mole of sulphuric acid. This means for a sample containing 1 %C as carbonate the CNV will be 81.67 kg H_2SO_4/t. A total carbon assay is commonly used to calculate CNV but for materials where some carbon occurs in organic forms the use of total carbon results in over-estimation of CNV. Therefore, in this study inorganic-carbon contents were preferentially used to calculate CNVs by multiplying the inorganic carbon contents (as %C) by a factor of 81.67.

Net Acid Producing Potential

The NAPP is the amount of acid (kg H_2SO_4/t) that potentially could be produced by a sample after allowance for any ANC that the sample has. The measurement of NAPP is often referred to an acid-base account in that it is based on separate determinations of acid potential (MPA) and neutralisation potential (ANC and/or CNV), expressed in units of kg H_2SO_4/t. In this study the NAPP of each sample was calculated by subtracting the ANC from the MPA value.

Net Acid Generation (NAG) Test

The NAG test is a direct oxidation procedure for estimating the acid forming potential of a sample. The NAG test involved reaction of a 2.5 g sub-sample of material with 250 mL of 15% hydrogen peroxide, which acts as an oxidant to any sulphides present. The samples were allowed to react overnight to provide sufficient time for oxidation to occur. The reaction flasks were then gently heated for approximately 1 hour to decompose any residual peroxide. After cooling, the liquor pHs were recorded. As both acid generation and acid neutralisation can occur simultaneously during a NAG test, the end result represents a direct measurement of the net amount of acid that a sample can generate. A sample is considered to be acid forming if the pH after reaction is less than pH 4.5. For such samples, the actual amount of acidity generated (expressed as kg H_2SO_4/t) was also determined by back-titration of the mixture to a pH 7 end-point.

Classification of ARD Potential

ARD classifications were assigned based on the NAPP and NAG test results. The NAG test compliments the measurement of NAPP, and because they are completely independent measurements, the NAPP and NAG combination provides greater certainty to the assessment of ARD potential. The ARD potentials of the tailings and ICP solids were classified using the following criteria, which are internationally regarded as standard practise:

- *Potentially Acid Forming (PAF)* - positive NAPP and NAG pH<4.5

  The exposure of such a material to atmospheric conditions is likely to result in sulphide oxidation, which in turn could result in acidification.

- *Non-Acid Forming (NAF)* - negative NAPP and NAG pH≥4.5

  Although sulphides may be present in such samples, the inherent ANC should be sufficient to neutralise any acid that might have been produced by sulphide oxidation.

- Uncertain *(UC)* - when there is a disparity between the NAPP and NAG results and a definitive classification cannot be assigned.

2.4 Kinetic Column Leach Testing

Kinetic testing of the samples was based on the free draining leach column procedure as documented in Appendix F of the *AMIRA International (2002) ARD Test Handbook*[2]. The column leach method is widely used in Australia and Internationally to quantify the geochemical behaviour of a test material within a laboratory environment that allows controlled exposure to atmospheric conditions, cyclic wetting and drying, and leaching at a specified rate. The method is particularly suited to sulphidic mine waste materials and provides empirical data on rates of sulphide oxidation, lag periods, potential rates of acidification, and leach rates for environmentally important elements. As standard test conditions are applied the results for any given sample can be evaluated against the range of geochemical characteristics commonly observed with mine waste materials under similar conditions.

Figure 1 shows the overall column setup and leachate collection system, and also close-up photographs of the surface of the four columns prior to leaching. Each column comprised 2.0 kg of material housed within a plastic Buchner funnel measuring 174 mm in diameter and 100 mm in height. The funnel configuration provides a free-draining condition and a relatively high exposure area per unit mass of sample, thereby providing conditions amenable to sulphide oxidation.

The columns were housed within a custom built frame (see Figure 1) with overhead heat lamps to enhance the drying of samples between water additions. The lamps operated for approximately 8 hours each day. When operating, the heat lamps maintained a surface temperature of approximately 30 ºC.

The kinetic column leach tests were commissioned on 20 November 2017 and operated for 40 weeks. During the first month the columns were leached on a one-week cycle to accelerate leaching of soluble salts. During this period, deionised water was added as a once weekly addition at a rate 400 mL/kg, with the leachate collected during the following three days. After day 28 the leaching regime reverted to a four-week cycle, which is the normal leach regime for column tests typically run by EGi. With this regime, the samples were subjected to cyclic wetting and drying over a four-week leach cycle. During the first three weeks of each cycle the samples were moistened by a once weekly addition of water at a rate of 100 mL/kg, most of which was retained by the solids or lost via evaporation. On the fourth week of each cycle, the samples were flushed by addition of 400 mL/kg, with the leachates collected for analysis over the following three days. Typically around 400 mL of leachate were collected from a column per cycle.

[2] **AMIRA International (2002).** ARD Test Handbook. Project P387A Prediction & Kinetic Control of Acid Mine Drainage. Prepared by Ian Wark Research Institute & Environmental Geochemistry International Pty Ltd, May 2002.

FIGURE 1: *Photographs of Carrapateena kinetic column leach tests*

The analysis of leachates included measurements of pH, electrical conductivity (EC), and acidity or alkalinity. A subsample of each leachate was also filtered and preserved prior to despatch to Australian Laboratory Services Pty Ltd (ALS) in Sydney for elemental analysis which includes: Al, As, Ba, Ca, Cd, Cl, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, SO_4, U and Zn. Total dissolved salts (TDS) was also calculated as the sum of cations and anions (which included alkalinity as HCO_3^-)

3.0 Acid Forming Characteristics

The acid forming characteristics of the four samples representing flotation tailings and ICP residues are given in **Table 1**, and acid-base account and ARD classification plots are presented in **Figures 2** and **3**, respectively. The main findings in relation to acid forming characteristics of samples as provided by Oz Minerals were as follows:

3.1 Flotation Tailings Solids

- The flotation tailings solids as provided were slightly alkaline (pH 7.6) and slightly saline (EC 583 µS/cm). In the latter case this indicates the presence of some soluble-salts.
- The total sulphur content of the flotation tailings solids was relatively low at 0.17 %S. The low sulphur content suggests that recovery of sulphide (*i.e.* chalcopyrite, bornite and pyrite) during the flotation stage of processing was essentially complete.
- It is difficult to be definitive in relation to sulphur speciation, as the concentrations were close to the limits of detection of the various methods used for sulphur speciation. Approximately 0.04 %S was extractable with HCl acid, which suggests some sulphur occurred as sulphate. A sulphide-S content of 0.13 %S was calculated by difference between total-S and sulphate-S contents, and the chromium reducible sulphur content was also 0.13 %S. A sulphide-S content of 0.13 %S gives an MPA for the flotation tailings solids of 4 kg H_2SO_4/t, which commonly would be regarded as inconsequential for flotation tailings.
- The flotation tailings solids had a modest capacity to inherently neutralise acid. The ANC as measured by the modified Sobek method was 14 kg H_2SO_4/t, and the CNV based on inorganic carbon (i.e. carbonate) content was approximately the same at 16 kg H_2SO_4/t.
- The NAPP of the flotation tailings solids was negative at -10 kg H_2O_4/t, and the flotation tailings did not acidify when oxidised in the NAG test. Only a very slight reaction was observed during the NAG tests, consistent with little, if any sulphide oxidation taking place. At the completion of the test the NAG liquor remained alkaline with a pH of 7.6. As such, the NAG capacity was zero.
- Based on the NAPP and NAG test results the flotation tailings sample was classified NAF. Furthermore, the tailings ANC was more than three-times greater than any acidity that might be generated by minor sulphides within the tailings. This is illustrated in the acid-base account plot (Figure 2) where the tailings plot above the ANC/MPA=3 line. The tailings sample also plots definitively within the upper left quadrate of the ARD classification plot (Figure 3).

3.2 ICP Solids

- The ICP solids when added to water were slightly acidic (pH 5.4).
- They also had a high content of soluble salts (EC 15,260 µS/cm) such that they would be classified as highly saline.

TABLE 1: *Acid forming characteristics of Carrapateena flotation tailings and ICP solids*

Parameter	Unit	Flotation Tailings	ICP Solids	Blend Tailings & ICP Solids	Float Tails & CTP Barren Liquor
Existing pH and EC	-				
- pH	-	7.6	5.4	6.5	3.1
- EC	µS/cm	583	15,260	6,260	160,000
Sulphur Speciation					
- Total-S	(%S)	0.17	11.5	1.29	0.70
- Sulphate-S	(%S)	0.04	12.0	1.34	0.61
- Sulphide-S	(%S)	0.13	<0.01	<0.01	0.09
- Cr Reducible-S	(%S)	0.13	<0.02	0.13	0.11
Carbon Speciation					
- Total-C	(%C)	0.24	0.13	0.21	0.05
- Organic-C	(%C)	0.05	0.06	0.08	0.03
- Inorganic-C	(%C)	0.19	0.07	0.13	0.02
Neutralising Characteristics					
- Fizz Rating (Sobek)	-	0	0	0	0
- ANC (Sobek)	(kg H_2SO_4/t)	14	0	10	1
- CNV	(kg H_2SO_4/t)	16	6	11	2
Acid Generating Characteristics					
- MPA	(kg H_2SO_4/t)	4	<0.3	<0.3	3
- NAPP	(kg H_2SO_4/t)	-10	0	-10	2
- NAG	(kg H_2SO_4/t)	0	0	0	<1
- NAGpH		7.5	5.4	6.9	4.2
ARD Classification		**NAF**	**NAF**	**NAF**	**PAF-lc**

Abbreviations

CNV = Carbonate Neutralising Value
ANC = Acid Neutralising Capacity
MPA = Maximum Potential Acidity
NAPP = Net Acid Producing Potential
NAG = Net Acid Generation capacity
NAGpH = pH of NAG liquor
NAF = Non-Acid Forming
PAF-lc = Potentially Acid Forming but with only a very low capacity for acid generation

Methods

Existing pH and EC measured on 1:2 ssuspension of solids with deionide water, except for Float Tails/CTP Barren Liquor which was measured directly on the slurry liquor fraction

Total sulphur - Measured using a Leco sulphur analyser

Sulphate-sulphur - Sample leached with hot HCl to remove acid-soluble sulphates. The amount of sulphate within the leachate is then determined by ICPAES.

Sulphide-sulphur - Calculated as the difference between Total-S and Sulphate-S values.

Cr Reducible S - Sample reacted with hot acidic CrCl2 to reduce (non-sulphate) inorganic sulphur forms to H_2S which are trapped in zinc acetate solution and determined.

Total carbon - Measured using a Leco carbon analyser

Organic-carbon - Sample digested with hot HCl to remove any carbonates, then rinsed with distilled water. The residual carbon in the residue (i.e. acid-insoluble carbon) then measured by Leco.

Inorganic-carbon - Calculated as the difference between Total-C and Organic-C values.

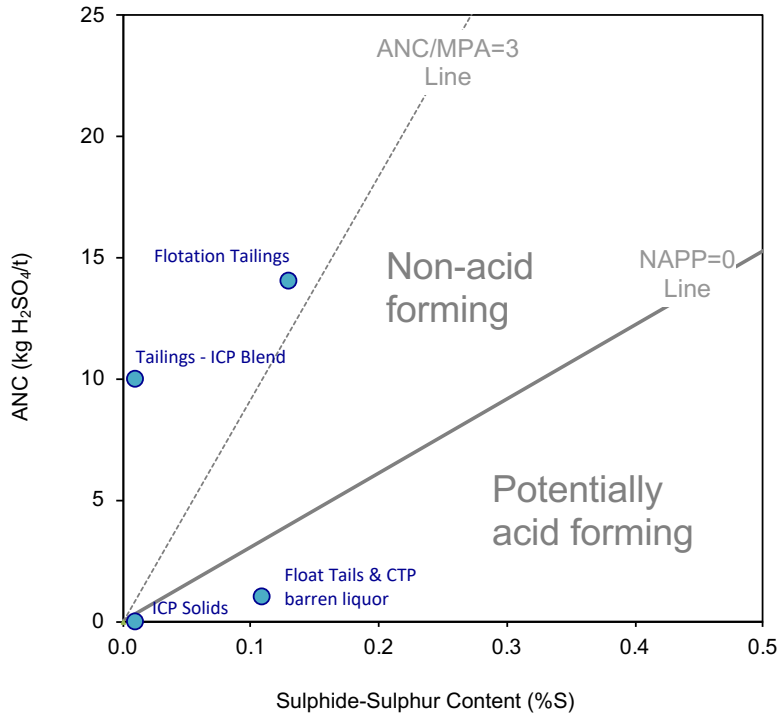


FIGURE 2: *Acid-base account plot for Carrapateena flotation tailings and ICP solids*

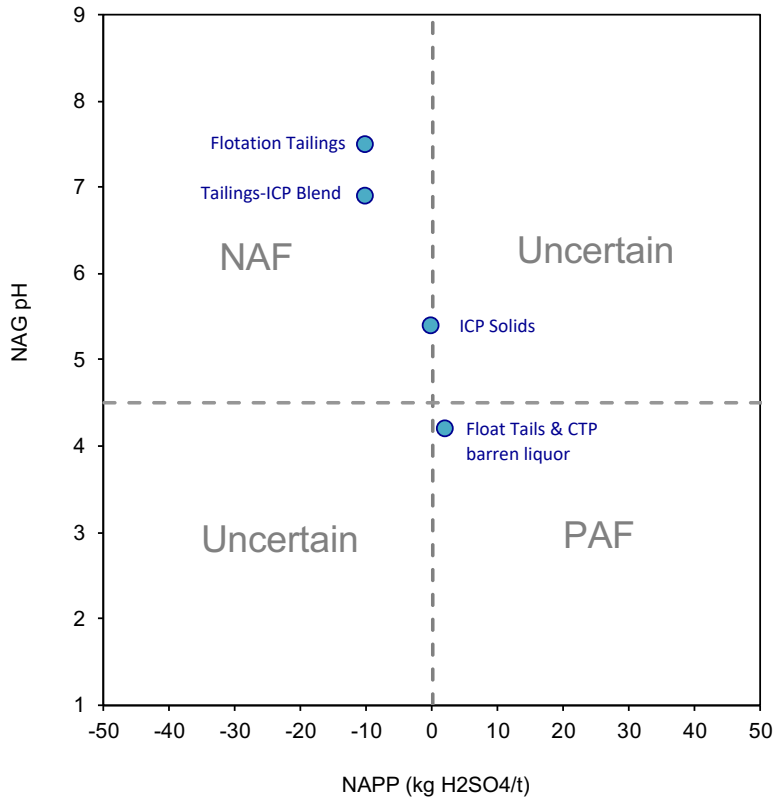


FIGURE 3: *ARD classification plot for Carrapateena flotation tailings and ICP solids*

- The sulphur content of the ICP solids was significant at approximately 11.5 %S, but the speciation results suggest that the sulphur occurred in the form of sulphate[3], predominantly in combination with calcium and copper (see Section 4). Consequently, the sulphide-S content was negligible, and the MPA was effectively zero. The ANC of the ICP solids was also zero, and correspondingly so too was the NAPP. In effect, the ICP solids were essentially barren with respect to both acid and neutralising potentials.
- The NAG test results confirmed the absence of acid generation. The final pH of the NAG liquor after reaction of the sample with peroxide was 5.4, which is above the pH 4.5 cut-off used to indicate acid generation.
- Based on the NAPP and NAG test results the ICP solids were classified NAF.

3.3 Blended Flotation Tailings & ICP Solids

- The characteristics of the flotation tailings/ICP blend were consistent with weight-based averages for the two material types within the blend.
- The measured total sulphur content was 1.29 %S (compared to a weight-base average of 1.53 %S) and the ANC was 11 kg H_2SO_4/t (compared to a weight-base average of 12 %S).
- With the flotation tailings/ICP blend most (90%) of the sulphur originated from the ICP solids whereas all of the ANC originated from the tailings solids.
- The NAPP of the flotation tailings/ICP blend was negative (-10 kg H_2SO_4/t) and the sample did not acidify under NAG test conditions.
- Based on the NAPP and NAG test results the flotation tailings/ICP blend was classified NAF.

3.4 Flotation Tailings & CTP Barren Liquor

- The solids of the flotation tailings/CTP barren liquor sample differed to the flotation tailings alone in that the total sulphur content was higher at 0.7 %S. As the flotation tailings solids alone contained only 0.17 %S, the additional sulphur in this sample must have derived from the input of CTP barren liquor, which presumably must have had some solids content when the mix was prepared by SGS Minerals Metallurgy.
- Most of the sulphur occurred as sulphate. The sulphide-sulphur content of the flotation tailings mixed with CTP barren liquor was approximately 0.1 %S only.
- The ANC was essentially negligible at 1 kg H_2SO_4/t. The low ANC is consistent with the acidic CTP barren liquor having reacted with the tailings solids to the extent that virtually all of the inherent ANC of the flotation tailings solids was depleted.
- The MPA based on a sulphide-sulphur content of 0.1 %S was 3 kg H_2SO_4/t, and the NAPP of the flotation tailings/CTP Barren liquor sample was 2 kg H_2SO_4/t, suggesting the solids may have a small potential for acid generation.

[3] The sulphate-S content as reported by ALS was actually marginally greater than the total-S content (i.e. 12.0 %S compared to 11.5 %S). This discrepancy can probably be attributed to sample variability and/or analytical error. The total-S measurement involved the Leco furnace method, which is generally regarded as a more accurate procedure.

- In the NAG test a final pH of 4.2 was recorded, which is slightly below the pH 4.5 criteria commonly used to signify acid generation. However, the NAG value was less than 1 kg H_2SO_4/t. It is expected that the "acidic" nature of this sample was partly a function of the barren liquor depleting the flotation solids of any buffer capacity, although there could be a small capacity for acid generation related to the sulphide present.
- Based on the NAPP and NAG test results the flotation tailings/CTP Barren liquor was classified PAF but the capacity for acid generation was low, and quite possibly associated with some solid phase material added to the tailings via the CTP barren liquor.

4.0 Elemental Composition of Solids

The elemental compositions of the flotation tailings and process residue solids are given in **Table 2**. To provide some relativity to the elemental data, the compositions of the solids were compared to typical concentrations reported for soil in non-mineralised areas. The purpose of this comparison was to highlight any elements that were significantly enriched, and which could have implications for tailings management and water quality. The comparison is expressed as a Geochemical Abundance Index (GAI), which relates enrichment to the median soil abundance value using the formula:

$GAI = \log_2 [C / (1.5*S)]$

where C is the concentration of the element in the sample and S is the median soil[4] content for that element. It should be noted that median soil contents are based on typical values for soils from non-mineralised areas, and do not represent the actual soils occurring at the Carrapateena project area.

GAIs are rounded to integer increments (0 through to 6, respectively) where a GAI of 0 indicates the element is present at a concentration similar to, or less than, median soil abundance and a GAI of 6 indicates approximately a 100-fold, or greater, enrichment above median soil abundance. The enrichment ranges for the GAI are as follows:

Little or No Enrichment	GAI = 0 (< 3 times median soil)
Minor Enrichment	GAI = 1 (3-12 times) or 2 (6-12 times)
Significant Enrichment	GAI = 3 (12-24 times), 4 (24-48 times), 5 (48-96 times) or 6 (≥ 96 times)

Table 2 includes the GAIs for the flotation tailings and process residue samples.

The flotation tailings solids were significantly enriched (GAI≥3) relative to median soil contents with copper, cobalt, molybdenum and uranium. The ICP solids were also significantly enriched with copper and uranium, as well as sulphur. The presence of elevated concentrations of copper is to be expected given that the tailings are from copper-bearing ore.

There were also minor enrichments (GAI=1 or 2) of both waste types with arsenic, iron and nickel.

4 References for median soil data: (1) Bowen, H.J.M. (1997) Environmental Chemistry of the Elements. Academic Press, London. (2) Berkman, D.A. (1976) Field Geologists' Manual, The Australian Institute of Mining and Metallurgy, Parkville, Victoria, Australia

TABLE 2: *Elemental compositions of Carrapateena flotation tailings and ICP solids*

Assay	Unit	Limit of Detection	Elemental Composition				*Median Soil Content	Geochemical Abundance Indices			
			Flotation Tailings	ICP Solids	Blend Float Tails & ICP Solids	Float Tails & CTP Barren Liquor		Flotation Tailings	ICP Solids	Blend Float Tails & ICP Solids	Float Tails & CTP Barren Liquor
Al	%	0.01	2.4	0.1	2.1	2.3	7.1	0	0	0	0
As	mg/kg	0.2	22	59	26	24	6	1	2	1	1
Ba	mg/kg	10	730	10	700	630	500	0	0	0	0
Ca	%	0.01	0.4	13	2	0.4	1.5	0	2	0	0
Cd	mg/kg	0.02	<0.02	0.5	0.05	0.06	0.4	0	0	0	0
Co	mg/kg	0.11	296	90	280	304	8	4	2	4	4
Cr	mg/kg	1	289	52	262	295	70	1	0	1	1
Cu	mg/kg	0.2	2,600	37,900	5,990	2,180	30	5	6	6	5
Fe	%	0.01	23	12	21	21	4	1	1	1	1
Hg	mg/kg	0.005	0.05	0.02	0.05	0.07	0.06	0	0	0	0
K	%	0.01	0.9	0.03	0.8	0.8	1.4	0	0	0	0
Mg	%	0.01	0.2	0.06	0.2	0.2	0.5	0	0	0	0
Mn	mg/kg	5	850	38	745	512	1000	0	0	0	0
Mo	mg/kg	0.05	58	6	52	56	2	4	0	4	4
Na	%	0.01	0.1	2.0	0.2	0.8	0.5	0	1	0	0
Ni	mg/kg	0.2	231	353	248	229	50	1	2	1	1
Pb	mg/kg	0.5	38	178	54	50	35	0	1	0	0
S	%	0.01	0.2	12	1.3	0.7	0.07	0	6	3	2
Sb	mg/kg	0.05	3.1	1.0	3.0	3.1	1	1	0	0	1
Se	mg/kg	1	4	1	4	1	0.4	2	0	2	0
Sn	mg/kg	0.2	17	0.2	15	16	4	1	0	1	1
U	mg/kg	0.1	186	70	169	98	2	5	4	5	5
Zn	mg/kg	2	34	214	58	37	90	0	0	0	0

GAI Enrichment Factors

GAI = 0	*Little or No Enrichment*	*< 3 times median soil*
GAI=1 or 2	*Minor Enrichment*	*1=3 to 6 times, 2=6 to 12 times*
GAI 3 to 6	*Significant Enrichment*	*3=12 to 24 times, 4=24 to 48 times, 5= 48 to 96 times, or 6 ≥ 96 times*

**** Median soil data from:***

Bowen, H.J.M. (1979) Environmental Chemistry of the Elements. Academic Press, London.

Berkman, D.A. (1976) Field Geologists' Manual, The Australian Institute of Mining and Metallurgy,Victoria, Australia.

A summary of enrichments for the four waste material types is given below.

Sample	Significant (GAI>3)	Minor (GAI=1 or 2)
Flotation tailings	Cu, U, Co, Mo	As, Fe, Ni, Cr, Sb, Se, Sn
ICP solids	Cu, U, S	As, Fe, Ni, Ca, Co, Pb, Na
Float tails/ICP blend	Cu, U, Co, Mo, S	As, Fe, Ni, Cr, Se, Sn
Float tails/CTP liquor	Cu, U, Co, Mo	As, Fe, Ni, Cr, Sb, S, Sn

The high concentrations of calcium (13 %) and sulphur (12 %) within the ICP solids are indicative of the presence of calcium sulphate precipitate (*i.e.* gypsum). There was also 12% iron within the ICP solids which likely occurred as iron oxy-hydroxides, and approximately 3.8 % copper, which likely occurred as copper hydroxide and/or co-precipitated with the iron.

Environmentally important elements that were not enriched relative to median contents of soil included cadmium, manganese, mercury, and zinc.

5.0 Water Soluble Elements

Only the Flotation Tailings / CTP Barren Liquor sample was provided as a slurry, which could be analysed directly. For the other samples that were provided as dry or moist solids, the ASLP test was used to determine the residual contents of soluble salts associated with the solid phases, and any potential for leaching of metals, metalloids and other elements of environmental interest. The test involved batch extraction with deionised water, which means the extractions occurred at the existing pHs of the samples. The results of the water extraction tests are given in **Table 3**. The main findings were as follows:

5.1 Flotation Tailings

- The ASLP leachate associated with the tailings solids was circum-neutral (pH 6.1) and slightly saline (EC 641 µS/cm). These results confirm the measurements made as part of the assessment of acid forming characteristics (see Table 1).
- The main dissolved cations were calcium (47 mg/L) and sodium (13 mg/L), with charge-balance provided mainly by chloride (146 mg/L) and sulphate (13 mg/L).
- There was some leaching of copper (7 mg/L) and manganese (7 mg/L), and to a lesser extent cobalt (0.4 mg/L) and zinc (0.2 mg/L).
- The dissolved concentrations of other elements that commonly are regarded as environmentally important were low, and in some cases less than the limits of analytical detection. Such elements included antimony (<0.001 mg/L), arsenic (0.002 mg/L), cadmium (0.0002 mg/L), chromium (0.004 mg/L), lead (<0.001 mg/L), mercury (<0.0001 mg/L), molybdenum (0.001 mg/L) selenium (<0.01 mg/L), tin (<0.001 mg/L) and uranium (0.04 mg/L).

TABLE 3: *Water extractable elements in Carrapateena flotation tailings and ICP solids*

Assay	Unit	Limit of Detection	Conpositions of ASLP leachates*			Composition of Tailings Liquor
			Flotation Tailings	ICP Solids	Float Tails & ICP Blend	Float Tails & CTP Liquor
pH		0.01	6.1	5.5	6.7	3.1
Alkalinity	mg $CaCO_3$/L	1	20	2	15	-
Acidity	mg $CaCO_3$/L		-	-	-	12,570
EC	µS/cm	10	641	6,820	2,920	~ 160,000
TDS	mg/L		259	4,954	1,956	~ 112,000
Al	mg/L	0.01	0.06	<0.01	<0.01	177
As	mg/L	0.001	0.002	0.002	<0.001	0.27
Ba	mg/L	0.001	0.38	0.04	0.02	<0.01
Ca	mg/L	1	47	609	467	566
Cd	mg/L	0.0001	0.0002	0.005	0.0001	0.14
Cl	mg/L	1	146	1,080	112	27,700
Co	mg/L	0.001	0.4	1.1	0.1	193
Cr	mg/L	0.001	0.004	<0.001	0.002	15
Cu	mg/L	0.001	7	32	0.1	2,320
Fe	mg/L	0.05	0.4	<0.05	<0.05	7,470
Hg	mg/L	0.0001	<0.0001	<0.0001	<0.0001	0.003
K	mg/L	1	5	2	6	40
Mg	mg/L	1	8	20	4	748
Mn	mg/L	0.001	7	0.3	2	662
Mo	mg/L	0.001	0.001	<0.001	0.001	<0.01
Na	mg/L	1	13	886	74	26,700
Ni	mg/L	0.001	0.07	3	0.1	33
Pb	mg/L	0.001	<0.001	0.002	<0.001	<0.01
Sb	mg/L	0.001	<0.001	<0.001	<0.001	0.04
Se	mg/L	0.01	<0.01	<0.01	<0.01	0.5
Si	mg/L	0.05	2	5	1	263
Sn	mg/L	0.001	<0.001	<0.001	<0.001	<0.01
SO_4	mg/L	1	10	2,310	1,280	44,000
U	mg/L	0.001	0.04	0.03	0.06	117
Zn	mg/L	0.005	0.2	3	0.03	43

** Based on Australian Standard Leaching Procedure (ASLP) using deionised water at a solids:liquor ration of 1:20.*

< Indicates concentration below analytical detection limit

5.2 ICP Solids

- The ASLP leachate associated with the ICP solids was slightly acidic (pH 5.5) and, in contrast to flotation tailings, it had a high concentration of dissolved salts (EC of 6,820 µS/cm and TDS of 4,965 mg/L).
- The high salinity of the extract was mainly due to sulphate (2,310 mg/L), chloride (1,080 mg/L), sodium (886 mg/L) and calcium (609 mg/L). The concentrations of sulphate and calcium are indicative of the leachate composition being in equilibrium with the solubility of gypsum (*i.e.* calcium sulphate).
- There was also significant release of copper (32 mg/L) from the ICP solids.
- Other metals with dissolved concentrations exceeding 1 mg/L included cobalt (1.1 mg/L), nickel (3 mg/L) and zinc (3 mg/L). There was also minor leaching of manganese (0.3 mg/L).
- Other environmentally important elements that were not leached to any significant extent included antimony (<0.001 mg/L), arsenic (0.002 mg/L), cadmium (0.005 mg/L), chromium (0.001 mg/L), lead (0.002 mg/L), mercury (<0.0001 mg/L), selenium (<0.01 mg/L), tin (<0.001 mg/L) and uranium (0.03 mg/L).

5.3 Blended Flotation Tailings & ICP Solids

- The ASLP leachate for the flotation tailings/ICP blend was circum-neutral at pH 6.7.
- The pH was approximately half a pH-unit higher than the pH of the leachate for the flotation tailings alone, and more than one-unit higher than the pH of leachate from the ICP solids alone. It is not clear why the blended sample should have a higher pH. It may simply represent analytical variability as the alkalinity of the ASLP leachate for the blend was consistent with what might be expected based on the alkalinities recorded for extracts of the separate materials (i.e. 15 mg $CaCO_3$/L for the blend, compared to 20 and 2 mg $CaCO_3$/L for flotation tailings and ICP, respectively).
- The extract produced by the tailings/ICP blend was saline (EC 2,920 µS/cm), albeit to a lesser extent than the ICP solids alone. The high salinity of the extract was mainly due to calcium (467 mg/L) and sulphate (1,280 mg/L). The concentrations of these elements were significantly higher than what would be expected based on average-weighted values for the tailings and ICP solids alone. This suggests that dissolved concentrations of calcium and sulphate in the extract of the blend were controlled by the solubility of gypsum contained within the ICP component of the blend.
- There was some leaching of manganese (2 mg/L) but dissolved concentrations of copper (0.1 mg/L) and cobalt (0.1 mg/L) and zinc (0.03 mg/L) were low in comparison to what might be expected based on concentrations reported for the extracts of the individual materials. Again, it is not clear why that should be the case, but it likely relates to the higher pH reported for the blend, as the solubilities of the metals are pH-dependent.
- There was no evidence of significant leaching of antimony (<0.001 mg/L), arsenic (<0.001 mg/L), cadmium (0.0001 mg/L), chromium (0.002 mg/L), lead (<0.001 mg/L), mercury (<0.0001 mg/L), molybdenum (0.001 mg/L), selenium (<0.01 mg/L), tin (<0.001 mg/L) or uranium (0.06 mg/L).

5.4 Flotation Tailings & CTP Barren Liquor

As this sample was provided as a slurry the liquor fraction was analysed directly, instead of the ASLP test used for the other three samples. The composition of the liquor fraction of the slurry of the flotation tailings/CTP barren liquor is given in **Table 3**. The main characteristics were as follows:

- The liquor fraction of the slurry was highly saline, with an EC of approximately 160,000 µS/cm and a TDS of approximately 112,000 mg/L.
- The high salinity was mainly associated with high concentrations of chloride (27,700 mg/L), sodium (26,700 mg/L) and sulphate (44,000 mg/L).
- The liquor fraction was also highly acidic, with a pH of 3.1, and a measured acidity of approximately 12,570 mg $CaCO_3$/L.
- Most of the acidity was associated with high concentrations of dissolved iron (7,470 mg/L) and copper (2,320 mg/L).
- There were also elevated concentrations of other metals including aluminium (177 mg/L), cobalt (193 mg/L), manganese (662 mg/L), nickel (33 mg/L), uranium (117 mg/L) and zinc (43 mg/L).

6.0 Kinetic Column Leach Testing

The kinetic column leach tests were run for a total of 40 weeks. For the first four weeks the samples were leached with deionised water on a weekly basis, and thereafter leaching was on a four-week cycle. A total of 14 leachate samples were collected as follows: Week 0, 1, 2, 3, 4, 8, 12, 16, 20, 24, 28, 32, 36 and 40.

On each sampling event a total of 800 ml of deionised water was added to the surface of each column, and on average, approximately 400 mL of leachate was collected. The difference was retained within the column and typically lost via evaporation prior to the next leach event. During the 40 week test period the total volumes of leachate collected from the four columns ranged from 5,435 to 5,697 ml, which equate to average leach rates between 9.7 to 10.2 ml/kg/day.

The analyses of leachates from the four kinetic column leach tests are tabulated in **Appendix A**, and time series plots for key parameters and elements are included in **Appendix B**. Time series plots are presented for pH, acidity/alkalinity, TDS, sulphate, chloride, calcium, magnesium, sodium, copper, manganese, zinc, cobalt, nickel and uranium. The results for the initial phase of weekly leaching are shown in plots marked (a), and the results for the four-week leach cycle phase are marked (b).

Table 4 provides a summary of leachate quality data for the column leach tests. Listed is the quality of the first flush of leachate (week 0) from each material, and the median quality for weeks 8 to 40 when leaching was on a 4-week cycle. Also, **Figure 4** shows the total amounts of key elements leached during the 40 week test period, expressed as mg/kg of solids.

The main findings of the kinetic column leach tests on the flotation tailings and ICP residue samples were as follows:

TABLE 4: *Summary of column leachate assay results for Carrapateena flotation tailings and ICP solids*

Parameters	Unit	Flotation Tailings		ICP Solids		Blended Flotation Tailings & ICP Solids		Flotation Tailings & CTP Barren Liquor	
		Initial (week 0)	Median (wks 8 - 40)	Initial (week 0)	Median (wks 8 - 40)	Initial (week 0)	Median (wks 8 - 40)	Initial (week 0)	Median (wks 8 - 40)
pH	-	7.2	7.1	5.3	4.9	6.6	6.9	4.0	4.8
Alkalinity	mg/l	70	40	-	-	37	46	-	-
Acidity	mg/l	-	-	154	210	-	-	2,540	316
EC	µS/cm	4850	946	68,200	4,190	34,200	2,580	88,000	2,630
TDS	mg/L	3,125	770	190,590	3,062	18,961	2,287	59,301	2,534
Al	mg/l	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01	14	0.22
As	mg/l	<0.01	<0.001	<0.01	0.002	<0.01	<0.001	0.16	0.012
Ba	mg/l	0.027	0.02	0.09	0.011	0.011	0.01	<0.01	0.01
Ca	mg/l	194	183	498	718	614	593	618	551
Cd	mg/l	<0.001	<0.0001	0.14	0.015	0.0016	<0.0001	0.09	0.0003
Cl	mg/l	910	17	78,000	582	6,780	60	14,100	10
Co	mg/l	0.03	0.13	9	6	0.35	0.28	122	13
Cr	mg/l	< 0.01	<0.001	<0.01	<0.001	<0.01	<0.001	0.078	<0.001
Cu	mg/l	0.10	0.10	35	130	0.24	0.09	1470	204
Fe	mg/l	<0.1	<0.05	0.4	<0.05	<0.1	<0.05	1.0	0.1
Hg	mg/l	<0.0001	<0.0001	0.037	<0.0001	<0.0001	<0.0001	0.01	<0.0001
K	mg/l	75	10	100	1	152	9	5	4
Mg	mg/l	28	20	1,550	7	238	46	925	5
Mn	mg/l	0.6	1.7	3	1.9	13	1.1	570	2.6
Mo	mg/l	0.3	0.11	<0.01	<0.001	<0.01	0.005	<0.01	<0.001
Na	mg/l	749	<1	62,600	20	5,720	2	18,700	8
Ni	mg/l	<0.01	0.006	23	20	0.3	0.1	33	1.1
Pb	mg/l	<0.01	<0.001	2.4	0.006	<0.01	<0.001	<0.01	<0.001
Sb	mg/l	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001
Se	mg/l	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01	0.51	0.04
Si	mg/l	4	3	8	7	<0.1	2	22	21
Sn	mg/l	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001
SO_4	mg/l	1,120	501	47,700	1,370	5,420	1,420	22,600	1,640
U	mg/l	1.3	0.4	0.14	0.06	0.04	0.14	91	1.7
Zn	mg/l	<0.05	0.005	61	14.2	0.18	0.006	30	0.19

< Indicates concentration below analytical detection limit

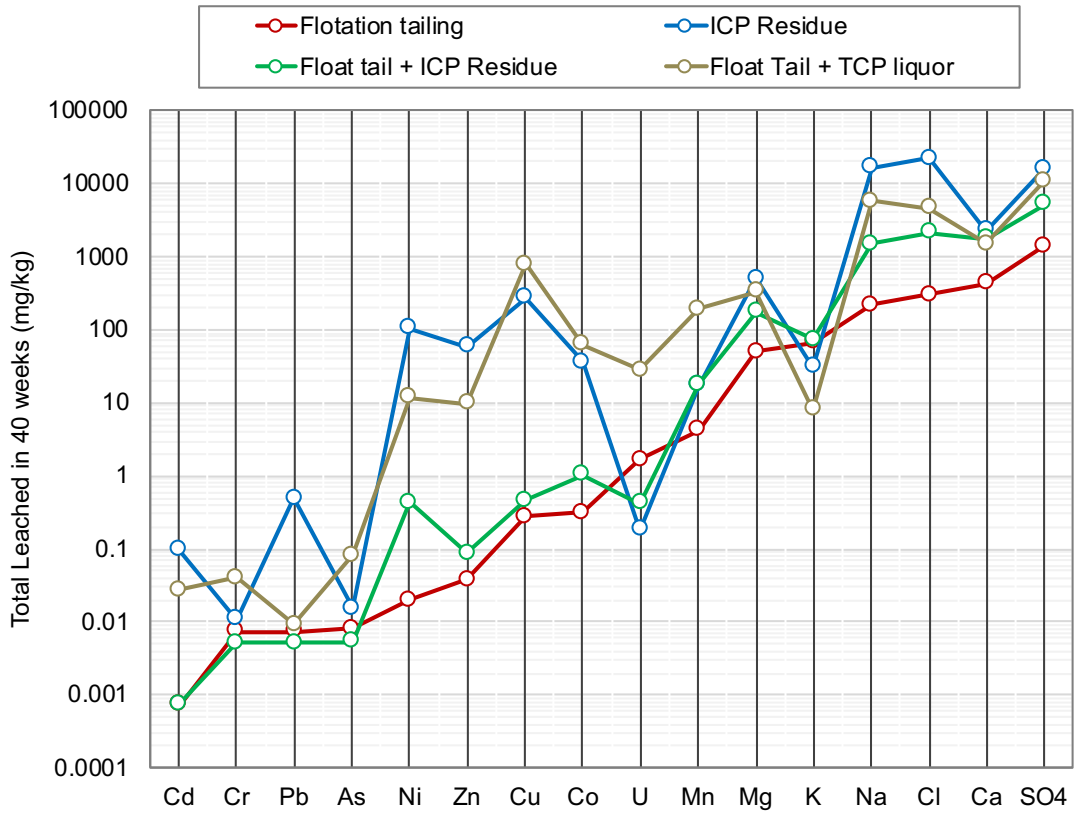


FIGURE 4: *Total leachable amounts of key elements from the Carrapateena flotation tailings and ICP residue samples during the 40 week column leach tests*

(elements sorted according to amounts leached from flotation tailings)

6.1 Flotation Tailings

- The flotation tailings remained circum-neutral throughout the 40-week test period, with a median pH of 7.1 and a median alkalinity of 47 mg $CaCO_3$/L.
- There was an initial flush of some salts (TDS 3,125 mg/L). Some and possibly most were residual soluble salts retained when the slurry solids were dried by SGS Minerals Metallurgy prior to the sample being sent to EGi. The TDS of leachate subsequently decreased markedly during the initial phase of weekly leaching, then during the four-week leach cycle phase the TDS values typically fluctuated between 400 and 1250 mg/L, with a median of 770 mg/L.
- After the initial flush of soluble salts, the concentrations of major cations and anions in leachate remained steady at relatively low values for the remainder of the 40 week test period. During the four-week leach phase the median concentrations of major ions were:
    - sulphate = 501 mg/L
    - chloride = 0.17 mg/L
    - calcium = 183 mg/L
    - magnesium = 20 mg/L

- There were also trace concentrations of some metals, with median concentrations as follows:
    - manganese = 1.7 mg/L
    - uranium = 0.4 mg/L
    - cobalt = 0.13 mg/L
    - molybdenum = 0.11 mg/L
    - copper = 0.10 mg/L
- The concentrations of other elements considered to be environmentally important were typically close to, or less than, the limits of analytical detection. Those elements included:
    - mercury and cadmium ≤0.0001 mg/L,
    - antimony, arsenic, chromium and lead ≤0.001
    - nickel and zinc ≤0.006 mg/L

6.2 ICP Solids

- The ICP solids produced leachate that was moderately acidic during the 40-week leach test, with the pH fluctuating only slightly between 4.8 to 5.3 (median 4.9) and the acidity typically in the order of 200 mg $CaCO_3$/L.
- Leachates during the first few weeks had very high concentrations of dissolved solids. The TDS for the initial flush (Week 0) was approximately 191,000 mg/L, comprising mainly sulphate at 47,700 mg/L, chloride at 78,000 mg/L and sodium at 62,600 mg/L.
- As leaching progressed, the concentrations of dissolved salts decreased sharply. By week 4 the TDS was down to approximately 4,400 mg/L, and thereafter the TDS remained relatively steady, fluctuating around 3,000 mg/L. At this stage the main elements contributing to TDS were calcium (median 718 mg/L), sulphate (median 1,370 mg/L) and chloride (median 582 mg/L). The concentrations of calcium and sulphate suggest the leachate from the ICP residue was likely in equilibrium with gypsum solubility.
- There was also on-going leaching of a number of metals, including copper (median 130 mg/L), nickel (20 mg/L), zinc (14 mg/L), cobalt (6 mg/L) and manganese (2 mg/L) .
- The concentration of dissolved uranium was around 0.06 mg/L. This is only around one-tenth of the median concentration reported for uranium in leachate from the column of flotation tailings.
- There were trace concentrations of lead (0.06 mg/L) and cadmium (0.015 mg/L).
- Elements that were not leached to any significant extent (i.e. concentrations close to, or less than the analytical limits of detection) included arsenic (≤0.002 mg/L), aluminium (≤0.01 mg/L), iron (≤0.05 mg/L), antimony (≤0.001 mg/L)

6.3 Blended Flotation Tailings & ICP Solids

- As might be expected, in most respects the geochemical behaviour of the blend of flotation tailings and ICP solids was intermediate between the behaviours of the two individual material types.
- The pH of the first leachate from the column was 6.6, and over the 40-week test period the pH remained close to pH neutral, fluctuating between 6.7 and 7.2.

- The alkalinity of leachate was typically 30 to 40 mg/L during the first 20 weeks and gradually increased in the latter half of the test to 71 mg/L at week 40.
- The initial leachate from this column was highly saline (TDS ~ 19,000 mg/L), mainly due to high concentrations of chloride (6,780 mg/L), sodium (5,720 mg/L), sulphate (5,420 mg/L) and calcium (614 mg/L). The high salinity can primarily be attributed to the ICP residue component of the mix.
- Similarly, as with ICP residue, most of the readily soluble salts were rapidly leached, with TDS decreasing to approximately 2,300 mg/L by week 4. Thereafter TDS typically fluctuated between 2,000 to 3,000 mg/L, with a median of approximately 2,300 mg/L. At this stage the salinity was mainly associated with leaching of calcium (median 593 mg/L) and sulphate (median 1,420 mg/L), signifying that in the longer term the major ion chemistry of leachate from blended tailings and ICP residue will be determined by the solubility of gypsum contained with the ICP solids.
- From week 8 onward the concentrations of manganese, copper, cobalt and uranium in leachate were more closely aligned with concentrations occurring in leachate from the flotation tailings, rather than ICP residue. For example, the median concentrations from week 8 onward were manganese 1.1 mg/L, uranium 0.14 mg/L, cobalt 0.28 mg/L, and copper 0.09 mg/L. The similarity with concentrations reported for flotation tailings can likely be attributed to the pH of leachate from the blend being circum-neutral, like leachate from the flotation tailings.
- Similarly, as with flotation tailings, following the initial flush phase there was no evidence of significant leaching of arsenic (≤0.001 mg/L), cadmium (≤0.0001 mg/L), mercury (≤0.0001 mg/L) lead (≤0.001 mg/L) , antimony (≤0.001 mg/L), tin (≤0.001 mg/L) or zinc (≤0.006 mg/L).

6.4 Flotation Tailings & CTP Barren Liquor

- The first leachate sample from the flotation tailings/CTP barren liquor sample was highly saline and acidic. The TDS was approximately 59,300 mg/L due to high concentrations of sodium, calcium, chloride and sulphate. The pH and acidity were 4.0 and 2,540 mg $CaCO_3$/L, respectively.
- Although less acidic and less saline than the barren liquor itself (which was pH 3.1 and had a TDS of approximately112,000 mg/L), the results confirm the dry material placed into the column had a high residual salt content.
- As with other samples, most of the readily soluble salts were rapidly flushed, and by week 4 the TDS of leachate had decreased to around 2,700 mg/L. Thereafter the TDS remained relatively steady, decreasing only slowly with time to around 2,200 mg/L by week 40. During the latter phase the main ions in leachate were calcium (median 550 mg/L) and sulphate (median (1,640 mg/L), which again suggests ongoing dissolution of gypsum.
- The concentrations of copper trended lower with time, but remained relatively high throughout the leach test. A maximum of 282 mg/L copper was recorded at week 8, and at week 40 the concentration was 102 mg/L. These elevated concentrations compare to a copper concentration of only around 0.1 mg/L for leachate from the flotation tailings alone. The acidic pH of this sample is likely to be a factor in the continuance of copper leaching, whereas the leachate from the flotation tailings in isolation was circum-neutral.
- Other metals that leached to varying extents included cobalt (8 to 19 mg/L), manganese (0.6 to 15 mg/L), uranium (1.2 to 2.5 mg/L), nickel (0.5 to 1.8 mg/L), zinc (0.1 to 0.8 mg/L).

7.0 Summary and Implications for Tailings Management

7.1 Summary

This report presents the results of a geochemical assessment of samples representing flotation tailings and ICP solids that will be produced at the Carrapateena Project by ore processing and treatment of concentrate. The test samples were produced by SGS Minerals Metallurgy as part of the metallurgical program being undertaken for the project. The following four samples were included in the assessment:

- Flotation tailings solids
- ICP solids
- Blended flotation tailings and ICP solids
- Flotation tailings slurried with CTP barren liquor

The geochemical assessment involved both static and kinetic test methods. Static testing included multi-element analysis solids and determination of acid forming characteristics. Kinetic testing involved long-term leaching of the samples with deionised water using the column leach method. The main findings were as follows:

Flotation Tailings

- The flotation tailings were circum-neutral when mixed with water, and the solids were classified as NAF based on negative NAPP and NAG test vales. The sulphur content was negligible (< 0.2 %S), but there was enrichment of the solids with copper to the extent of 2,600 mg/kg, which is approximately 100-times greater than typically occurs in soils from non-mineralised areas. Other elements that were significantly enriched relative to soil were cobalt, molybdenum and uranium.
- The column leach results were consistent with the solids having a low sulphur content and being NAF. The pH remained circum-neutral and there was no indication of any longer-term increase in sulphate concentration that is typically associated with sulphide oxidation. There was an initial flush of soluble salts (mainly sulphate, chloride, sodium and calcium) with the first addition of water, but in the longer term the TDS typically fluctuated around 770 mg/L, and there were only trace concentrations of copper, cobalt, manganese, molybdenum and uranium in leachate. The concentrations of other elements considered to be environmentally important were typically close to, or less than, the limits of analytical detection.
- The composition of leachate was relatively stable during the latter half of 40 week test period, which suggests that leachate chemistry was in quasi-steady-state equilibrium with solid phases within the flotation tailings. As such, there is no reason to expect that the quality of leachate would have deteriorated with time if the test had been continued beyond 40 weeks.

ICP Residue

- The ICP residue when mixed with water was slightly acidic at pH 5.4, but the solids were classified as NAF based on negative NAPP and NAG test results. The ICP solids comprised mainly calcium (13%), iron (12%) and sulphur (12%) in precipitate forms, the most likely being gypsum and iron oxy-hydroxides. The ICP solids also contained approximately 3.8 % copper and were significantly enriched in uranium.

- The kinetic column leach test on ICP residue indicated a high content of soluble salts. The TDS of the initial flush was approximately 191,000 mg/L, comprising mainly sulphate at 47,700 mg/L, chloride at 78,000 mg/L and sodium at 62,600 mg/L. However, as leaching progressed, the concentrations of dissolved salts decreased sharply, and from week 8 onward the TDS remained relatively steady at around 3,000 mg/L, primarily due calcium and sulphate. The concentrations of calcium and sulphate suggest the leachate from the ICP residue was likely in equilibrium with gypsum solubility. As gypsum is a major component of ICP residue it would be expected that the residue would continue to generate leachate with elevated concentrations of sulphate and calcium into the long term.
- In addition, there was significant on-going leaching of copper (median 130 mg/L), nickel (20 mg/L), zinc (14 mg/L), cobalt (6 mg/L) and manganese (2 mg/L), but unlike the flotation tailings the leaching of uranium was limited to around 0.06 mg/L.

Blended Flotation Tailings and ICP Residue

- A blend of the tailings and ICP solids was included in the test program to assess the geochemical characteristics and behaviour in the event both materials are co-disposed into the TSF at the Carrapateena site. The tailings/ICP blend comprised 88% flotation tailings and 12 % ICP solids.
- As might be expected, the geochemical characteristics and leaching behaviour were intermediate between those exhibited by the individual material types. The blend had a high sulphur content (due to the ICP) but almost all occurred as sulphate, and the mix overall was classified NAF. The solids were also significantly enriched with copper, cobalt, molybdenum and uranium.
- The pH of the blended materials was 6.5, and during the 40 week leach test period the blend remained circum-neutral and produced leachate that typically had an alkalinity greater than 30 mg $CaCO_3$/L.
- The initial leachate from the blend was highly saline, primarily due to the soluble salts contained within ICP component of the mix. However, as was the case with ICP residue, most of the readily soluble salts were leached in the first few weeks, and thereafter the TDS of leachate was typically between 2,000 to 3,000 mg/L, with calcium and sulphate the dominant ions being released by steady-state dissolution of gypsum contained within the ICP. However, the concentrations of manganese, copper, cobalt and uranium in leachate were more closely aligned with the lower concentrations recorded for leachate from the flotation tailings, rather than ICP residue. This can likely be attributed to the pH of leachate from the blend being circum-neutral like leachate from the flotation tailings.

Flotation Tailings Slurried with Barren CTP Liquor

- The addition of CTP barren liquor to flotation tailings results in a highly saline (TDS ~112,000 mg/L) and acidic (pH 3.1) slurry. The addition of acidic barren liquor has the effect of depleting the neutralising capacity of the flotation tailings. Also, the slurry provided for geochemical assessment had a small sulphide content which, together with the absence of ANC, resulted in this sample being classified as PAF, albeit with only a low capacity for acid generation.
- As with other samples, most of the readily soluble salts were rapidly flushed. By week 4 of the kinetic column leach test the TDS of leachate had decreased to around 2,700 mg/L, and at the end of the 40 week test period it was around 2,200 mg/L, with calcium and sulphate dominant.

- In contrast to the flotation tailings alone, there was significant release of copper throughout the 40 week leach test, with concentrations in leachate trending only gradually lower with time, from a maximum of 282 mg/L at week 8 to a concentration of 102 mg/L at week 40. This is more than 1000-times higher than the 0.1 mg/L typically recorded for leachate from flotation tailings alone. The higher copper concentrations can be attributed to the lower pH created by slurrying the flotation tailings with highly acidic barren CTP liquor. Other metals that leached to varying extents included cobalt, manganese, uranium, nickel, zinc.

7.2 Implications

The static and kinetic test results for flotation tailings and ICP residue samples from the metallurgical development program provide empirical data on the geochemical characteristics and prospective geochemical behaviours of the two process waste types that will be produced during the Carrapateena Project. At the time of reporting, the options for management of tailings and residues were still being evaluated by OZ Minerals, hence a range of combinations of tailings and residue were geochemically assessed.

As the project involves mining and processing of sulphidic ore, a key consideration of the geochemical program was to assess the acid generation potential of the materials, as this could have implications for the manner in which flotation tailings and ICP residue are management within the TSF. There could also be implications for closure of the TSF.

Flotation Tailings and ICP Residue

Based on the samples tested, the sulphide contents of both the flotation tailings and ICP residue will be low, and the corresponding acid potentials will be negligible. The individual samples representing flotation tailings and ICP residue were classified as NAF, as was the blended composite of the two waste types. Therefore, based on the test samples, acid potential will not be a consideration for how flotation tailings and/or ICP residue are managed. This means there should not be any need for specific ARD related management or prevention measures (*e.g.* sub-aqueous deposition) to be incorporated into the overall design and operation of the TSF at Carrapateena.

It is likely that during operations most of the flotation tailings solids and/or ICP residue within the TSF will be below water, although there could be beach areas associated with spigot discharge points where the deposited materials are wet but not fully saturated. The results of this study suggest that if flotation tailings alone are discharged to the TSF then the decant will be circum-neutral and only slightly saline, although there could be elevated concentrations of dissolved copper and manganese in the discharge. If the discharge is a blend of tailings/ICP residue then the salinity (or TDS) of the decant will be higher, primarily due to elevated concentrations of calcium and sulphate that are in chemical equilibrium with solid phase gypsum within the residue.

The results of the column leach tests are probably more relevant to closure, when there is no longer process discharge, and the final beached tailings across the TSF are left to dry out and periodically flushed by incident rain. In this respect, it should be noted that the standard column leach test is not designed to specifically replicate site conditions in relation to ambient climate or operational circumstances. Rather, the intension of the column test is to provide a leach environment where oxidation process can readily occur,

solubility constraints with respect to precipitation of secondary mineral phases can ensue if conditions are met, and the overall leach rate is adequate for leaching of readily soluble salts.

In the column leach tests carried out in this study, the addition of water to the surface of columns during the 40 week period was equivalent to an annual rainfall of approximately 866 mm, but due to evaporation from the column, the actual rate of leaching (i.e. as indicated by volume of leachate collected) was much lower at around 300 mm when expressed on a column surface area basis. This represents a higher rate of leaching than would be expected at the Carrapateena site, where the annual rainfall is around 200 mm. However, it is expected the geochemical processes that occurred with the column will similarly prevail with a TSF after closure when the surface tailings become unsaturated but are subject to periodic rainfall events.

As noted above, the absence of significant sulphide in flotation tailings will preclude acid generation occurring in the TSF if the tailings are exposed to atmospheric conditions, and the results from the column tests involving flotation tailings confirmed the absence of acidification during the 40 week test period. The concentrations of sulphate in leachate also remained relatively low, and there was no indication of any increasing trend in sulphate release that commonly is associated with sulphide oxidation processes. There was some ongoing release of manganese, uranium, cobalt, molybdenum, and copper, but the releases of other elements considered to be environmentally important such as mercury, lead, cadmium and arsenic were negligible.

Disposal of ICP residue with flotation tailings significantly increases the potential for long-term release of soluble salts, primarily in the form of calcium and sulphate, via dissolution of gypsum. The ICP residue solids also have a high copper content as well as elevated concentrations of cobalt, nickel and uranium. The results of the column test involving a blend of flotation tailings and ICP residue indicated potential for release of these metals during the first few months of testing, but in the longer term the concentrations in leachate were more consistent with those found in leachate from the column containing only flotation tailings.

Given the arid climate at Carrapateena, it would be expected that the TSF will have a negative water balance post closure. Under such conditions there could be potential for capillary rise of salts from within the tailings mass toward the surface, giving rise to salt crusting at the surface. If that does occur, then the co-disposal of ICP reside with flotation tailings would exacerbate the issue, as the ICP residue represents a significant loading of sparingly soluble precipitates such as gypsum. The potential for salt rise should be considered during development of a closure plan for the TSF, as salinity could affect the capacity of a cover layer to support vegetation in the long-term. If that is the case then a capillary break layer may be need to be included in the overall design of a final cover.

Flotation Tailings and Barren CTP Liquor

The sample of flotation tailings that was slurried with barren CTP liquor did contain some sulphide and the sample was classified as PAF, albeit with only a low capacity for acid generation. Based on the sample provided, the acidity of the barren CTP liquor will be significantly greater than the inherent neutralising capacity of the flotation tailings solids, hence there will be only limited potential for *in-situ* neutralisation of the acidic liquor by the tailings solids within the TSF. Assuming the flotation tailings and barren CTP liquor have similar characteristics to the test samples, and the combination of the two is as highly acidic (pH 3.1) as the sample provided, then the small amount of additional acid potential associated with the occurrence of minor sulphide will be inconsequential.

Overall, the high acid load associated with the barren CTP liquor will create a much different geochemical setting with the TSF compared to what would be the case with flotation tailings alone or a blend of tailings with ICP residue, where slightly alkaline conditions are expected.

APPENDICES

APPENDIX A-1: *Column leachate assay results - Flotation tailings*

Parameters		Flotation Tailings													
		Initial	Week 1	Week 2	Week 3	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24	Week 28	Week 32	Week 36	Week 40
pH	-	7.2	7.7	7.8	7.7	7.4	6.7	6.7	6.9	6.7	7.1	7.1	7.4	7.4	7.4
Alkalinity	mg/l	70	51	73	74	79	32	35	43	41	35	37	40	55	57
Acidity	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EC	µS/cm	4850	1910	812	689	661	1,210	1,180	946	429	812	791	681	946	952
TDS	mg/L	3,125	488	482	457	478	1,019	1,249	725	770	673	399	423	896	892
Al	mg/l	0.1	0.01	0.01	0.1	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
As	mg/l	0.01	0.004	0.002	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ba	mg/l	0.027	0.045	0.030	0.025	0.026	0.022	0.020	0.019	0.017	0.018	0.02	0.02	0.02	0.01
Ca	mg/l	194	74	93	94	102	244	201	164	183	157	102	104	224	221
Cd	mg/l	0.001	0.0001	0.0001	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cl	mg/l	910	76	47	31	25	25	20	17	19	17	11	9	19	15
Co	mg/l	0.03	0.02	0.05	0.06	0.06	0.10	0.10	0.09	0.14	0.13	0.12	0.16	0.32	0.30
Cr	mg/l	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cu	mg/l	0.10	0.08	0.09	0.09	0.09	0.10	0.07	0.06	0.09	0.09	0.10	0.13	0.15	0.13
Fe	mg/l	0.1	0.05	0.05	0.1	0.05	0.05	0.05	0.05	0.38	0.05	0.05	0.05	0.05	0.05
Hg	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
K	mg/l	75	40	32	26	20	26	17	14	12	10	7	6	7	6
Mg	mg/l	28	10	12	12	13	28	22	20	23	18	13	12	22	15
Mn	mg/l	0.6	0.6	1.2	1.3	1.6	2.5	2.3	1.5	1.7	1.4	1.1	1.2	2.6	2.0
Mo	mg/l	0.3	0.2	0.09	0.10	0.10	0.12	0.13	0.11	0.11	0.11	0.08	0.07	0.08	0.06
Na	mg/l	749	66	17	11	4	5	2	2	1	1	1	1	1	1
Ni	mg/l	0.01	0.003	0.004	0.01	0.004	0.005	0.006	0.003	0.021	0.004	0.004	0.006	0.009	0.009
Pb	mg/l	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Sb	mg/l	0.01	0.002	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se	mg/l	0.1	0.01	0.01	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Si	mg/l	4	4	4	4	4	4	3	3	3	3	2	2	2	2
Sn	mg/l	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_4	mg/l	1,120	185	230	232	260	665	960	477	501	444	239	263	583	594
U	mg/l	1.3	0.94	0.78	0.65	0.61	0.41	0.37	0.25	0.27	0.38	0.27	0.3	0.8	0.5
Zn	mg/l	0.05	0.005	0.005	0.05	0.005	0.006	0.005	0.005	0.009	0.005	0.005	0.006	0.005	0.009

Underline indicates that the concentration is less than the limit of detection

APPENDIX A-2: *Column leachate assay results - ICP residue*

Parameters		ICP Solids													
		Initial	Week 1	Week 2	Week 3	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24	Week 28	Week 32	Week 36	Week 40
pH	-	5.3	5.2	4.8	4.9	4.9	4.9	4.9	4.9	4.8	4.9	5.0	5.1	5.1	5.2
Alkalinity	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acidity	mg/l	154	99	139	185	189	195	210	187	180	212	192	219	247	251
EC	µS/cm	68,200	51,700	20,210	10,260	7,210	5,880	5,760	4,360	4,270	4,190	4,110	3,630	3,310	3,350
TDS	mg/L	190,590	41,682	13,172	6,859	4,365	3,373	3,373	3,062	3,335	3,210	2,644	2,679	2,695	2,604
Al	mg/l	0.1	0.1	0.01	0.1	0.1	0.1	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01
As	mg/l	0.01	0.01	0.01	0.01	0.01	0.006	0.001	0.003	0.004	0.003	0.001	0.002	0.001	0.001
Ba	mg/l	0.09	0.04	0.03	0.03	0.03	0.02	0.011	0.012	0.016	0.013	0.01	0.009	0.008	0.007
Ca	mg/l	498	726	942	1,260	1,200	906	718	778	846	869	676	697	676	616
Cd	mg/l	0.14	0.05	0.04	0.04	0.04	0.03	0.01	0.01	0.02	0.02	0.013	0.016	0.014	0.011
Cl	mg/l	78,000	14,200	5,690	2,960	1,490	947	582	699	871	717	499	484	454	432
Co	mg/l	9	16	33	29	22	13	5	6	10	7	5	6	5	3
Cr	mg/l	0.01	0.01	0.001	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cu	mg/l	35	39	43	77	90	111	98	102	130	160	117	152	140	142
Fe	mg/l	0.4	0.1	0.05	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Hg	mg/l	0.037	0.001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
K	mg/l	100	19	6	4	10	1	1	1	1	1	1	1	1	1
Mg	mg/l	1,550	410	252	99	29	19	9	15	15	7	5	4	2	2
Mn	mg/l	3	10	20	15	9	6	2	3	5	3	1.1	1.3	0.8	0.5
Mo	mg/l	0.01	0.01	0.001	0.01	0.01	0.001	0.001	0.005	0.002	0.001	0.001	0.001	0.00	0.001
Na	mg/l	62,600	13,100	3,160	873	191	55	26	40	36	20	18	12	10	8
Ni	mg/l	23	37	76	82	70	43	15	20	33	27	15	20	16	14
Pb	mg/l	2.4	0.014	0.009	0.01	0.013	0.01	0.008	0.007	0.007	0.006	0.005	0.004	0.004	0.004
Sb	mg/l	0.01	0.01	0.001	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se	mg/l	0.1	0.1	0.01	0.1	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Si	mg/l	8	10	10	10	11	10	7	7	9	9	6.0	6	6	6
Sn	mg/l	0.01	0.01	0.001	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_4	mg/l	47,700	13,100	2,920	1,420	1,210	1,240	1,900	1,380	1,360	1,370	1,290	1,280	1,370	1,370
U	mg/l	0.1	0.07	0.04	0.06	0.07	0.06	0.06	0.06	0.07	0.07	0.05	0.06	0.06	0.05
Zn	mg/l	61	15	21	31	33	22	10	11	19	20	11	15	14	9.5

Underline indicates that the concentration is less than the limit of detection

APPENDIX A-3: *Column leachate assay results - Blended flotation tailings and ICP residue*

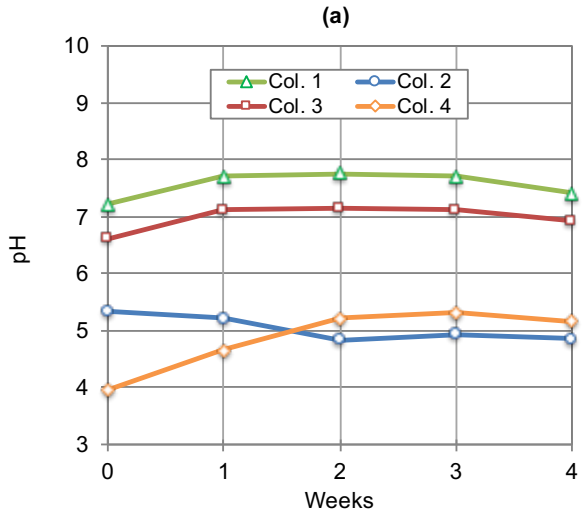
Parameters		Blended Flotation Tailings & ICP Solids													
		Initial	Week 1	Week 2	Week 3	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24	Week 28	Week 32	Week 36	Week 40
pH	-	6.6	7.1	7.2	7.1	6.9	6.8	6.9	6.9	6.7	6.7	6.7	7.1	7.0	7.1
Alkalinity	mg/l	37	34	69	48	41	42	45	31	30	51	46	55	69	71
Acidity	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EC	µS/cm	34,200	5,460	3,660	2,860	2,550	2,660	2,710	2,580	2,520	2,710	2,750	2,450	2,330	2,350
TDS	mg/L	18,961	3,107	2,492	2,333	2,292	2,302	3,041	2,481	2,287	2,382	2,049	1,965	2,107	2,039
Al	mg/l	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
As	mg/l	0.01	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ba	mg/l	0.011	0.017	0.012	0.013	0.013	0.012	0.012	0.010	0.011	0.01	0.01	0.007	0.008	0.008
Ca	mg/l	614	809	644	648	651	633	594	593	584	670	564	555	594	536
Cd	mg/l	0.0016	0.0003	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cl	mg/l	6,780	495	351	233	161	207	168	137	86	60	36	26	28	35
Co	mg/l	0.35	0.52	0.39	0.46	0.44	0.22	0.20	0.22	0.27	0.28	0.38	0.43	0.46	0.43
Cr	mg/l	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cu	mg/l	0.24	0.30	0.12	0.13	0.12	0.07	0.06	0.17	0.07	0.27	0.09	0.29	0.27	0.09
Fe	mg/l	0.1	0.1	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05
Hg	mg/l	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
K	mg/l	152	38	20	22	12	13	12	13	9	9	5	5	4	4
Mg	mg/l	238	94	42	33	24	58	68	71	53	46	31	20	14	16
Mn	mg/l	13	23	12	12	10	3	2	1	1	1.0	1.1	1.1	1.1	1.0
Mo	mg/l	0.01	0.002	0.001	0.002	0.001	0.003	0.004	0.005	0.005	0.005	0.004	0.005	0.005	0.005
Na	mg/l	5,720	104	27	12	6	10	8	5	3	2	2	2	1	1
Ni	mg/l	0.3	0.4	0.2	0.2	0.2	0.08	0.06	0.08	0.05	0.10	0.07	0.10	0.10	0.1
Pb	mg/l	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Sb	mg/l	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se	mg/l	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Si	mg/l	0.1	2	2	2	2	2	2	1	2	2	2	2	2	2
Sn	mg/l	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_4	mg/l	5,420	1,520	1,350	1,340	1,400	1,350	2,160	1,640	1,530	1,560	1,380	1,320	1,420	1,400
U	mg/l	0.04	0.3	0.2	0.2	0.2	0.1	0.11	0.12	0.13	0.14	0.15	0.17	0.21	0.15
Zn	mg/l	0.18	0.04	0.01	0.02	0.01	0.006	0.005	0.02	0.005	0.03	0.006	0.03	0.02	0.005

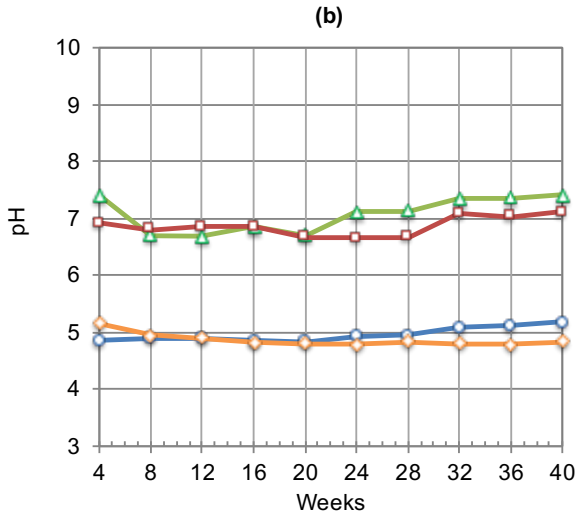
Underline indicates that the concentration is less than the limit of detection

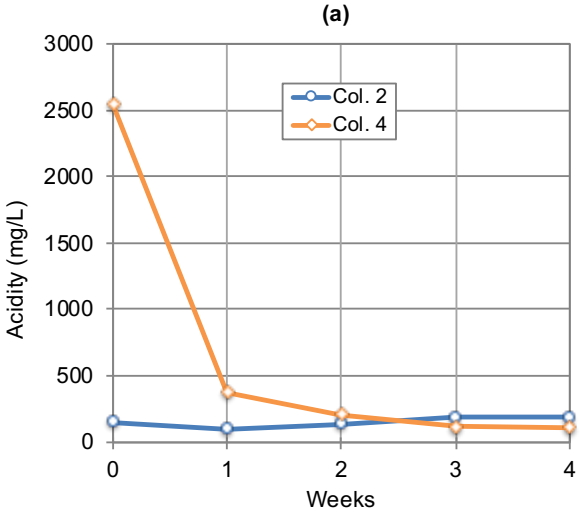
APPENDIX A-4: *Column leachate assay results - Flotation tailings slurried with CTP barren liquor*

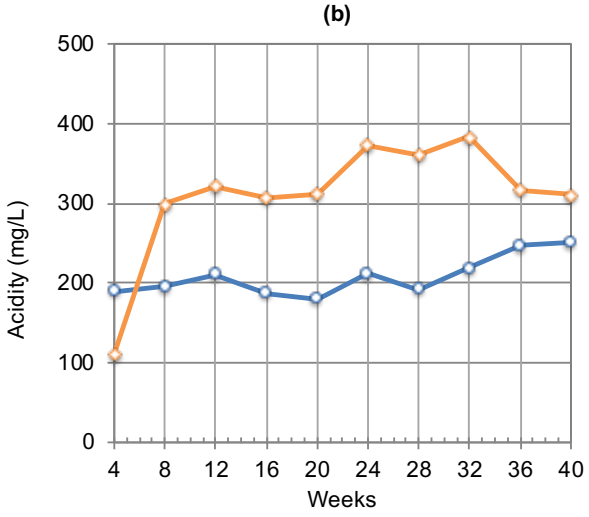
Parameters		Flotation Tailings & CTP Barren Liquor													
		Initial	Week 1	Week 2	Week 3	Week 4	Week 8	Week 12	Week 16	Week 20	Week 24	Week 28	Week 32	Week 36	Week 40
pH	-	4.0	4.7	5.2	5.3	5.2	4.95	4.9	4.8	4.8	4.78	4.83	4.8	4.8	4.8
Alkalinity	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acidity	mg/l	2,540	375	210	116	110	298	321	307	311	372	360	383	316	310
EC	µS/cm	88,000	15,960	6,770	5,150	3,210	3,080	3,110	2,630	2,550	2,710	2,700	2,530	2,410	2,430
TDS	mg/L	59,301	14,437	5,183	3,705	2,727	2,798	3,756	2,702	2,534	2,624	2,338	2,124	2,232	2,171
Al	mg/l	14	0.7	0.05	0.1	0.06	0.14	0.18	0.01	0.13	0.28	0.25	0.22	0.31	0.39
As	mg/l	0.16	0.1	0.009	0.011	0.008	0.013	0.007	0.007	0.015	0.016	0.01	0.016	0.012	0.009
Ba	mg/l	0.01	0.1	0.01	0.01	0.01	0.009	0.009	0.009	0.009	0.008	0.01	0.01	0.01	0.01
Ca	mg/l	618	635	524	426	586	587	587	561	542	526	525	551	557	506
Cd	mg/l	0.09	0.02	0.003	0.004	0.001	0.001	0.001	0.0003	0.0003	0.0003	0.0002	0.0001	0.0001	0.0001
Cl	mg/l	14,100	3,130	913	564	188	192	170	42	28	10	2	1	2	4
Co	mg/l	122	27	12	7	6	14	19	16	13	15	13	9	8	9
Cr	mg/l	0.078	0.1	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cu	mg/l	1470	278	92	53	81	231	282	226	204	248	173	136	108	102
Fe	mg/l	1.0	1	0.05	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.2
Hg	mg/l	0.01	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
K	mg/l	5	2	1	1	1	2	3	4	4	4	4	3	3	4
Mg	mg/l	925	292	70	54	32	34	26	12	7	5	4	2	2	2
Mn	mg/l	570	127	55	27	16	15	11	4.4	2.7	2.6	1.5	0.7	0.6	0.6
Mo	mg/l	0.01	0.1	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Na	mg/l	18,700	4,050	913	410	121	54	29	12	7	8	7	5	6	8
Ni	mg/l	33	6.0	2.1	1.2	0.8	1.4	1.8	1.2	1.1	1.2	1.0	0.6	0.5	0.6
Pb	mg/l	0.01	0.001	0.001	0.01	0.002	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Sb	mg/l	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Se	mg/l	0.51	1	0.02	0.1	0.04	0.03	0.04	0.01	0.09	0.10	0.03	0.1	0.05	0.04
Si	mg/l	22	23	19	21	24	25	24	22	24	21	15	13	13	11
Sn	mg/l	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_4	mg/l	22,600	5,850	2,580	2,140	1,670	1640	2,600	1,800	1,700	1,780	1590	1,400	1,530	1,520
U	mg/l	91	9	1.0	0.6	0.6	1.3	2.1	1.3	1.2	2.5	1.8	1.5	1.7	2.0
Zn	mg/l	30	5	2	0.7	0.6	0.8	0.6	0.3	0.2	0.2	0.1	0.1	0.1	0.1

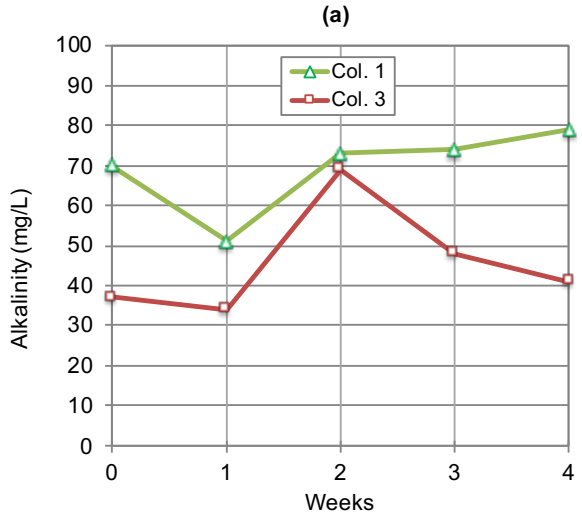
Underline indicates that the concentration is less than the limit of detection

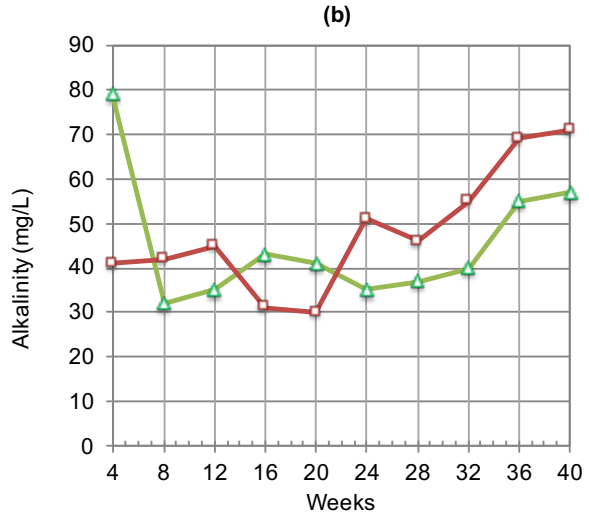






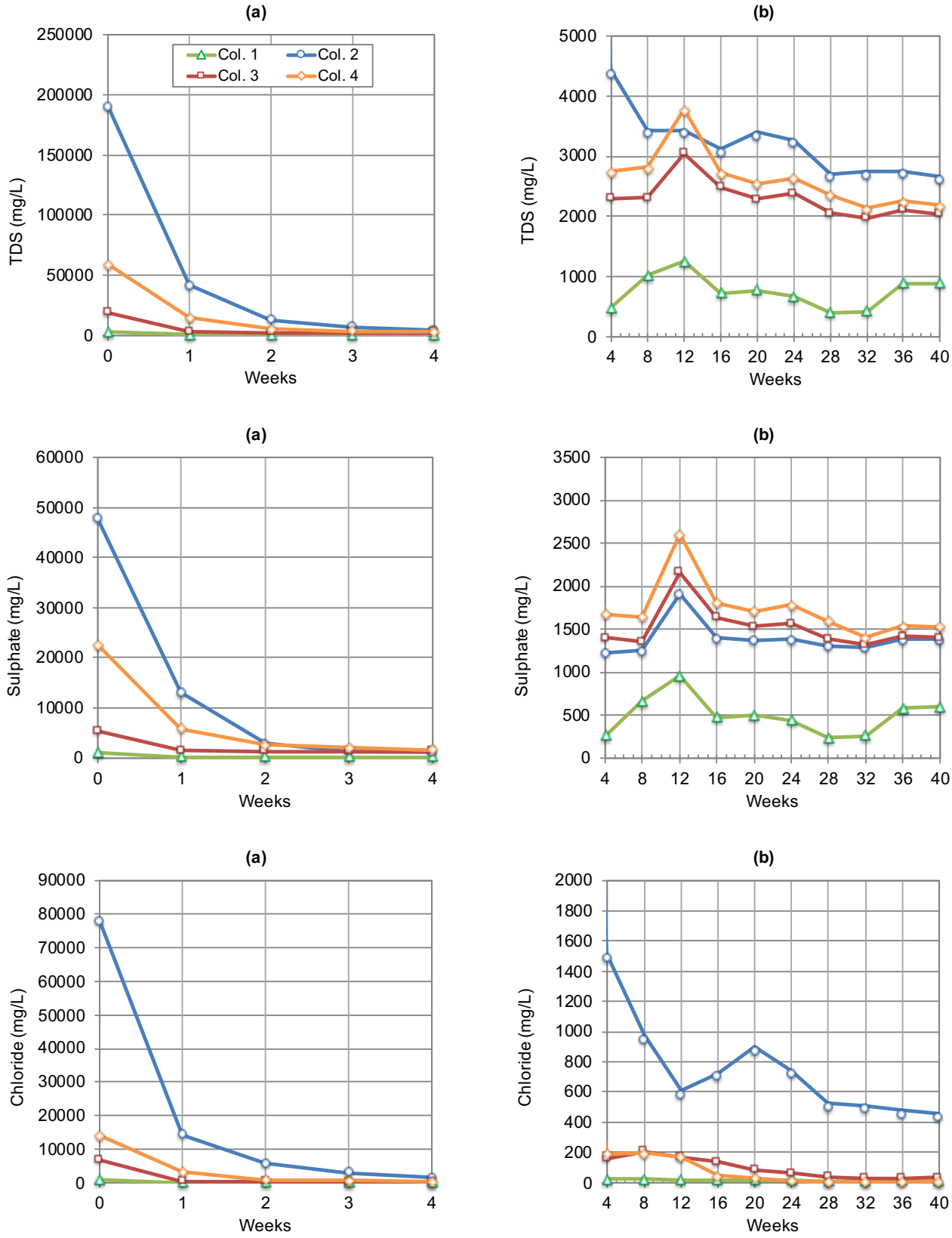






APPENDIX B: *Leachate quality versus time plots for flotation tailings and ICP residue samples*

Col 1 *=flotation tailings,* ***Col 2*** *=ICP solids,* ***Col 3*** *=Blend flotation and ICP,* ***Col 4*** *=Flotation & CTP barren liquor*



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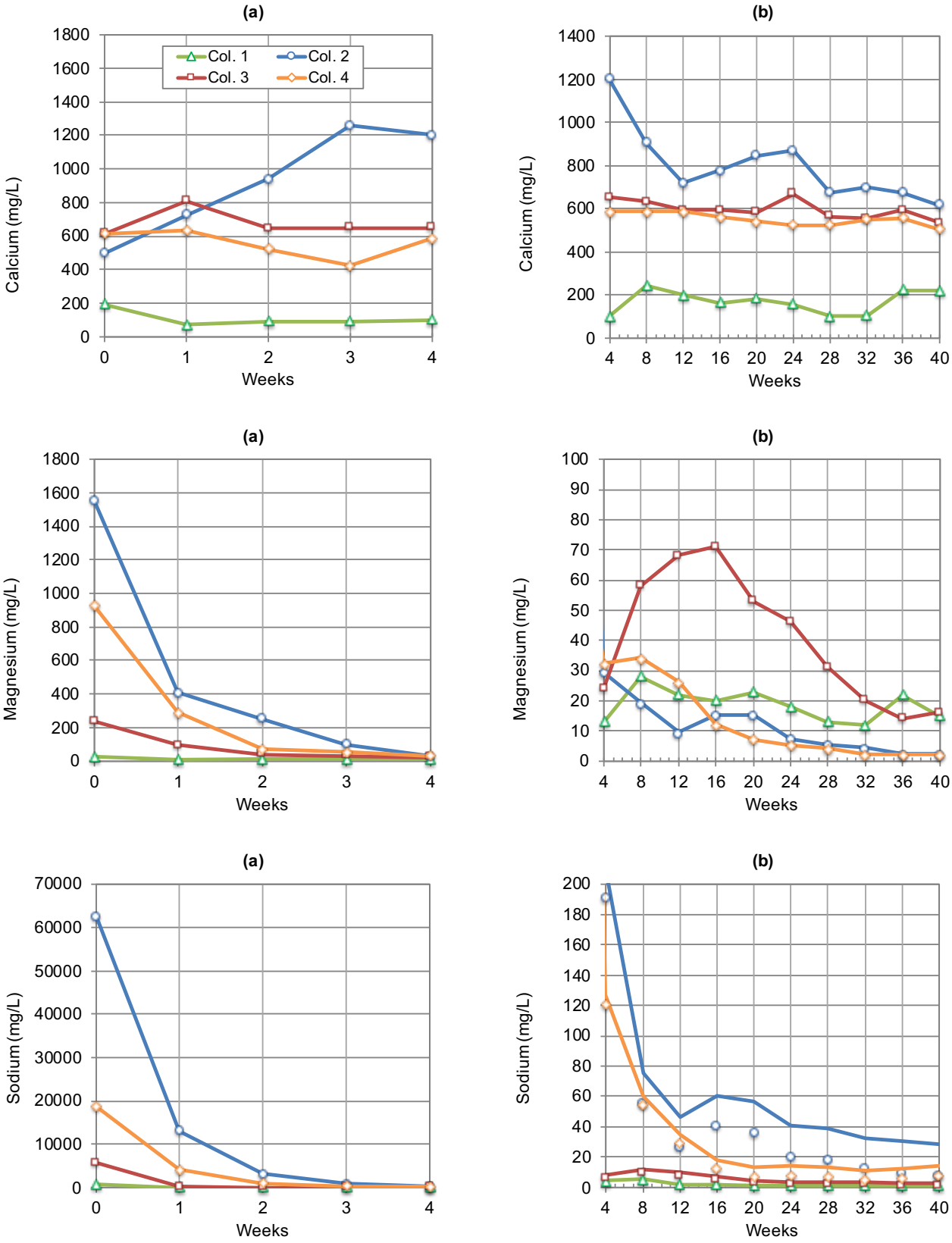

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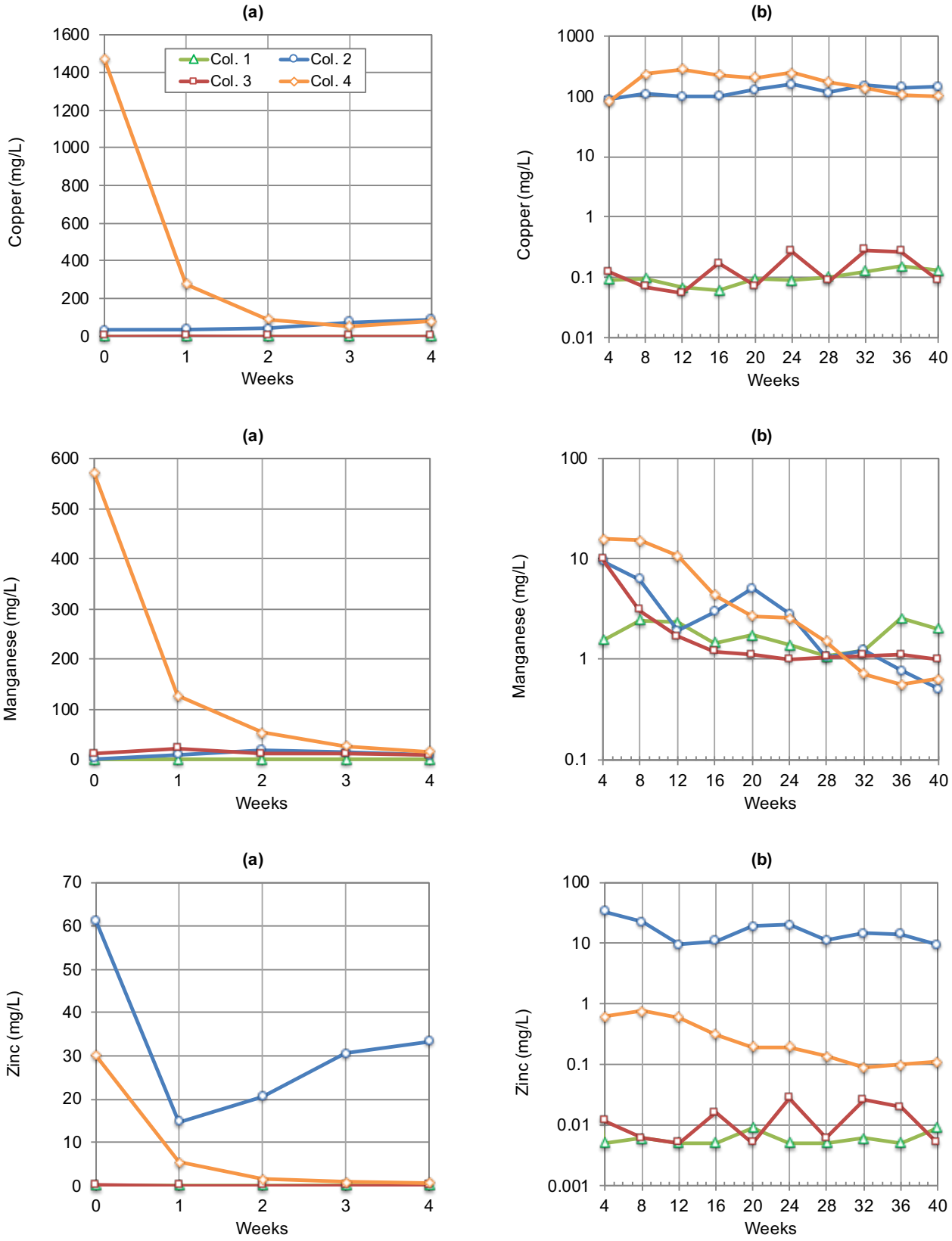

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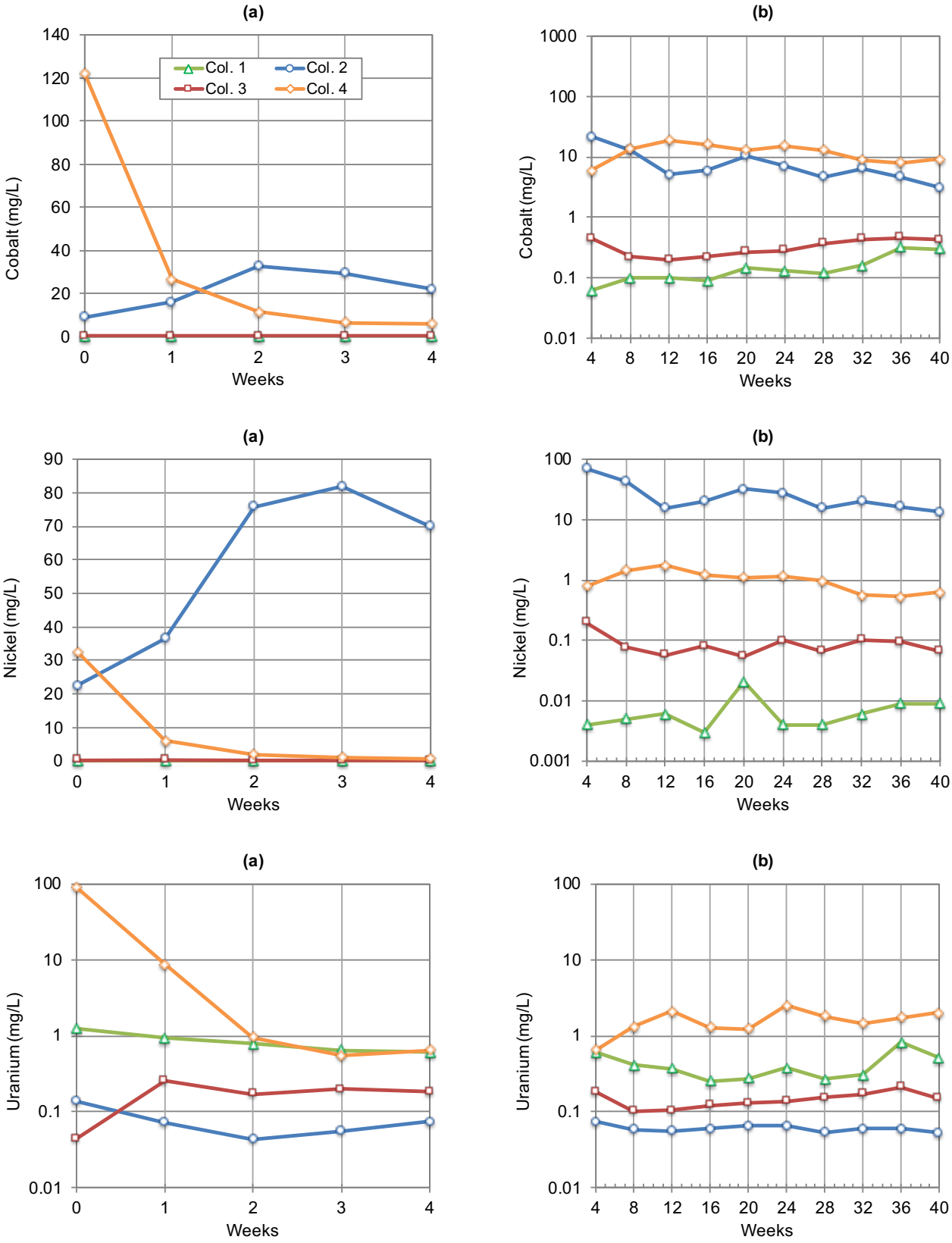

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APPENDIX B
Geochemical Kinetic Testing of Flotation Tailings

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Geochemical Kinetic Testing of Flotation Tailings

BHP Group Limited Carrapateena Project

S2043 / J000663 / R1499

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Geochemical Kinetic Testing of Flotation Tailings

BHP GROUP LIMITED CARRAPATEENA PROJECT

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LIST OF ABBREVIATIONS

ABBREVIATIONS USED IN GEOCHEMICAL ASSESSMENT

ARD	Acid Rock Drainage
AMD	Acid and Metalliferous Drainage
NMD	Neutral and Metalliferous Drainage
ABA	Acid Base Account
$pH_{1:2}$	pH of a sample slurry with a solid to water ratio of 1:2 (by weight)
$EC_{1:2}$	Electrical Conductivity of a sample slurry with a solid to water ratio of 1:2 (by weight)
S	Sulphur
CRS	Chromium Reducible Sulphur
KCl	Potassium Chloride
H_2SO_4	Sulphuric Acid
SO_4	Sulphate
$CaCO_3$	Calcium Carbonate
ANC	Acid Neutralising Capacity in kg H_2SO_4/t
ABCC	Acid Buffering Characteristic Curve
ANC_{ABCC}	Acid Neutralising Capacity in kg H_2SO_4/t estimated from ABCC testing
CNV	Carbonate Neutralising Value in kg H_2SO_4/t
MPA	Maximum Potential Acidity, calculated from total S in kg H_2SO_4/t
NAPP	Net Acid Producing Potential, calculated from ANC and total S (or MPA) in kg H_2SO_4/t.
NAG	Net Acid Generation (test)
NAGpH	pH of NAG solution before titration
$NAG_{(pH4.5)}$	NAG acidity titrated to pH 4.5 in kg H_2SO_4/t
$NAG_{(pH7.0)}$	NAG acidity titrated to pH 7.0 in kg H_2SO_4/t
GAI	Geochemical Abundance Index based on multi-element analysis of solids
PAF	Potentially Acid Forming
PAF-LC	Potentially Acid Forming - Low Capacity
NAF	Non-Acid Forming
UC	Uncertain

UNITS OF MEASUREMENTS

%	Percentage
°C	Degrees Celsius
dS	Deci Siemen
µm	Micrometre
mm	Millimetre
m	Metre
mg	Milligram
g	Gram
kg	Kilogram
t	Tonne
L	Litre
mL	Millilitre

OTHER ABBREVIATIONS

ALS	Australian Laboratory Services
EGi	Environmental Geochemistry International Pty Ltd
ROM	Run-of-Mine

EXECUTIVE SUMMARY

BHP's Carrapateena mine currently uses sub-level caving (SLC) to access copper bearing ore, principally as chalcopyrite and bornite which is upgraded through flotation, with the tailings deposited in a valley fill tailings storage facility (TSF). The Carrapateena Expansion will build upon the existing SLC mining operation to access deeper mineralisation within the deposit through Block Cave (BC) development to increase production up to 12 million tonnes per annum (Mtpa) and extend the life of mine (LOM). During this time, the nature of the ore will evolve, with a decrease in copper-sulphur ratio (Cu:S) corresponding to decreasing bornite and chalcopyrite and increasing pyrite in the plant feed. When future block cave (FBC) ore is processed, the current bulk flotation process may be modified to include liming to facilitate pyrite depression. Under these conditions sulphur deportment to the tailings may increase, potentially changing the acid rock drainage (ARD) potential of the tailings in the TSF.

As a part of the Carrapateena expansion project involving an increase to the TSF capacity, EGi was commissioned to undertake a study of the geochemical properties of tailings that will represent the materials which will be deposited in the TSF to LOM. To this end, six kinetic leach column (KLC) tests were conducted for period of six months. The KLC tests were:

- Bornite (Bn) tailings from the Carrapateena concentrator using both deionised (DI) and process water for leaching
- Chalcopyrite (Cpy) tailings from the Carrapateena concentrator using both DI and process water for leaching
- Future block cave (FBC) tailings produced from laboratory flotation using both DI and process water for leaching

In one set of tests, kinetic leach column testing was conducted with the three tailings types (Cpy, Bn and FBC) using process water to produce leachates. This was done to simulate conditions at the TSF surface during the operational period in which tailings are deposited as a slurry in the hypersaline process water (≈100 g/L salinity) from the plant. It was thought that the high salinity of the process water has the potential to influence both the pyrite oxidation rate and the mobility of metals released during oxidation of the tailings.

In a second set of tests, each of the three tailings samples were subjected to leach column testing using DI water. This was done to assess the leaching behaviour of tailings under oxidative conditions in the period following cessation of deposition of tailings in the TSF, when the only water added to the tailings will be rainfall, or if processing were conducted using fresh (low salinity) makeup water.

The three tailings samples underwent geochemical testing to define the acid forming characteristics of each material. This testing demonstrated that the Cpy tailings was largely devoid of pyrite and contained limited neutralising capacity in the form of dolomite. The Bn and FBC tailings contained increasing amounts of pyrite and dolomite. A combination of mineralogical analysis and geochemical testing demonstrated that the three tailings samples used in this study, are non-acid forming (NAF) materials which are unlikely to generate ARD on exposure to air. While the Bn and FBC tailings contain sufficient pyrite to potentially generate acidity when oxidised, any acidity will be readily neutralised by reaction with dolomite present in the tailings.

The results of leach column testing for three tailings samples using both hypersaline process water and DI water for the leaching experiments, demonstrated that the very high salinity of the process water in comparison with DI water resulted in very different leaching behaviour for each of the tailings samples. While in both cases leachate pH was circum-neutral for all three tailings, in process water, leachate metal concentrations were significantly higher than in DI water leachates, even after correction for the background concentrations present in the process water. In addition, the rate of pyrite oxidation appeared to be suppressed in process water in comparison to DI by about an order of magnitude. These results suggest the potential for different leaching behaviour for tailings in the TSF pre- and post-closure (assuming the use of hypersaline process water to closure) or for tailings generated from processing using hypersaline and low salinity processing waters.

Specifically, the findings from this study on the geochemical behaviour of flotation tailings at Carrapateena can be summarised as follows:

- If the Cpy and Bn tailings used for this study are representative of tailings that will be produced during processing of ore during the remaining period of SLC mining at Carrapateena, the tailings deposited in the TSF will be NAF, with an excess of neutralising capacity derived principally from dolomite.
- If the FBC tailings used for this study are representative of tailings that will be produced during processing of ore during the future period of BC mining at Carrapateena, the tailings deposited in the TSF will have higher pyrite content than the Cpy and Bn tailings and the balance between the potential acidity generated from pyrite oxidation and the acid neutralising capacity in the tailings (principally from dolomite) will be more evenly balanced. Combined, test results suggest a NAF classification for the tested FBC tailings sample.
- The NAF classification of the tailings tested in this study and the apparent very slow oxidation rate of pyrite in the tailings when leached with process water, resulted in neutral pH leachate, with alkalinity in the entrained pore water sufficient to neutralise any acidity generated from pyrite oxidation.
- Despite the neutral pH and excess alkalinity in leachates, the high chloride concentration in process water resulted in solubilisation and mobilisation of a range of heavy metals, principally as metal chloride complexes. Mobilised metals included Ag, Co, Cu, Mn, Ni, Tl, U and Zn which were present in leachates at significantly elevated concentrations.
- Should the salinity of process water increase over time due to evaporative concentration in both short- (thickener O/F) and long-recycle (TSF decant), then it is possible that mobilisation of some metals may increase in the longer-term, with the potential for higher metal concentrations in TSF seepage.
- Following cessation of active tailings deposition after closure, a decrease in tailings pore water salinity may occur, which will likely result in an increase in the rate of pyrite oxidation. However, should the tailings be NAF as was the case here, this will not result in low pH acidic pore water.
- Lower tailings pore water salinity will also likely result in lower concentrations of most heavy metals in TSF seepage, with the exception of uranium, concentrations of which appear to be less sensitive to salinity.
- Salt crusts formed on the surface of the column leach tests flushed with process water, contained very little heavy metals (<0.1 wt.%).

The results summarised above show that, despite all three tailings examined being non-acid forming, metal concentrations in neutral pH, saline leachates were elevated. Concentrations generally exceeded ANZECC default guideline values (DGV) by orders of magnitude. This may mean that in pore water in the oxidative zone of the TSF, metal concentrations can be expected to exceed ANZECC DGV by a considerable amount during the operational period if tailings slurry is deposited in hypersaline process water. Should tailings from processing of FBC ore have higher pyrite content than the sample examined here, then it is possible that some PAF material may be present in the TSF. This may result in even higher metals concentrations in pore waters in the oxidative zone at the tailings surface.

In view of these findings, it is recommended that further work is conducted to better define the geochemical properties of tailings deposited in the TSF and their impact on TSF pore water and potential interaction with groundwater. Specifically, it is recommended that the following should be conducted:

- Tailings should be monitored for their ARD properties to ascertain if the materials tested during the current study are representative of the plant tailings in general and that therefore the conclusions drawn from this work will be applicable to the tailings deposited in the TSF.
- Tailings samples collected from the plant should be monitored on a regular basis, using Total S and ANC analyses to assess acid and neutralising potentials, respectively. Total C and inorganic C will not be suitable surrogates to determine effective ANC because of the presence of substantial siderite/ankerite in the plant tailings. This will provide a larger data set to evaluate the ARD properties of tailings and their likely leaching properties.

- Should PAF plant tailings be identified, then leach column testing of the type undertaken here should be conducted to evaluate the geochemical properties of this class of tailings.
- TSF decant water quality should continue to be monitored including for a range of heavy metals to evaluate any potential long-term changes in tailings pore water quality.

1. INTRODUCTION

BHP's Carrapateena mine currently uses sub-level caving (SLC) to extract copper-gold ore. Copper mineralisation is principally associated with bornite (Bn) and chalcopyrite (Cpy) which is upgraded using a bulk flotation process involving flotation at natural (circum-neutral) pH. Flotation tailings are dewatered using a high-rate thickener, with the underflow deposited in a valley fill tailings storage facility (TSF). The Carrapateena Expansion will build upon the existing SLC mining operation to access deeper mineralisation within the deposit through Block Cave (BC) development to increase production up to 12 million tonnes per annum (Mtpa) and extend the life of mine (LOM). Resource definition drilling suggests that during this time the nature of the ore will evolve, with a decrease in copper-sulphur ratio (Cu:S) corresponding to decreasing bornite and chalcopyrite and increasing pyrite in the plant feed. When "Future block cave" (FBC) ore is processed, the current bulk flotation process may be modified to include liming to facilitate pyrite depression. Under these conditions sulphur deportment to the tailings may increase, potentially changing the acid rock drainage (ARD) potential of the tailings in the TSF.

If during processing of BC ore tailings density is increased from the current 60-65% solids, this will result in decreasing water content within the tailings at a time when tailings are likely to have increased pyrite content. Post closure, when water input to the TSF will include only rainfall and run-off, the tailings will dry out further due to the large negative water balance prevailing at Carrapateena.

Process water at Carrapateena is sourced from hypersaline groundwater with a salinity of around 90 g/L. Consequently, pore and supernatant water in the TSF currently has a salinity of around 100 g/L which appears to be increasing as evaporation concentrates salt within the TSF. If there is continued use of hypersaline water for processing, salinity may increase to LOM and beyond as the tailings dry out. Under these hypersaline conditions, there is potential for pyrite oxidation and metal leaching to show modified behaviour in comparison with freshwater conditions. For example, oxidative dissolution rates in saline solutions up to 200 g/L have been shown to decrease by an order of magnitude. This was attributed in part to deceased oxygen solubility in hypersaline water and possible chloride adsorption on the pyrite surface[1]. Hypersaline conditions may also modify the leaching characteristics of the tailings, with high salinity often increasing the mobility of metals through formation of soluble metal complexes and saturation of ion exchange sites in the presence of high salt content[2].

Under these conditions it can be expected that, at closure, tailings will become undersaturated with decreased seepage from the base of the tailings, and capillary rise bringing saline pore water to the surface where evaporation will likely leave salt deposits. These deposits will potentially contain secondary minerals resulting from sulphide oxidation which, on contact with incident rainfall and run-off, may produce acidic and metalliferous drainage.

Based on the above, kinetic testing of tailings from Carrapateena was undertaken using three tailings samples covering the range of tailings which will be generated from processing of the evolving ore types. Testing included both standard leaching using deionised (DI) water and process water to investigate possible effects of hypersaline water on sulphide oxidation and solute mobility.

Testing included six kinetic leach column (KLC) tests which were conducted for period of six months. The KLC tests were:

- Bornite tailings from the Carrapateena concentrator using both DI and process water for leaching

[1] V. Vandeginste et al., 2021. Effect of salinity on the kinetics of pyrite dissolution in oxygenated fluids at 60°C and implications for hydraulic fracturing, *J. Natural Gas Sci. Engineering*, **86**, 103722.
[2] Government of Western Australia, Department of Environment Regulation, 2015. Background paper on the use of leaching tests for assessing the disposal and re-use of waste-derived materials, State of Western Australia 2015.

- Chalcopyrite tailings from the Carrapateena concentrator using both DI and process water for leaching
- Future block cave tailings produced from laboratory flotation using both DI and process water for leaching

This report describes the results of the above leach column tests and potential implications for management of the TSF during life of mine and post mine closure.

2. METHODOLOGY

2.1. Samples

Three tailings samples were received from Golder's Perth laboratory facility where dewatering testing was undertaken. The three samples described below were received as slurries or as a moist paste. The samples tested were:

1. Plant tailings collected during processing of "chalcopyrite" (Cpy) ore from sub-level caving with a Cu:S ratio of 1.03
2. Plant tailings collected during processing of "bornite" (Bn) ore from sub-level caving with a Cu:S ratio of 1.32
3. Laboratory flotation tailings from "future block cave" (FBC) ore obtained from drill core with a Cu:S ratio of 0.45

These samples were originally used by FLSmidth for thickening and filtration experiments[3] and unused tailings slurries were subsequently sent to Golders for further testing[4]. Information supplied by Golder described the history of the samples as follows:

- Golder received the samples on 9 February 2021 from FLSmidth. We are not aware of what procedures/sampling that FLSmidth undertook with respect to air drying, re-saturation etc. Because FLSmidth did its program studying dewatering of tailings the samples were received as slurry.
- Golder undertook testing as follows:
    - Sample of each stream of the solids for
        - particle size distribution. Sample discarded.
        - specific gravity of solids. Sample discarded.
        - plasticity index. Sample discarded.
        - standard compaction. This test uses about 10 kg of solids and could be considered "destructive" - we compact the soil in layers into a mold using a 2.5 kg hammer. This part of the sample may have undergone some particle crushing, but no testing was undertaken to identify whether this occurred or not (it is not standard procedure to do so). The optimum moisture content of the sample was about 11%, so we dried the sample as part of the test work. Sample returned to buckets as this was a relatively high mass and a fair bit of the sample.
    - Then, test work only on Bn and Cpy tailings streams that included:

[3] FLSmidth 2020. Report of the investigation into the thickening and filtration of Carrapateena copper tailings for OZ Minerals, December 2020.
[4] Golder Associates Pty Ltd 2021. Tailings Storage Facility CarraX Feasibility Study Phase 1, Report prepared for OZ Minerals Carrapateena Pty Ltd 20438022-04-R-RevA, May 2021.

- Remolding ~800g of solids into a cylinder for strength testing where we shear the sample. Sample is flushed with deionised water at the start of the test and then oven dried at the end of the test. Samples returned to respective buckets after testing as dry solids.
- Pouring ~1 kg of slurry at 62% w/w slurry into a small mold and loading it with a computer-controlled press. Samples were oven dried at the end of the test. Solids returned to respective buckets after testing as dry solids.

Process water used for leach column testing was collected from the Carrapateena concentrator on the 3rd of September 2021. 60 L of water was received for testing on the 14th of September 2021. Filtered (0.45 μm membrane) process water was submitted to the ALS Environment laboratory in Sydney for multi-element analysis including a suite of metals (ICP-MS), and major cations and anions. pH, EC and alkalinity were measured in EGi's laboratory.

Sub-samples of each of the tailings were collected from thoroughly mixed samples and then dried to a constant weight at 60°C. The moisture content was calculated (Table 1) and these values used to calculate the wet mass of material required to provide 2 kg dry weight equivalent to be used for column testing. The dried samples were retained for further geochemical characterisation testing described below.

Table 1: Moisture content of tailings samples as received

EGi Sample Code	Description	Moisture Content (%)
21780 (21376 + 21378)	Chalcopyrite	16%
21380	Bornite	10%
21377	Future Block Cave	8%

2.2. Characterisation of tailings samples

The initial geochemical characterisation of the three tailings samples included analysis or calculation of the following:

- Multi-element analysis of solids (supplied by OZ Minerals and conducted by Bureau Veritas, Wingfield SA)
- Particle size distribution (obtained from FLSmidth and conducted by Bureau Veritas, Wingfield SA)
- Sulphur and Carbon contents and speciation
- Acid neutralising capacity (ANC)
- Acid buffering characteristic curve (ABCC - Bn and FBC samples only)
- Maximum potential acidity (MPA)
- Net acid producing potential (NAPP)
- Net acid generation (NAG) capacity
- Kinetic NAG test (FBC sample only)
- (Semi)-Quantitative X-Ray Diffraction (QXRD) Analysis

ANC, ABCC and NAG testing was conducted by EGi using methods described in the ARD Test Handbook[5]. Sulphur speciation analysis, which included Total S analysis by high temperature combustion analysis, sulphate analysis by HCl extraction and chromium reducible sulphur (CRS) analysis, were conducted by the ALS Geochemistry and Environmental laboratories in Brisbane. Carbon speciation analysis including Total C (high temperature combustion analysis) and organic carbon analysis (high temperature combustion analysis after pre-treatment with acid) were also conducted by ALS Geochemistry in Brisbane.

QXRD analysis was undertaken by McKnight Mineralogy. X-ray diffraction traces were obtained from the samples with a Panalytical Aeris Research Powder Diffractometer and Pixcel linear detector. Operating conditions were CoKα, 40kV/15mA, Fe Kß filter, step scan 0.01/29 secs˚2Θ at, 1/4˚ divergence and a 1.0˚ ant-scatter slit. Scan range was 5° to 90° 2Θ. Phases were identified by computer search-match of the ICDD PDF4 2020 Minerals and 2021 COD Databases. Quantitative results have been determined with full pattern Rietveld refinement software.

2.3. Kinetic leach column testing

EGi's standard free-draining column leach method was used for leach column testing, as described in the ARD Test Handbook. The columns were set-up and maintained at EGi's specialised geochemical laboratory in Sydney. Each column comprises 2.0 kg (dry weight) of tailings housed within a plastic Buchner funnel measuring 174 mm in diameter and 100 mm in height. The funnel configuration provides a free-draining condition and a relatively high exposure area per unit mass of sample, thereby providing conditions amenable to sulphide oxidation should it occur. For tailings deposited in a TSF, this would most closely represent tailings at the surface of the deposited material which has dried sufficiently to be unsaturated for the majority of the time.

Leach column testing of the three samples commenced on 1 October 2021. Immediately following setup, the samples were flushed with 800 mL of deionised water or Carrapateena process water and first-flush leachates were collected for analysis on 5 October 2021. Thereafter, samples were subjected to cyclic wetting and drying on a weekly basis over a four-week leach cycle. During the first three weeks of each cycle the samples were moistened by a once weekly addition of water at a rate of 100 mL/kg (typically on Friday). On the fourth week the samples were flushed by addition of 400 mL/kg, with the leachates collected in plastic containers positioned immediately beneath the funnel spouts. Typically, 500 to 550 mL of leachate were collected from each column per cycle. Heat lamps positioned above the columns are operated for 8 hours per day for 4 days during each week of the four-weekly cycle (typically Monday to Thursday) to allow drying of the samples. Under this regime, surface temperatures are typically around 30 ^{o}C during the heating cycle, simulating drying of the TSF beaches.

Leachates from the columns were assayed for pH, EC, alkalinity/acidity, and a suite of elements that included Ag, Al, As, B, Ba, Be, Ca, Cd, Cl, Co, Cr, Cu, Cs, F, Fe, Hg, Li, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Si, Sn, SO4, Sr, Th, Tl, U and Zn.

Leaching extended for 24 weeks which, in addition to the initial flush, included seven 4-week leach cycles.

2.4. Solution speciation modelling calculations

Solution speciation modelling was conducted using Visual MINTEQ 3.1 modelling software. Modelling was undertaken using the Specific Ion Interaction Theory (SIT) method for activity calculations. Standard methodologies such as the

[5] Environmental Geochemistry International and Ian Wark Research Institute, University of SA, 2002. ARD Test Handbook, AMIRA International, May 2002.

use of the Debye-Hückel term to calculate ion activities are typically suitable only up to an ionic strength in the order of 0.3 M. The process water solutions modelled in this instance ranged from about 2.0 to 2.5 M ionic strength. The SIT method has been shown to provide reliable results typically up to around 3 M ionic strength[6], and in some instances for solutions as high as 10 M[7]. Thus, the use of SIT for calculation of solution species activities was thought more appropriate to the process water leachate solutions studied here.

The SIT method adds an additional term to the Debye-Hückel term to calculate ion activities known as the ion interaction coefficient. Unfortunately, there are a limited number of experimentally determined ion interaction coefficients available. Thus, while there is a broad range of ion interaction coefficients available in the literature for mono-valent cations such as sodium and potassium and covering a large number of anionic species, the number available for di- and tri-valent cations such as calcium and ferric iron is very limited[8]. Therefore, the Visual MINTEQ 3.1 modelling software uses estimates for ion interaction coefficients where these are not available.

3. RESULTS

3.1. Tailings characterisation

3.1.1. QXRD analysis results

The results for QXRD analysis of the three tailings samples are shown in Table 2. All samples contained quartz (35 – 40%) and hematite (45 – 50%) as the dominant phases, in addition to chamosite (iron rich chlorite) as a less dominant phase (2 – 10%). Carbonate mineralogy includes dolomite (all samples) and siderite (Bn and FBC). QEM-SCAN analysis of the Cpy and Bn samples conducted by OZ Minerals (not reported here) suggested the presence of ankerite (iron rich dolomite), which may also be present. The presence of significant leachable manganese (see Sections 3.1.3 and 3.3.1) may suggest manganese rich siderite and/or ankerite which is not distinguished by XRD. Sulphide mineralogy is dominated by pyrite, with FBC and Bn tailings showing the highest concentrations. Copper sulphides covellite - CuS (Bn tailings only) and digenite - Cu_9S_5 (Cpy tailings only) are present in trace amounts. Notably, bornite and chalcopyrite were not detected in any of the tailings samples (except 0.1% chalcopyrite in the Cpy tailings), suggesting that flotation had successfully separated these copper minerals from pyrite gangue. The presence of only trace amounts of gypsum may indicate limited oxidation had occurred during the storage of these materials. Trace amounts of halite have probably occurred as a result of precipitation during drying of the samples prior to analysis.

These QXRD results were generally in agreement with other analytical results (see Section 3.1.2) supporting the mineral composition of the tailings samples as detailed in Table 2. It should be noted that XRD analysis detects only crystalline phases, and any non-crystalline materials are not identified. The amorphous content of the three tailings samples were not determined during XRD analysis, and so the mineral compositions shown in Table 2 represent only the crystalline component of the tailings samples, which may or may not constitute the total sample.

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[6] M. P. Elizalde and J. L. Aparicio, 1995. Current theories in the calculation of activity coefficients – II. Specific interaction theories applied to some equilibria studies in solution chemistry, *Talanta*, **42**(3), 395 – 400.
[7] P. Silpos, 2008. Application of the Specific Ion Interaction Theory (SIT) for the ionic products of aqueous electrolyte solutions of very high concentrations, *J Mol. Liquids*, **143**, 13 – 16.
[8] I. Grenthe, A. V. Plyasunov and K. Spahiu, 1997. Estimations of medium effects on thermodynamic data, in *Modelling in aquatic chemistry*, I Grenthe and I Puigdomenech eds., Organization for Economic Co-Operation and Development, 1997, Paris, France.

Table 2: QXRD analysis results for tailings samples.

Phase	Cpy[1,2]	Bn[1,2]	FBC[1,2]
Quartz	39.7	39.6	35.7
Hematite	47.8	47.9	47.1
Chamosite	2.1	4.3	8.9
Dolomite	0.2	0.9	3.9
Siderite	0	1.1	1.6
Biotite	2.9	1.7	0.6
Muscovite	2.7	1.9	0.3
Pyrite	0.2	0.8	1
Halite	0.6	0.7	0.4
Microcline	2.9	0	0
Apatite	0.5	0.7	0.4
Covellite	0	0.3	0
Gypsum	0.1	0.1	0.1
Chalcopyrite	0.1	0	0
Bornite	0	0	0
Digenite	0.2	0	0

1. Results are wt. % normalised to 100%.
2. 0 wt. % denotes below the detection limit

3.1.2. Acid forming characteristics

The three tailings samples were subjected to extensive static geochemical analysis in order to determine their acid forming characteristics. The results of these analyses are presented in Tables 3 to 5 and based on these results the ARD classification for each sample is shown Table 6.

Table 3 shows the results of sulphur and carbon speciation analysis. These results can be summarised as:

- The sulphur content of the Cpy tailings is low with approximately half present as sulphate.
- Bn and FBC tailings have higher sulphur content most of which is present as sulphide S
- There is good agreement between sulphide S and CRS results, suggesting sulphide S is principally present as pyrite[9] in agreement with QXRD results
- Total C content of the three tailings samples ranged from about 0.2 to 0.4%, almost all of which is present as inorganic C
- Comparison of inorganic C measurements with QXRD results suggest the carbonate contents of these materials derived from QXRD are probably overestimated in most cases but are in general agreement.

[9] R. Schumann, W. Stewart, S. Miller, N. Kawashima, J. Li and R. Smart, 2012. Acid-base accounting assessment of mine wastes using the chromium reducible sulfur method, *Sci. Total Environ.*, **424**, 289-296.

Table 4 shows the results of ANC analysis of the three tailings samples. Comparison of ANC and carbonate neutralisation value (CNV) calculated from the inorganic C content show that for the Bn and FBC samples, CNV suggests significantly higher neutralising capacity than the standard ANC value. ABCC analysis, which determines the content of readily available neutralising capacity, shows excellent agreement between ANC and ABCC, implying CNV has overestimated the neutralising capacity of Bn and FBC tailings (Table 4). ABCC results (Figure 1) indicate that dolomite is the dominant neutralising mineral present in these samples, but also suggest the possible presence of siderite or ferroan dolomite in agreement in QXRD analysis results.

Comparison of the acid forming and acid neutralising characteristics of the three tailings samples show that:

- The Cpy tailings has an excess of neutralising capacity
- There is a close balance between the acid and neutralising capacity for the Bn tailings sample with potentially a slight excess of neutralising capacity
- There is a close balance between the acid and neutralising capacity for the FBC tailings sample with potentially a slight excess of acid forming capacity

NAG testing was used to support the results of acid base analysis and confirmed the excess neutralising capacity of the Cpy and Bn tailings (Table 5). These samples were therefore classified as NAF (Table 6). The FBC sample gave a NAGpH of 4.6 indicating little change in the pH of the peroxide solution used for the NAG test. This suggests neither an excess of acid forming, nor acid neutralising reactions occurred during NAG testing of this material, in agreement with acid-base analysis results. The conflict between ABA and NAG test results suggests an uncertain ARD classification for the FBC sample (Table 6), but kinetic NAG testing demonstrated a lack of reactivity in this material (Figure 2) supporting a likely NAF classification.

In summary, the combination of QXRD analysis and ARD testing demonstrate that the three tailings samples used in this study to assess the leaching characteristics of typical tailings materials which will be generated through the life of the Carrapateena mine, are non-acid forming materials which are unlikely to generate low pH acidic leachates on exposure to air. While the Bn and FBC tailings contain sufficient pyrite to potentially generate acidic conditions when oxidised, any acidity will be readily neutralised by reaction with dolomite present in the tailings.

Table 3: Sulphur and carbon speciation analysis results for tailings samples

	Sulphur and Carbon Analysis						
Sample Description	**Total %S**	**CRS %S**	**SO4 %S**	**Sulphide %S**	**Total %C**	**Org %C**	**Inorganic %C**
Cpy Tailings	0.12	0.07	0.07	0.05	0.17	0.02	0.15
Bn Tailings	0.39	0.34	0.09	0.30	0.26	0.03	0.23
FBC Tailings	0.67	0.53	0.12	0.55	0.38	0.03	0.35

Table 4: Calculated acid-base values and measured ANC and ABCC for tailings samples

Sample Description	Acid Base Analysis								
	MPA	**ANC**	**CNV**	**ABCC**	**NAPP**	**NAPP***	**NAPP****	**NAPP*****	**ANC/MPA**
Cpy Tailings	4	12	12	-	-8	-10	-11	-	3.3
Bn Tailings	12	12	19	11	0	-3	-10	-2	1.0
FBC Tailings	21	15	29	14	6	2	-12	3	0.7

MPA = Total S x 30.6 (kg H_2SO_4/t)

ANC = Acid Neutralising Capacity (kg H_2SO_4/t)

CNV = Inorganic C * 81.7 (kg H_2SO_4/t)

NAPP = Total S * 30.6 - ANC (kg H_2SO_4/t)

NAPP* = Sulphide S * 30.6 - ANC (kg H_2SO_4/t)

NAPP** = Sulphide S * 30.6 - CNV (kg H_2SO_4/t)

NAPP*** = Sulphide S * 30.6 - ABCC (kg H_2SO_4/t)

Table 5: NAG test results for tailings samples

Sample Description	NAG Test		
	NAGpH	**$NAG_{(pH4.5)}$**	**$NAG_{(pH7.0)}$**
Cpy Tailings	7.8	0	0
Bn Tailings	7.7	0	0
FBC Tailings	4.6	0	5

NAGpH = pH of NAG liquor

$NAG_{(pH4.5)}$ = Net Acid Generation capacity to pH 4.5 (kg H_2SO_4/t)

$NAG_{(pH7.0)}$ = Net Acid Generation capacity to pH 7.0 (kg H_2SO_4/t)

Table 6: ARD classification for tailings samples

Sample Description	ARD Classification
Cpy Tailings	NAF
Bn Tailings	NAF
FBC Tailings	UC (NAF)

NAF = Non-Acid Forming

PAF = Potentially Acid Forming

PAF-LC = PAF - low capacity

UC = Uncertain Classification

(Expected classification in brackets)

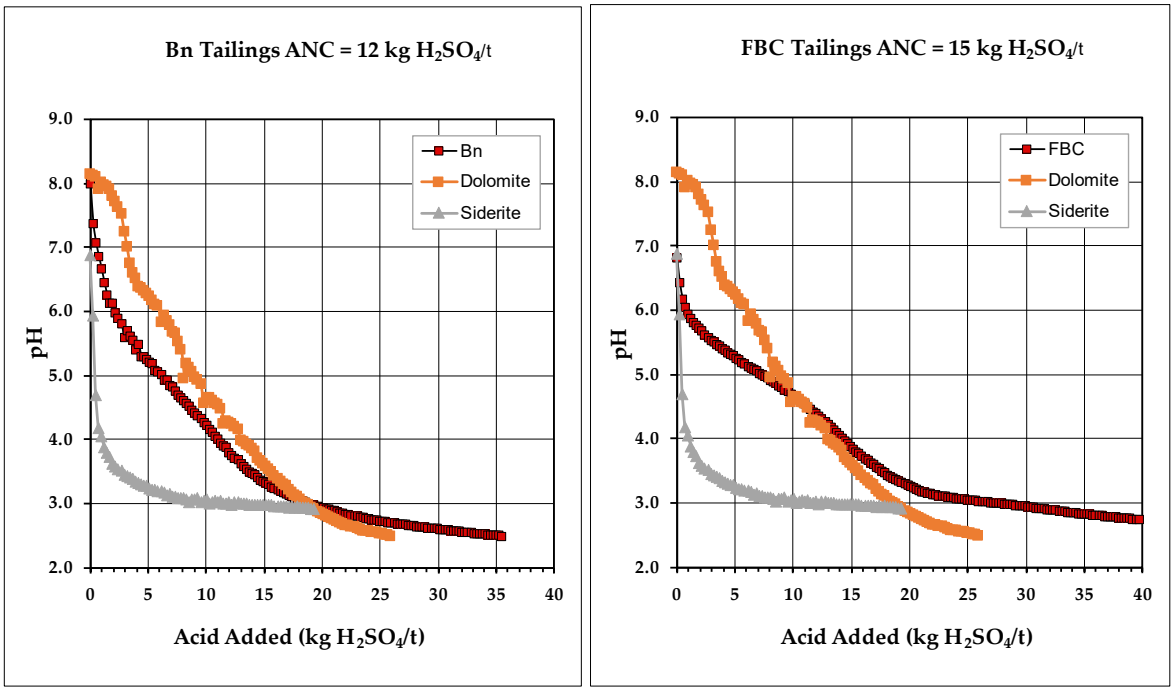


Figure 1: ABCC test results for the Bn tailings (left) and FBC tailings (right) samples. For comparison dolomite and siderite samples with an equivalent ANC of 13 kg H_2SO_4/t are shown for each plot.

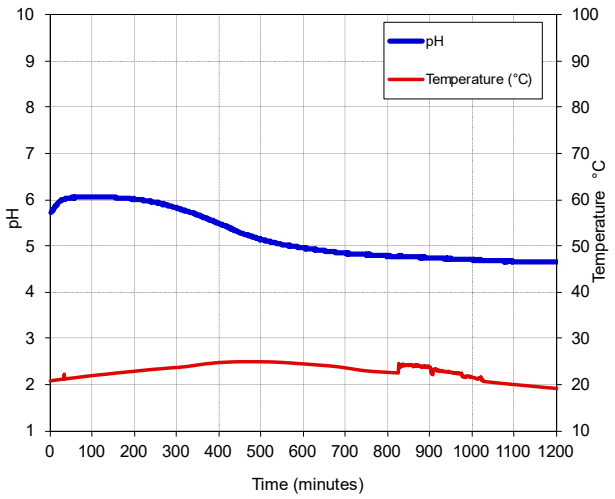


Figure 2: Kinetic NAG test results for the FBC tailings sample

3.1.3. Multi-element assay results

Multi-element assays were conducted previously by Bureau Veritas (results supplied by OZ Minerals) on the three tailings samples are reproduced in Table 7. Using these results, geochemical abundance indices (GAI) were calculated to determine where there is significant enrichment of various elements in the samples. The calculated GAI are also provided in Table 7. Where the GAI value is 3 or above, this represents significant enrichment above the typical background level of each element. Note, where the GAI value is shown as "-", this indicates a calculated GAI of <0.5. The data provided in Table 7, show most or all of the tailings samples show significant enrichment in Ag, As, Ce, Co, Cs, La, Mo, Se, U and W, with Be and Bi displaying evidence of some enrichment.

While elevated concentrations in a material may indicate the potential for higher concentrations in leachates, the mobility of any given element will depend on the mineral associations and environmental conditions including extent of oxidation, leachate pH etc. Enrichment in a particular element does not therefore necessarily guarantee the mobility of enriched elements.

Table 7: Multi-element assay results and calculated Geochemical Abundance Indices (GAI) for tailings samples[1]

Element	Unit	Assay Result			Median Soil Abundance	GAI		
		Cpy	Bn	FBC		Cpy	Bn	FBC
Ag	ppm	1	2	1	0.05	4	5	3
Al	%	2.66	2.59	1.99	7.10	-	-	-
As	ppm	67	57	24	6	3	3	1
B	ppm	100	80	<40	20	2	1	-
Ba	ppm	478	420	292	500	-	-	-
Be	ppm	2.0	1.9	1.5	0.3	2	2	2
Bi	ppm	1.6	1.4	1.5	0.2	2	2	2
Ca	%	0.46	0.38	0.61	1.50	-	-	-
Cd	ppm	<0.5	<0.5	<0.5	0.35	-	-	-
Ce	ppm	1560	1460	840	50	4	4	3
Co	ppm	65	75	155	8	2	3	4
Cr	ppm	100	100	450	70	-	-	2
Cs	ppm	3.1	2.5	0.5	4	-	-	-
Cu	ppm	654	750	658	30	4	4	4
Fe	%	32.50	34.00	41.80	4.00	2	3	3
Ga	ppm	<0.2	<0.2	0.6	20	-	-	-
Ge	ppm	<20	<20	<20	1	3	3	3
Hf	ppm	1	1.2	0.6	6	-	-	-
In	ppm	0.1	0.08	0.1	1	-	-	-
K	%	1.22	1.08	0.14	1.40	-	-	-
La	ppm	904	835	455	40	4	4	3
Li	ppm	28.5	30	31.5	25	-	-	-
Mg	%	0.30	0.27	0.64	0.50	-	-	-
Mn	ppm	590	382	3340	1000	-	-	1
Mo	ppm	18.5	17.5	63	1.2	3	3	5
Na	%	0.09	0.13	0.04	0.50	-	-	-
Nb	ppm	27.5	28.5	38	10	1	1	1
Ni	ppm	24	24	324	50	-	-	2
P	ppm	1600	1700	1900	800	-	1	1
Pb	ppm	32	33	33	35	-	-	-
Rb	ppm	75.2	69.4	13.8	150	-	-	-
Re	ppm	<0.1	<0.1	<0.1	-			
S	%	0.095	0.12	0.07	0.07	-	-	-
Sb	ppm	3.8	3.80	2.4	1	1	1	1
Sc	ppm	9	8	7	7	-	-	-
Se	ppm	10	10	10	0.4	4	4	4
Sn	ppm	20	16	22	4	2	1	2
Sr	ppm	132	133	49	250	-	-	-
Ta	ppm	0.4	0.5	0.5	2	-	-	-
Te	ppm	1.2	1.2	0.8	-			
Th	ppm	24.3	26.6	21.9	9	1	1	1
Ti	%	0.10	0.10	0.07	0.50	-	-	-
Tl	ppm	0.3	0.3	0.1	0.2	-	-	-
U	ppm	66.6	66.6	175	2	4	4	6
V	ppm	50	45	40	90	-	-	-
W	ppm	85	76	110	1.5	5	5	6
Y	ppm	111	111	65.9	40	1	1	-
Zn	ppm	56	58	114	90	-	-	-
Zr	ppm	44	40	22	400	-	-	-

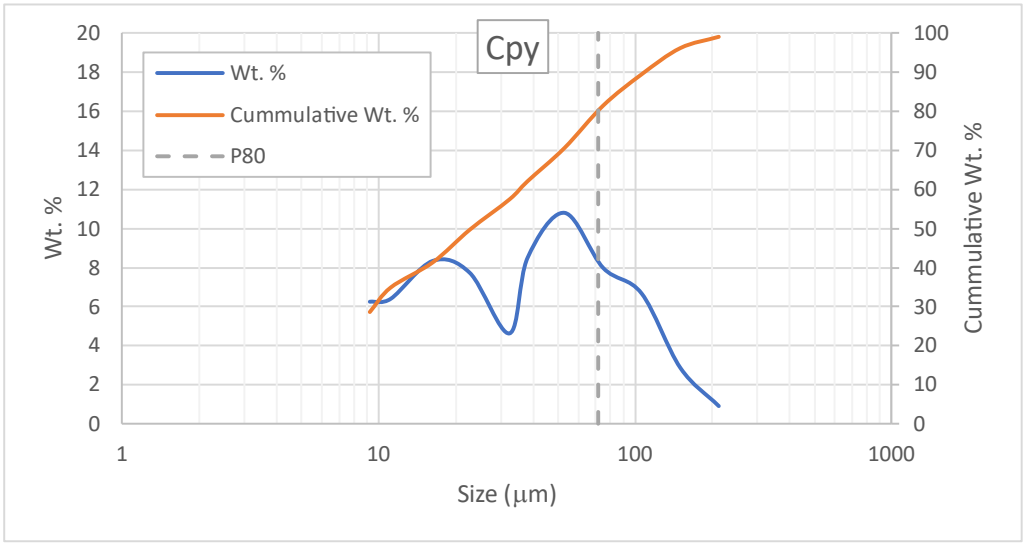
1. Highlighted GAI show GAI values ≥3 indicating significant enrichment over background concentrations.

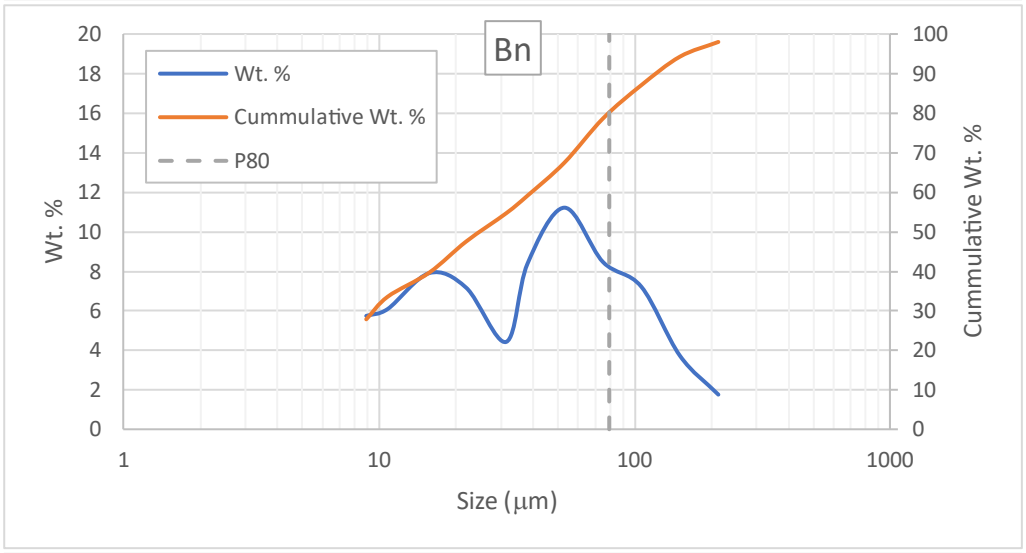
3.1.4. Particle size distribution

Particle size distributions were analysed for the three tailings samples used for this study by Bureau Veritas for FLSmidth for their earlier study conducted using the same samples. PSD analysis was conducted using screens down to 38 μm, and then Cyclosizing on the -38 μm fraction. The results of this analysis are reproduced in Figure 3.

The results show that all three samples provide an approximately bimodal distribution centred around 16 and 53 μm and all three samples also gave P80 values of between 70 and 80 μm. However, the Cpy and Bn samples, which were obtained from the plant, gave a higher percentage of material above 100 μm and a higher percentage of fines below 10 μm than the laboratory generated FBC tailings.

While these differences in PSD between comminution in the plant and laboratory mills may have implications for flotation recoveries and grades, they are unlikely to result in any significant differences in leaching rates during weathering of the tailings, given most of the material in each case is sub-100 μm. It is therefore likely that the results from leach column testing of the laboratory generated FBC tailings would be replicated when using plant tailings if they were available. It is therefore considered the use of lab generated tailings will not have significant implications for the results.





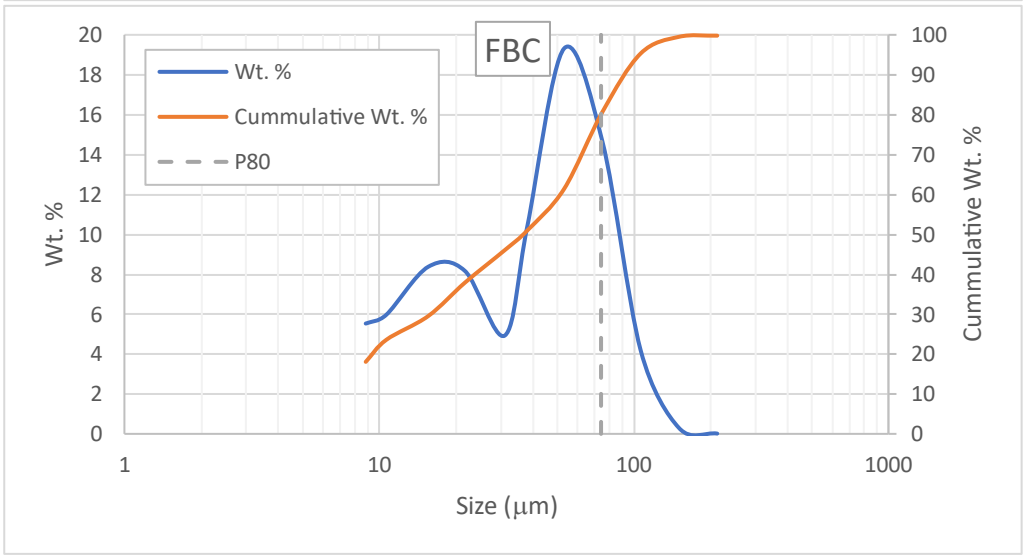


Figure 3: Particle size distributions for Cpy (top), Bn (middle) and FBC tailings (bottom).

3.2. Process water analysis

The results of process water analysis are provided in Table 8. As expected, the water is hypersaline with an ionic strength of 1.8 M equivalent to around 95 g/L salinity, principally due to sodium chloride (83 g/L) with lesser amounts of Ca, Mg, K and SO4. Significantly the process water contains 75 mg $CaCO_3$/L alkalinity at neutral pH (7.6), together with a number of metals (Co, Cu, Fe, Mn, Mo, Ni, U). The concentrations of these metals were used as baseline concentrations during analysis of column leachates and subtracted from the measured leachate concentrations to determine the concentrations leached from the tailings.

Table 8: Multi-element assay results for the process water used in this study

Parameter	Unit	Detection Limit	Result
pH		0.1	7.6
EC	dS/m	0.001	116.2
Alkalinity	mg $CaCO_3$/L	1	75
Ag	mg/L	0.001	<0.010
Al	mg/L	0.01	<0.10
As	mg/L	0.001	<0.010
B	mg/L	0.05	2.81
Ba	mg/L	0.001	0.251
Be	mg/L	0.001	<0.010
Ca	mg/L	1	4580
Cd	mg/L	0.0001	<0.0010
Cl	mg/L	1	52800
Co	mg/L	0.001	0.017
Cr	mg/L	0.001	<0.010
Cu	mg/L	0.001	0.253
F	mg/L	0.1	2
Fe	mg/L	0.05	0.14
Hg	mg/L	0.0001	<0.0001
K	mg/L	1	751
Mg	mg/L	1	1890
Mn	mg/L	0.001	1.31
Mo	mg/L	0.001	0.255
Na	mg/L	1	30400
Ni	mg/L	0.001	0.035
P	mg/L	1	<10
Pb	mg/L	0.001	<0.010
Sb	mg/L	0.001	<0.010
Se	mg/L	0.01	<0.10
Si	mg/L	0.1	5.0
Sn	mg/L	0.001	<0.010
SO4	mg/L	1	4180
Sr	mg/L	0.001	38
Th	mg/L	0.001	<0.010
Tl	mg/L	0.001	<0.010
U	mg/L	0.001	0.491
Zn	mg/L	0.005	<0.050

3.3. Kinetic leach column tests

3.3.1. Flushing with process water

Kinetic leach column testing was conducted with the three tailings types (Cpy, Bn and FBC) using process water to conduct weekly watering and monthly flushing during each four week cycle. This was done to simulate conditions on the TSF surface (oxygen freely available) during the operational period in which tailings are deposited as a slurry in the hypersaline water used in the plant. It was thought that the high salinity of the process water has the potential to influence both pyrite oxidation and the mobility of metals released during oxidation of the tailings.

Figure 4 shows some of the leachate chemistry measured during leaching of the tailings in the presence of process water. The full leachate assay data set is provided in Appendix A. The figure shows the pH and alkalinity of the process water was reduced when it was added to the tailings samples to flush any oxidation products from the column. The reduction in pH was greatest for FBC and Bn tailings and was less evident for the Cpy tailings. The decrease in alkalinity was in the order FBC>Bn>Cpy. These results suggest that alkalinity was consumed by acidity generated by oxidation of pyrite present in the tailings, with acidity generation (and alkalinity reduction) proportional to the amount of pyrite in the tailings i.e., FBC>Bn>Cpy. These results indicate on-going oxidation of pyrite in the tailings under the conditions of the leach column test in the presence of hypersaline water.

Sulphate release was also measured in column leachates (Figure 4) to estimate pyrite oxidation. However, it is evident from the data shown in Figure 4, that the concentrations of sulphate in leachates was actually lower than in the process water used to flush the columns. A similar effect was seen for calcium (Figure 4). Solution speciation calculations suggest that gypsum is a saturated phase in the process water and it possible that, on contact with the tailings during the flushing process, gypsum precipitation occurs, resulting in reduction of sulphate and calcium concentrations in leachates. It was therefore not possible to determine the rate of pyrite oxidation based on sulphate concentrations.

Figure 5 shows the calculated average intrinsic oxidation rate (IOR) for the three tailings samples plotted as a function of the sulphide sulphur content of these materials. The IOR, typically measured in units of kg $O_2/m^3/s$, provides a measure of the rate of oxidation of pyrite (expressed as the amount of oxygen consumed by the reaction) for a material where oxygen is not limiting to the reaction and therefore reflects the reactivity of the pyrite in the sample. For the columns where process water was used, IOR were calculated from the decrease in alkalinity. For the DI water columns, sulphate release was used to calculate IOR.

The strong relationship between sulphide content and IOR suggests that pyrite in these tailings samples all have similar reactivity, as the IOR is proportional to the amount (surface area) of pyrite. The results also suggest that the presence of high salinity in pore water in tailings watered and flushed with process water, has resulted in approximately an order of magnitude decrease in IOR compared with the IOR calculated for tailings flushed with DI water. This decrease in oxidation rate agrees with changes previously reported for pyrite oxidation rates measured in hypersaline solution[1]. However, IOR calculated from a decrease in leachate water alkalinity may potentially underestimate the oxidation rate, because it does not consider any dissolution of dolomite which may provide additional neutralising capacity, and which was not assessable from changes in calcium concentrations for the reasons described above. Nevertheless, these results may imply that pyrite oxidation in tailings deposited during the operational phase of the TSF is significantly attenuated due to the presence of high salinity in the pore water, and that following closure, oxidation rates could potentially increase if pore water salinity near the surface were to decrease in the longer-term due to flushing of salt by incident rainfall and run-off. It should be noted however, that IOR estimated for these tailings leached in process water are in the order of 10^{-9} kg $O_2/m^3/s$, which is at the very low end of oxidation rates measured for pyritic materials, and a 10-fold increase to 10^{-8} kg $O_2/m^3/s$ still represents a very moderate rate for pyrite oxidation.

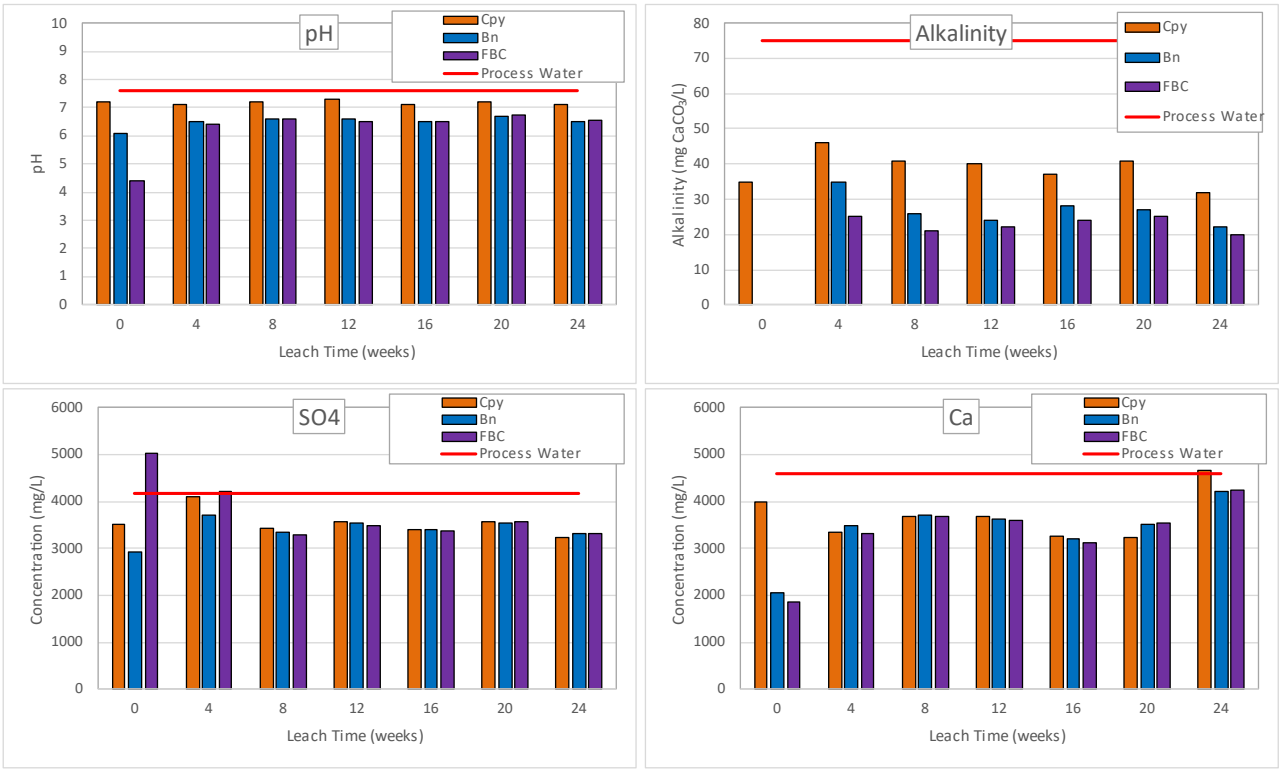


Figure 4: Leachate analysis results for the three tailings samples flushed with process water including pH (top left), alkalinity (top right), sulphate (bottom left) and calcium (bottom right). The red lines represent the corresponding values measured in the process water used in these experiments.

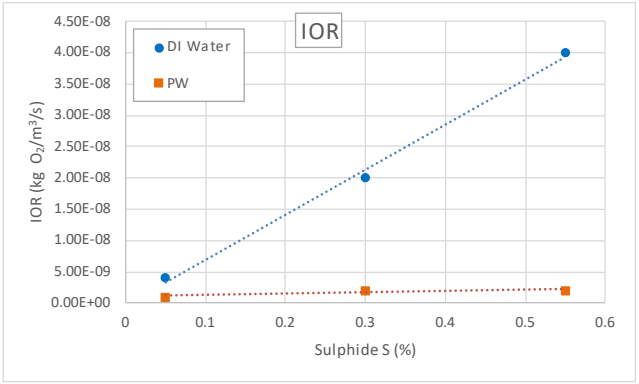


Figure 5: Average IOR for the three tailings samples flushed with process water or DI water as a function of sulphide sulphur content. IOR were calculated from SO4 release for columns flushed with DI water and from the decrease in process water alkalinity for the columns flushed with process water.

Selected leachate chemistry for the leach column tests conducted on the three tailings samples using process water is shown as time series plots provided in Figures 6 – 9 below. For comparison, the leachate chemistry of the same materials for leach column tests conducted using DI water are also provided in these figures.

The results shown in these figures can be summarised by the following:

- Leachate pH was lower in the initial flush for the Bn and FBC tailings probably reflecting the presence of oxidation products accumulated during storage.
- Process water leachate pH remained circum-neutral (6 – 7) throughout the 6-month period of the test following the initial flush in agreement with the NAF classification of the three tailings samples.
- Metal/metalloid leachate concentrations generally followed the order Mn>>U≈Zn≈Cu≈Ag>Co≈Mo>Ni>Tl>As
- As and Mo were only present in leachates from Cpy tailings
- Other metals were leached from all of the tailings materials tested, but generally in higher concentrations for the FBC and Bn tailings.
- Cu and Mn were non-detectable in the leachates from the Cpy tailings.
- Ag, Co, Cu, Ni, Tl and Zn were all detected in much higher concentrations in process water leachates than in DI water leachates.
- Mn was not found in leachates (process water or DI water) for the Cpy tailings but was found in leachates from the FBC and Bn tailings and in higher concentrations in the process water leached tailings.
- U was found in significant concentrations (mg/L range) in leachates from all of the tailings samples and in higher concentrations in the process water leached tailings.

Leachate metal concentrations were generally higher from columns flushed with process water than those flushed with DI water and generally higher than would normally be expected in aqueous solution at circum-neutral pH. Solution speciation calculations suggest that the presence of high concentrations of chloride ion has resulted in the higher dissolved metal concentrations in process water. Table 9 shows metal speciation calculated for leachate from flush 5 for the FBC tailings flushed with process water. The results, which were reproduced for other process water leachates, show that for most metals (except U), chloride salts of the form MCl_x^{y-} are predicted to be the dominant solution species. These chloride complexes appear to have increased the solubility and mobility of the metals present in the tailings, resulting in higher leachate concentrations[10,11] than found in DI water leachates.

In addition to enhanced metal leaching due to the presence of high chloride concentrations, uranium concentrations in leachates were also considerably elevated. Uranium is significantly enriched in the tailings used for leach column testing (Table 7) and it appears that it is readily leached from these materials under the oxidative conditions prevailing on the leach column test.

Table 10 shows average metal concentrations during the 6-month leaching period for the three tailings samples. For comparison, the ANZECC default guideline values (DGV) are also included in the table. The data show that metal concentrations in leachates generally exceed DGV by orders of magnitude. This may mean that in pore water in the oxidative zone of the TSF, metal concentrations can be expected to exceed ANZECC DGV by a considerable amount during the operational period when tailings slurry in hypersaline process water is deposited. While attenuation of metal concentrations may occur during migration into the underlying groundwater, it is also possible that adsorption processes are limited by high levels of salts which will saturate ion exchange sites and the metals remain mobilised.

[10] P. Altinkaya, J. Mäkinen, P. Kinnunen, E. Kolehmainen, M. Haapalainen and M. Lundström, 2018. Effect of biological pretreatment on metal extraction from flotation tailings for chloride leaching, *Minerals Eng*., **129**, 47-53.
[11] Z. Ye, S. Hong, C. He, Y. Zhang, Y. Wang, H. Zhu and H. Hou, 2022. Evaluation of different factors on metal leaching from nickel tailings using generalised additive model (GAM), *Ecotox. Environ. Safety*, **236**, 113488

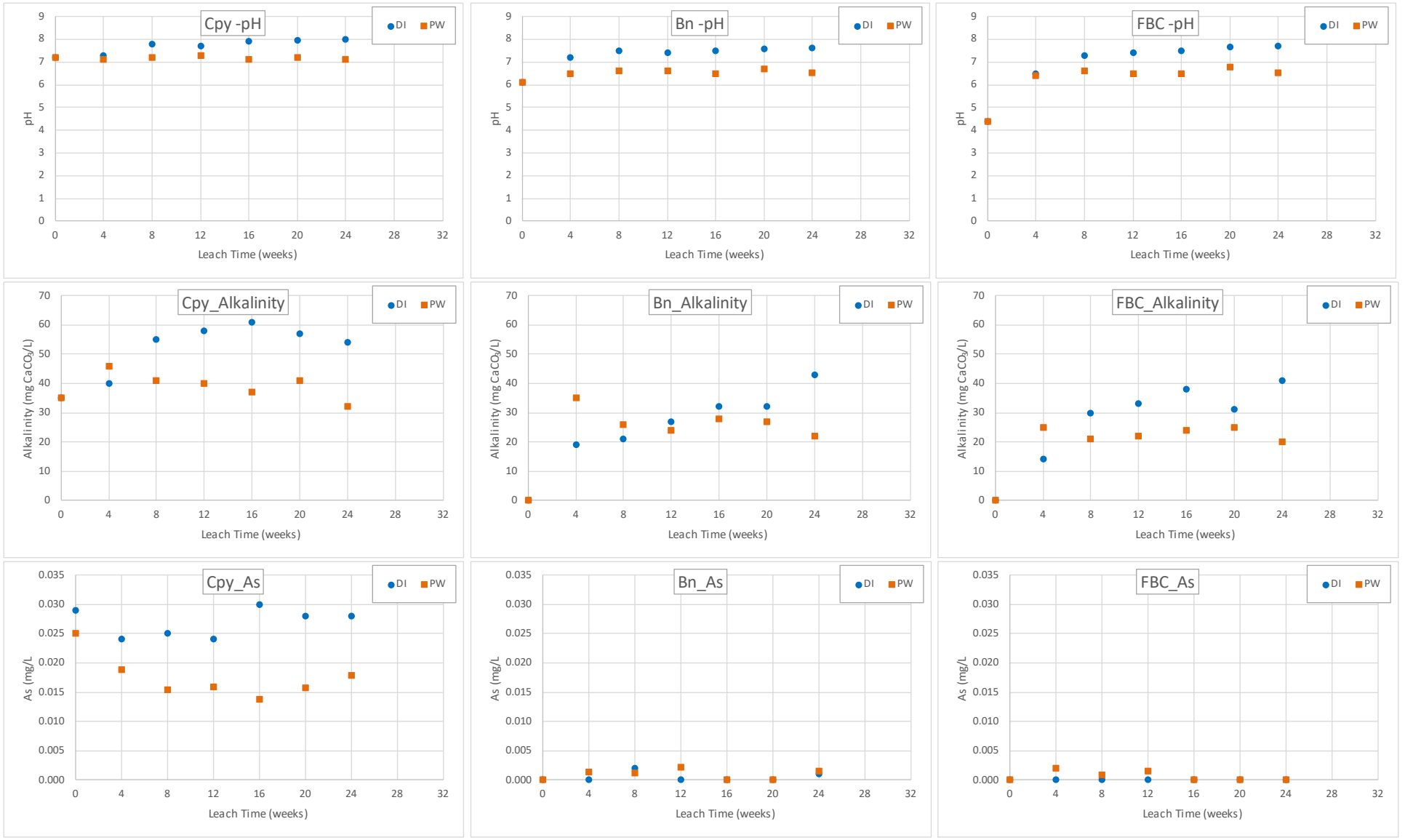


Figure 6: Leachate analysis results for Cpy (left), Bn (middle) and FBC tailings (right) flushed with process or deionised water including pH (top), alkalinity (middle) and As (bottom).

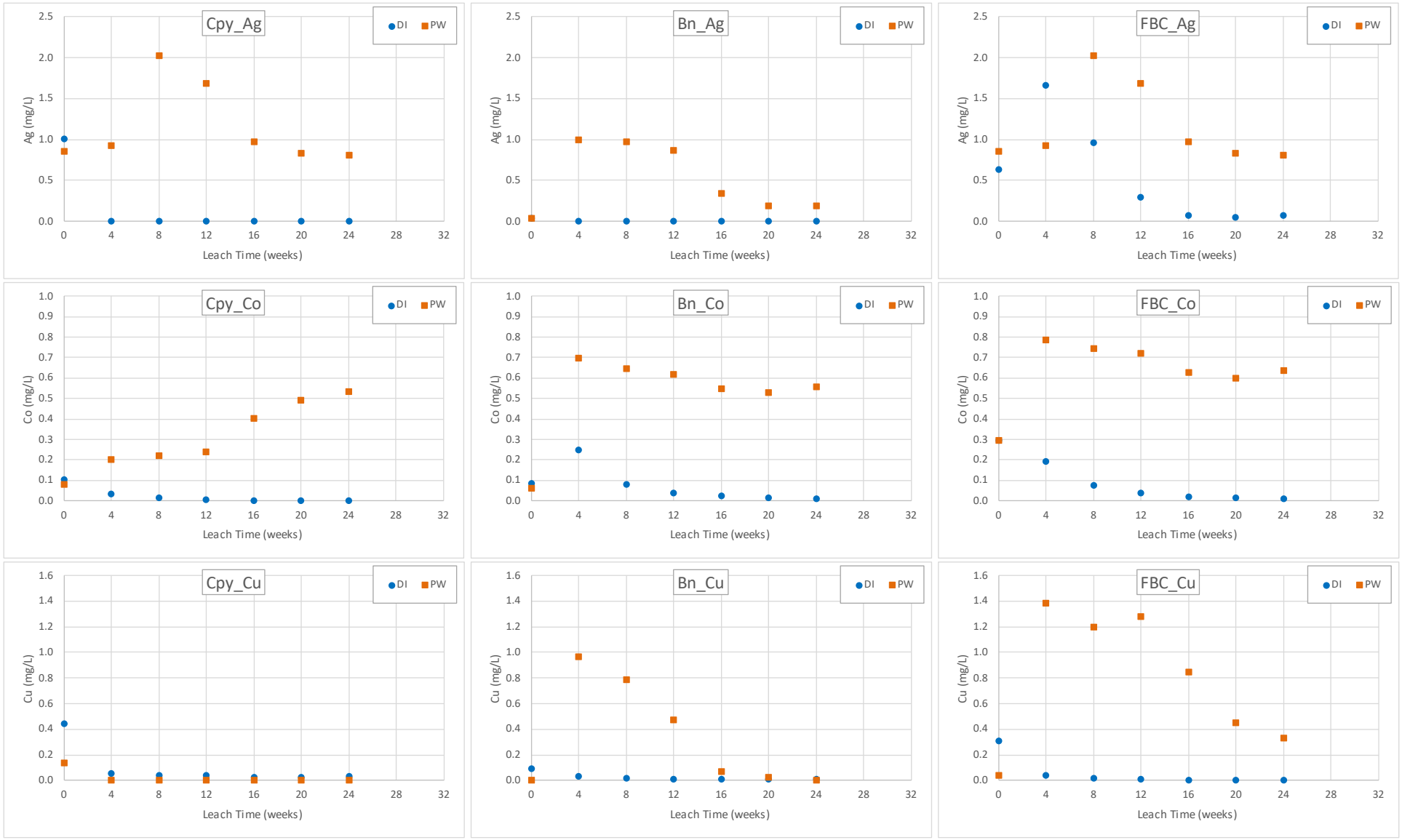


Figure 7: Leachate analysis results for Cpy (left), Bn (middle) and FBC tailings (right) flushed with process or deionised water including Ag (top), Co (middle) and Cu (bottom).

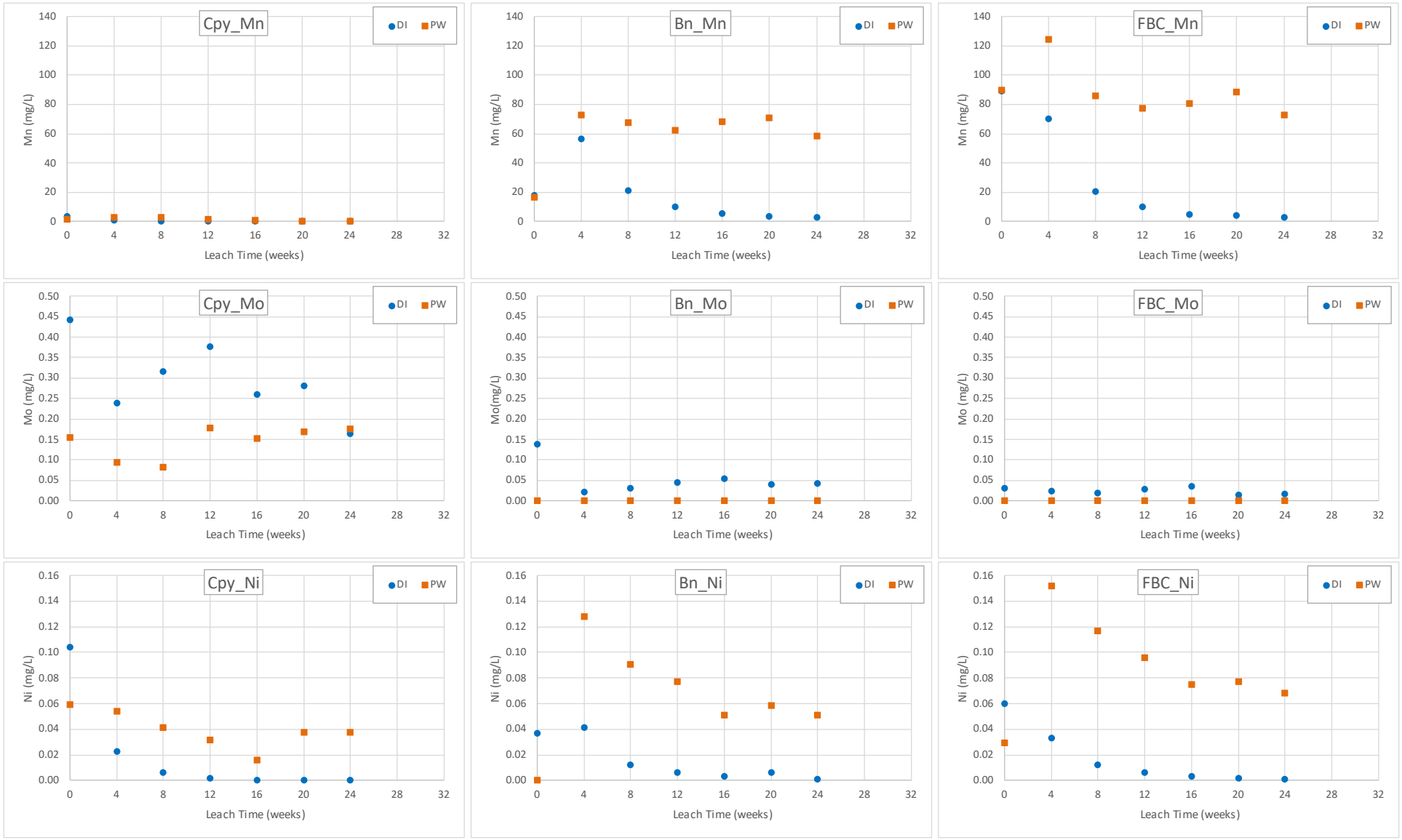


Figure 8: Leachate analysis results for Cpy (left), Bn (middle) and FBC tailings (right) flushed with process or deionised water including Mn (top), Mo (middle) and Ni (bottom).

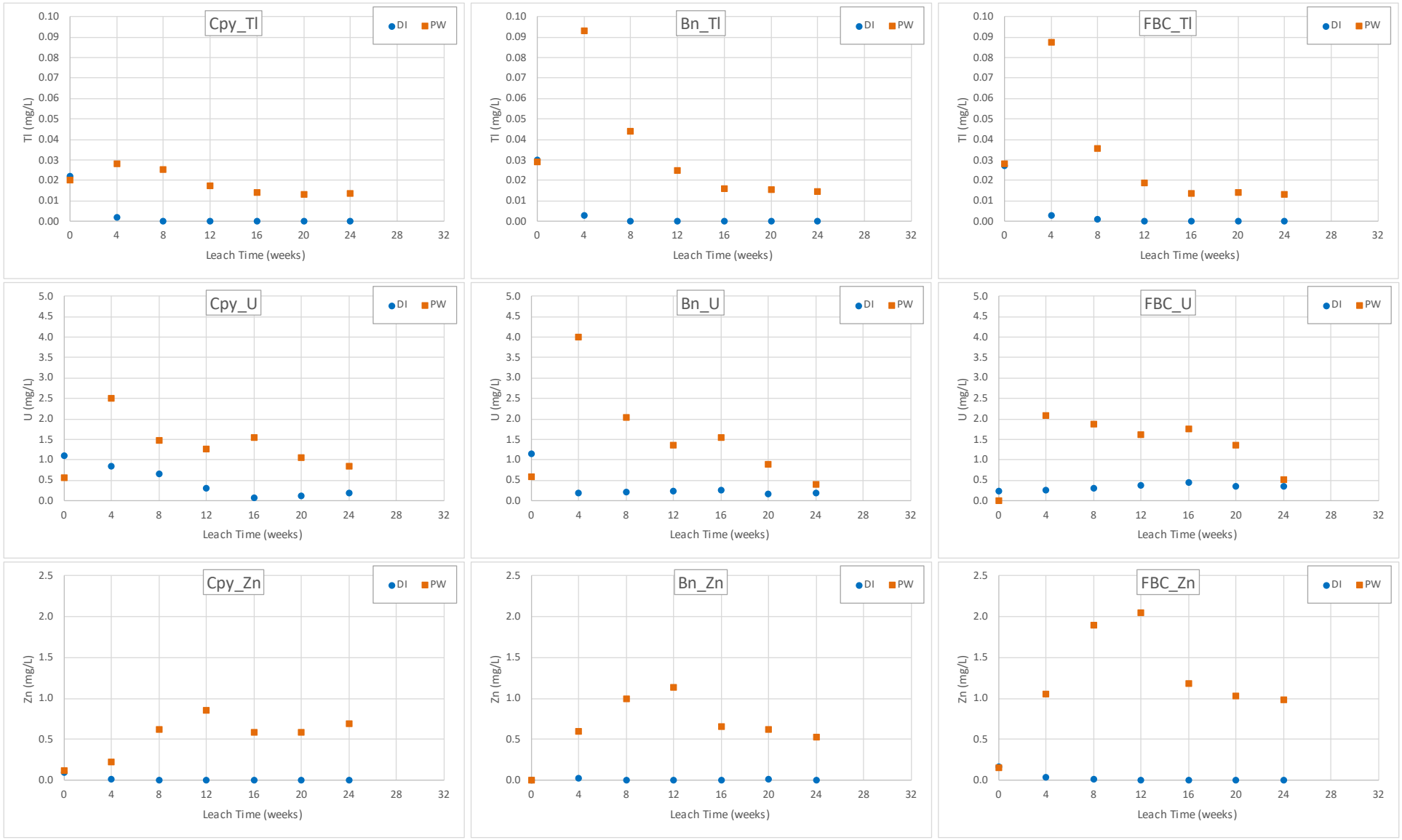


Figure 9: Leachate analysis results for Cpy (left), Bn (middle) and FBC tailings (right) flushed with process or deionised water including Tl (top), U (middle) and Zn (bottom).

Table 9: Solution speciation calculation results for process water leachate from flush 5 (week 20) for the FBC tailings

Component	% Of total concentration	Species
Ag+1	0.043	AgCl (aq)
	11.062	AgCl2-
	88.895	**AgCl3-2**
Co+2	**69.795**	**Co+2**
	0.018	CoOH+
	0.011	CoF+
	25.922	**CoCl+**
	4.255	CoSO4 (aq)
Cu+2	**51.822**	**Cu+2**
	6.214	CuOH+
	0.018	Cu(OH)2 (aq)
	0.181	Cu2(OH)2+2
	0.01	CuF+
	23.977	**CuCl+**
	14.752	**CuCl2 (aq)**
	0.41	CuCl3-
	0.019	CuCl4-2 1
	2.28	CuSO4 (aq)
	0.316	CuH2BO3+
Mn+2	**25.085**	**Mn+2**
	25.353	**MnCl3-**
	30.888	**MnCl2 (aq)**
	17.524	**MnCl+**
	1.145	MnSO4 (aq)
Ni+2	**71.24**	**Ni+2**
	0.029	NiOH+
	23.322	**NiCl+**
	0.802	NiCl2 (aq)
	4.602	NiSO4 (aq)
Tl(OH)3	0.34	Tl(OH)3
	0.515	TlCl3 (aq)
	99.144	**TlCl4-1**
UO2+2	0.468	UO2+2
	0.727	UO2OH+
	0.064	(UO2)2(OH)2+2
	2.894	(UO2)3(OH)5+
	87.757	**(UO2)4(OH)7+**
	0.242	(UO2)3(OH)7-
	1.279	(UO2)3(OH)4+2
	0.501	UO2(OH)3-
	4.19	UO2(OH)2 (aq)
	0.448	UO2F+
	0.02	UO2F2 (aq)
	0.041	UO2Cl2 (aq)
	0.304	UO2Cl+
	0.27	UO2SO4 (aq)
	0.044	UO2(SO4)2-2
	0.743	UO2H3SiO4+
Zn+2	0.977	Zn+2
	4.982	ZnCl+
	72.924	**ZnCl4-2**
	16.137	**ZnCl3-**
	4.826	ZnCl2 (aq)
	0.139	ZnSO4 (aq)
	0.012	Zn(SO4)2-2

Table 10: Average metal concentrations in leachates during 6 months of leaching and corresponding ANZECC DGV

Metal	Average Concentration in Leachates (µg/L)			ANZECC DGV[1] (µg/L)
	Cpy	Bn	FBC	
Ag	1150	520	530	0.05
Co	330	540	650	1
Cu	190	560	1040	1.4
Mn	2740	60880	90000	1900
Ni	75	100	120	11
Tl	19	34	30	0.03[2]
U	1810	2040	1770	0.5[2]
Zn	530	760	1190	8

1. Default Guideline Value for 95% Species protection level for fresh water
2. Protection level not specified

3.3.2. Analysis of salt crusts

The climatic conditions at Carrapateena are arid with an annual rainfall around 200 mm and evaporation around 3,100 mm. This significant water deficiency results in a lack of permanent surface water and means that TFS beaches will for the most part be unsaturated, with evaporation of tailings pore water resulting in formation of a salt crust on the TSF surface. This salt represents a potential source for transport of oxidation leach products from the TSF to the surrounding environment via wind transport of fine salt particles or aerosols.

During leach column testing, at the end of each weekly drying cycle, salt deposits were evident on the top of the tailings flushed with process water (Figure 10). To assess the composition of the salt crusts and determine if they are a potential source of heavy metals, the salt crust from each column was removed for analysis. Because it was difficult to remove salt without recovering some of the tailings, the salt composition was assessed by dissolving in DI water, followed by filtration to remove undissolved tailings. The resulting salt solutions were analysed for a range of metals/metalloids and major cations and anions.

To get a sense of the relative composition of the salt crust, the solution analysis results were converted from concentrations in mg/L to mmol/L. The two major anions sulphate and chloride where then assigned stoichiometrically to each cation, starting first with sulphate salts of Ca, Mg, Ba and Sr until sulphate was exhausted and then chloride was assigned in the same way to remaining cations. The calculated molar amount of each species was then converted back to mass and mass of each species calculated as a percentage of the total mass. The results of this process are shown in Table 11.

While this process does not provide unequivocal identification of the species present in the salt crust, it does allow an estimate of the relative mass of likely species in the salt. The results suggest that the majority of the salt formed on the tailings during leach testing is likely comprised of halite and gypsum. Significantly, the amount of heavy metal salts is calculated to comprise less than 0.1 wt. % of the salt crust. These results indicate that wind borne transport of salt from the TSF is unlikely to represent a significant pathway for transport of heavy metals from the TSF to the surrounding environment.

Figure 10: Images of Cpy (top left), Bn (top right) and FBC tailings (bottom left) flushed with process water and subsequently dried at week 24.

Table 11: Calculated salt composition based on measured concentrations of major cations, anions and metals in water extracts of salt crusts from leach column tests at week 24.

	Calculated Relative Amount (%)		
Species	**Cpy**	**Bn**	**FBC**
NaCl	59%	64%	65%
$CaSO_4.2H_2O$	33%	26%	25%
$MgSO_4.7H_2O$	5%	3%	2%
$MgCl_2.6H_2O$	2.5%	5.6%	8.4%
KCl	0.6%	0.6%	0.7%
$SrSO_4$	0.08%	0.09%	0.09%
BaSO4	0.002%	0.002%	0.002%
H_4SiO_4	0.056%	0.023%	0.021%
$B(OH)_3$	0.018%	0.019%	0.023%
AgCl	0.0008%	0.0001%	0.0000%
$CdCl_2$	0.000002%	0.000004%	0.000003%
$CoCl_2$	0.001%	0.001%	0.001%
$CuCl_2$	0.0003%	0.0004%	0.0004%
$MnCl_2$	0.005%	0.061%	0.084%
$NiCl_2$	0.0001%	0.0002%	0.0002%
$(UO_2)_4(OH)_7Cl$	0.001%	0.001%	0.002%
$ZnCl_2$	0.003%	0.002%	0.002%
H_3AsO_4	0.000205%	0.000000%	0.000016%
Heavy Metals/Metalloids	0.01%	0.07%	0.09%
Others	99.99%	99.93%	99.91%

3.3.3. Flushing with deionised water

To assess the leaching behaviour of tailings in the presence of low salinity water, as may occur should future processing include the use of fresh makeup water, or in the period following active deposition of tailings in the TSF, when the only water added to the tailings will be rainfall, each of the three tailings samples were subjected to leach column testing using DI water to undertake the weekly watering and monthly flush of the columns during each 4-week cycle. As the tailings were added to the columns as either a slurry or moist paste in process water, the initial flushes represent displacement of the process water from the tailings. Figure 11 shows chloride concentrations in leachates from the three columns flushed with DI water. Since chloride is unlikely to be generated from oxidation/dissolution reactions, or retained to any significant extent, chloride represents a good marker to determine when all of the original process water has been flushed from the tailings. The results shown in Figure 11, suggest that essentially all of the process water was flushed from the tailings during the first 3 flushes and that leachates from subsequent flushes (week 12 onwards) represent solutes flushed from the tailings as a result of reactions occurring at the tailings mineral surface, rather than solutes originally present in the process water.

Leachate chemistry is shown in Figures 6 – 9 for selected parameters and the full set of analysis results are given in Appendix B. The discussion below is restricted to flushes 3 (week 12) onwards when there is insignificant influence from residual process water.

Leachate analysis of tailings samples can be summarised by the following:

- Leachates for all tailings samples maintained a pH above neutral (7 -8) with an excess of alkalinity (30 – 50 mg $CaCO_3$/L).

- SO_4 and Ca concentrations generally slightly decreased across the leaching period but maintained a molar ratio of close to 1, suggesting that there was on-going oxidation of pyrite, with the acidity generated neutralised by dissolution of dolomite maintaining near neutral pH conditions and a slight excess of alkalinity.
- The order of SO_4 release followed the order FBC>Bn>Cpy in agreement with the pyrite content of these materials and calculated IOR based on SO4 concentrations ranged from $4x10^{-9}$ (Cpy) to $4x10^{-8}$ kg $O_2/m^3/s$ (FBC). These pyrite oxidation rates estimated for DI water are about an order of magnitude higher than for the same materials in process water.
- Arsenic was present in leachates for the Cpy tailings at relatively low concentrations (25 – 30 μg/L) but was not leached from Bn or FBC tailings.
- Ag, Co, Cu, Ni, Tl and Zn, which were present in process water leachates, were absent or at very low concentrations in DI water leachates, possibly indicating that these metals were retained within the column either through precipitation and/or adsorption processes.
- Mo (Cpy only) and Mn (Bn and FBC) were found at significant concentrations in DI water leachates, with elevated Mn concentrations possibly reflecting dissolution of Mn carbonate mineral(s).
- While lower than in process water leachates, concentrations of uranium in DI water leachates were still at elevated levels (200 – 400 μg/L, cf. ANZECC DGV of 0.5 μg/L) throughout the 6-month leaching period, indicating that high levels of chloride are not required to mobilise uranium, probably as a uranyl salt, as predicted by solution speciation calculations.

The results from leach column experiments conducted with DI water suggest that if, following cessation of active tailings deposition, infiltration of rainfall results in a significant decrease in pore water salinity, the rate of pyrite oxidation within the surface tailings layer may increase by up to an order of magnitude. Despite this possible increase in pyrite oxidation rate, for tailings represented by the tailings materials tested here, pore water pH will remain neutral and metal concentrations are likely to decrease, due to decreased metal mobility resulting from precipitation and/or adsorption processes. Uranium concentrations appear to be an exception, which, while lower than in process water leachates, are likely to remain significantly elevated in surface pore water, and any seepage from the TSF may contain elevated concentrations of uranium.

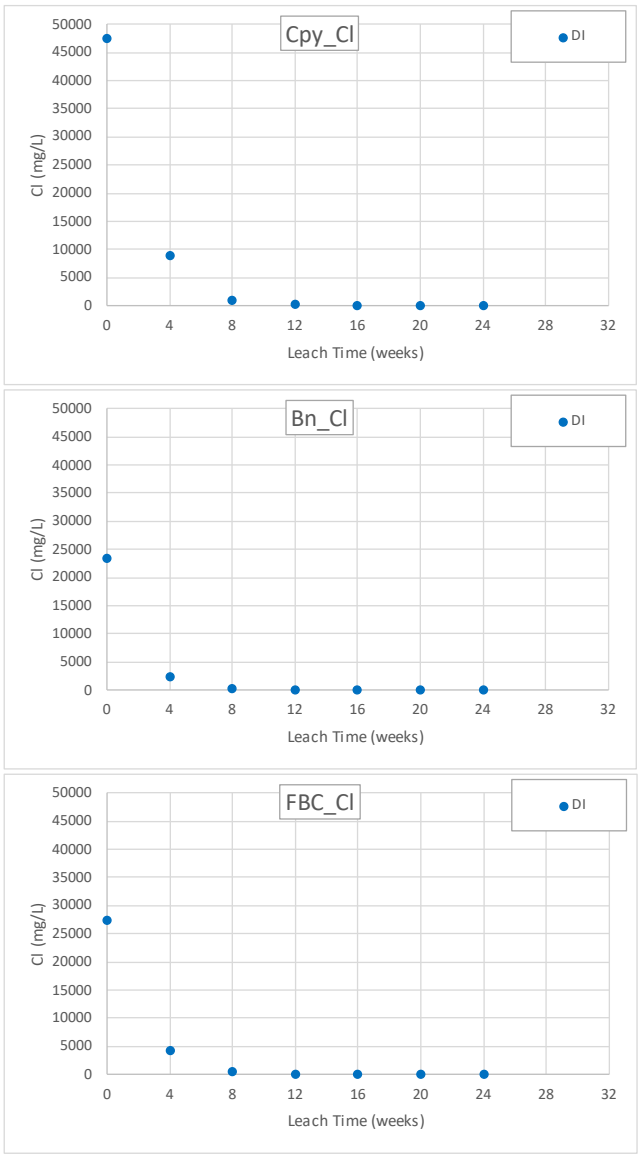


Figure 11: Concentration of chloride in leachates from Cpy (top), Bn (middle) and FBC tailings (bottom) flushed with deionised water.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Study Conclusions

Based on the results of geochemical characterisation and leach column testing of three tailings samples using both hypersaline process water and deionised water for the leaching experiments, the following conclusions can be drawn with implications for potential changes to TSF seepage water quality as follows:

- If the Cpy and Bn tailings used for this study are representative of tailings that will be produced during processing of ore during the remaining period of sub-level cave mining at Carrapateena, the tailings deposited in the TSF will be NAF, with an excess of neutralising capacity derived principally from dolomite.
- If the FBC tailings used for this study are representative of tailings that will be produced during processing of ore during the future period of block cave mining at Carrapateena, the tailings deposited in the TSF will have higher pyrite content than the Cpy and Bn tailings and the balance between the potential acidity generated from pyrite

oxidation and the acid neutralising capacity in the tailings (principally from dolomite) will be more evenly balanced. Combined, test results suggest a NAF classification for the tested FBC tailings sample.

- The NAF classification of the tailings tested in this study and the apparent very slow oxidation rate of pyrite in the tailings when leached with process water, resulted in neutral pH leachate, with alkalinity in the entrained pore water sufficient to neutralise any acidity generated from pyrite oxidation.
- Despite the neutral pH and excess alkalinity in leachates, the high chloride concentration in process water resulted in solubilisation and mobilisation of a range of heavy metals, principally as metal chloride complexes. Mobilised metals included Ag, Co, Cu, Mn, Ni, Tl, U and Zn which were present in leachates at significantly elevated concentrations.
- Should the salinity of process water increase over time due to evaporative concentration in both short- (thickener O/F) and long-recycle (TSF decant), then it is possible that mobilisation of some metals may increase in the longer-term, with the potential for higher metal concentrations in TSF seepage.
- Following cessation of active tailings deposition after closure, a decrease in tailings pore water salinity may occur, which will likely result in an increase in the rate of pyrite oxidation. However, should the tailings be NAF as was the case here, this will not result in low pH acidic pore water.
- Lower tailings pore water salinity will also likely result in lower concentrations of most heavy metals in TSF seepage, with the exception of uranium, concentrations of which appear to be less sensitive to salinity.
- Salt crusts formed on the surface of the column leach tests flushed with process water, contained very little heavy metals (<0.1 wt.%) and this suggests that salt blown as fine particles or aerosols from the TSF beaches will not represent a major pathway for heavy metal contamination from the TSF.

4.2. Recommendations

- Tailings should be monitored for their ARD properties to ascertain if the materials tested during the current study are representative of the plant tailings in general and that therefore the conclusions drawn from this work will be applicable to the tailings deposited in the TSF.
- Tailings samples collected from the plant should be monitored on a regular basis, using Total S and ANC analyses to assess acid and neutralising potentials, respectively. Total C and inorganic C will not be suitable surrogates to determine effective ANC because of the presence of substantial siderite/ankerite in the plant tailings. This will provide a larger data set to evaluate the ARD properties of tailings and their likely leaching properties.
- Should PAF plant tailings be identified, then leach column testing of the type undertaken here should be conducted to evaluate the geochemical properties of this class of tailings.
- TSF decant water quality should continue to be monitored including for a range of heavy metals to evaluate any potential long-term changes in tailings pore water quality.
- Monitoring of groundwater bores downgradient of the TSF should be continued to establish if seepage from the TSF is impacting groundwater quality. Increased heavy metal concentrations in the groundwater may indicate mitigation measures such as enhanced dewatering of the tailings is required to minimise seepage and groundwater contamination.

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APPENDIX A
Leachate Analysis Results – Process Water

Table A1: Column leach test results of Cpy tailings, watered with process water

Sample Characteristics								
Sulphur	ANC	NAPP	$NAG_{4.5}$	$NAG_{7.0}$	NAGpH	Weight	Start	Sample
%S	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t		g	Date	Code
0.12	12	-8	0	0	7.8	2000	01/10/21	21780 PW

Parameters		Background Uncorrected Results						
		0	4	8	12	16	20	24
		5-Oct-21	1-Nov-21	29-Nov-21	30-Dec-21	24-Jan-22	21-Feb-22	21-Mar-22
		21780 Process-In	**21780 Process-1**	**21780 Process-2**	**21780 Process-3**	**21780 Process-4**	**21780 Process-5**	**21780 Process-6**
Volume	mL	370	493	496	511	516	540	551
pH	-	7.2	7.1	7.2	7.3	7.1	7.2	7.1
EC	dS/m	101.4	128.30	144.70	155.19	138.80	136.30	140.20
Alkalinity	mg CaCO3/L	35	46	41	40	37	41	32
Acidity	mg/L	-	-	-	-	-	-	-
Ag	mg/L	0.858	0.923	2.020	1.680	0.970	0.831	0.810
Al	mg/L	<0.10	0.005	<0.005	0.006	<0.05	<0.05	0.014
As	mg/L	0.025	0.019	0.015	0.016	0.014	0.016	0.018
B	mg/L	2.36	3.13	3.11	3.76	3.24	8.41	3.85
Ba	mg/L	0.08	0.09	0.11	0.12	0.09	0.09	0.10
Be	mg/L	<0.010	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.0002
Ca	mg/L	4000	3350	3670	3680	3260	3240	4660
Cd	mg/L	0.0020	0.0021	0.0014	0.0012	0.0013	<0.001	0.0012
Cl	mg/L	44700	87000	142000	96500	94500	93200	79600
Co	mg/L	0.099	0.221	0.236	0.256	0.419	0.509	0.552
Cr	mg/L	<0.010	<0.0005	<0.0005	0.0014	<0.005	<0.005	0.0096
Cu	mg/L	0.389	0.215	0.200	0.139	0.140	0.137	0.122
F	mg/L	3.6	2.6	5.3	2.6	1.3	1.1	1.5
Fe	mg/L	0.14	0.008	<0.005	0.014	<0.05	<0.05	0.030
Hg	mg/L	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	688	933	1170	1180	1100	992	1500
Mg	mg/L	1330	2210	2840	2870	2700	2400	3760
Mn	mg/L	3.12	4.42	4.00	3.08	1.84	1.73	1.02
Mo	mg/L	0.409	0.350	0.338	0.432	0.407	0.423	0.430
Na	mg/L	27600	35900	46200	46200	41100	39100	60200
Ni	mg/L	0.094	0.089	0.077	0.067	0.051	0.072	0.073
P	mg/L	<10	<10	<20	<5	<20	<10	<20
Pb	mg/L	<0.010	0.0012	0.0024	0.0013	<0.002	0.0417	0.0024
Sb	mg/L	<0.010	0.005	0.006	0.004	<0.005	<0.005	<0.001
Se	mg/L	<0.10	0.04	0.06	0.05	0.05	0.05	0.05
Si	mg/L	5.22	3.48	2.13	<2.50	3.03	3.08	3.03
Sn	mg/L	<0.010	<0.005	<0.005	<0.005	<0.05	<0.05	<0.01
SO_4	mg/L	3510	4090	3420	3570	3390	3580	3240
Sr	mg/L	32.6	59.6	80.4	82.2	71.1	62.9	62.5
Th	mg/L	<0.010	0.0002	0.0002	0.0005	<0.001	<0.001	<0.0002
Tl	mg/L	0.0200	0.0282	0.0253	0.0176	0.0140	0.0132	0.0137
U	mg/L	1.05	3.00	1.96	1.76	2.04	1.56	1.33
Zn	mg/L	0.12	0.22	0.63	0.86	0.59	0.59	0.69

Table A2: Column leach test results of Bn tailings, watered with process water

Sample Characteristics								
Sulphur	ANC	NAPP	$NAG_{4.5}$	$NAG_{7.0}$	NAGpH	Weight	Start	Sample
%S	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t		g	Date	Code
0.39	12	0	0	0	7.7	2001	01/10/21	21380 PW

Parameters		Background Uncorrected Results						
		0	4	8	12	16	20	24
		5-Oct-21	1-Nov-21	29-Nov-21	30-Dec-21	24-Jan-22	21-Feb-22	21-Mar-22
		21780 Process-In	**21780 Process-1**	**21780 Process-2**	**21780 Process-3**	**21780 Process-4**	**21780 Process-5**	**21780 Process-6**
Volume	mL	492	518	517	523	523	541	552
pH	-	6.1	6.5	6.6	6.6	6.5	6.7	6.5
EC	dS/m	61.5	133.8	150.1	153.3	139.2	137.10	139.40
Alkalinity	mg CaCO3/L	-	35	26	24	28	27	22
Acidity	mg/L	28	-	-	-	-	-	-
Ag	mg/L	0.034	1.0	1.0	0.9	0.3	0.2	0.2
Al	mg/L	<0.10	0.01	<0.005	<0.005	<0.05	<0.05	<0.01
As	mg/L	<0.010	0.001	0.001	0.002	<0.005	<0.005	0.002
B	mg/L	0.65	2.77	2.67	3.19	2.92	4.94	3.47
Ba	mg/L	0.05	0.08	0.09	0.11	0.07	0.07	0.09
Be	mg/L	<0.010	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.0002
Ca	mg/L	2040	3470	3720	3610	3210	3520	4220
Cd	mg/L	0.0206	0.044	0.012	0.007	0.007	0.006	0.005
Cl	mg/L	23900	53900	149000	97700	84700	102000	80000
Co	mg/L	0.081	0.714	0.662	0.637	0.567	0.546	0.574
Cr	mg/L	<0.010	<0.0005	<0.0005	0.0012	<0.005	<0.005	0.003
Cu	mg/L	0.123	1.22	1.04	0.73	0.33	0.27	0.24
F	mg/L	2.4	1.60	3.70	2.00	1.10	1.00	1.20
Fe	mg/L	<0.10	<0.005	<0.005	<0.005	<0.05	<0.05	0.01
Hg	mg/L	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001
K	mg/L	279	986	1270	1220	1120	1130	1390
Mg	mg/L	553	2470	3140	2990	2790	2740	3440
Mn	mg/L	17.6	74	69	64	70	72	60
Mo	mg/L	0.129	0.066	0.068	0.066	0.053	0.059	0.060
Na	mg/L	13600	38600	50200	47900	41800	44000	54500
Ni	mg/L	0.035	0.163	0.126	0.112	0.086	0.093	0.086
P	mg/L	<10	<10	<20	<5	<20	<10	<20
Pb	mg/L	<0.010	0.005	0.005	0.004	0.002	<0.002	0.001
Sb	mg/L	<0.010	0.001	0.001	<0.0005	<0.005	<0.005	<0.001
Se	mg/L	<0.10	0.079	0.075	0.072	0.054	0.055	0.063
Si	mg/L	2.1	1.05	<1.00	<2.50	<1.00	0.96	<1.00
Sn	mg/L	<0.010	<0.005	<0.005	<0.005	<0.05	<0.05	<0.01
SO_4	mg/L	2930	3720	3350	3550	3390	3540	3320
Sr	mg/L	14.30	67.9	97.1	108.0	72.6	58.4	66.3
Th	mg/L	<0.010	<0.0001	<0.0001	0.0001	<0.001	<0.001	<0.0002
Tl	mg/L	0.029	0.093	0.044	0.025	0.016	0.015	0.014
U	mg/L	1.08	4.50	2.54	1.85	2.03	1.38	0.90
Zn	mg/L	<0.050	0.597	1.00	1.14	0.66	0.62	0.53

Table A3: Column leach test results of FBC tailings, watered with process water

Sample Characteristics								
Sulphur	ANC	NAPP	$NAG_{4.5}$	$NAG_{7.0}$	NAGpH	Weight	Start	Sample
%S	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t		g	Date	Code
0.67	15	6	0	5	4.6	2001	01/10/21	21377 PW

Parameters		Background Uncorrected Results						
		0	4	8	12	16	20	24
		5-Oct-21	1-Nov-21	29-Nov-21	30-Dec-21	24-Jan-22	21-Feb-22	21-Mar-22
		21780 Process-In	**21780 Process-1**	**21780 Process-2**	**21780 Process-3**	**21780 Process-4**	**21780 Process-5**	**21780 Process-6**
Volume	mL	499	521	520	521	525	532	547
pH	-	4.4	6.4	6.6	6.5	6.5	6.8	6.5
EC	dS/m	64.8	136.90	148.80	159.80	139.40	136.50	138.80
Alkalinity	mg CaCO3/L	-	25	21	22	24	25	20
Acidity	mg/L	39	-	-	-	-	-	-
Ag	mg/L	0.635	1.66	0.96	0.30	0.07	0.05	0.07
Al	mg/L	<0.10	<0.005	<0.005	<0.005	<0.05	<0.05	0.02
As	mg/L	<0.010	0.002	0.001	0.002	<0.005	<0.005	<0.001
B	mg/L	0.47	2.68	2.99	3.34	3.02	6.39	3.58
Ba	mg/L	0.03	0.07	0.08	0.09	0.07	0.06	0.08
Be	mg/L	<0.010	<0.0001	<0.0001	0.0001	<0.001	<0.001	<0.0002
Ca	mg/L	1850	3310	3680	3600	3110	3540	4240
Cd	mg/L	0.0297	0.0314	0.0075	0.0046	0.0036	0.0023	0.0039
Cl	mg/L	26500	115000	172000	96400	93400	92600	79000
Co	mg/L	0.311	0.802	0.760	0.738	0.645	0.614	0.654
Cr	mg/L	<0.010	<0.0005	<0.0005	0.0009	<0.005	<0.005	0.0024
Cu	mg/L	0.295	1.64	1.45	1.53	1.10	0.70	0.59
F	mg/L	2.1	1.8	4.0	2.1	1.2	1.1	1.6
Fe	mg/L	<0.10	0.01	<0.005	<0.005	<0.05	<0.05	0.01
Hg	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	142	971	1250	1220	1080	1120	1400
Mg	mg/L	665	2540	3100	2970	2670	2730	3500
Mn	mg/L	91.3	126	87	78	82	90	74
Mo	mg/L	0.027	0.015	0.013	0.013	0.011	0.018	0.024
Na	mg/L	16300	39800	49800	47300	40700	43800	55100
Ni	mg/L	0.064	0.187	0.152	0.131	0.110	0.112	0.103
P	mg/L	<10	<10	<20	<5	<20	<10	<20
Pb	mg/L	<0.010	0.002	0.024	0.002	<0.002	0.002	0.001
Sb	mg/L	<0.010	<0.0005	<0.0005	<0.0005	<0.005	<0.005	<0.001
Se	mg/L	<0.10	0.07	0.07	0.06	0.05	0.05	0.05
Si	mg/L	4.6	1.8	<1.00	<2.50	<1.00	0.8	<1.00
Sn	mg/L	<0.010	<0.005	<0.005	<0.005	<0.05	<0.05	<0.01
SO_4	mg/L	5010	4220	3290	3480	3380	3580	3320
Sr	mg/L	7.75	64	91	97	75	57	67
Th	mg/L	<0.010	0.0001	0.0001	0.0002	<0.001	<0.001	<0.0002
Tl	mg/L	0.028	0.09	0.04	0.02	0.01	0.01	0.01
U	mg/L	0.221	2.57	2.36	2.10	2.25	1.86	1.02
Zn	mg/L	0.16	1.05	1.89	2.05	1.18	1.03	0.99

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APPENDIX B
Leachate Analysis Results – Deionised Water

Table B1: Column leach test results of Cpy tailings, watered with dionised water

Sample Characteristics								
Sulphur	ANC	NAPP	$NAG_{4.5}$	$NAG_{7.0}$	NAGpH	Weight	Start	Sample
%S	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t		g	Date	Code
0.12	12	-8	0	0	7.8	2000	01/10/21	21780 DW

Parameters		Week						
		0	4	8	12	16	20	24
		5-Oct-21	1-Nov-21	29-Nov-21	30-Dec-21	24-Jan-22	21-Feb-22	21-Mar-22
		21780 DW-Initial	**21780 DW-1**	**21780 DW-2**	**21780 DW-3**	**21780 DW-4**	**21780 DW-5**	**21780 DW-6**
Volume	mL	371	492	498	500	510	575	561
pH	-	7.2	7.3	7.8	7.7	7.9	8.0	8.0
EC	dS/m	102.6	62.90	10.31	8.61	1.79	0.68	0.48
Alkalinity	mg CaCO3/L	35	40	55	58	61	57	54
Acidity	mg/L	-	-	-	-	-	-	-
Ag	mg/L	1.01	0.009	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/L	<0.10	<0.01	<0.01	<0.01	0.02	<0.01	0.04
As	mg/L	0.029	0.024	0.025	0.024	0.030	0.028	0.028
B	mg/L	2.40	1.68	1.09	0.70	0.50	0.44	0.30
Ba	mg/L	0.08	0.05	0.02	0.03	0.04	0.04	0.05
Be	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/L	4130	790	269	101	50	51	34
Cd	mg/L	0.0022	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/L	47500	8840	912	259	38	15	5
Co	mg/L	0.104	0.036	0.015	0.006	0.002	0.002	0.002
Cr	mg/L	<0.010	<0.001	<0.001	<0.001	0.001	<0.001	0
Cu	mg/L	0.440	0.051	0.037	0.039	0.027	0.022	0.030
F	mg/L	3.6	3.4	2.6	2.2	1.8	1.2	0.5
Fe	mg/L	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hg	mg/L	0.0007	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	698	306	40	20	15	14	9
Mg	mg/L	1430	241	46	18	9	8	5
Mn	mg/L	3.24	1.10	0.49	0.26	0.11	0.12	0.11
Mo	mg/L	0.442	0.240	0.317	0.376	0.259	0.280	0.165
Na	mg/L	28800	4990	642	158	48	19	9
Ni	mg/L	0.104	0.023	0.006	0.002	<0.001	<0.001	<0.001
P	mg/L	<10	<1	<1	<1	<1	<1	<1
Pb	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	mg/L	<0.010	0.004	0.002	0.003	0.001	0.002	<0.001
Se	mg/L	<0.10	0.02	0.01	0.01	0.01	0.01	0.01
Si	mg/L	5.5	4.9	4.5	4.8	5.1	5.3	5.6
Sn	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO_4	mg/L	3650	2070	873	327	123	109	69
Sr	mg/L	35.00	8.67	2.11	0.87	0.47	0.44	0.38
Th	mg/L	<0.010	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Tl	mg/L	0.022	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
U	mg/L	1.10	0.84	0.67	0.31	0.08	0.12	0.19
Zn	mg/L	0.10	0.02	0.01	<0.005	<0.005	<0.005	<0.005

Table B2: Column leach test results of Bn tailings, watered with dionised water

Sample Characteristics							
Sulphur	ANC	NAPP	$NAG_{4.5}$	$NAG_{7.0}$	NAGpH	Weight	Start	Sample
%S	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t		g	Date	Code
0.39	12	0	0	0	7.7	2001	01/10/21	21380 DW

Parameters		Week						
		0	4	8	12	16	20	24
		5-Oct-21	1-Nov-21	29-Nov-21	30-Dec-21	24-Jan-22	21-Feb-22	21-Mar-22
		21380 DW-Initial	**21380 DW-1**	**21380 DW-2**	**21380 DW-3**	**21380 DW-4**	**21380 DW-5**	**21380 DW-6**
Volume	mL	494	520	519	521	521	545	560
pH	-	6.1	7.2	7.5	7.4	7.5	7.6	7.6
EC	dS/m	61.6	19.70	5.21	4.79	2.16	1.21	0.87
Alkalinity	mg CaCO3/L	-	19	21	27	32	32	43
Acidity	mg/L	28	-	-	-	-	-	-
Ag	mg/L	0.040	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/L	<0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
As	mg/L	<0.010	<0.001	0.002	<0.001	<0.001	<0.001	0.001
B	mg/L	0.67	0.61	0.38	0.27	0.23	0.18	0.14
Ba	mg/L	0.04	0.02	0.01	0.01	0.02	0.02	0.02
Be	mg/L	<0.010	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/L	2170	514	430	358	286	219	122
Cd	mg/L	0.0206	0.0035	0.0006	0.0003	<0.0001	<0.0001	0.0001
Cl	mg/L	23400	2360	282	28	4	1	<1
Co	mg/L	0.085	0.248	0.080	0.041	0.023	0.014	0.010
Cr	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	mg/L	0.094	0.034	0.014	0.013	0.010	0.006	0.008
F	mg/L	2.5	1.7	1.5	1.9	1.8	1.8	1.1
Fe	mg/L	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hg	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	294	48	19	11	8	7	4
Mg	mg/L	589	171	107	59	33	25	16
Mn	mg/L	17.8	56.60	21.00	9.82	5.51	3.58	2.62
Mo	mg/L	0.138	0.022	0.031	0.044	0.055	0.040	0.043
Na	mg/L	14400	1310	178	28	8	2	1
Ni	mg/L	0.037	0.041	0.012	0.006	0.003	0.006	0.001
P	mg/L	<10	<1	<1	<1	<1	<1	<1
Pb	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/L	<0.10	0.17	0.07	0.03	0.01	<0.01	<0.01
Si	mg/L	2.1	1.9	1.6	1.7	1.7	1.7	1.7
Sn	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO_4	mg/L	3020	2850	1460	554	834	517	352
Sr	mg/L	14.90	2.10	1.03	0.78	0.63	0.45	0.33
Th	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tl	mg/L	0.03	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
U	mg/L	1.16	0.20	0.23	0.24	0.26	0.18	0.20
Zn	mg/L	<0.050	0.03	0.01	<0.005	<0.005	0.01	<0.005

Table B3: Column leach test results of FBC tailings, watered with dionised water

Sample Characteristics							
Sulphur	ANC	NAPP	$NAG_{4.5}$	$NAG_{7.0}$	NAGpH	Weight	Start	Sample
%S	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t	kgH_2SO_4/t		g	Date	Code
0.67	15	6	0	5	4.6	2000	01/10/21	21377 DW

Parameters		Week						
		0	4	8	12	16	20	24
		5-Oct-21	1-Nov-21	29-Nov-21	30-Dec-21	24-Jan-22	21-Feb-22	21-Mar-22
		21377 DW-Initial	**21377 DW-1**	**21377 DW-2**	**21377 DW-3**	**21377 DW-4**	**21377 DW-5**	**21377 DW-6**
Volume	mL	496	510	515	512	516	567	571
pH	-	4.4	6.5	7.3	7.4	7.5	7.7	7.7
EC	dS/m	65.9	21.70	6.16	5.79	3.21	1.78	1.16
Alkalinity	mg CaCO3/L	-	14	30	33	38	31	41
Acidity	mg/L	33	-	-	-	-	-	-
Ag	mg/L	0.587	0.004	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/L	<0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
As	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
B	mg/L	0.50	0.50	0.32	0.24	0.19	0.17	0.14
Ba	mg/L	0.03	0.01	0.01	0.01	0.01	0.01	0.02
Be	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/L	1850	712	563	472	420	344	205
Cd	mg/L	0.0287	0.0024	0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Cl	mg/L	27400	4270	431	30	4	5	1
Co	mg/L	0.296	0.193	0.076	0.037	0.020	0.015	0.010
Cr	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	mg/L	0.306	0.040	0.016	0.010	0.005	0.002	0.003
F	mg/L	2.3	2.1	1.6	2.0	1.8	1.6	1.0
Fe	mg/L	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hg	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	142	23	7	4	2	2	1
Mg	mg/L	659	210	134	76	46	44	38
Mn	mg/L	89.2	70.30	20.40	9.89	5.07	3.84	3.05
Mo	mg/L	0.031	0.025	0.020	0.028	0.036	0.015	0.016
Na	mg/L	16100	2400	268	27	9	5	2
Ni	mg/L	0.060	0.033	0.012	0.006	0.003	0.002	0.001
P	mg/L	<10	<1	<1	<1	<1	<1	<1
Pb	mg/L	0.014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/L	<0.10	0.10	0.06	0.03	0.01	<0.01	<0.01
Si	mg/L	4.6	1.7	1.3	1.3	1.2	1.1	1.1
Sn	mg/L	<0.010	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO_4	mg/L	4940	2700	1870	734	1220	845	665
Sr	mg/L	7.74	2.21	1.00	0.74	0.65	0.52	0.40
Th	mg/L	<0.010	0.001	0.001	<0.001	<0.001	<0.001	0.002
Tl	mg/L	0.027	0.003	0.001	<0.001	<0.001	<0.001	<0.001
U	mg/L	0.237	0.26	0.31	0.39	0.44	0.36	0.37
Zn	mg/L	0.16	0.04	0.01	<0.005	<0.005	<0.005	<0.005

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APPENDIX C
Salt Crust Water Extracts

Table C1: Analysis results for water extracts of salt crusts from leach columns leached with process water at week 24

Parameter		Detection Limit	Water Extract Result		
			Cpy	Bn	FBC
pH		0.1	8.4	7.9	7.6
EC	dS/m	0.001	13.79	17.16	16.29
Ag	mg/L	0.001	0.049	0.006	0.004
Al	mg/L	0.01	<0.01	<0.01	<0.01
As	mg/L	0.001	0.009	<0.001	0.001
B	mg/L	0.05	0.26	0.42	0.46
Ba	mg/L	0.001	0.094	0.15	0.169
Be	mg/L	0.001	<0.001	<0.001	<0.001
Ca	mg/L	1	629	760	670
Cd	mg/L	0.0001	0.0001	0.0003	0.0002
Cl	mg/L	1	3100	5200	4950
Co	mg/L	0.001	0.02	0.051	0.052
Cr	mg/L	0.001	<0.001	<0.001	<0.001
Cu	mg/L	0.001	0.011	0.021	0.024
F	mg/L	0.1	0.4	0.5	0.5
Fe	mg/L	0.05	<0.05	<0.05	<0.05
Hg	mg/L	0.0001	0.0001	<0.0001	<0.0001
K	mg/L	1	25	40	44
Mg	mg/L	1	65	120	134
Mn	mg/L	0.001	0.168	3.31	4.3
Mo	mg/L	0.001	0.03	0.04	0.043
Na	mg/L	1	1940	3160	2960
Ni	mg/L	0.001	0.004	0.011	0.012
P	mg/L	1	<1	<1	<1
Pb	mg/L	0.001	<0.001	<0.001	<0.001
Sb	mg/L	0.001	<0.001	<0.001	<0.001
Se	mg/L	0.01	0.01	0.01	<0.01
Si	mg/L	0.1	1.4	0.8	0.7
Sn	mg/L	0.001	<0.001	<0.001	<0.001
SO4	mg/L	1	1670	1970	1680
Sr	mg/L	0.001	3.27	5.09	5.26
Th	mg/L	0.001	<0.001	<0.001	<0.001
Tl	mg/L	0.001	<0.001	<0.001	<0.001
U	mg/L	0.001	0.02	0.032	0.037
Zn	mg/L	0.005	0.117	0.135	0.133

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APPENDIX C
ABA Analysis of Tailings Composites

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TECHNICAL MEMORANDUM

TO:	BHP Carrapateena
ATTENTION:	Nicholas Jones and Josh Allen
FROM:	Russell Schumann
DATE:	11 June 2024
DOCUMENT NO:	S2043 / J000760 / R1534 Rev1
SUBJECT:	ABA Analysis of Tailings Composites

BACKGROUND

Previous geochemical testing of typical tailings produced from processing of chalcopyrite/bornite ore from BHP's Carrapateena operation suggested that tailings of this type are likely to be non-acid forming (NAF)[1]. A recommendation from this work was to undertake acid base analysis (ABA) (Total S and acid neutralising capacity (ANC) analyses) of plant tailings on an on-going basis to determine if the NAF classification of the tailings used in the earlier test work is more generally applicable to the plant tailings, or is there significant variation in the acid forming potential of plant tailings?

This memo provides the results of ABA analysis of daily tailings composite samples undertaken by the Bureau Veritas (BV) laboratory in Wingfield SA and also by EGi's laboratory in Balmain NSW. The results were used to calculate the net acid producing potential (NAPP) and ANC/MPA ratio (maximum potential acidity (kg H_2SO_4/t) = Total S % x 30.6) of tailings across the test period, and comparison of results from the two laboratories provide a quality control measure for the analyses.

SAMPLES AND ANALYSIS

Total S and ANC were analysed by BV for 21 tailings samples (Table 1). Samples were split from daily composite samples collected over a 4-week period between mid-June and mid-July 2022, which are routinely analysed as a part of process accounting. BV provided EGi with splits from 5 of the 21 samples (Table 2) for similar analysis to provide an inter-laboratory comparison of the results and verify the results provided by BV. A further 5 daily composite tailings samples collected between mid-July and mid-August 2022 were provided to EGi for analysis (Table 2). In addition to Total S and ANC analyses, EGi also conducted acid buffering characteristic curve (ABCC) analysis. This was done to confirm that the standard ANC method routinely used for testing neutralising capacity, provided a satisfactory measure of the readily available neutralising capacity of the tailings. ANC and ABCC testing were conducted using the methods described in the AMIRA ARD Test Handbook[2].

As a part of their Quality Control (QC) procedures, BV analysed one duplicate sample with each set of samples submitted, typically in batches of 4 or 5 samples. In addition to duplicate sample analyses (Total S, ANC), Certified Reference Material (CRM) samples were assayed for Total S (NBM1, Certified Value 0.28 ± 0.01 %S, DS-1, Provisional Value 2.61 ± 0.063 %S) and ANC (KZK-1, Method Specific values between 58.9 and 64.8 kg $CaCO_3$/t).

[1] Environmental Geochemistry International, 2024. Geochemical Kinetic Testing of Flotation Tailings, Doc. No. S2043/J000663/R1499, 04/06/2024

[2] AMIRA ARD Test Handbook, Environmental Geochemistry International and Ian Wark Research Institute, AMIRA International, 2002.

Table 1 – Samples analysed by the BV lab

SAMPLE ID	SAMPLE DATE
CU.FINAL.TAIL NS 18062022	18/06/2022
CU.FINAL.TAIL NS 19062022	19/06/2022
CU.FINAL.TAIL NS 20062022	20/06/2022
CU.FINAL.TAIL NS 21062022	21/06/2022
CU.FINAL.TAIL NS 28062022	28/06/2022
CU.FINAL.TAIL NS 29062022	29/06/2022
CU.FINAL.TAIL NS 30062022	30/06/2022
CU.FINAL.TAIL NS 01072022	1/07/2022
CU.FINAL.TAIL NS 02072022	2/07/2022
CU.FINAL.TAIL NS 03072022	3/07/2022
CU.FINAL.TAIL NS 04072022	4/07/2022
CU.FINAL.TAIL NS 05072022	5/07/2022
CU.FINAL.TAIL NS 06072022	6/07/2022
CU.FINAL.TAIL NS 10072022	10/07/2022
CU.FINAL.TAIL NS 11072022	11/07/2022
CU.FINAL.TAIL NS 12072022	12/07/2022
CU.FINAL.TAIL NS 13072022	13/07/2022
CU.FINAL.TAIL NS 14072022	14/07/2022
CU.FINAL.TAIL NS 15072022	15/07/2022
CU.FINAL.TAIL NS 16072022	16/07/2022
CU.FINAL.TAIL NS 17072022	17/07/2022

Table 2 – Samples analysed by the EGi lab

EGi Code	Sample ID	Sample Date
23479	CU.FINAL.TAIL NS 18062022	18/06/2022
23480	CU.FINAL.TAIL NS 28062022	28/06/2022
23481	CU.FINAL.TAIL NS 04072022	4/07/2022
23482	CU.FINAL.TAIL NS 10072022	10/07/2022
23483	CU.FINAL.TAIL NS 16072022	16/07/2022
23534	CU.FINAL.TAIL COMPS 18072022 NS	18/07/2022
23535	CU.FINAL.TAIL COMPS 29072022 NS	29/07/2022
23536	CU.FINAL.TAIL COMPS 31072022 NS	31/07/2022
23537	CU.FINAL.TAIL COMPS 07082022 NS	7/08/2022
23538	CU.FINAL.TAIL COMPS 16082022 NS	16/08/2022

RESULTS

BV Results

Acid-Base analysis results for the 21 tailings composite samples analysed by BV are provided in Table 3. The Total S content of the tailings during the period between mid-June and mid-July was quite consistent, varying between 0.12 and 0.32% (Table 4). The neutralising capacity of tailings was also relatively consistent across the same period, ranging from 14 kg H_2SO_4/t to 36 kg H_2SO_4/t. All tailings samples were NAPP negative (- 5 to -30 kg H_2SO_4/t), with ANC/MPA ratios varying from 1.7 to 6.5, indicating that all tailings samples measured during this period can be classified as NAF, with little variation in their acid forming characteristics.

Table 3 – Acid-Base Analysis Results from BV

SAMPLE	Date	ANC	Total S	MPA	NAPP	ANC/MPA
UNITS		**kg H_2SO_4/t**	**%**	**kg H_2SO_4/t**	**kg H_2SO_4/t**	
DETECTION LIMIT		*1*	*0.01*			
CU.FINAL.TAIL NS 18062022	18/06/2022	17	0.25	8	-9	2.2
CU.FINAL.TAIL NS 19062022	19/06/2022	14	0.27	8	-5	1.7
CU.FINAL.TAIL NS 20062022	20/06/2022	17	0.20	6	-11	2.8
CU.FINAL.TAIL NS 21062022	21/06/2022	20	0.20	6	-14	3.3
CU.FINAL.TAIL NS 28062022	28/06/2022	17	0.20	6	-11	2.8
CU.FINAL.TAIL NS 29062022	29/06/2022	20	0.16	5	-15	4.1
CU.FINAL.TAIL NS 30062022	30/06/2022	16	0.22	7	-9	2.4
CU.FINAL.TAIL NS 01072022	1/07/2022	20	0.18	6	-14	3.6
CU.FINAL.TAIL NS 02072022	2/07/2022	20	0.15	5	-15	4.4
CU.FINAL.TAIL NS 03072022	3/07/2022	19	0.18	6	-13	3.4
CU.FINAL.TAIL NS 04072022	4/07/2022	20	0.32	10	-10	2.0
CU.FINAL.TAIL NS 05072022	5/07/2022	25	0.27	8	-17	3.0
CU.FINAL.TAIL NS 06072022	6/07/2022	17	0.12	4	-13	4.6
CU.FINAL.TAIL NS 10072022	10/07/2022	27	0.16	5	-22	5.5
CU.FINAL.TAIL NS 11072022	11/07/2022	30	0.16	5	-25	6.1
CU.FINAL.TAIL NS 12072022	12/07/2022	29	0.24	7	-22	3.9
CU.FINAL.TAIL NS 13072022	13/07/2022	36	0.18	6	-30	6.5
CU.FINAL.TAIL NS 14072022	14/07/2022	32	0.21	6	-25	4.9
CU.FINAL.TAIL NS 15072022	15/07/2022	24	0.20	6	-18	3.9
CU.FINAL.TAIL NS 16072022	16/07/2022	22	0.24	7	-15	3.0
CU.FINAL.TAIL NS 17072022	17/07/2022	27	0.20	6	-21	4.4

Table 4 – Statistics for tailings Acid Rock Drainage (ARD) analysis results for daily samples between June and July 2022

PARAMETER	UNIT	NUMBER OF RESULTS	MEAN	MINIMUM	MEDIAN	MAXIMUM
Total S	%	21	0.20	0.12	0.20	0.32
ANC	kg H_2SO_4/t	21	22	14	20	36
NAPP	kg H_2SO_4/t	21	-16	-30	-15	-5
ANC/MPA		21	3.7	1.7	3.6	6.5

The results of QC analyses are summarised in Table 5. Duplicate analyses were conducted for Total S and ANC. The percent relative standard deviation (% RSD), was calculated as the population standard deviation as a percentage of the mean value of duplicate measurements. RSD of duplicate measurements for Total S and ANC and calculated NAPP and ANC/MPA values were all on average below 10%, generally considered as an acceptable upper limit.

Table 5 also shows recovery of Total S for the NBM1 CRM calculated as the measured value as a percentage of the certified value. The certified value of this CRM of 0.28 ± 0.01 %S is in the range of Total S in Carrapateena tailings across the measurement period, meaning that this CRM is appropriate for QC purposes in this case. The average recovery of 101% (minimum recovery 100%, maximum recovery 104%) (Table 5) demonstrates the accuracy of the test method at the Total S level of these tailings. Results for analysis of the DS-1 CRM are not reported here as the Total S value for this sample is not a certified value and the value (2.61 %S) is significantly higher than that of the Carrapateena tailings. Similarly, the results of ANC analysis of the KZK-1 CRM were also not considered in this report, as the ANC values reported for this CRM are method specific, and comparison with the results provided by BV in the absence of specific method details are not reliable.

Table 5 – Statistics for duplicate and CRM analysis results conducted between June and July 2022

PARAMETER	UNIT	NUMBER OF RESULTS	MINIMUM	MEAN	MAXIMUM
Total S	% RSD Duplicates	4	0	1	1
ANC	% RSD Duplicates	4	2	5	9
NAPP	% RSD Duplicates	4	3	9	14
ANC/MPA	% RSD Duplicates	4	2	5	9
Total S_NMB1	% Recovery	5	100	101	104

EGi Results

Acid-Base analysis results for the 10 tailings composite samples analysed by EGi are provided in Table 6. Similar to the results from BV, the Total S contents of the tailings during the period between mid-June and mid-August were quite consistent, varying between 0.12 and 0.33%. The neutralising capacity of tailings was also relatively consistent across the same period, ranging from 14 kg H_2SO_4/t to 25 kg H_2SO_4/t. All tailings samples were NAPP negative (- 8 to -20 kg H_2SO_4/t), with ANC/MPA ratios varying from 2.1 to 6.3, indicating that all tailings samples measured during this period can be classified as NAF, with little variation in their acid forming characteristics.

Comparison of ABCC with ANC results (Figure 1) shows that, in general, the standard ANC method provides a good measure of readily available neutralising capacity of the tailings. The results also show that carbonate content is primarily associated with ferroan dolomite (Table 6), which is consistent with the results of earlier testing.

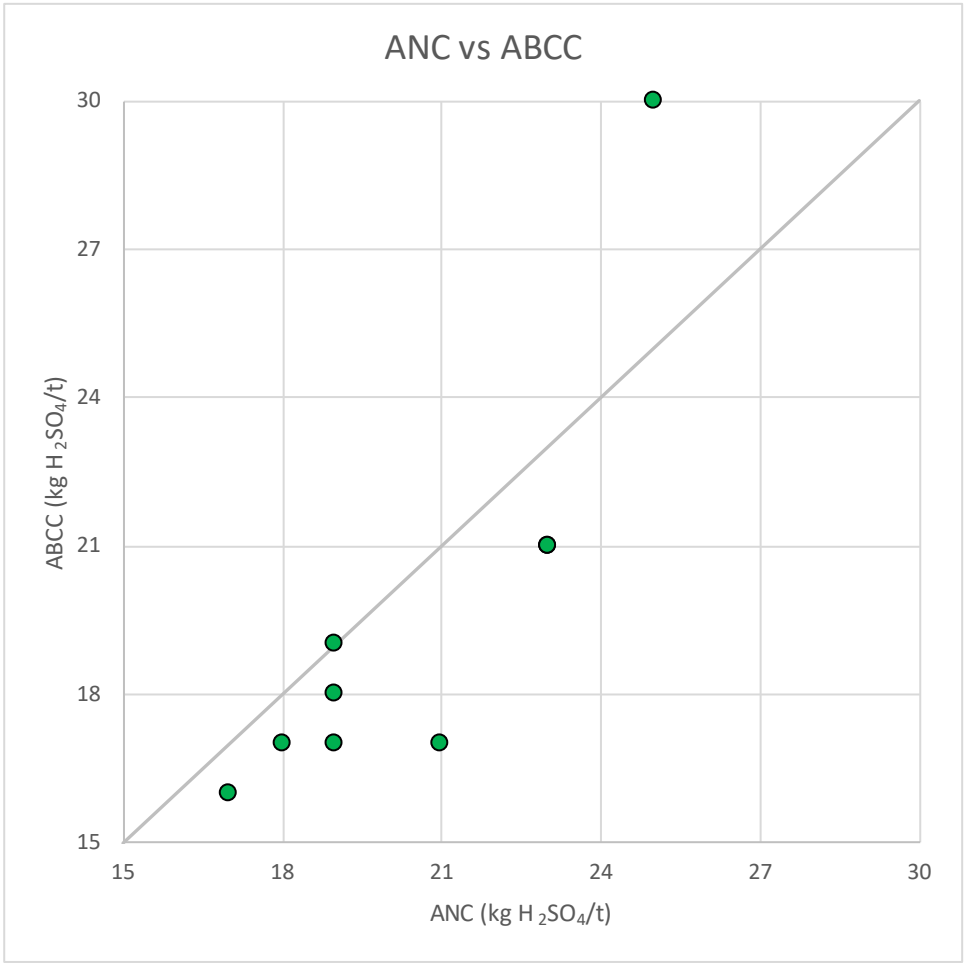

Figure 1: Comparison of ABCC and ANC for tailings samples

Table 6 – Acid-Base Analysis Results from EGi

EGi Code	SAMPLE ID	Date	ANC	ABCC	Type of Carbonate Buffering	S	MPA	NAPP (ANC)	NAPP (ABCC)	ANC/MPA
	UNITS		**kg H_2SO_4/t**	**kg H_2SO_4/t**		**%**	**kg H_2SO_4/t**	**kg H_2SO_4/t**	**kg H_2SO_4/t**	
	DETECTION LIMIT		*1*			*0.01*				
23479	CU.FINAL.TAIL NS 18062022	18/06/2022	19	18	Ferroan Dolomite	0.21	6	-13	-12	3.0
23480	CU.FINAL.TAIL NS 28062022	28/06/2022	18	17	Ferroan Dolomite	0.19	6	-12	-11	3.1
23481	CU.FINAL.TAIL NS 04072022	4/07/2022	21	17	Ferroan Dolomite	0.33	10	-11	-7	2.1
23482	CU.FINAL.TAIL NS 10072022	10/07/2022	23	21	Ferroan Dolomite	0.12	4	-19	-17	6.3
23483	CU.FINAL.TAIL NS 16072022	16/07/2022	17	16	Ferroan Dolomite	0.23	7	-10	-9	2.4
23534	CU.FINAL.TAIL COMPS 18072022 NS	18/07/2022	14	9	Ferroan Dolomite	0.20	6	-8	-3	2.3
23535	CU.FINAL.TAIL COMPS 29072022 NS	29/07/2022	23	21	Ferroan Dolomite	0.18	6	-17	-15	4.2
23536	CU.FINAL.TAIL COMPS 31072022 NS	31/07/2022	25	30	Dolomite	0.17	5	-20	-25	4.8
23537	CU.FINAL.TAIL COMPS 07082022 NS	7/08/2022	19	17	Ferroan Dolomite	0.21	6	-13	-11	3.0
23538	CU.FINAL.TAIL COMPS 16082022 NS	16/08/2022	19	19	Ferroan Dolomite	0.21	6	-13	-13	3.0

Comparison of BV and EGi Results

Five of the composite tailings samples analysed by BV were also analysed by EGi to provide an inter-laboratory comparison of results. Comparisons of ANC and Total S analyses made by the two laboratories are shown in Figure 2. The results show very good agreement between the two sets of results for Total S analysis. ANC analyses also showed reasonable agreement between the two laboratories, indicating that the BV lab used for ABA analysis of the Carrapateena tailings provides results which give a reliable measure of the acid forming potential of tailings.

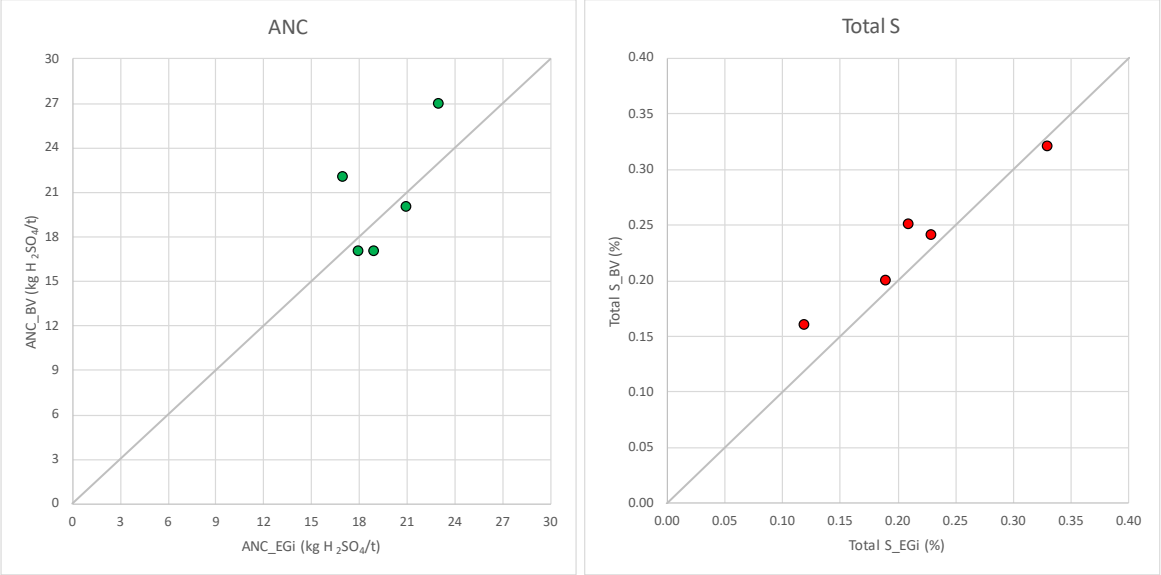

Figure 2: Comparison of ANC (left) and Total S (right) results from BV and EGi for tailings samples.

CONCLUSIONS

A total of 26 daily composite tailings samples from the Carrapateena flotation plant collected during the period between 18/06 and 16/08/2022 were analysed for Total S and ANC. The results, when converted to NAPP and ANC/MPA ratio (Figure 3), showed that all tailings samples during this period can be classified as NAF, with NAPP ranging from -5 to -30 kg H_2SO_4/t (average -21 kg H_2SO_4/t) and ANC/MPA ration ranging from 1.7 to 6.5 (average 3.6). The results also showed relatively little variation in either Total S or ANC in the tailings samples, indicating consistent acid forming characteristics for the tailings during this period.

The results from inter-laboratory testing of duplicate samples demonstrate good reproducibility, and ABCC testing demonstrated that the standard ANC method provides a good estimate of readily available neutralising capacity in the tailings. Together these results show that daily composite tailings samples sent to BV for the standard set of assays can, as required, be analysed for Total S and ANC to ascertain their acid forming characteristics.

Based on the results of this round of analyses, it is recommended that four daily composite samples are selected monthly for Total S, ANC and NAG analysis from the tailings samples sent to the BV laboratory for routine testing. Results from monthly analysis can be forwarded to EGi on a quarterly basis for assessment of any trends in the acid forming characteristics of tailings.

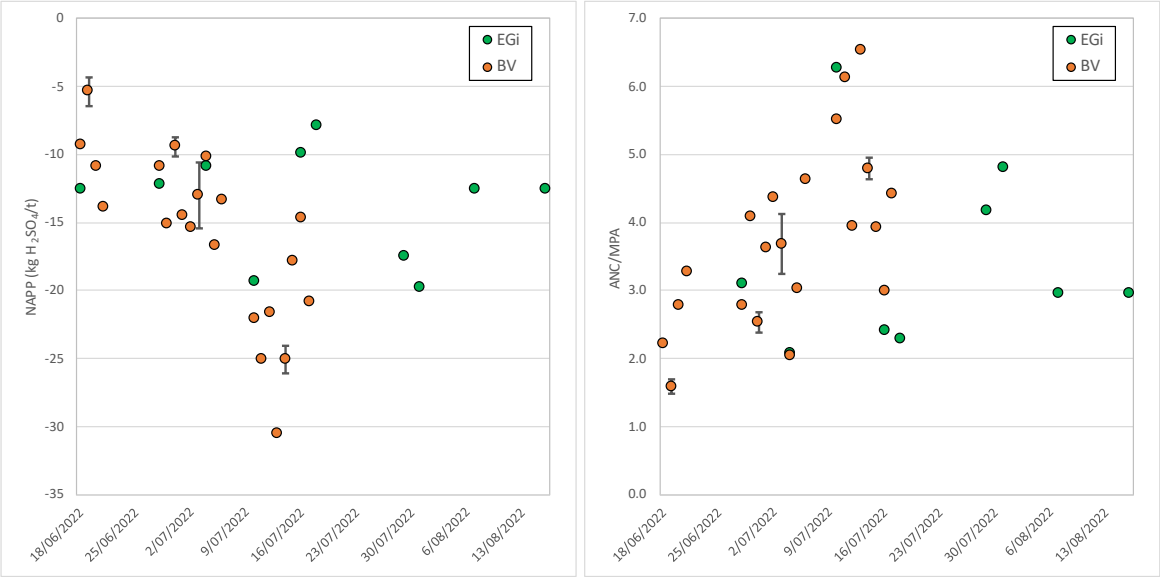

Figure 3: NAPP (left) and ANC/MPA (right) results from BV and EGi for tailings samples. Error bars show the 95% confidence interval of the mean value from duplicate measurements.

Please don't hesitate to contact me should you have any questions in relation to this report.

Regards,

Dr. Russell Schumann

Principal Environmental Chemist

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APPENDIX D
ARD Analysis of Carrapateena Tailings

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TECHNICAL MEMORANDUM

TO:	BHP Carrapateena
ATTENTION:	Josh Allen
FROM:	Russell Schumann
DATE:	7 June 2024
DOCUMENT NO:	J000852/ R1651 Rev1
SUBJECT:	ARD Analysis of Carrapateena Tailings 2022/2023

BACKGROUND

Previous geochemical testing of daily composite tailings samples taken during processing of chalcopyrite/bornite ore from BHP's Carrapateena operation between mid-June and mid-July 2022 demonstrated that tailings produced during this time were non-acid forming (NAF)[1]. A recommendation from this work was to undertake geochemical testing of plant tailings on an on-going basis to determine if the NAF classification of the tailings collected during the one month of testing conducted to that point was true in the longer-term, or is there significant variation in the acid forming potential of plant tailings?

This memo provides the results of Acid Base Accounting (ABA) and Net Acid Generation (NAG) testing of daily composite tailings samples collected weekly between October 2022 and November 2023.

SAMPLES AND ANALYSIS

Samples were split from daily composite samples (day + night shift) which are routinely analysed as a part of process accounting. Details of the tested samples are provided in Table 1.

Testing was undertaken by the Bureau Veritas (BV) laboratory in Wingfield SA. Testing included Total S, acid neutralising capacity (ANC) and NAG. ANC and NAG testing was conducted using the methods described in the AMIRA ARD Test Handbook[2]. Reported NAG values were titrated to pH 7.

As a part of their Quality Control (QC) procedures, BV analysed one duplicate sample with each set of samples submitted, typically in batches of 4 or 5 samples. In addition to duplicate sample analyses (Total S, ANC, NAG), Certified Reference Material (CRM) samples were assayed for Total S (NBM1, Certified Value 0.28 ± 0.01 %S, DS-1, Provisional Value 2.61 ± 0.063 %S) and ANC (KZK-1, Method Specific values between 58.9 and 64.8 kg $CaCO_3$/t).

The results from Total S and ANC analyses were used to calculate Net Acid Producing Potential (NAPP) according to Equation 1 and ANC/MPA ratio according to Equation 2.

$$NAPP = \text{Total S} \times 30.6 - ANC \quad [1]$$

$$ANC/MPA = ANC/(\text{Total S} \times 30.6) \quad [2]$$

[1] Environmental Geochemistry International, 2024. ABA Analysis of Tailings Composites, Doc. No. S2043/J000760/R1534 Rev1, 11/06/2024

[2] AMIRA ARD Test Handbook, Environmental Geochemistry International and Ian Wark Research Institute, AMIRA International, 2002.

Table 1 – Daily composite tailings samples analysed by the BV lab

SAMPLE DATE	SAMPLE ID	SAMPLE DATE	SAMPLE ID
2/10/2022	COMPS 02102022	26/06/2023	COMPS 26062023
9/10/2022	COMPS 09102022	3/07/2023	COMPS 03072023
16/10/2022	COMPS 16102022	11/07/2023	COMPS 11072023
22/10/2022	COMPS 22102022	16/07/2023	COMPS 16072023
29/10/2022	COMPS 29102022	23/07/2023	COMPS 23072023
6/11/2022	COMPS 06112022	30/07/2023	COMPS 30072023
12/11/2022	COMPS 12112022	6/08/2023	COMPS 06082023
19/11/2022	COMPS 19112022	13/08/2023	COMPS 13082023
26/11/2022	COMPS 26112022	20/08/2023	COMPS 20082023
3/12/2022	COMPS 03122022	27/08/2023	COMPS 27082023
10/12/2022	COMPS 10122022	3/09/2023	COMPS 03092023
17/12/2022	COMPS 17122022	14/09/2023	COMPS 14092023
24/12/2022	COMPS 24122022	17/09/2023	COMPS 17092023
31/12/2022	COMPS 31122022	25/09/2023	COMPS 25092023
7/01/2023	COMPS 07012023	1/10/2023	COMPS 01102023
14/01/2023	COMPS 14012023	8/10/2023	COMPS 08102023
21/01/2023	COMPS 21012023	15/10/2023	COMPS 15102023
27/01/2023	COMPS 27012023	22/10/2023	COMPS 22102023
4/02/2023	COMPS 04022023	29/10/2023	COMPS 29102023
11/02/2023	COMPS 11022023	5/11/2023	COMPS 05112023
18/02/2023	COMPS 18022023	12/11/2023	COMPS 12112023
25/02/2023	COMPS 25022023	19/11/2023	COMPS 19112023
4/03/2023	COMPS 04032023	26/11/2023	COMPS 26112023
11/03/2023	COMPS 11032023		
18/03/2023	COMPS 18032023		
26/03/2023	COMPS 26032023		
1/04/2023	COMPS 01042023		
8/04/2023	COMPS 08042023		
15/04/2023	COMPS 15042023		
22/04/2023	COMPS 22042023		
30/04/2023	COMPS 30042023		
7/05/2023	COMPS 07052023		
14/05/2023	COMPS 14052023		
21/05/2023	COMPS 21052023		
28/05/2023	COMPS 28052023		
4/06/2023	COMPS 04062023		
11/06/2023	COMPS 11062023		
19/06/2023	COMPS 19062023		

RESULTS

Full analysis results for the 61 tailings composite samples analysed by BV are provided in Table 4 at the end of this document. A summary of the results is provided in Table 2 and time -series plots of the results are shown in Figures 1 – 4.

The Total S contents of the tailings during the period between October 2022 and November 2023 were quite consistent, varying between 0.11 and 0.33% with an average value of 0.2% (Table 2). There was no apparent increasing or decreasing trend across this period (Figure 1). The neutralising capacity of tailings was also relatively consistent across the same period, ranging from 10 kg H_2SO_4/t to 39 kg H_2SO_4/t with a possible, but not significant, increase across the test period (Figure 2). All tailings samples were NAPP negative (-4 to -32 kg H_2SO_4/t) with a possible, but not significant, decrease across the test period (Figure 3). ANC/MPA ratios varied between 1.5 to 10.1, with only 6 samples (<10%) giving an ANC/MPA ratio below 2 and none below 1, indicating most samples contained a significant excess of neutralising capacity (Figure 4). All but one sample gave a NAGpH <7, and for this one sample the NAG to pH 7 was only 1 kg H_2SO_4/t (Table 4).

The results of QC analyses are summarised in Table 3. Duplicate analyses were conducted for Total S, ANC and NAG. However, all but one NAG result was reported as below the reporting limit, so duplicate results for NAG tests are not considered here. The percent relative standard deviation (% RSD), was calculated as the population standard deviation as a percentage of the mean value of duplicate measurements. RSD of duplicate measurements for Total S and ANC and calculated NAPP and ANC/MPA values were all on average well below 10%, generally considered as an acceptable upper limit.

Time series plots of Total S, ANC, NAPP and ANC/MPA (Figures 1 to 4) include error bars indicating the 95% confidence interval for the mean value of duplicate measurements. These plots show that any variation in duplicate measurements results is substantially less than the sample to sample variation across the time period of the analyses, showing that the variation in the measured/calculated ARD parameters of the tailings samples truly represent variation in tailings ARD properties across time.

Table 3 also shows recovery of Total S for the NBM1 CRM calculated as the measured value as a percentage of the certified value. The certified value of this CRM of 0.28 ± 0.01 %S is in the range of Total S in Carrapateena tailings across the measurement period, meaning that this CRM is appropriate for QC purposes in this case. The average recovery of 99% (minimum recovery 93%, maximum recovery 107%) (Table 3) demonstrates the accuracy of the test method at the Total S level of these tailings. Results for analysis of the DS-1 CRM are not reported here as the Total S value for this sample is not a certified value and the value (2.61 %S) is significantly higher than that of the Carrapateena tailings. Similarly, the results of ANC analysis of the KZK-1 CRM were also not considered in this report, as the ANC values reported for this CRM are method specific, and comparison with the results provided by BV in the absence of specific method details are not reliable.

Taken together, results from weekly testing show that all tailings samples analysed between October 2022 and November 2023 can be classified as NAF, with little variation and no significant trends in their acid forming characteristics. Furthermore, reported results from quality control measurements indicate that the accuracy and precision of the test methods are appropriate to provide reliable results to determine the ARD properties of the Carrapateena tailings.

Table 2 – Statistics for tailings Acid Rock Drainage (ARD) analysis results conducted between October 2022 and November 2023

PARAMETER	UNIT	NUMBER OF RESULTS	MEAN	MINIMUM	MEDIAN	MAXIMUM
Total S	%	61	0.20	0.11	0.21	0.33
ANC	kg H_2SO_4/t	61	24	10	24	39
NAPP	kg H_2SO_4/t	61	-18	-32	-18	-4
ANC/MPA		61	4.1	1.5	4.0	10.1
NAG to pH 7	kg H_2SO_4/t	61	-	<0.5	<0.5	1

Table 3 – Statistics for duplicate and CRM analysis results conducted between October 2022 and November 2023

PARAMETER	UNIT	NUMBER OF RESULTS	MINIMUM	MEAN	MAXIMUM
Total S	% RSD Duplicates	14	0	2	4
ANC	% RSD Duplicates	14	0	1	12
NAPP	% RSD Duplicates	14	0	2	16
ANC/MPA	% RSD Duplicates	14	0	2	12
Total S_NMB1	% Recovery	14	93	99	107

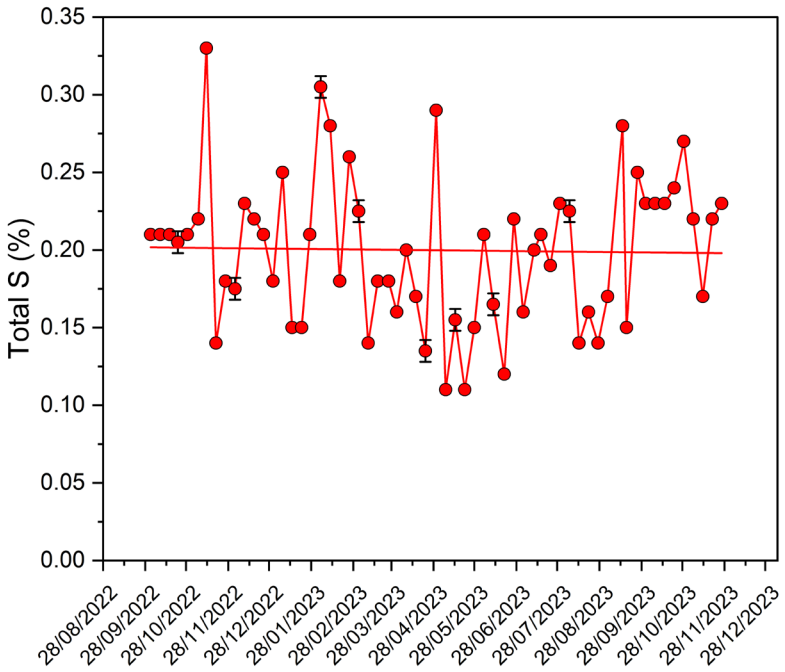

Figure 1: Total S for tailings between October 2022 and November 2023. Error bars show the 95% confidence interval of the mean value from duplicate measurements.

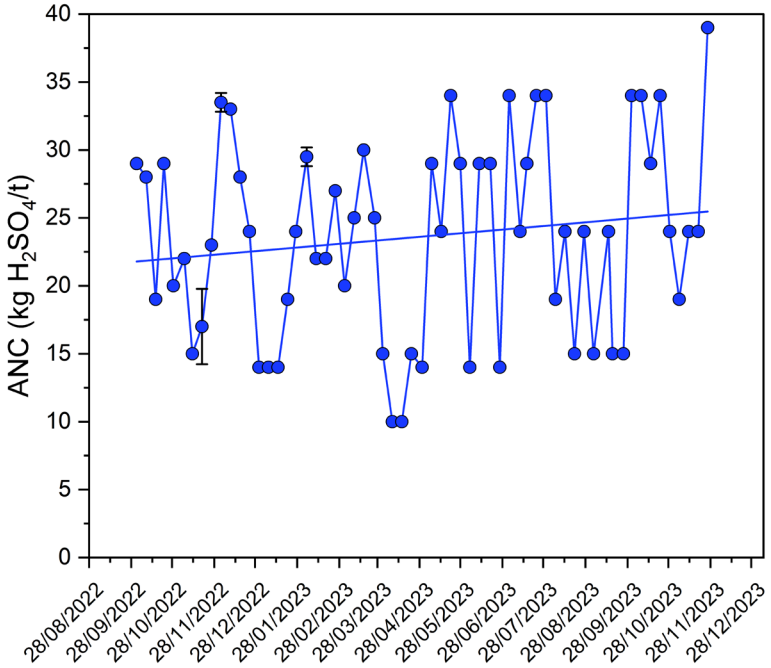

Figure 2: ANC values for tailings between October 2022 and November 2023. Error bars show the 95% confidence interval of the mean value from duplicate measurements.

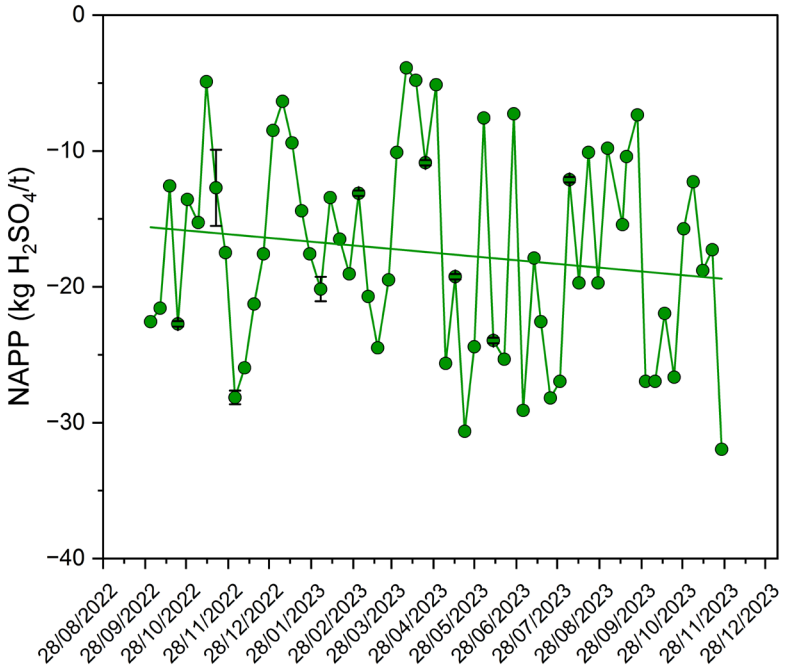

Figure 3: Calculated NAPP values for tailings between October 2022 and November 2023. Error bars show the 95% confidence interval of the mean value from duplicate measurements.

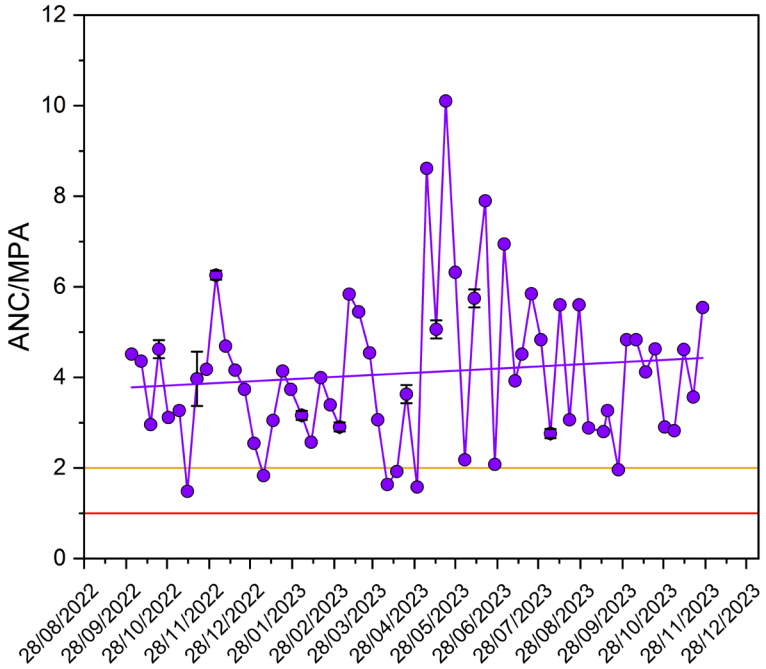

Figure 4: Calculated ANC/MPA ratios for tailings between October 2022 and November 2023. Error bars show the 95% confidence interval of the mean value from duplicate measurements.

RECOMMENDATIONS

Based on the results of tailings ARD analyses conducted between October 2022 and November 2023, it is recommended that one daily composite sample is selected monthly and sent to the BV laboratory for Total S, ANC and NAG analysis. Results from monthly analysis can be forwarded to EGi for assessment of any trends in the acid forming characteristics of tailings. The results can be reviewed and further recommendations made about on-going assessment in 12 months

Please don't hesitate to contact me should you have any questions in relation to this report.

Regards,

Dr. Russell Schumann

Principal Environmental Chemist

Table 4 – Acid-Base and NAG analysis results

SAMPLE	Date	ANC	Total S	NAPP	ANC/MPA	NAG_{pH7}
UNITS		**kg H_2SO_4/t**	**%**	**kg H_2SO_4/t**		**kg H_2SO_4/t**
DETECTION LIMIT		*1*	*0.01*			*0.5*
COMPS 02102022	2/10/2022	29	0.21	-23	4.5	<0.5
COMPS 09102022	9/10/2022	28	0.21	-22	4.4	<0.5
COMPS 16102022	16/10/2022	19	0.21	-13	3.0	<0.5
COMPS 22102022	22/10/2022	29	0.21	-23	4.5	<0.5
COMPS 29102022	29/10/2022	20	0.21	-14	3.1	<0.5
COMPS 06112022	6/11/2022	22	0.22	-15	3.3	<0.5
COMPS 12112022	12/11/2022	15	0.33	-5	1.5	<0.5
COMPS 19112022	19/11/2022	19	0.14	-15	4.4	<0.5
COMPS 26112022	26/11/2022	23	0.18	-17	4.2	<0.5
COMPS 03122022	3/12/2022	34	0.18	-28	6.2	<0.5
COMPS 10122022	10/12/2022	33	0.23	-26	4.7	<0.5
COMPS 17122022	17/12/2022	28	0.22	-21	4.2	<0.5
COMPS 24122022	24/12/2022	24	0.21	-18	3.7	<0.5
COMPS 31122022	31/12/2022	14	0.18	-8	2.5	1
COMPS 07012023	7/01/2023	14	0.25	-6	1.8	<0.5
COMPS 14012023	14/01/2023	14	0.15	-9	3.1	<0.5
COMPS 21012023	21/01/2023	19	0.15	-14	4.1	<0.5
COMPS 27012023	27/01/2023	24	0.21	-18	3.7	<0.5
COMPS 04022023	4/02/2023	29	0.31	-20	3.1	<0.5
COMPS 11022023	11/02/2023	22	0.28	-13	2.6	<0.5
COMPS 18022023	18/02/2023	22	0.18	-16	4.0	<0.5
COMPS 25022023	25/02/2023	27	0.26	-19	3.4	<0.5
COMPS 04032023	4/03/2023	20	0.22	-13	3.0	<0.5
COMPS 11032023	11/03/2023	25	0.14	-21	5.8	<0.5
COMPS 18032023	18/03/2023	30	0.18	-24	5.4	<0.5
COMPS 26032023	26/03/2023	25	0.18	-19	4.5	<0.5
COMPS 01042023	1/04/2023	15	0.16	-10	3.1	<0.5
COMPS 08042023	8/04/2023	10	0.20	-4	1.6	<0.5
COMPS 15042023	15/04/2023	10	0.17	-5	1.9	<0.5
COMPS 22042023	22/04/2023	15	0.14	-11	3.5	<0.5
COMPS 30042023	30/04/2023	14	0.29	-5	1.6	<0.5
COMPS 07052023	7/05/2023	29	0.11	-26	8.6	<0.5
COMPS 14052023	14/05/2023	24	0.15	-19	5.2	<0.5
COMPS 21052023	21/05/2023	34	0.11	-31	10.1	<0.5
COMPS 28052023	28/05/2023	29	0.15	-24	6.3	<0.5

Table 4 Cont. – Acid-Base and NAG analysis results cont.

SAMPLE	Date	ANC	Total S	NAPP	ANC/MPA	NAG_{pH7}
UNITS		**kg H_2SO_4/t**	**%**	**kg H_2SO_4/t**		**kg H_2SO_4/t**
DETECTION LIMIT		*1*	*0.01*			*0.5*
COMPS 04062023	4/06/2023	14	0.21	-8	2.2	<0.5
COMPS 11062023	11/06/2023	29	0.17	-24	5.6	<0.5
COMPS 19062023	19/06/2023	29	0.12	-25	7.9	<0.5
COMPS 26062023	26/06/2023	14	0.22	-7	2.1	<0.5
COMPS 03072023	3/07/2023	34	0.16	-29	6.9	<0.5
COMPS 11072023	11/07/2023	24	0.20	-18	3.9	<0.5
COMPS 16072023	16/07/2023	29	0.21	-23	4.5	<0.5
COMPS 23072023	23/07/2023	34	0.19	-28	5.8	<0.5
COMPS 30072023	30/07/2023	34	0.23	-27	4.8	<0.5
COMPS 06082023	6/08/2023	19	0.22	-12	2.8	<0.5
COMPS 13082023	13/08/2023	24	0.14	-20	5.6	<0.5
COMPS 20082023	20/08/2023	15	0.16	-10	3.1	<0.5
COMPS 27082023	27/08/2023	24	0.14	-20	5.6	<0.5
COMPS 03092023	3/09/2023	15	0.17	-10	2.9	<0.5
COMPS 14092023	14/09/2023	24	0.28	-15	2.8	<0.5
COMPS 17092023	17/09/2023	15	0.15	-10	3.3	<0.5
COMPS 25092023	25/09/2023	15	0.25	-7	2.0	<0.5
COMPS 01102023	1/10/2023	34	0.23	-27	4.8	<0.5
COMPS 08102023	8/10/2023	34	0.23	-27	4.8	<0.5
COMPS 15102023	15/10/2023	29	0.23	-22	4.1	<0.5
COMPS 22102023	22/10/2023	34	0.24	-27	4.6	<0.5
COMPS 29102023	29/10/2023	24	0.27	-16	2.9	<0.5
COMPS 05112023	5/11/2023	19	0.22	-12	2.8	<0.5
COMPS 12112023	12/11/2023	24	0.17	-19	4.6	<0.5
COMPS 19112023	19/11/2023	24	0.22	-17	3.6	<0.5
COMPS 26112023	26/11/2023	39	0.23	-32	5.5	<0.5

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Appendix C
Baseline, effects and impacts

Appendix C1.
Ecology baseline update

Carrapateena Operations

Flora and Fauna Survey 2024

BHP

LATHWIDA ENVIRONMENTAL

March 2025

Revision 0

Document status

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Project details

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The sole purpose of this report and the associated services performed by Lathwida is to document the 2024 Ecological Assessment for the survey area. This document and associated data will support the development of primary approval documentation required for the Carrapateena Mine site in South Australia. The report is based on the results of an annual flora and fauna survey for BHP. The scope of services, as described in this report, was developed with BHP.

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Executive summary

Carrapateena is a copper-gold mining operation located in South Australia approximately 160 km north of the regional centre of Port Augusta. BHP (previously OZ Minerals) have an approved Program for Environment Protection and Rehabilitation (PEPR) for the Carrapateena Mineral Lease (ML 6471), and associated Miscellaneous Purposes (MPLs) 149, 152, 153, 154 and 156, which satisfies section 70B of the Mining Act 1971 (SA) (Mining Act) (BHP 2024). Under the Mining Act Part 10A, a compliant program must be in force before carrying out operations as defined in the PEPR.

BHP engaged Lathwida Environmental (Lathwida) to conduct the annual flora and fauna survey to demonstrate approval conditions and outcomes as per the PEPR ML 6471 and associated MPLs. The relevant approval conditions focus on flora and fauna survey to monitor the following: plant diversity and abundance, plant health, evidence of new weed species that are declared under legislation, increases in abundance of existing (non-declared) weed species and evidence of pathogens or feral animals as a result of the mine operation or mine related activities. In addition, approval conditions require BHP to report records of fauna species with a National Conservation Rating (e.g. relevant species to Carrapateena listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)); Plains Mouse (*Pseudomys australis*), Night Parrot (*Pezoporus occidentalis*) and Thick-billed Grasswren (*Amytornis modestus indulkanna*). The PEPR outlines specific Outcome Measurement Criteria (OMC) which BHP are required to report against.

This report provides the outcomes of the spring 2024 survey, which builds upon the previous ecological compliance monitoring surveys undertaken since the commencement of construction in autumn 2018. The majority of surveys were conducted in spring (from September 2018), however an autumn survey was also conducted in 2023, given the change in rainfall in the preceding years. The intention of the 2023 autumn survey was to detect a different suite of flora and fauna and to provide an additional opportunity to capture the EPBC listed Plains Mouse. In 2024, Carrapateena rainfall was below average and fluctuated, with only two larger events in March (over 20 mm) and July (40mm), hence a spring survey was conducted rather than autumn.

Flora survey methods undertaken here are generally consistent with methods that have been used at the Carrapateena for baseline studies undertaken prior to construction (2012-2017), with minor modifications to align data collection with the outcomes and mine approval conditions. Flora methods include Jessup transects, Rangeland Assessment Methodology (RAM), canopy cover assessments and weed transects. These methods provide a combination of data that informs current native and exotic (weed) plant diversity and abundance, whilst canopy cover data provides an indication of tree health (and stress) within a creekline downstream of the Tailings Dam. Results are compared to baseline survey data where applicable data is available. Landscape Functional Analysis (LFA) was conducted at four sites (two established 2020, two established in 2022) that have begun rehabilitation. LFA uses field assessment of physical, chemical and biological processes to determine the degree to which the land system is self-sustaining, and in particular, assesses the capture or loss of resources from the system. The results of the spring 2024 LFA were compared with 2019 - 2023 results and baseline data from corresponding representative 'analogue' sites. One site no longer requires monitoring (Tjungu), one only requires one method of monitoring given the plant density is high, and one site should be rehabilitated again, given shallow ripping is very slow to

rehabilitate and one transect has been compromised. In future additional LFA sites and new analogue sites could be established immediately adjacent the LFA Sites, once infrastructure locations are final, and the rehabilitation is evident.

Fauna survey methods followed a modified version of the biological survey methods (as per Owens 2000), with a focus on pitfall trapping to address the lease area condition relating to small mammal and reptile diversity, including the EPBC listed as Vulnerable Plains Mouse (*Pseudomys australis*). A single trap line was installed at eight established fauna sites, and bird surveys were undertaken at 20 sites, aligning with vegetation survey sites. One un-baited camera trap was also installed at each trap line site, and Song Meters were deployed at 10 sites to record bird calls and at three sites to record microbat calls. Opportunistic observation / capture of all vertebrate species across the site was also recorded to provide information about overall species diversity at Carrapateena, which is comparable with previous surveys.

Despite below average rainfall for the year prior to the survey, an above average winter rainfall event in July and reduced grazing impacts has resulted in an abundance of short-lived flora species and sustained the four main long-lived flora species at Carrapateena and high numbers of reptiles which have less reliance on sustained rainfall. However, lack of sustained rainfall earlier in the year, and suitable food resources (e.g. grass seeds), has likely influenced the overall fauna records at the site, i.e. lower rodent diversity and captures and continued lack of detection of EPBC listed Plains Mouse,

ES1 Flora results

The conditions of the PEPR require native vegetation condition surveys that assess native plant species abundance and diversity. In 2024, total species diversity recorded across all flora sites (141 native species) was the equal highest recorded during compliance monitoring, due to a very high diversity of short-lived species being recorded. During construction monitoring, variation in total species diversity within the mining lease has largely been due to variation in diversity of short-lived species that germinate in response to rainfall events, such as the well above average rainfall received in July 2024. Grazing impact continued to be low in 2024, following widespread destocking across the mining lease, which also likely influenced short-lived species diversity and widespread increased abundance of palatable species (e.g. Bladder Saltbush, Bush Minuria and Plains Lantern Bush). The population abundance of the five most abundant and/or widespread long-lived perennials declined during 2018 to 2020, but have all increased since 2021 (Bladder Saltbush, Samphire, Sea-heath, Bush Minuria, Plains Lantern Bush). The declines and increases in long lived perennial species are attributed to yearly and long-term rainfall totals rather than mining impacts (e.g. the 50% increases in Plains Lantern Bush and Cunningham's Daisy abundance in 2022 and/or 2023 were particularly striking). Similar to 2023, in 2024 the mean total species diversity for impact sites and for control sites was not significantly different, were within the baseline range, and comparable with mean total species diversities recorded in 2018 (early compliance). Based on the above, mining activities are not considered to be impacting either short-lived or long-lived species diversity at the mineral lease. Hence, results suggest there are no impacts on native flora species diversity and abundance from mining activities, satisfying Schedule 6 Conditions of the PEPR and OMCs SWRF1, AQ2.

Impacts in Eliza Creek have the potential to occur as a result of reduced surface water flows, reduced groundwater flows and / or groundwater contamination attributed to tailings seepage from the Tailings Storage Facility (TSF), or flood water released through activation of the decant dam spillway in a 1 in 100-year 72 AEP rain event. Since 2018, there has been no distinct trend in species diversity for any of the Eliza Creek sites, with both small increases and decreases occurring yearly at each site. There are also no distinct differences in species diversity between sites. There is no clear pattern emerging in species diversity data relating to the time since the TSF establishment and the distance from the TSF. Ten of the most abundant long-lived woody perennials recorded at the Eliza Creek Jessup transects were separately analysed. All 10 species have shown yearly fluctuations, but no downward population trends at any of the Eliza Creek sites since 2018, with the exception of Dead Finish at Site 10. The slight downward trend of Dead Finish may be attributable to fluctuating numbers between surveys and difficulty in separating dense clusters of spiky plants into individuals. Regardless, the Eliza Creek Jessup transects have shown an increase in total perennial species abundance. Canopy cover assessments have also shown positive tree health for the sites downstream of the TSF. Western Myall trees have shown an increase in foliage and recruitment and River Red Gums have regained canopy losses, but there was still no recruitment of Red Gums recorded along transects. Lack of recruitment from River Red Gums along the transects (located furthest from the TSF) are likely reflective of lower than average rainfall. No impact from mining activities is considered evident (based on diversity, abundance and canopy cover assessments) at the formal Eliza Creek sites. The results of the formal monitoring sites results would suggest there are no impacts on Eliza Creek vegetation arising from the TSF and associated mining activities, satisfying Sixth Schedule Condition 2 of the PEPR and OMC SWRF1, TSF6. However, downstream of the TSF there has been a seepage incident at the Decant Dam, resulting in the death of Western Myall trees and understorey shrubs upstream of Site 17. This is currently considered non-compliant until the extent of impact is finalised, and Significant Environmental Benefit (SEB) offset is accounted for. A follow up survey in spring 2024 has been undertaken to finalise the SEB offset requirement under the Native Vegetation Act 1991 (refer Separate memo).

Weed species were surveyed at existing flora sites; at designated weed transects, and at opportune locations throughout the lease area, including the camps and dams. Most weeds recorded were annual herbs or grasses. Most annual weed records were from dams or drainage lines, areas naturally susceptible to weed invasion, and from the dune habitats, and their presence is unrelated to mining activities. There were no new weeds recorded in 2024 and no overall increase in abundance or extent of weeds declared under legislation. Although not declared, Wards Weed was recorded along the Western Access Road for the first time, however was previously recorded along the SAR (2021). This introduction may be due to mine related activities. It is recommended that this small population be located in winter when it is actively growing and eradicated.

Ongoing control of Tobacco Bush at Dawson Dam and South Eliza Dam is recommended. Fluctuations in density reflect seasonal rainfall patterns rather than mining impacts. No new species of declared weeds were recorded during spring 2024, indicating compliance with the Schedule 6 Condition 6, Schedule 2 Condition 28, and OMC WP1 and WP2.

No EPBC listed or NPW Act listed flora species were recorded during the 2024 survey.

ES2 LFA results

The current status and trends at four rehabilitation sites (Aerodrome laydown, Ventia laydown, Midway Quarry and Tjungu) were again measured by Landscape Function analysis (LFA), using the Established Method and Point Centre Quarter (PCQ) method for all sites. The LFA and PCQ show a positive trend in the number and area of plants per hectare (ha) at all four rehabilitation sites. Plant colonisation across sites is currently dominated by short-lived perennial species (*Sclerolaena* spp.) although several longer-lived perennials were also recorded and some distant from the transects. The short-lived species are an important colonising component of the naturally occurring vegetation in the stony tableland habitat, and all plants improve soil stability and function. As plants (patches) establish and increase in size, the potential for resource capture and nutrient cycling improves leading to ongoing increased potential for recruitment of native species. Developed patches also provide cover and habitat opportunities for native fauna species and reduce soil loss and erosion.

Although LFA monitoring is in its early stages, there are evident differences between application of different rehabilitation techniques which may be affecting recruitment. These include deeper contour ripping and application of rocky surface strew at the Aerodrome, Midway Quarry and Tjungu sites compared with shallow contour ripping at the Ventia site. The addition of hand seeding has also likely accelerated establishment of plants at the Tjungu site, although only a few species from the seed mix were recorded, regardless this site no longer requires monitoring. The absence of resource trapping patches (troughs) at the Ventia site is likely to substantially limit the speed with which the site rehabilitates, plus one transect was decommissioned in 2024 given it had been compromised by vehicle tracks. However, additional intervention or restoration activities of the remaining sites may further enhance site rehabilitation for all sites, including applying native woody debris (e.g. old Myall fence posts, fallen branches), planting local groundcovers and low shrubs, and providing supplementary watering during critical periods of plant establishment. Ongoing monitoring will assist in informing trends and the benefit of additional intervention such as deeper or repeat ripping and seeding.

Currently, LFA data is compared with data from a series of 'analogue sites' which were collected prior to construction at the site. Whilst this analogue data is considered broadly representative of the vegetation communities around the mine lease, and therefore a useful indicator of rehabilitation success, a more precise reference would be to establish LFA sites adjoining each rehabilitation site.

Overall, OMC LUP4 is considered to be in-progress / compliant.

ES3 Fauna results

The 2024 spring fauna survey identified a total of 107 vertebrate species from the eight survey sites and opportunistically across the study area. Capture rates for small mammals and reptiles were within baseline and compliance ranges. Reptile and bird diversity, and total species diversity across the whole of Carrapateena was however within or above the range of diversity that has been recorded during baseline surveys, meaning construction and early operational activities do not appear to have resulted in a loss of abundance or diversity. Compared to recent years, increased reptile captures and the highest diversity recorded were most likely influenced by the warmer temperatures (e.g. a day of 36 and 40 degrees,

respectively), however there were also thunderstorms and extreme wind events. Bird diversity was within baseline and compliance range, with waterbird presence increased as a result of water present in dams and a temporary water source at South Eliza. Mammal captures were within baseline and compliance ranges, but diversity was slightly lower for rodents and no planigales were detected. However, these mammal types were generally captured in smaller numbers in previous surveys and respond to rainfall (or lack of). Higher total fauna capture rates were also likely associated with presence of short-lived flora species, a winter rainfall event and the warmer daily temperatures during the survey. The common species were captured in numbers within baseline ranges (e.g. Stripe-faced Dunnart, Fat-tailed Dunnart, Saltbush Ctenotus, Earless Dragons). Similar to the other compliance monitoring surveys, the reduced survey effort (reduced trap lines) compared with baseline surveys did not appear to influence capture rates per site. This trapping effort appears sufficient to capture information that is required for the mine conditions and PEPR outcomes, which focus on habitat quality and species presence or absence (diversity) rather than abundance, as well as comparison between control and impact sites. Diversity of species and families was comparable to baseline data, and birds and reptiles showed evidence of breeding (e.g. plumage, multi-sex groupings and presence of juveniles), suggesting that mining related construction activities are not negatively impacting fauna at Carrapateena. Small mammal capture numbers were again skewed towards Stripe-faced Dunnarts, aligning with baseline and compliance trends, with the exception of 2022 when Fat-tailed Dunnarts were captured in higher numbers. This may suggest conditions were more favourable for Stripe-faced Dunnarts compared to Fat-tailed Dunnarts at the time of the survey. In addition, microbats were surveyed using Song Meter acoustic device at three opportunistic sites and five species were detected, three of these had not been recorded since baseline.

The approval conditions of the PEPR (Schedule 2 Condition 28) require that any records of three EPBC Act listed as threatened species (Night Parrot *Pezoporus occidentalis*, Thick-billed Grasswren *Amytornis modestus*, and Plains Mouse *Pseudomys australis*) are documented and provided to the Biological Databases of South Australia (BDBSA), if they are recorded during ecological surveys at Carrapateena, or opportunistically during regular site activities. None of these EPBC listed threatened were detected during the 2024 survey. One EPBC listed as threatened and migratory was detected (Sharp-tailed Sandpiper) and one EPBC listed as migratory species (Common Sandpiper) was detected throughout the spring 2024 survey; both detected in small numbers at South Eliza Dam. Both species have previously been detected at Carrapateena at dams or effluent irrigation areas with run off.

During the spring 2024 survey, there were fauna species detected that had not previously recorded within the lease during baseline and compliance monitoring (Pelican, Red-necked Avocet, Rufous Songlark) and others that had not been detected since baseline (Southern Four-toed Slider, Australian Pratincole, Inland Forest Bat, Inland Free-tailed Bat and Lesser Long-eared Bat). Gould's Wattled Bat was also detected, considered as likely present in 2023, but calls could only be verified to Genus level that year. Carrapateena occurs within or on the edge of the known range of these species and there are historic BDBSA records for these species within the broader region (i.e. > 50km from the study area).

Less invasive fauna detection methods such as Song Meters and cameras have again proved useful to complement bird and fauna survey effort, particularly in the arid zone, where local climate can affect species presence during a survey.

Overall, OMC WP1, WP2, EPBC1, EPBC2, EPBC3 are considered to be compliant.

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1 Introduction

1.1 Operation background

Carrapateena is a copper-gold mine, now owned and operated by BHP Group Limited (BHP), and which located in South Australia on the eastern margin of the Gawler Craton, approximately 160 km north of the regional centre of Port Augusta (Figure 1.1). Construction on Carrapateena was completed by OZ Minerals in late 2019 – early 2020, and is now in a steady state of operation. The Carrapateena operation is an underground copper gold mine using a sub-level cave mining method. Onsite there is the Tjati and materials handling declines, process plant, ancillary infrastructure, Tailings Storage Facility (TSF), Tjungu village and Aerodrome. An exploration village that was temporary is also likely to be retained and updated given expansions that are in progress. OZ Minerals was purchased by BHP in 2023 and all former OZ Minerals assets are now part of BHP.

BHP have an approved Program for Environment Protection and Rehabilitation (PEPR) for the Carrapateena Mineral Lease (ML 6471), which satisfies section 70B of the Mining Act 1971 (SA) (Mining Act). Under Part 10A of the Mining Act, a compliance program must be in force before carrying out operations as defined in the PEPR. OZ Minerals was granted ML 6471 on 3 January 2018. The PEPR was updated in June 2024. In addition to the ML, the Carrapateena PEPR also includes the following Miscellaneous Purposes Licence (MPLs) for infrastructure associated with the mine:

- Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure (MPL 149), granted 5 July 2017
- Western Infrastructure Corridor (MPL 152), granted 3 January 2018
- Eastern Radial Wellfield (MPL 153), granted 3 January 2018
- Southern Access Road and Radial Wellfield (MPL 154), granted 3 January 2018
- Northern Wellfield (MPL 156), granted 11 December 2018.

Jacobs were previously engaged to conduct construction and operational ecological monitoring surveys in autumn and spring of 2018, spring 2019, spring 2020, spring 2021, spring 2022, and autumn 2023 in order to meet approval conditions outlined in the PEPR ML 6471. This report represents the findings from the eighth compliance monitoring survey; undertaken in spring 2024 by Lathwida Environmental (Lathwida). The approval conditions focus on:

- Surveying native plant species to ensure there is no decline in diversity and abundance as a result of mining activities,
- Monitoring of plant health to demonstrate there are no detrimental impacts on plants as a result of mining activities (e.g. including impacts from raised dust levels, contaminants and/or declines in surface water flow),
- Monitoring to demonstrate that no new weed species declared under legislation have been introduced to Carrapateena, and no increase in abundance of existing (non-declared) weed species, pathogens or feral animals has occurred as a result of mining activities,

- Surveying common native fauna to ensure there is no loss in diversity or abundance, as a result of as a result of mining activities (e.g. from direct impacts, impacts to habitat, weeds and pests),
- Surveying native fauna species to ensure there is no decline in diversity and abundance of NPW Act or EPBC Act listed fauna as a result of mining activities, and
- Reporting of any records of EPBC Act listed fauna species, including migratory species, with specific objectives for several EPBC listed species (discussed below).

Figure 1.1: Project Location
Carrapateena Flora and Fauna Survey

LATHWIDA

1.1.1 Relevant conditions of approval

As stated in the initial compliance monitoring report, which occurred during construction (Carrapateena Ecology autumn 2018 survey, Jacobs 2018a), the approval conditions of the PEPR for ML 6471 and associated MPLs define a number of conditions relating to fauna and flora values that occur within the lease areas, which are summarised in Table 1.1 below. The PEPR, updated in 2024, also outlines the monitoring program including Outcome Measurement Criteria (OMC), Leading Indicators and Strategies to demonstrate compliance with the defined and agreed Outcomes, which are summarised in Table 1.2.

Table 1.1: Mineral Lease 6471 and associated MPLs fauna and flora conditions relevant to annual monitoring

Schedule and Conditions Reference no.	Condition Environmental Outcome / OMC ID
Schedule 2 Condition 28.2 to 28.4 (ML 6741, MPL 152 to 154)	To ensure the protection of Matters of National Environmental Significance, the Tenement Holder must: 28.1 (refer Schedule 6) 28.2. Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Databases of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions; 28.3. Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team; and 28.4. Provide data from any future sightings and records of the Plains Mouse to the BDBSA to enable effective monitoring and record keeping, as per the Recovery Plan Actions. OMC ID EPBC1, EPBC2, EPBC3
Schedule 6 Condition 6 and 28.1 (ML 6471) Condition 3 (MPL 156) Condition 6 (MPL 152 to 154) Conditon10 (MPL149)	The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining related activities. 28.1. Develop, implement and maintain appropriate management actions to ensure the control of feral animal populations, including cats and foxes. OMC ID WP1, WP2
Schedule 6 Condition 17 (ML 6471)	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities. OMC SWRF1, TSF6
Schedule 6 Condition 7, 6, 4 (MPL 6471, MPL 149, 152 to 154, 156)	The Tenement Holder must during construction and operation ensure no impacts to agricultural productivity for third-party land users on or off the Land as a result of mining-related activities other than those agreed between the Tenement Holder and the affected user or determined by an appropriate court as evidenced in its order(s) (and the Tenement Holder must provide the Director of Mines (or other authorised officer) with a copy of the order(s), which shall be placed on the Mining Register). OMC LUP4
Schedule 6 Condition 14 (ML 6471)	The Tenement Holder must during construction, operation and post Completion ensure no adverse change to the air quality environment as a result of particulate emissions and/or dust generated by mining operations or mining related activities. OMC AQ2

Table 1.2: Outcomes, Outcome Measurement Criteria (OMC) / Leading Indicator / Strategies

Outcome Measurement Criteria (OMC) Code	Relevant Environmental Outcomes	OMC / Leading Indicator / Strategy	Achievement Values
SWRF1	The Tenement Holder must during construction, operation and post Completion ensure no adverse impact to surface water quality and water dependent ecosystems (excluding surface water in the mine subsidence zone), on or off the Land, as a result of contamination and sedimentation caused by mining operations or mining-related activities.	Annual surveys undertaken by an independent and suitably qualified expert demonstrates no adverse impact on the diversity and abundance of native vegetation and water dependent ecosystems at Eliza Creek monitoring attributed to reduced surface water flows caused by mining operations when compared to baseline conditions	No adverse impact on the diversity and abundance of native vegetation and water dependant ecosystems attributed to reduced surface water flows caused by mining operations when compared to baseline conditions (Appendix C5 of PEPR - Ecological Baseline BHP 2024) unless a significant environmental benefit has been approved in accordance with the relevant legislation Linked to Native Vegetation Outcome (Schedule 6 Condition 11)
TSF6		Annual surveys undertaken by an independent and suitably qualified expert demonstrates no adverse impact on the diversity and abundance of native vegetation and water dependent ecosystems at Eliza Creek monitoring sites attributed to tailings seepage when compared to baseline conditions (Appendix C5 Ecological Baseline of PEPR BHP 2024) and surveys for new sites undertaken prior to commencement Stage 1 Tailings commissioning)	No adverse impact on the diversity and abundance of native vegetation and water dependant ecosystems attributed to tailings seepage when compared to baseline conditions (Appendix C5 of PEPR - Ecological Baseline BHP 2024) unless a significant environmental benefit has been approved in accordance with the relevant legislation. Linked to Native Vegetation Outcome (Schedule 6 Condition 11).
WP1	The tenement holder must during construction and operation ensure no introduction of new species of weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining activities mining operations or mining-related activities.	Annual flora and fauna surveys undertaken by suitably qualified ecologists at flora, fauna and weeds monitoring locations demonstrates no introduction of new species of weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals) as a result of mining related activities when compared to previously recorded weed species and introduced fauna	No introduction of: • new species of weeds declared or listed under relevant legislation • plant pathogens, pests (including feral animals) when compared to previously recorded weed species and introduced fauna.
WP2		Annual flora and fauna surveys undertaken by independent and suitably qualified ecologists at flora, fauna and weed monitoring locations demonstrates no increase in the abundance of existing weeds or pest species in the land compared to previous survey records as a result of mining related activities	No increase in the abundance of existing weeds or pest species in the land compared to previous survey records.

Outcome Measurement Criteria (OMC) Code	Relevant Environmental Outcomes	OMC / Leading Indicator / Strategy	Achievement Values
AQ2	The Tenement Holder must during construction, operation and post Completion ensure no adverse change to the air quality environment as a result of particulate emissions and/or dust generated by mining operations or mining-related activities.	Annual surveys undertaken by a suitably qualified and experienced expert demonstrates no adverse impact on the diversity and abundance of native vegetation at monitoring sites (Figure 2.1) directly attributed to dust deposition from mining operations or mining related activities when compared to baseline native vegetation conditions	No adverse impact on the diversity and abundance of native vegetation at monitoring sites directly attributed to dust deposition from mining operations or mining related activities when compared to baseline native vegetation conditions (Appendix C5 Ecological Baseline of BHP 2024)
EPBC1	Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Databases of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions.	Future records of the Thick-billed Grasswren are to be provided to the BDBSA to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites or opportunistic sighting (Figure 2.1, Figure 2.2, Figure 2.3)	Records of the Thick-billed Grasswren provided to the BDBSA if observed. Linked to MNES Condition (Schedule 2 Condition 28.2).
EPBC2	Provide data from any future sightings and records of the Plains Mouse to the BDBSA to enable effective monitoring and record keeping, as per the Recovery Plan Actions	Future records of the Plains Mouse are to be provided to the BDBSA to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites or opportunistic sighting (Figure 2.1, Figure 2.2, Figure 2.3)	Records of the Plains Mouse, provided to the BDBSA if observed. Linked to MNES Condition (Schedule 2 Condition 28.4).
EPBC3	Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team	Future records of the Night Parrot are provided to the Night Parrot Recovery Team to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites or opportunistic sighting (Figure 2.1, Figure 2.2, Figure 2.3)	Records of the Night Parrot provided to the Night Parrot Recovery Team if observed. Linked to MNES Condition (Schedule 2 Condition 28.3)
LUP4	The Tenement Holder must ensure that the Land is progressively and finally rehabilitated to support the future land use.	Rehabilitation trials shall be undertaken at infrastructure locations no longer required Figure 2.6 and ongoing (annual) assessment at LFA monitoring sites are assessed annually demonstrating development of trends and annual improvement of rehabilitation through LFA methodology. Should the data indicate rehabilitation not trending towards sustainability root-cause investigations will be undertaken and rectification methods be identified and implemented	Rehabilitation has achieved, or is likely to achieve, a landscape function equivalent to that of adjacent analogue LFA sites

Note WP3 includes monthly weed inspections, this is not part of the scope of this report.

1.2 History of monitoring at Carrapateena

The history of baseline ecological monitoring at Carrapateena was summarised in the Carrapateena Ecology autumn 2018 survey report (Jacobs 2018a), which represented the first of the compliance monitoring reports following commencement of construction. Briefly, baseline flora and fauna surveys were undertaken by EBS Ecology within and surrounding the Carrapateena Mineral Lease (ML 6471), biannually between autumn 2012 and spring 2016 / 2017 (references provided in Jacobs 2018). The surveys covered a range of seasonal and yearly climatic conditions and therefore collectively provide a robust baseline data set describing the fauna and flora values present at the site, against which impacts from the Carrapateena construction and operation can be compared.

A summary of baseline ecological monitoring (2012 to 2017, EBS Ecology 2017b) is provided in previous monitoring reports (Jacobs 2018a, 2018b; 2019, 2020, 2021, 2022, 2023d). The autumn and spring 2018, and spring 2019 to 2023 surveys (conducted by Jacobs) are considered to represent the commencement of, and ongoing construction and operational compliance monitoring associated with the mining operation approved under ML 6471. It is noted that whilst baseline surveys were conducted in 2017, some raw data (primarily floristic data) was not available for comparison against the compliance monitoring data.

1.3 Climate at Carrapateena

The nearest weather station to Carrapateena Mine that provides detailed temperature and rainfall data is the Woomera Aerodrome (station number 16001, Commonwealth of Australia Bureau of Meteorology (BoM) 2023a), approximately 70 km to west of the operational area. Long term climatic statistics are available for this site (1949 to current) providing an insight into the region's climatic trends. The mine is located in an arid environment, with a hot, dry climate, and average rainfall of approximately 180 mm per year (BoM 2024a). Long-term mean monthly rainfall shows no distinct seasonal variation, whereas mean monthly temperature maximums vary from the mid to low 30s in the summer months to below 20 degrees Celsius in the winter months (Figure 1.2).

In the 12 months preceding the spring 2024 survey, the Woomera region recorded below average yearly rainfall, despite July and December receiving around 14 mm and 40 mm more rain than mean long term totals respectively (Figure 1.3, Figure 1.4, and Figure 1.5). This shortfall can be explained by six months of the year receiving at least 10 mm rain less than the mean monthly long-term totals (Figure 1.3). All remaining months during this period received within 5 mm of the mean monthly long-term totals. Further detail about specific trends in rainfall at Carrapateena are discussed in Section 3.1.

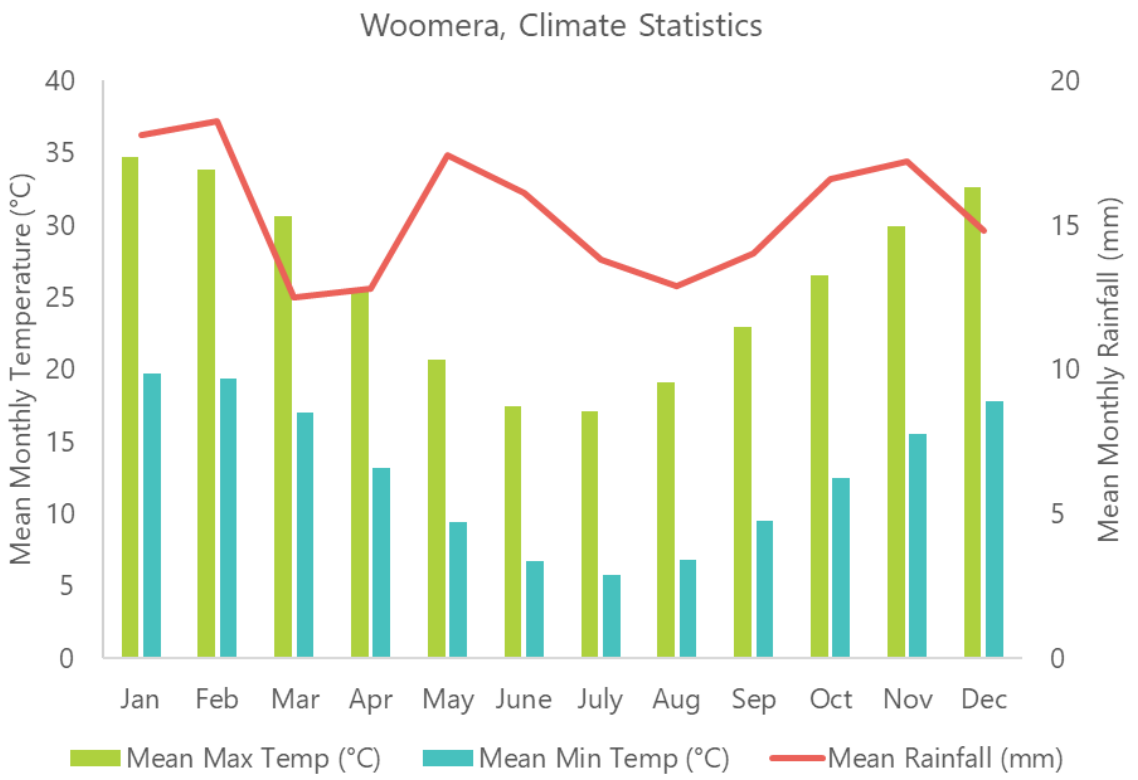

Figure 1.2: Long-term climate averages (1949-2024) for regional weather station nearest to Carrapateena, Woomera Aerodrome

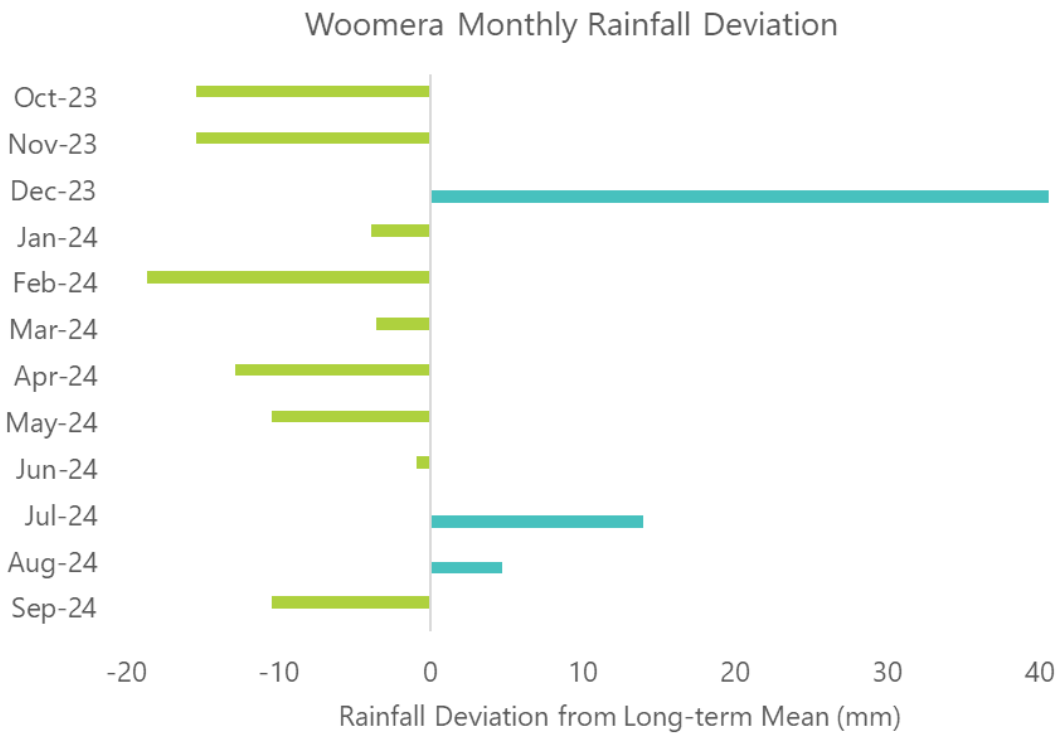

Figure 1.3: Rainfall deviations between year preceding survey and long-term averages (1949-2024) for regional weather station nearest to site, Woomera Aerodrome

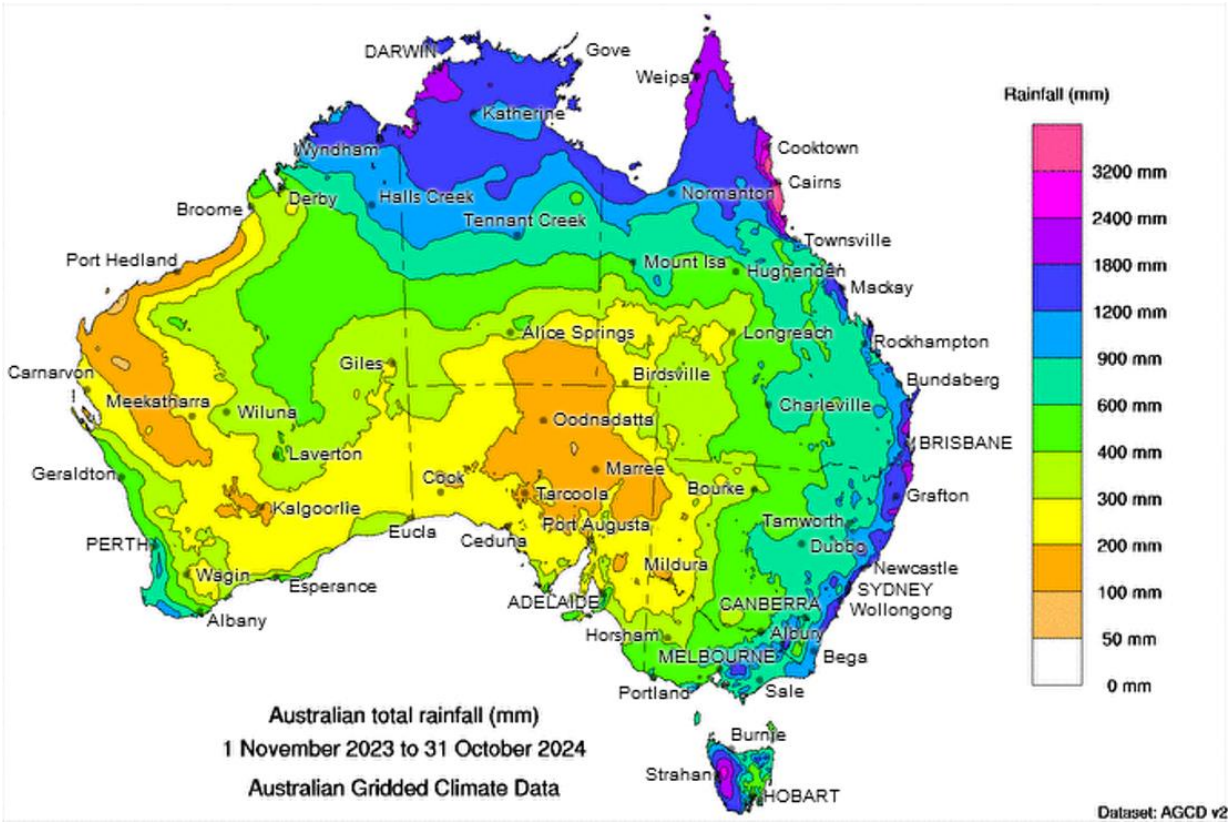

Figure 1.4: Total rainfall across Australia, 12 months preceding the spring 2024 survey (BoM 2024b)

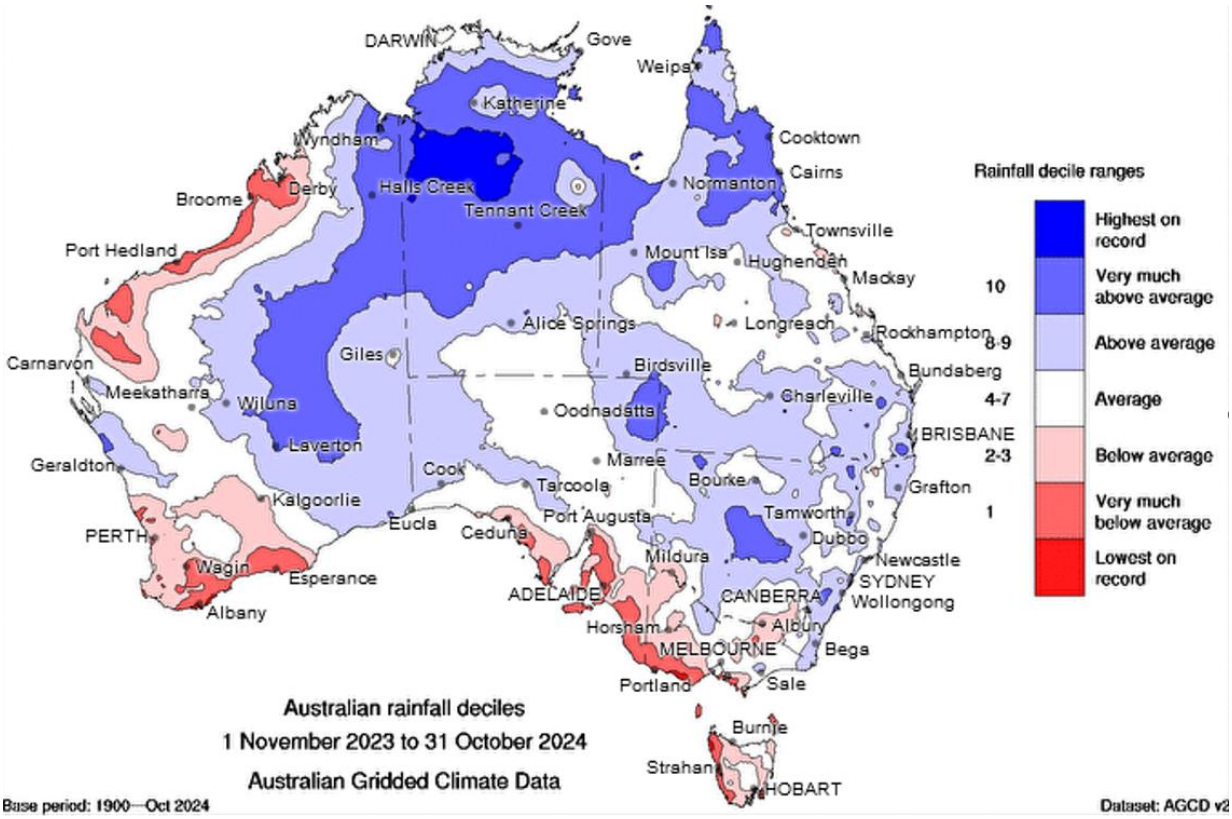

Figure 1.5: Rainfall deciles across Australia, 12 months preceding the spring 2024 survey (BoM 2024b)

2 Methods

2.1 Survey details

Lathwida undertook the spring flora and fauna surveys at Carrapateena between 14 and 23 October 2024. The survey team included the following suitably qualified personnel:

- Principal Ecologist Dr Zeta Bull undertook trap installation, morning and afternoon trap checks, bird survey, mammal and reptile identification lead, flora survey assistant, trap removal.
- Senior Associate Ecologist Greg Smith undertook trap installation, morning and afternoon trap checks, mammal and reptile identification, bird survey, flora survey, trap removal and Song Meter deployment and analysis. Greg specifically surveyed 'men only' cultural sites;
- Senior Ecologist Dr Sonia Croft undertook trap installation, morning and afternoon trap checks, flora surveys, bird survey, trap removal;
- Undergraduate Ecologist Andy Delvaux provided survey assistance and undertook trap installation, assisted with morning and afternoon trap checks, assisted with flora survey, mammal and reptile identification, bird survey and trap removal. Andy assisted with survey of the 'men only' cultural sites.

BHP Environmental personnel Josh Allen, Nicholas Kruger, Bob Starkey, Trent Anderson and Jennifer Kerr assisted with various logistics associated with the survey.

2.2 Permitting

Undertaking ecological research and handling/trapping of animals in South Australia can only legally be undertaken with relevant permits and licences in place. Relevant permits and licences were obtained prior to field survey commencement. All works were undertaken in accordance with permit and licence conditions; details as below.

- Permit to Undertake Scientific Research:
  - Permit # A27482-1, valid from 11/10/2024 to 10/10/2025
- Wildlife Ethics Committee Permit:
  - Application number Bull_26/2023 statewide fauna with semi-pitfalls, approval period 31/08/2023 to 01/09/2026
- Permit to Undertake Scientific Research for State-wide Vegetation Surveys:
  - Permit # U27347-2-16, valid 17/10/2024 to 16/10/2025
- Licence for 'teaching, research or experimentation involving animals':
  - Licence # 414, expires 25/8/2025

- Licence to 'possess and administer Prescription Drug[1]:
  - Licence # 2023-87672, expires 12/09/2026.

2.3 Spring 2024 Sites

The objective of the survey monitoring program is to demonstrate compliance against the conditions of the Mineral Lease and the approved outcomes during the mine construction, operations and rehabilitation. Table 2.1 below includes a summary of previous monitoring sites against the compliance survey sites and an explanation for any changes. Table 2.2 provides a summary of specific spring 2024 survey site details. Refer spring 2019 report (Jacobs 2020a) for further details. The locations of the spring 2024 survey sites are provided on Figure 2.1 for flora and canopy cover, Figure 2.2 for fauna sites, Figure 2.3 for weed transects, and Figure 2.6 for LFA, as part of the operational monitoring.

[1] A condition of Scientific Research Permits is that 'best practice' for biological survey work is undertaken, including vouchering of specimens of interest for the South Australian Museum (SAM). This condition is included on permits as a means of maximising value obtained from survey work across the State, to enable taxonomic specialists the chance to verify field identification, and to encourage survey records to be included in the Biological Database of South Australia for broader knowledge. As such, the project team liaised with the SAM prior to undertaking the survey to ascertain whether the Museum had particular interest in the region being surveyed. In this case, the curator of mammals and curator of reptiles requested voucher specimens and liver tissue samples be collected for target species. Pentobarbitone sodium is used to euthanize specimens, however, was not required on this survey as no animals were euthanized.

Table 2.1: Sites surveyed in spring 2024, compared with baseline survey sites

Baseline Survey Sites (2012-2017)	Compliance sites	Construction / Operational (Compliance) Monitoring Survey Sites (spring 2024)
Flora		
Jessup transects (x 16 sites) (Flora Site 1 to Flora Site 16)	Jessup sites (x 18)	Jessup sites (as per baseline Flora Site 1 to Flora Site 16), plus additional Jessup sites at Eliza Creek Flora Sites 17 to 20. *Note in spring 2019, Site 8 and 14 were permanently removed from the program given proximity to stock impact areas, interfering with assessment of mining impacts. Refer Jacobs Spring 2019 for additional detail (Jacobs 2020a). **Jessup sites not undertaken at site 21, 22 sand dune habitat as per Section 2.4
Flora sites (x 16 sites) (Flora Site 1 to 16)	Rangeland (x 20)	Flora Site 1 to 16), Eliza Creek sites (Sites 17 to 20) and dune habitat sites (Sites 21 and 22), excludes Site 8 and 14. Baseline and Compliance surveys recorded all plant species and cover/abundance within a 1 ha area. For Compliance surveys Rangeland Assessment Method (RAM) (NVC 2024) was also undertaken (assessing grazing impact and life stages present for long-lived plant species).
Flora cover sites (x 33 sites) (CFL01 to CFL33)	NA	Baseline surveys only, not continued. Survey sites covered 10 m x 5 m area, deemed too small to capture meaningful change in this habitat type.
Canopy cover (x 11 transects). 7 Eliza Creek transects, 4 Yeltacowie Creek transects (CCC01 to CCC11)	8 sites (Eliza Creek)	Baseline Yeltacowie Creek and Eliza Creek canopy cover sites (CCC01 to CCC11, EBS 2017) were not assessed as per 2018-2023. Eliza Creek canopy cover transects (sites17AB, 18AB, 19AB and 20AB), were surveyed in spring (2018 to 2022, 2024) and in autumn (2018, 2019, 2023).
Weed Monitoring (x 4 transects) (CWM01 to CWM04)	10 weed transects	Baseline weed transects (CWM01 to CWM04), CWM06, CWM07 (established in 2018) and CWM05 (established in 2022). Northern Wellfield MPL 156, transects NWM01, NWM02 and NWM03 were assessed. Opportunistic observations of declared weed species or species listed under legislation are also recorded (e.g. dams, villages and effluent irrigation areas, spill areas).
Fauna		
Reptiles and mammals (x 8 sites) Fauna Sites 1 – 6, 15, 16)	8 sites	Semi-permanent pitfall trap line sites as per baseline surveys (Fauna Site 1 to 6, Fauna Site 15 to 16). As per 2018 to 2023, only one pitfall line was opened at each site and only 6 pits per line. No Elliott traps were deployed as per baseline (2015-2017), and compliance / operation (2018 to 2023). This methodology will be continually reviewed based on an analysis of compliance monitoring trapping data for small rodents (e.g. Plains Mouse). Camera traps have also been used (1 per line) since 2021.
Bats	NA	As per 2018 to 2023. Common microbat audible to humans (Dennis Mathews, pers. com.) assessed during spotlighting. No bats likely to be present at the site have a conservation rating. In 2024 Song Meters were deployed to detect birds and microbats at Site 7, 10 and South Eliza Dam.
Bird Sites (x 16 sites - Fauna Site 1 – 16), opportunistic surveys at water points	20-22 sites, opportunistic at water points / irrigation areas	Bird surveys at 14 of the baseline sites (e.g. Fauna Site 1 to 6, 15 and 16, Flora site 7, 9, 10, 11,12,13) and 6 compliance sites (17,18,19, 20, 21, 22). Opportunistic surveys were also undertaken at water points (e.g. farm dams), camps to capture diversity across the site as per baseline surveys. Survey of water points also enables opportunistic observations of seasonal of migratory shorebirds. Song meters were deployed to detect bird species by call at all fauna sites (except site 3 adjacent admin), South Eliza Dam, Eliza Creek Site 10, and Flora site 7 (Bosworth Creek). The dam was full of water, the creeks were dry.
Landscape Functional Analysis (LFA)		
Landscape Functional Analysis (CEF01 to CEF07)	4 sites, each with 2 transects	Four Landscape Functional Analysis sites (LFAAL1, LFAVOL2, LFAQUA3, LFATJU4), each with two transects labelled A and B (e.g. LFAAL1A, LFAAL1B) were assessed. In October 2024, Site LFAVOL2 Transect A was discontinued, due to 50% of the transect being graded and used as a temporary laydown area for widening of the adjoining road. No vegetation was present on the remainder of the transect.

Refer to Jacobs Spring 2019 report for additional detail (Jacobs 2020a).

Table 2.2: Summary of survey sites, codes and coordinates

Survey Techniques at Site	Site Code	Start / End	Easting	Northing
Weed Transect	CWM01	Start	737108	6517520
		End	736871	6516550
	CWM02	Start	737842	6530179
		End	738177	6529435
	CWM03	Start	733610	6535627
		End	732611	6535266
	CWM04	Start	735912	6540184
		End	736548	6540963
	CWM05	Start	700638	6518508
		End	701466	6519078
	CWM06	Start	717686	6529628
		End	718673	6529505
	CWM07	Start	743694	6539567
		End	743410	6540518
	NWM01	Start	726014	6554920
		End	726937	6554923
	NWM02	Start	726955	6569623
		End	725963	6569751
	NWM03	Start	720606	6580675
		End	720551	6581674
RAM, Jessup, Fauna Trapping, Birds	Flora / Fauna 1	Start	731707	6550590
	Flora / Fauna 2	Start	734223	6545185
	Flora / Fauna 3	Start	736001	6540156
	Flora / Fauna 4	Start	736251	6534615
	Flora / Fauna 5	Start	729131	6532955
	Flora / Fauna 6	Start	739690	6531181
	Flora / Fauna 15	Start	737123	6538106
	Flora / Fauna 16	Start	732472	6535805
RAM, Jessup, Birds	Flora / Fauna 7	Start	732755	6548730
	Flora / Fauna 9	Start	746788	6544253
	Flora / Fauna 10	Start	740538	6541973
	Flora / Fauna 11	Start	734655	6536360
	Flora / Fauna 12	Start	740402	6532837
	Flora / Fauna 13	Start	745093	6528963
RAM, Jessup, Birds, Canopy Cover	Flora / Fauna 17, CC17A	Start	739269	6536920
	Flora / Fauna 18, CC18A	Start	739350	6537556
	Flora / Fauna 19, CC19A	Start	739621	6539504
	Flora / Fauna 20, CC20A	Start	739950	6541083
Canopy Cover	CC17B	Start	739265	6536929
	CC18B	Start	739345	6537556
	CC19B	Start	739676	6539434
	CC20B	Start	739959	6541060
RAM, Birds	Flora / Fauna 21	Start[1]	722657	6531233
	Flora / Fauna 22	Start[1]	718006	6529448
Landscape Function Analysis	LFA Site 1 Aerodrome Laydown (Aerodrome)	Start	733020	6534295
		End	733063	6534316
		Start	733052	6534277
		End	733068	6534319
	LFA Site 2 Ventia (Office) Laydown (Ventia)[2]	Start	736103	6540338
		End	736103	6540391
	LFA Site 3 Midway Quarry Laydown (Midway Quarry)	Start	729264	6533139
		End	729291	6533097
		Start	729307	6533163
		End	729335	6533123
	LFA Site 4 Tjungu to WAR	Start	734595	6536191
		End	734631	6536219
		Start	734631	6536219
		End	734673	6536252

[1]Refer Jacobs (2019) for further detail; [2]Transect A Start Easting 736070 Northing 6540392, End Easting 736069 Northing 6540392 discontinued in 2024 due to transect being 50% graded and used as temporary laydown area for widening of the adjoining road. The remainder of the transect contained no plants.

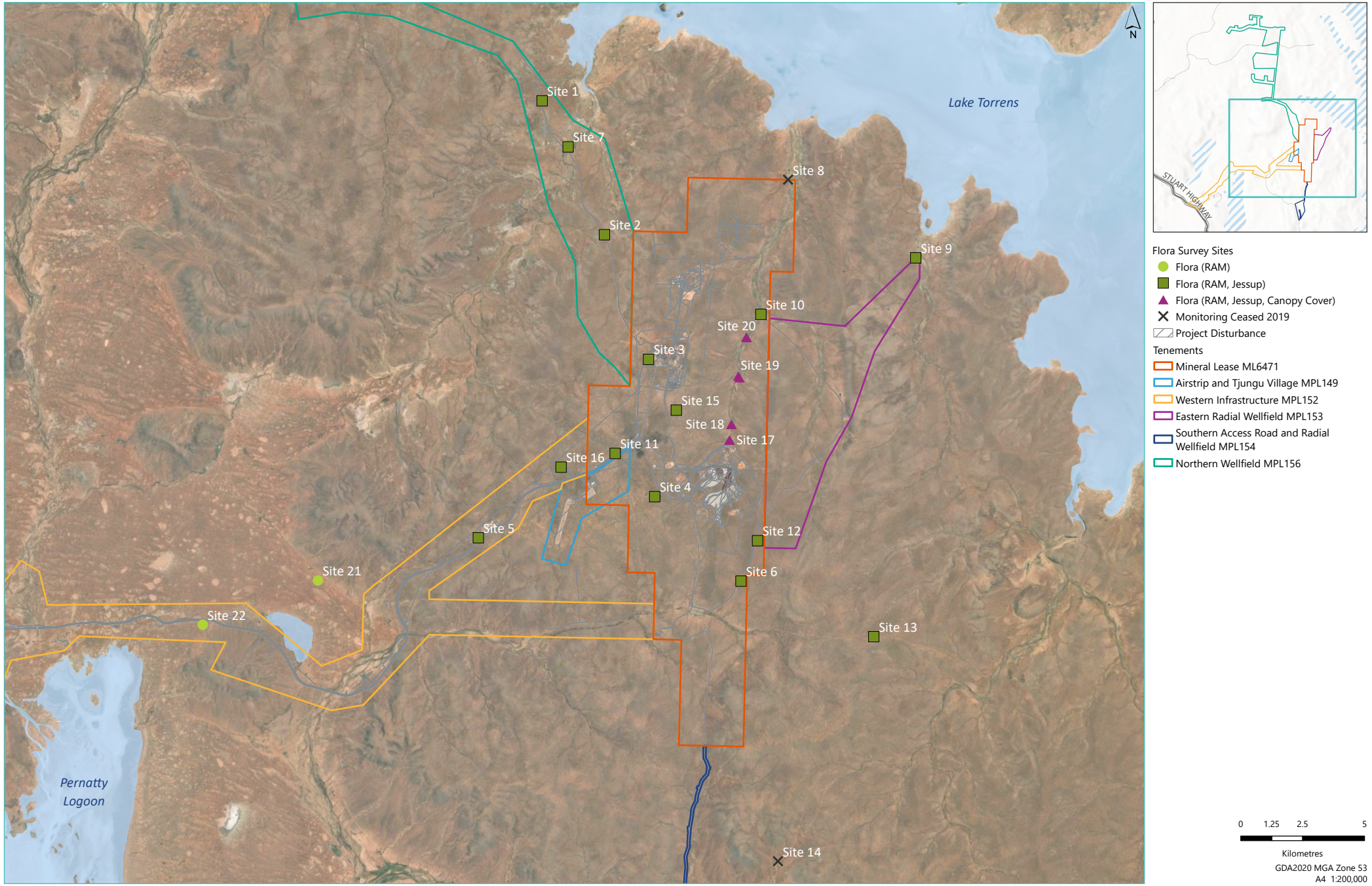

Figure 2.1: Location of Flora Sites
Carrapateena Flora and Fauna Survey

LATHWIDA

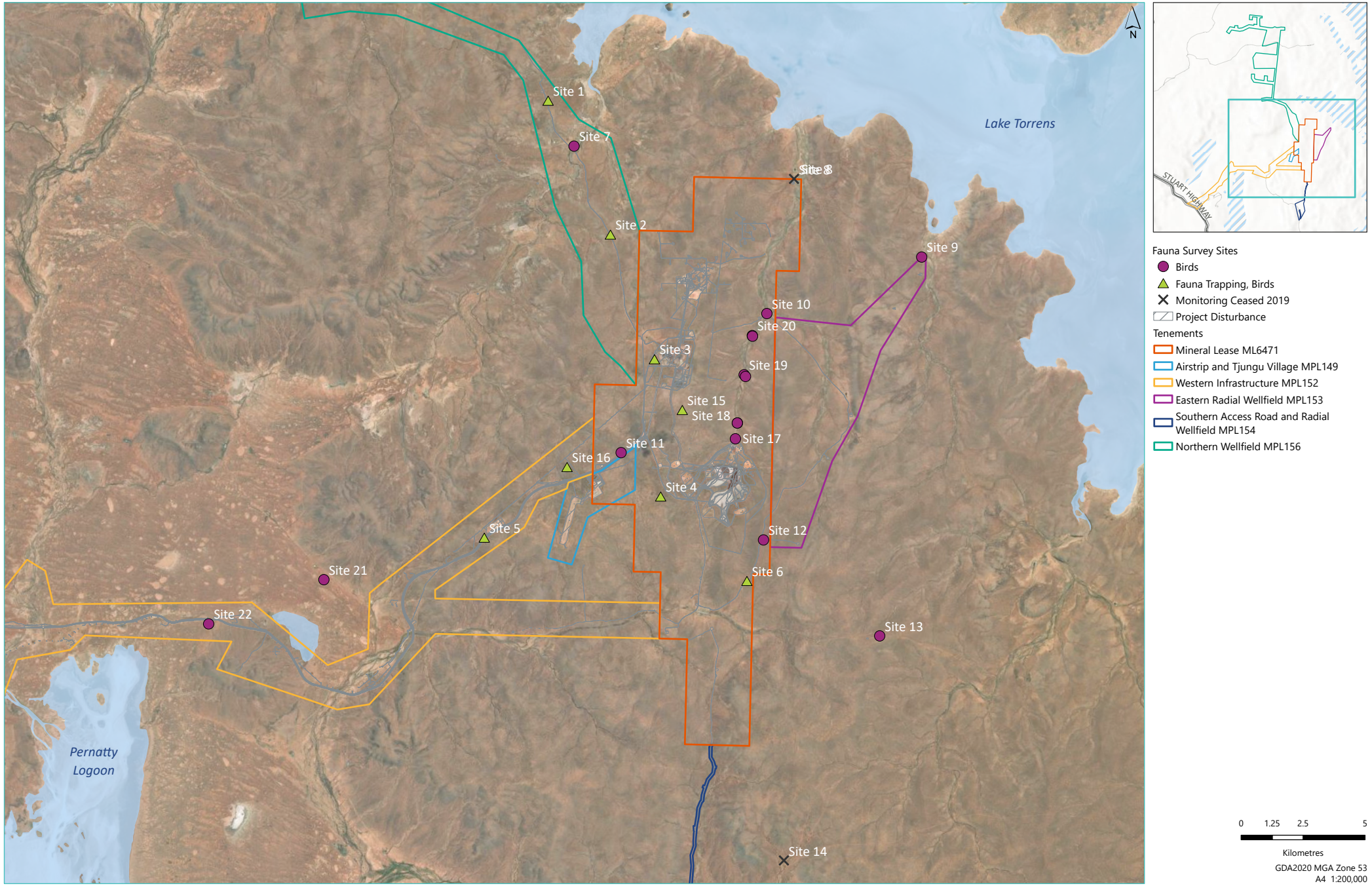

Figure 2.2: Location of Fauna Sites
Carrapateena Flora and Fauna Survey

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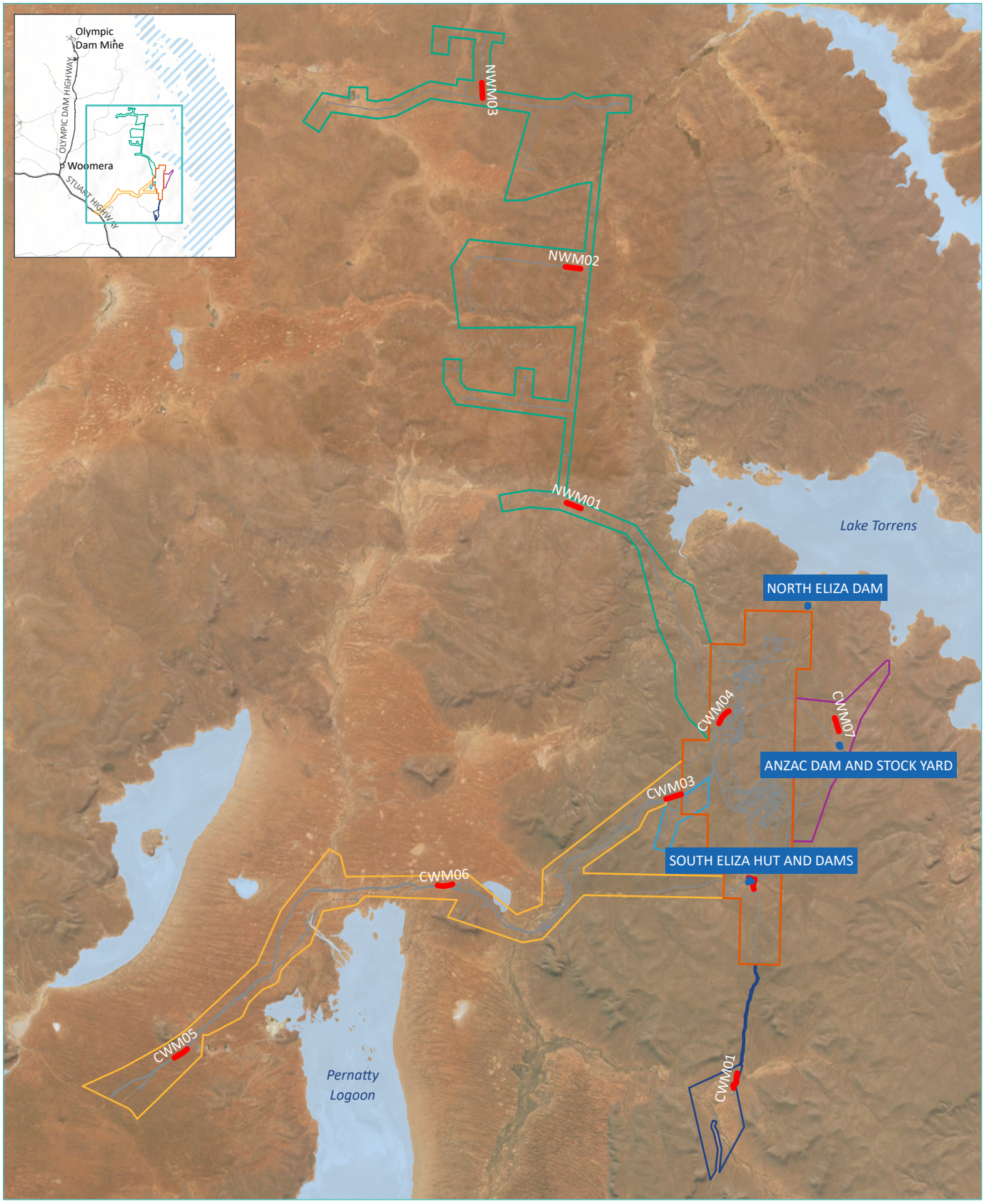

Weed Transect
Dam Locations
Project Disturbance

Tenements

Mineral Lease ML6471
Airstrip and Tjungu Village MPL149
Western Infrastructure MPL152
Eastern Radial Wellfield MPL153
Southern Access Road and Radial Wellfield MPL154
Northern Wellfield MPL156

N

0 2.5 5 10

Kilometres

GDA2020 MGA Zone 53
A4 1:350,000

Figure 2.3: Location of Weed transects
Carrapateena Flora and Fauna Survey

LATHWIDA

2.3.1 Nomenclature

Survey site naming conventions remain as per previous spring surveys (Jacobs 2019a, 2020a, 2021, 2022, 2023a). It is noted that throughout this report, a simplified version of site names is often used e.g. Site 1, whereas CAR001 is the code used for data permit (refer Section 2.7) and the Carrapateena database.

2.3.2 Designation of control sites and impact sites

Survey sites are assigned to be either a control site (no detectable impact from mining considered likely) or an impact site (impacts on flora and/or fauna from mining activities considered possible). All sites on Eliza Creek, downstream of the tailings dam, were considered to be possible impact sites, due to potential changes in groundwater and / or surface water impacting vegetation, and the analysis of potential impacts here will be a comparison of results over time, and with distance from the Tailings Storage Facility (TSF) embankment.

For other sites, impacts on flora and / or fauna were considered to be most likely due to increased dust, noise and / or increased vehicle presence, and for sites near the airstrip, also aerial collision of birds with aircraft. For non-Eliza Creek sites, there were considered to be potential impacts from mining activities if the site was < 2 km from infrastructure. Distances > 2 km were considered unlikely to be impacted by possible raised dust (e.g. based on air quality modelling), noise and / or increased vehicle presence, and as such, sites located > 2 km from infrastructure (including roads) were designated as control sites for future comparison.

The initial designation in 2018 assumed the Western Access Road (WAR) would be a major thoroughfare, complete at the time of the 2022 and 2023 surveys, the Midway Quarry adjacent site 5 and the WAR (but is being progressively rehabilitated) and site 22 (sand dune site) is also adjacent the WAR. Site 6 located 1.5 km off the Southern Access Road (1.5 km from South Eliza Dam), but 2.4 km from the south-eastern edge of the TSF has been swapped to a control site in 2024 due to the Southern Access Road no longer being widely used, and being hydrogeologically distant and over 2 km from the TSF. Compliance monitoring to date has shown that sites 1.5 km from roads have not been impacted by mining activities and no change in flora of fauna is expected due to the lower vehicle activity on the SAR. Similarly, Site 4 is < 300 m from the Southern Access Road and former gatehouse, but also remains 1.5 km from the TSF. Again, compliance monitoring to date has demonstrated no impact from mining activities on flora and fauna at this site and no changes are anticipated in future, due to reduced vehicle use of the SAR. Hence this site has also been swapped to a control site.

A site summary, including distance from infrastructure and designation as control or impact, is provided in Table 2.3 below. Control sites were Sites 1, 2, 7, 9, 13 and 21, from 2012 to 2023, but also included Site 4 and 6 in 2024, given the reduction in potential impact, as a result of the reduced use of the SAR. Impact sites for the 2024 survey were sites 3, 5, 10, 11, 12, 15, 16, 17,18, 19, 20 and 22 (Site 4 and 6 were swapped to Control in 2024). Site locations relevant to infrastructure, including roads are provided in Figure 2.4 and Figure 2.5 below. It is noted that degree of impact varies and all sites are close to roads or tracks, but some have lower levels of traffic (e.g. Site 12). Regardless data is assessed for trends and if trends emerge further analysis is undertaken where necessary.

Rehabilitation sites (LFA sites) were assessed in 2024 as at the Aerodrome Laydown (LFA Site 1 / Aerodrome), Ventia Laydown (LFA Site 2 / Ventia), Midway Quarry Laydown (LFA Site 3 / Midway Quarry) and Tjungu to WAR Laydown (LFA Site 4 / Tjungu), with two transects at each site, noting only one transect was assessed at the Ventia site in 2024 (refer Table 2.3, Figure 2.6 and Section 2.5 for further information).

Weeds have been recorded at standard flora sites, designated weed transects, targeted sites (dams and villages), and opportunistically. Details of weed transect relative locations and habitat are provided in Table 2.4.

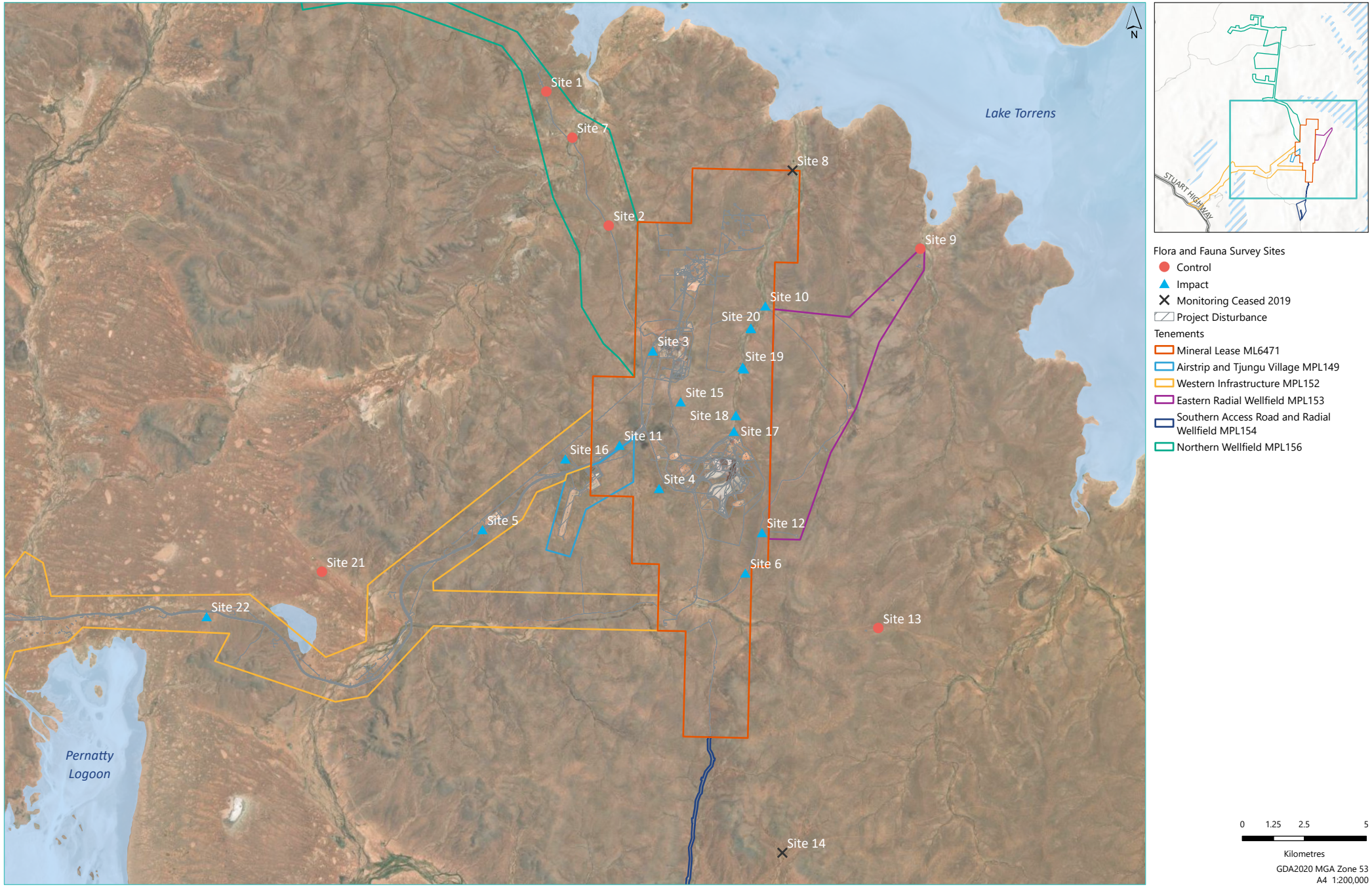

Figure 2.4: Carrapateena Control and Impact Sites (Baseline to 2023 Original Treatment)
Carrapateena Flora and Fauna Survey

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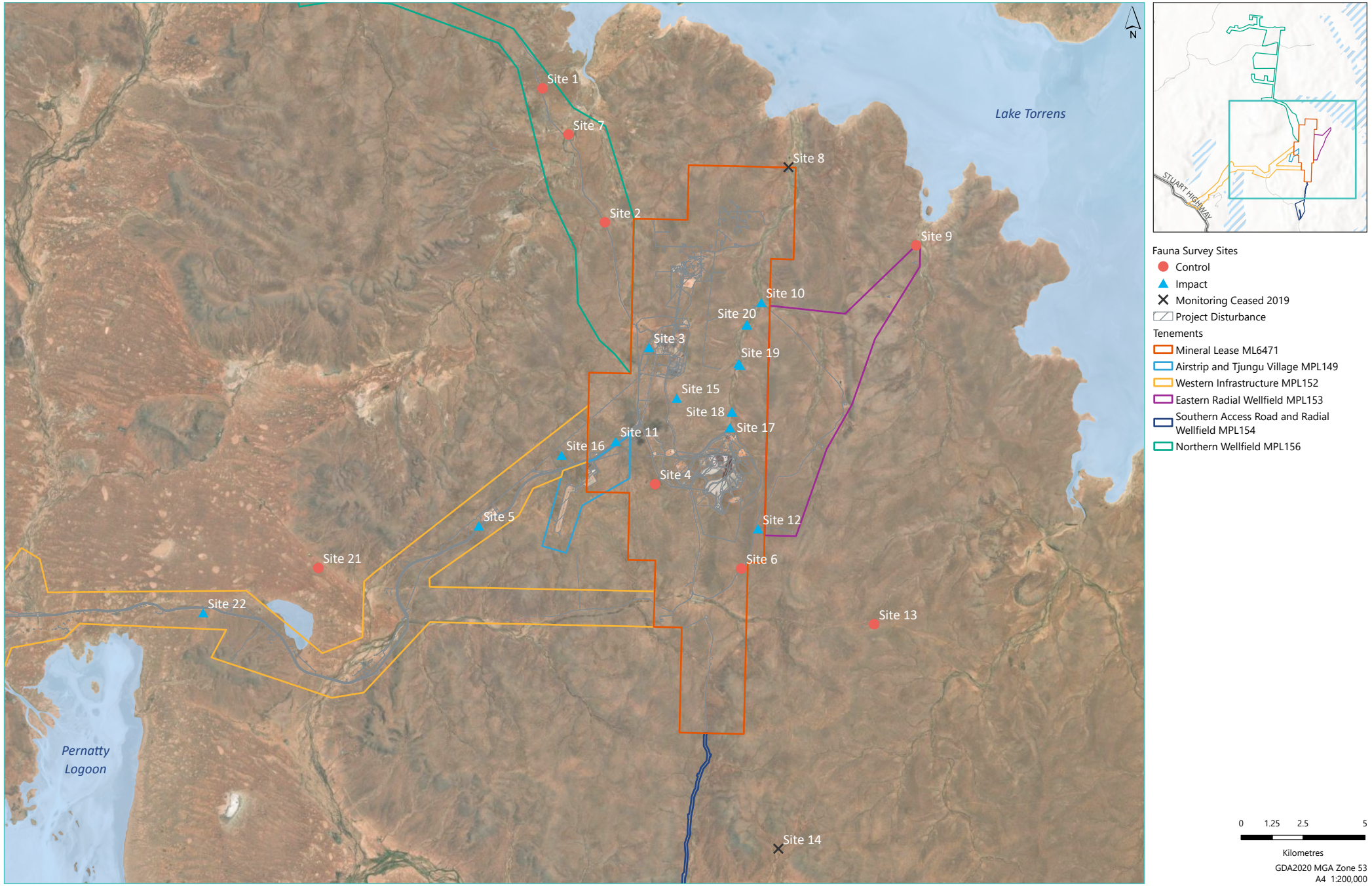

Figure 2.5: Carrapateena Control and Impact Sites (2024 Updated Treatment)
Carrapateena Flora and Fauna Survey

LATHWIDA

Table 2.3: Summary of survey sites, and designation as control or impact

Site	Vegetation Association	Landform	Distance from Infrastructure	Site Type
Flora / Fauna Site 1 (CAR001)	Bladder Saltbush (*Atriplex vesicaria*) Low Open Shrubland	Stony Tableland with shallow drains	7 km from Drill pad, and outside lease area, adjacent northern wellfield road (Khamzin)	Control
Flora / Fauna Site 2 (CAR002)	Bladder Saltbush Low Very Open Shrubland	Stony Tableland	Approximately 2 km west of Drill Pad, adjacent northern wellfield road (Khamzin). Depending on future traffic volume these sites may need to be considered impact in the future.	Control
Flora / Fauna Site 3 (CAR003)	Bladder Saltbush / Samphire (*Tecticornia medullosa*) Low Open Shrubland		Southern Access Road, adjoining western edge of Processing Plant and approximately 2 km SW of Expo Village.	Impact
Flora / Fauna Site 4 (CAR004)	Bladder Saltbush +/– Samphire Low Open Shrubland		Approximately 1.5 km west of tailings dam. Approximately 300 m from Southern Access Road. With the completion of the WAR, the SAR now receives very little vehicle use. Further it is hydrogeologically disconnected from the TSF. Hence, in 2024, Site 4 was changed from being an Impact site to a Control site.	Control
Flora / Fauna Site 5 (CAR005)			Western Access Road. Site begins about 40 m from WAR. Site is at least 3.5 km from airstrip	Impact
Flora / Fauna Site 6 (CAR006)	Bladder Saltbush Low Open Shrubland		1.5 km east of South Eliza Dam / SAR. 2.4 km from south-eastern edge of tailings dam. With the completion of the WAR the SAR now receives very little vehicle use. Further it is hydrogeologically disconnected from the TSF. Hence, in 2024, Site 6 was changed from being an Impact site to a control site.	Control
Flora / Bird Site 7 (CAR007)			100 m west of Hilson Creek and 3 km south of Lake Torrens. 5 km north-west of Drill Pad	Control
Flora / Bird Site 9 (CAR009)	Western Myall (*Acacia papyrocarpa**) Tall Open Shrubland on minor drainage line over Bladder Saltbush Low Open Shrubland	Minor drainage line (150m west of junction with Tadpole Creek) / adjoining stony plain. Approximately 1.5 km from Lake Torrens.	12 km north-east of tailings dam. 600 m from Radial Pipeline.	Control
Flora / Bird Site 10 (CAR010)	Northern River Red Gum (*Eucalyptus camaldulensis* ssp. *arida*) Low Open Woodland	Eliza Creek, junction with major tributary. 8 km south of Lake Torrens.	Approximately 5.5 km downstream of tailings dam	Impact
Flora /, Bird Site 11 (CAR011)	Bladder Saltbush Low Open Shrubland fringed by Western Myall	Stony Tableland and Minor Drainage Line	Approximately 1.5 km from Southern Access Road junction. 200 m west of lay down area, and 40 m from Western Access Road. 2 km northeast of Tjungu Accommodation Village.	Impact
Flora /, Bird Site 12 (CAR012)	Bladder Saltbush) Low Open Shrubland	Stony Tableland	Approximately 0.8 km east of the Tailing Dam's mid-eastern boundary	Impact
Flora / Bird Site 13 (CAR013)	Bladder Saltbush +/- Samphire Low Open Shrubland		Adjoining minor vehicle track, approximately 15 km SE of mining village. Approximately 6 km SE of Tailings Dam and 6 km from Radial Pipeline.	Control
Flora / Fauna Site 15 (CAR015)	Bladder Saltbush Low Open Shrubland		Approximately 1.5 – 2 km south of processing plant and 650 m from Explosives Magazine.	Impact
Flora /, Fauna Site 16 (CAR016)			Approximately 1 km north west of Tjungu Accommodation Village and airstrip and 500 m north of Western Access Road.	Impact
Flora / Bird Site 17 (CAR017)	Western Myall Low Open Woodland)	Major Drainage Line / Eliza Creek	230 m north of the Tailings Storage Facility Decant Dam Embankment	Impact
Flora / Bird Site 18 (CAR018)			870 m north of the Tailings Storage Facility Decant Dam Embankment	Impact
Flora / Bird Site 19 (CAR019)	Northern River Red Gum* Low Open Woodland		3 km north of northern bank of tailings dam on Eliza Creek. 730 m from Injection Well.	Impact
Flora / Bird Site 20 (CAR020)			5 km north of northern bank of tailings dam on Eliza Creek and 470 m from Injection Pipeline.	Impact
Flora / Bird Site 21 (CAR021)	Umbrella Bush (*Acacia ligulata*) Tall Shrubland	Sand Dune	>2 km from WAR	Control[1]
Flora / Bird Site 22 (CAR022)	Umbrella Bush shrubland over Sandhill Cane-grass (*Zygochloa paradoxa*) Hummock Grassland		150 m from Western Access Road	Impact

Site	Vegetation Association	Landform	Distance from Infrastructure	Site Type
LFA Aerodrome Laydown (LFAAL1A-B)	Formerly Bladder Saltbush Low Open shrubland	Stony Plain	10 m from airport road, 100 m from airport	Impact
LFA Ventia Laydown (LFAVOL2A-B)	Formerly Bladder Saltbush / Samphire Low Open Shrubland	Stony Tableland	5 m from road, 100 m from processing plant	Impact
LFA Midway Quarry Laydown (LFAQUA3A-B)			Western Access Road (40 m in), west of Mid-way Quarry	Impact
LFA Tjungu to WAR Laydown (LFATJU4A-B)	Formerly Bladder Saltbush (Low Open Shrubland		Western Access Road, approximately 1.5 km from Southern Access Road junction.	Impact

*Refer Appendix B for explanation of taxonomy; [1]Refer Jacobs (2019) for additional detail about change of site location

Table 2.4: Weed Transects location and habitat

Transect	Road	Habitat
CWM01	Southern Access Road (SAR)	Gibber stony tableland is dominant, but the transect also includes creeks and culverts
CWM02		
CWM03	Western Access Road (WAR)	Gibber stony tableland
CWM04	Access Road west of Administration and Processing area	Gibber stony tableland, includes "Ventia" LFA site
CWM05	Western end of WAR	Mulga (*Acacia aneura*) woodland on sandy loam
CWM06	WAR	Gibber stony tableland, dunes and minor creek
CWM07	Minor road, north-east of Anzac Dam	Gibber stony tableland
NWM01	Northern Wellfields Road	
NWM02		
NWM03		Drainage Line

2.4 Techniques to address OMC

Table 2.5 summarises the survey techniques used in spring 2024 to assess each OMC. More detailed descriptions of each method (Jessup, RAM, Photopoints, Canopy Cover, Weeds) are provided in the 2018 -2022 reports (Jacobs 2018a, 2019a, 2019b, 2020a, 2021a, 2022a, 2023a).

At each Flora site where a RAM (NVC 2024) was undertaken, it was within a 1 ha area. For the stony tableland sites (1 – 7, 9, 11–13, 15 and 16) this was a survey of 100 m x 100 m plot, 50 m either side of the line joining the start and end of the Jessup transect. For the Eliza Creek sites (Flora Site 10, Flora sites 17 – 20) the one-hectare survey was confined to vegetation considered to be under the influence of the creek landform and water regime.

As per spring 2019 – 2023 surveys, Jessup surveys were not undertaken at Site 21 and 22 (sand dunes), given the sand dune sites were not marked in the field (due to potential heritage values). The RAM survey area at Sites 21 and 22 is an area centred on the site coordinate, with a 55 m radius (namely a circular area of approximately 1 ha).

As per 2021 to 2023 reporting, Canopy Cover results include data from spring 2018 onwards, given alterations in transect alignment from initial establishment in autumn 2018. For Canopy Cover sites, densitometer results are provided for individual transects at each site, as well as mean data results for the two transects at a site. Canopy Cover intactness is calculated as the extent of the individual tree's live canopy at the time of the survey compared to the potential extent of the canopy for a fully healthy tree.

Weed transect refinements were required at some locations in spring 2024. Due to realignments and substantial widening of the WAR since the initial weed transects were established, survey point locations along the transect have varied. In 2024, new coordinates were recorded for the start, 250 m, 500 m, 750 m and end (1000 m) locations. The distances (250 m, 500 m, 750 m and 1000 m) represent the distance in a straight line from the start of the transect and not necessarily the distance along the road (some transects have bends/curves). For the SAR and WAR roads, two photographs are taken on both sides of the road, photo bearings being parallel with the road (i.e. four photos at each survey location). The area surveyed is a semicircle on either side of the road with a radius of 50 m beginning from the carriageway (the surveyed area includes the road shoulder/verge). For weed transects on the Northern Wellfield Road and narrow tracks (CWM04 and CWMO7), the area surveyed is a circle with a 50 m radius from centre of road.

Table 2.5: Survey techniques used in spring 2024 to address Outcome Measurement Criteria

OMC Code	Outcome Measurement Criteria (OMC)	Technique / data collection strategy to determine if obligations are being met
SWRF1	Annual surveys undertaken by an independent and suitably qualified expert demonstrates no adverse impact on the diversity and abundance of native vegetation and water dependent ecosystems at Eliza Creek monitoring (Figure 9.2, Figure 9.3 of the PEPR) attributed to reduced surface water flows caused by mining operations when compared to baseline conditions (Appendix C6 Ecological Baseline and surveys for new sites undertaken prior to commencement Stage 1 Tailings commissioning).	RAM survey x five sites on Eliza Creek (0.23 km, 0.87 km, 3 km, 5 km and 5.5 km) at increasing distance (downstream) from the northern bank the TSF dam. Results assist with distinguishing grazing impacts from other causes of defoliation / plant damage, provides inventory of species present and detection of any loss of diversity. Abundance data allows detection of changes in native and introduced species, with repeat monitoring. Jessup (DENR 2011) and Canopy Cover transects at the same location as RAM sites. One Jessup transects at each of the five sites. Provides information on population structure of long-lived perennials, including recruitment. Eight canopy Cover sites (2 parallel transects at each of the five sites) to assess possible impacts on tree health due to potential higher watertable, reduced surface water flows and / or tailings seepage. Comparing the total number of GRS densitometer foliage records along a transect over time provides an indication of changes in total canopy volume. Canopy data recorded from 100 points at each location. One transect representing instream habitat and one representing bank habitat. In summary, Jessup, Rangeland Assessment and Canopy Cover Assessment provides detailed information on plant species diversity, abundance and health at each site: vegetation structural layers, population data for woody perennials (number of adults and number of juveniles), and grazing impacts on woody perennials, plus notes on existing disturbance agents at each site.
TSF6	Annual surveys undertaken by an independent and suitably qualified expert demonstrates no adverse impact on the diversity and abundance of native vegetation and water dependent ecosystems at Eliza Creek monitoring sites (Figure 9.2, Figure 9.3 of the PEPR) attributed to tailings seepage when compared to baseline conditions (Appendix C6 Ecological Baseline and surveys for new sites undertaken prior to commencement Stage 1 Tailings commissioning).	
WP1	Annual flora and fauna surveys undertaken by suitably qualified and experienced ecologists at flora (including weeds) and fauna monitoring locations (Figure 9.2, Figure 9.3 and 9.4 of the PEPR) demonstrates no introduction of new species of weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals) as a result of mining related activities when compared to previously recorded weed species and introduced fauna. Annual flora and fauna surveys undertaken by independent and suitably qualified ecologists at flora (including weeds) and fauna monitoring locations (Figure 9.2, Figure 9.3 and 9.4 of the PEPR) demonstrates no increase in the abundance of existing weeds or pest species in the land compared to previous survey records as a result of mining related activities	The four Weed Transects surveyed during baseline from 2013 to 2016 re-surveyed (CMW01-CMW04). Namely, for each weed transect, the abundance and cover of all weeds recorded at 5 locations (250 m intervals, 50 m radius) along a 1000 m transect). Additional weed transects established along the WAR (CMW05, CWM06) and near Anzac Dam (CWM07) to monitor potential impacts along the WAR and the eastern wellfield. Additional weed transects established along Northern Wellfields Road to monitor potential impacts from dust due to mine vehicle traffic (NWM01, NWM02 and NWM03). Opportunistic records of all weed species made whilst moving around the whole mine site in general. Weed location, habitat, and weed population size and extent recorded. In addition, active searches of areas with a high potential for weed establishment also undertaken (e.g. dams, spill areas, and effluent irrigation areas adjacent the Exploration Village and the Tjungu Village).
WP2		
AQ2	Annual surveys undertaken by a suitably qualified and experienced expert demonstrates no adverse impact on the diversity and abundance of native vegetation at monitoring sites (Figure 9.3 Flora of the PEPR) directly attributed to dust deposition from mining operations or mining related activities when compared to baseline native vegetation conditions (Appendix C5 Ecological Baseline of the PEPR).	Jessup Transects x 14 sites, RAM x 14 sites with the addition of collecting species cover and abundance information using both the Crown Separation Ratio scale. Jessup and RAM at the same location. Undertaken at the existing 14 of the 16 baseline flora site locations to enable comparison. Additional sites along the WAR within dune habitat that was not covered by the existing baseline data (namely, sites 21 and 22, RAM only).
EPBC1	Future records of Thick-billed Grasswren are to be provided to the Biological Database of South Australia BDSA to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites ((Figure 9.2, Figure 9.3 and 9.4 of the PEPR))	Bird surveys conducted at 14 of the 16 baseline bird monitoring sites, as well as at the 4 Eliza Creek flora sites and the 2 WAR dune sites. Opportunistic records of Thick-billed Grasswren to be recorded. All records of Thick-billed Grasswren will be forwarded to Department for Environment and Water (DEW) as part of the Permit reporting requirements, which will then be uploaded into the BDBSA.
EPBC2	Future records of Plains Mouse are to be provided to the Biological Database of South Australia BDSA to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites (Figure 9.2, Figure 9.3 and 9.4 of the PEPR)	Fauna surveys conducted at each of the eight baseline sites as per autumn 2017. Pitfall traps and un-baited cameras used to detect any Plains Mouse captures in spring 2024, aligning with the later years of the baseline surveys.
EPBC3	Future records of Night Parrot are provided to the Night Parrot Recovery Team to enable effective monitoring and record keeping if observed during annual flora and fauna surveys at monitoring sites (Figure 9.2, Figure 9.3 and 9.4 of the PEPR)	Bird surveys are undertaken as part of annual survey. (none detected to date during compliance monitoring).
LUP4	Rehabilitation trials shall be undertaken at infrastructure locations no longer required and ongoing assessment at LFA monitoring at sites (Figure 9.3; CEF1-7 of the PEPR) are assessed annually demonstrating development of trends and annual improvement of rehabilitation through LFA methodology. Should the data indicate rehabilitation not trending towards sustainability root-cause investigations will be undertaken and rectification methods be identified and implemented	Following site rehabilitation, LFA is being undertaken within rehabilitation zones, and comparable data from these sites is being compared with baseline data, and future more relevant control sites will be established. Four LFA sites established.

Refer Appendix C for additional detail about species classification and long-lived and short-lived, flora taxonomy and identification.

2.5 Landscape function

2.5.1 LFA sites

To meet the requirements of Outcome Measurement Criteria (OMC) LUP4 in the PEPR (Table 1.2), Landscape Function Analysis (LFA) monitoring was conducted at four sites in October 2024. LFA measures various processes that contribute to the formation of self-sustaining ecosystems and can be used to monitor revegetation post-impact (Tongway & Hindley 2005). The data collected during the October 2024 survey represents the sixth year of data collection for the two sites established in 2019 and third year for the two sites established in 2022.

Initially, two rehabilitation areas were selected by BHP for LFA assessment prior to the 2019 survey: a laydown area adjacent to the operational Carrapateena airport (referred to as the Aerodrome Site in this report) and a second laydown area adjacent to the Carrapateena Mine Processing Plant (referred to as the Ventia Site in this report). Prior to the Spring 2019 survey, the rehabilitation sites were contour ripped to create troughs ('patches') for nutrients and water to accumulate and facilitate regeneration and revegetation; Aerodrome – June 2018, Ventia Laydown August-September 2019. The objective of subsequent LFA surveys (2019 to present) was to measure the success of returning the sites to sustainable pre-impact levels of landscape function. The two sites established in spring 2022 are both on the WAR, one adjacent the Midway Quarry that was used for WAR construction and one near the Tjungu Village (opposite Flora Site 11).

The Midway Quarry site is situated west of the WAR on a northwest facing gentle slope with two transects (3A and 3B) installed in a northwest facing direction (perpendicular to the WAR) with Site 3A slightly southwest of and parallel to transect 3B. The Tjungu village site is situated on the south-eastern side of the WAR on a north-east facing moderate slope which extends down to a minor drainage line. Both sites were deeply ripped prior to the 2022 survey. The Tjungu site was hand seeded three months prior to the September 2022 survey, whilst the Midway Quarry site was not seeded, trialling natural recruitment / regeneration. The surface at both sites comprises large flat broken rock in deeply ripped contours, more irregular at the Midway Quarry site.

For the initial surveys of all sites, the LFA Bank and Trough assessment method was undertaken for the new sites as they comprised only non-vegetated rip lines (refer Jacobs 2023h). By the second or third survey, the ripped troughs had levelled out and sufficient vegetation had established to convert to the Established method, whereby patches comprised plants and inter-patches comprised soil/rocks. The rehabilitation of the four areas has been monitored using two complementary methods: the LFA, following the established method, supplemented by the Point-centred Quarter (PCQ) method during the early phase of colonisation and succession (Tongway and Hindley 2005). Jacobs (2023h) provides a summary of the methodologies applied and reasoning for the change. Table 2.6 provides a summary of where the different approaches have been applied to date. For LFA transect coordinates and location refer Table 2.2 above and Figure 2.6.

Section 2.5.2 and 2.5.3 below provides a summary of the methodologies applied and reasoning for the change. Table 2.6 provides a summary of where the different approaches have been applied to date.

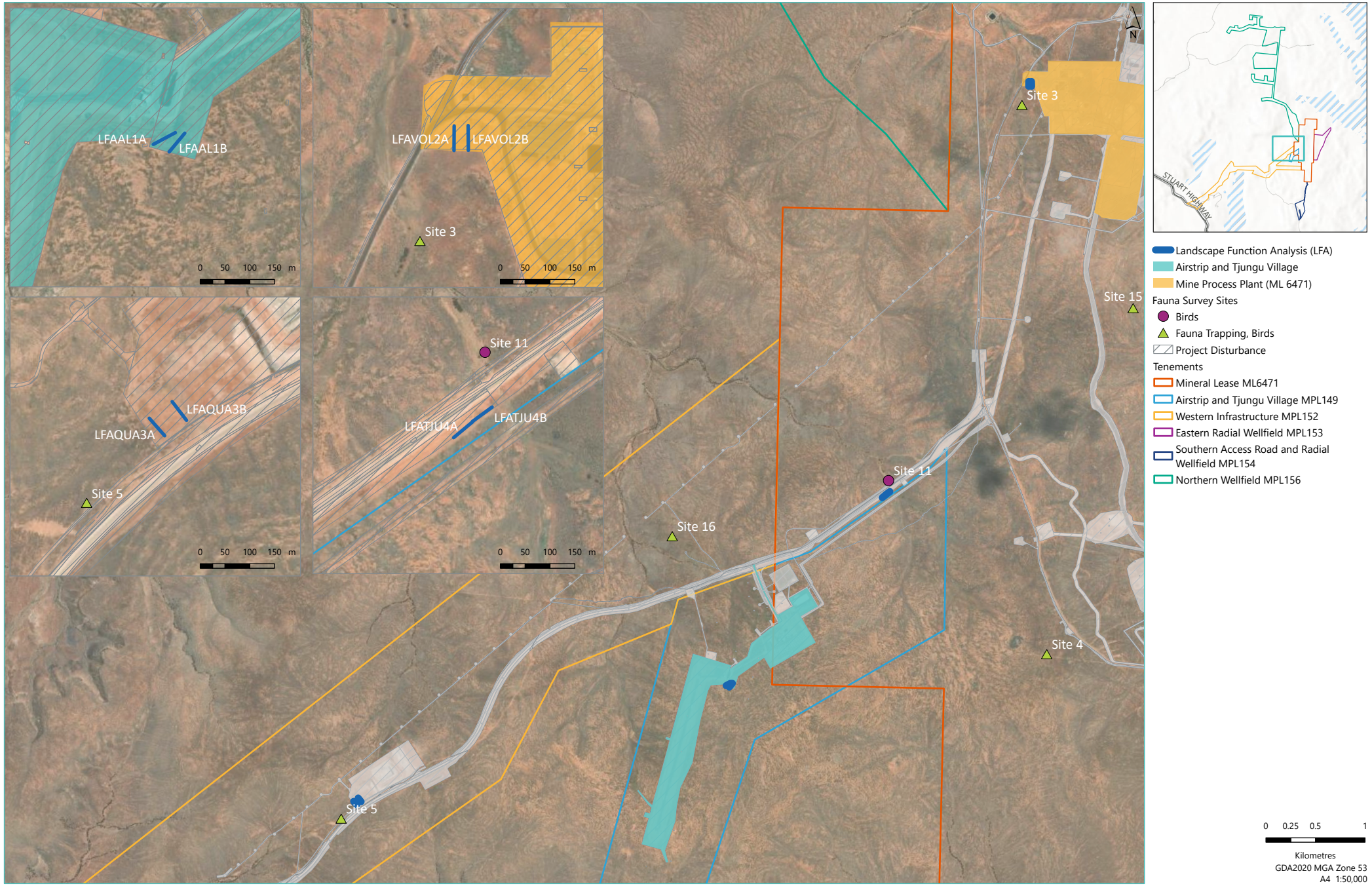

Figure 2.6: LFA Sites, Aerodrome Laydown (LFAAL), Ventia Laydown (LFAVOL), Midway Quarry (LFAQUA), Tjungu (LFATJU)
Carrapateena Flora and Fauna Survey

LATHWIDA

2.5.2 The LFA established method

The methodology used during compliance monitoring for the LFA 'Established Method' is as described in Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) (2013). At each site, two fixed transects have been established, 50 m in length (Table 2.2). Directly beneath the transect line, the zones that occur are classified as a patch (represented by a plant/s with overlapping canopies or other resource-accumulator such as litter or logs), or interpatch (e.g. rocky surface, or bare ground). All short-lived and long-lived perennial species have been included as patches. Short-lived perennials, particularly *Sclerolaena* species, comprise a large proportion of the groundcover in the LFA site natural habitat.

2.5.3 Supplementary vegetation sampling using the Point-centred Quarter (PCQ) Method

Rehabilitation in semi-arid Australia is expected to be slow. In the early phase, plants may colonise in low abundance, or a clumped pattern, making it difficult to representatively sample using a fixed transect (Tongway and Hindley 2004). To supplement the LFA Established Method, the PCQ Method was used.

The fixed transects were dived into regular intervals: 10 m, 20 m, 30 m, 40 m and 50 m. At each point, the nearest long-lived perennial or biennial plant up to 10 m away was located within each of four quadrants. No data was recorded for a quarter where there were no perennial or biennial plants within 10 m of the sample point that had not already been sampled for a prior quadrant (Tongway and Hindley 2005).

For each transect the mean distance between plants, and plant density per 100 m^2 were derived from the PCQ data. It is anticipated that the mean distance between plants would decrease (as more plants become established), while the plant density would increase. A summary of the different methods of data collection that have been applied for LFA at the Carrapateena site is presented below in Table 2.6.

Table 2.6: Summary of methods used to date for Landscape Function Analysis at Carrapateena

Survey	Sites	LFA Bank & Trough Method	LFA Established Method	LFA Soil Surface Assessment (SSA)	Point-centred Quarter (PCQ) method
2013 /2014 Baseline (EBS)	6 analogue sites	Nil	All 6 sites	X	Nil
September 2019 (Jacobs) (newly ripped soil)	2 sites with 2 transects each	1A, 1B, 2A, 2B		1A, 1B, 2A, 2B	Nil
September 2020 survey (Jacobs)		2A	1A, 1B, 2B	1A, 1B, 2A, 2B	1A, 1B, 2A, 2B
September 2021 (Jacobs)		Nil	1A, 1B, 2A, 2B	1A, 1B, 2A, 2B	1A, 1B, 2A, 2B
September 2022 (Jacobs)	4 sites with 2 transects each	3A, 3B, 4A, 4B	1A, 1B, 2A, 2B	1A, 1B, 2A, 2B	1A, 1B, 2A, 2B
May 2023 (Jacobs)		Nil	1A, 1B, 2A, 2B 3A, 3B, 4A, 4B	1A, 1B, 2A, 2B 3A, 3B, 4A, 4B	1A, 1B, 2A, 2B 3A, 3B, 4A, 4B
October 2024 (Lathwida)	3 sites with 2 transects each, 1 site with one transect	Nil	1A, 1B, 2B, 3A, 3B, 4A, 4B	1A, 1B, 2B, 3A, 3B, 4A, 4B	1A, 1B, 2B, 3A, 3B, 4A, 4B

2.6 Fauna survey method

2.6.1 Fauna trapping

As per 2018-2023 monitoring, fauna trapping was undertaken at eight sites, with groups of four sites monitored over two consecutive trapping periods. Each site was monitored for four days and four nights between 14 and 23 October 2024. Two sites were opened on 14 October, and two sites were opened on the 15 October which were closed on 18 and 19 October respectively, and a second round of sites was opened on 18 October and closed on 22 October. All equipment and flagging tape was removed from each site at the end of each survey, except for semi-permanent pits which remained in-situ with lids re-established, and screwed in with 'hex' screws to prevent animals entering the pits post monitoring. Trench lines for drift fencing between pit traps were backfilled.

The configuration at each site was as follows:

- A single pitfall line was opened from one of four semi-permanent baseline pit lines that are established at the eight fauna site (i.e. Sites 1-6, 15, 16), noting Site 5 only has three semi-permanent pit lines remaining, one being removed in 2019 due to a number pits with decreased integrity / holes in bases.
- Six pitfall traps were opened at each site, as required by the SA Vertebrate Survey Guidelines (Owens 2000).
- Each drift fence line, was approximately 80 m x 0.3 m, dug into the ground approximately 5-10 cm depth. Lines running across semi-permanent pitfall traps, 10 m apart (fence extending approximately 5 m either side of the first and last pitfall trap).
- The semi-permanent pitfall traps were 240 mm diameter (standard PVC 225 / 250 mm pipe - internal diameter 240mm) and 600 mm deep with a mesh base to allow water drainage were used to target small to medium sized mammals and reptiles.
- Two funnel trap pairs were placed evenly along each line.
- Two camera traps were established facing each trap line at open locations, with minimal vegetation to avoid accidental triggers (as per 2021).
- No Elliott traps, cage traps, HARP traps or ANABAT recorders were used.
- One Song Meter was established at a suitable location away from the trapping line, with the exception of Site 3 which is immediately adjacent the noisy processing plant. A Song Meter was established at Dawson Dam which is 0.5 km from Site 3.
- Refer spring 2019 report (Jacobs 2020a) for additional details.

2.6.2 Bird/bat detection

As per previous monitoring (2018 to 2023), bird surveys were undertaken at least once at each of the 20 survey sites (Flora sites 1 to 7, 9 to 13, 15 to 16, plus sites 17, 18, 19, 20, 21 and 22), for 30 minutes at each site within 2 hours of dawn. If weather conditions or timing were not considered optimal, repeat surveys were undertaken. Bird data was also collected opportunistically during multiple visits to the fauna trapping sites and when driving between sites, during flora surveys, at four dams, camps and at the two effluent irrigation areas.

In addition, in 2024 Song Meters were deployed at all fauna trapping sites, one dam and one creek site, in order to detect additional species that were not detected during the day or nocturnal / crepuscular species. Song meters were deployed for a minimum of 24 hours at each site. Desktop analysis was undertaken post field to determine whether any additional species were present. Such analysis involves ecologists reviewing images and calls of bird calls and bat calls and verifying species against recognised images.

Six Autonomous Recording Units (ARUs), of the Song Meter Mini Bat model (Wildlife Acoustics, 2022), were fitted with an acoustic stub microphone to enable recording of vocal bird species in the audible frequency range. They were deployed within areas of habitat considered suitable for detection of birds approximately 100-200m from fauna trapping lines. ARUs were configured to record in the acoustic mode: for one hour either side of both sunset and sunrise. In this configuration, for every 24 hours of deployment, each ARU captured 14 hours of acoustic recordings (birds) and 4 hour of ultrasonic records (bats).

Each ARU was affixed to a stake or other stable object using cable ties. All cable ties were clipped short to avoid the potential for whistling interference in high winds. This model of ARU is synchronised with the GPS reading from the user's smartphone to correctly set sunrise and sunset times. The location of each deployment was also marked using a GPS unit (IPAD).

2.6.2.1 Acoustic analysis

ARUs recorded all data to Secure Digital (SD) cards. The data was then transferred to a laptop computer and backed-up to internal servers. All bird recordings were processed using Kaleidoscope Software for visual and acoustic assessment. Analyses for these deployments followed the procedure of analysing recordings for the presence of any fauna species by first detection using a combination of listening through in real time and high-speed visual spectrogram scanning. All audible taxa were noted in the order in which they appear in recordings. A total of 434 hours of recording were collected from 10 sites between 18-22 October 2024.

Bat data that was analysed included at total of 539 WAV format bat detector sound files from three recording sites over 8 recording nights (nights of 16 – 21 October 2024); Site 7, Site 10 (Eliza Creek) and South Eliza Dam).

The ultrasonic recordings provided were recorded in WAV sound format from Wildlife Acoustics Song Meter Mini Bat bat detectors. All sound files were inspected in Anabat Insight version 2.1.3 software and Adobe Audition version 23.1 (Specialised Zoological 2025, provided in Appendix F).

Species identifications were made based on measurements of characteristic frequency and observation of pulse shape, and with reference to information in Armstrong et al. (2021b, cited in Specialised Zoological 2025). Nomenclature follows Jackson and Groves (2015, cited in Specialised Zoological 2025). Distribution information for all bat species considered here was checked against the BatMap resource hosted by the Australasian Bat Society, Inc (https://www.ausbats.org.au/batmap.html) (Milne et al. 2023, cited in Specialised Zoological 2025).

2.6.3 Active reptile, track and scat search

Given the warmer conditions of the spring 2024 survey and the high number of reptile captures at fauna trapping sites, active reptile searches were not undertaken. Additional reptile species were also detected as part of opportunistic observations throughout the survey, and via camera trapping.

2.6.4 Spotlighting

As per previous monitoring (2018 - 2023), nocturnal searches were conducted at a subset of sites that were easier to safely access at night (e.g. Site 10 - Eliza Creek). Survey involved spotlighting with head-torches (LED), active searching and listening for nocturnal vertebrate species including Night Parrot and a bat species that are audible to the human ear (e.g. White-striped Free-tail Bat). Searches were undertaken for a minimum of 30 minutes at Site 10 and 20 minutes at the next drainage line by 4 observers / spotters. Noting the Camera Traps (one per site), and Song Meters were also collecting nocturnal images / acoustic data for four / one trap nights (respectively) at each of the eight fauna sites (Sites 1-4, 15, 16) and Site 10 Eliza Creek.

2.6.5 Opportunistic observations

Opportunistic observations make up an important component of a fauna survey and constitute any observations made while travelling around the Operations area, targeted searches at likely locations for fauna (e.g. dams), or between the survey sites. Any animals identified opportunistically, either via direct observation or by evidence, were recorded on fauna and flora data sheets with location and any useful notes. These species were added to site species lists if identified at a survey site, or to a general survey species list if from the broader Operations area (if not attributed to a particular habitat type).

Location details for the key opportunistic observation locations are provided in Table 2.7 and on Figure 2.3.

Table 2.7: Key opportunistic survey site locations at Carrapateena

Location	Easting	Northing
Exploration Camp	737500	6541120
Exploration Village Effluent Irrigation Area (EV EIA)	733550	6535200
Anzac Dam	743880	6539300
Tjungu Village EIA (TV EIA)	733700	6535306
Dawson Dam	735690	6541028
North Eliza Dam	741682	6547790
South Eliza Dam	737960	6529976
Yeltacowie Homestead	724430	6530245

*MGA zone 53. GDA1994

2.6.6 Identification

It is noted that some species have undergone taxonomic revision since earlier reports; where possible the common name follows the nomenclature of the Biological Databases of Australia flora and fauna taxonomy (DEW

The following reference material and taxonomic keys were used for species identification and classification:

Reptiles and Amphibians

- A Complete Guide to Reptiles of Australia 2nd edition (Wilson and Swan 2008)
- Reptiles and Amphibians of Australia (Cogger 2014)
- Key to the Geckos of South Australia (Hutchinson and Williams 2024a)
- Key to the Skinks of South Australia (Hutchinson and Williams 2024b)
- Key to the Snakes of South Australia (Hutchinson and Williams 2024c)
- Key to the Dragons of South Australia (Hutchinson and Williams 2024d)
- Key to the Goannas of South Australia (Hutchinson and Williams 2024e)
- Checklist of the Reptile and Frogs of South Australia (Hutchinson and Williams 2024f).

Birds

- The Field Guide to the Birds of Australia, 9th edition (Pizzey et al. 2012)
- Field Guide to the Birds of Australia, 8th edition (Simpson and Day 2010)
- eGuide to Birds of Australia, application (Morcombe 2011-2019, Version 1.6.2)
- The Australian Bird Guide. (Menkhorst et al. 2019)
- Annotated List of the Birds of South Australia (Horton et al. 2020)

- The compact Australian Bird Guide (Davies et al. 2022).

Mammals

- A Field Guide to the Mammals of Australia (Menkhorst and Knight 2004)
- Mammals of Australia (Strahan 1995)
- Tracks, Scats and Other Traces (Triggs 2004)
- Key to Dasyuridae of SA (Kemper and Stokes 2020)
- Key to Muridae of South Australia (Kemper and Stokes 2021)
- Australian Bats (Churchill 2008).

Plants

- PlantNET - NSW FloraOnline (2024)
- Plants of Western New South Wales (Cunningham et al. 1992)
- Field guide to the plants of outback South Australia (Kutsche et al. 2023).
- South Australian Seed Conservation Centre (2024)
- The Australasian Virtual Herbarium (AVH) (2024)
- Atlas of Living Australia (ALA) (2024).

2.6.7 Vouchering

No vouchering of fauna species was required, as all species captured had been sufficiently vouchered previously.

Flora vouchering was undertaken as per permits (2.2).

2.6.8 Fauna survey limitations

The limitations associated with this fauna survey, consistent with most fauna surveys, are as follows:

- The results of the fauna surveys are only a 'snapshot' in time and cannot describe seasonal variation or migrations on their own.
- Scats could not always be correctly attributed to species, however where they could be confidently identified, they provide an accurate indication of the presence and habitat preferences of certain species (Triggs 2004).
- Detection of nocturnal species by spotlighting potentially does not detect all of the animals present and is affected by environmental factors (Wayne et al. 2005).
- Read & Moseby (2001) concluded that environmental factors affected the capture rates of small reptiles. Unfortunately, planning logistics for fauna surveys around specific environmental conditions is very difficult. Planning to survey when weather conditions are generally favourable (as was done here) allows the best chance of favourable conditions during a survey and species

identification. It is noted that daily conditions were considered favourable for reptiles during this survey.

- Conditions for birds were suitable as the survey was undertaken in mid spring, however there were extreme windy and above average warm days (e.g. two days 36-40 degrees). Bird detection was also enhanced at each individual site with Song Meter deployment, and opportunistic observations from across the broader Operation area (e.g. dams, tracks, camps, creeks). Given many Song Meter files were wind affected, each site was analysed for one 24-hour period and at least two mornings.
- Similar to recent surveys, for camera traps, facing the camera towards open areas, without vegetation, or roads in the field of view are noted to produce less false triggers.

3 Results

3.1 Climate during and preceding survey

3.1.1 Rainfall preceding survey

Average yearly rainfall totals for the region are approximately 180 mm (BOM 2024b). The mean monthly rainfall totals are relatively consistent over the year, with a slight decrease generally observed during the late autumn and late winter months. In the years 2021, 2022, and 2023, annual rainfall at Woomera weather station totalled 155 mm, 381.4 mm and 173.2 mm respectively; 2022 being well above the long-term annual mean rainfall.

In the 12 months preceding the survey (01 October 2023 to 30 September 2024), the Carrapateena weather station recorded 157 mm of rain, 15% below the regional yearly average, due to mostly below average rainfall totals between January and June. This annual rainfall deficit was reported despite the two months, December and July, recording almost 40% of the total rainfall for this period. For all but July, monthly rainfall totals at Carrapateena and Woomera differed by less than 10 mm.

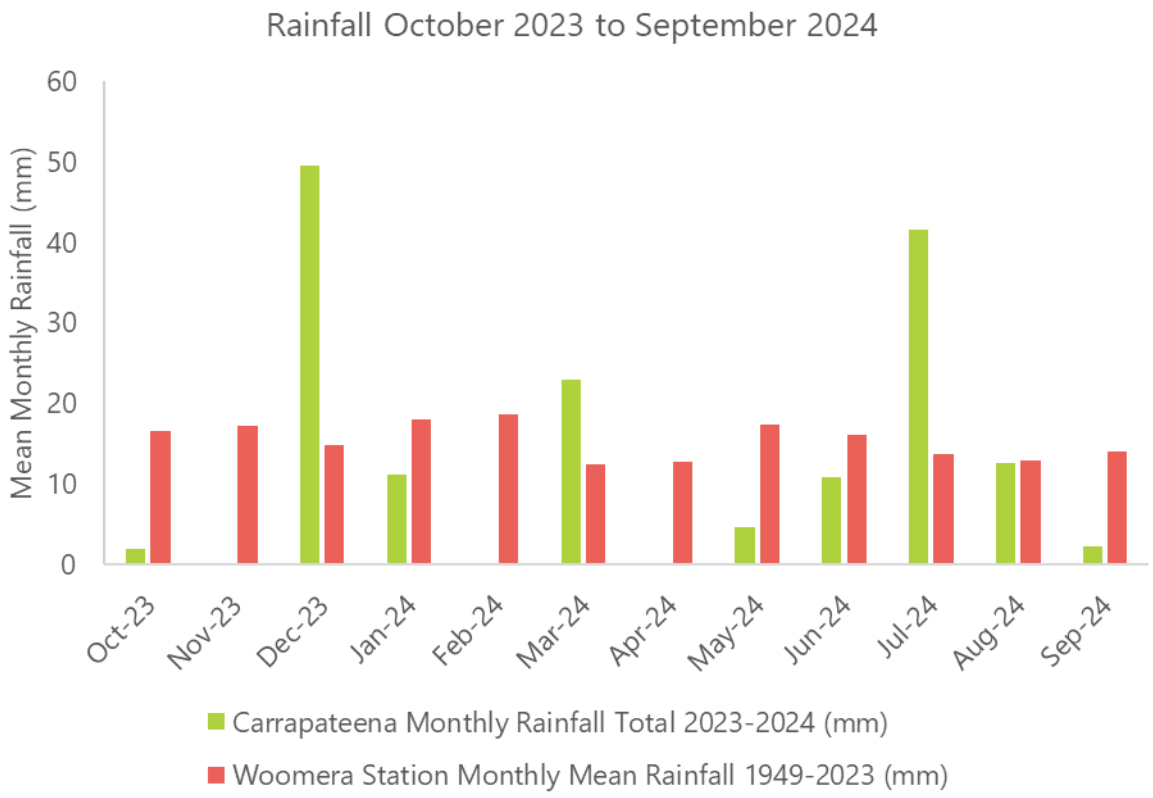

Figure 3.1: Rainfall 12 months preceding the spring 2024 survey at Carrapateena (OZ unit – Vaisala WXT520) and regional long-term averages (1949-2024) at regional weather station nearest to site, Woomera Aerodrome

3.1.2 Weather during survey

The weather conditions during the survey are summarised in Table 3.1 below, presenting data from the on-site weather station located near the Tailings Storage Facility (a Vaisala WXT520). Conditions (including overnight temperatures) were warm to hot, with the maximum daily temperatures ranging between 23.3°C to 40.5°C, and an average of 30.8°C for the survey period. These temperatures are higher than the average regional long-term maximum daily temperatures for October of 26.5°C (Woomera Aerodrome, BoM 2024a).

Minimum overnight temperatures were relatively mild and ranged from 11.2°C to 21.7°C, with an average of 17.6°C, notably higher than the long-term mean minimum temperature of 12.5°C for October (Woomera Aerodrome, BOM 2024a).

During the spring survey, average winds were light to moderate breezes each day, with average speeds ranging between 11.3 and 23.6 km/h. There was also a thunderstorm event, and strong winds on 17 October, with very few captures the following morning, as would be expected. These conditions are considered generally optimal for bird surveys and Song Meter deployment; excluding excessively windy periods. Overall conditions were considered generally suitable for fauna survey, and the warmer days likely increased reptile activity.

Table 3.1: Field survey weather (Carrapateena All Weather Data Spring 2022)

Observation	14-Oct	15-Oct	16-Oct	17-Oct	18-Oct	19-Oct	20-Oct	21-Oct	22-Oct	23-Oct	24 Oct
Min temp (°C)	20.89	21.66	20.77	20.17	15.21	11.24	15.24	20.56	19.68	15.59	12.35
Max temp (°C)	32.27	31.09	36.85	40.47	24.78	26.85	28.71	32.82	34.21	27.52	23.28
Mean wind (km/h)	15.20	17.00	21.40	22.00	23.60	17.70	14.00	11.30	15.90	18.90	21.00
Rainfall total (mm)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.2 Flora

3.2.1 Plant diversity

A general floristic description of each site is provided in the Carrapateena Ecology Survey – Autumn 2018 report (Jacobs 2018a). Representative photographs of each site during the spring 2024 survey are provided in Appendix A.

3.2.1.1 Total species diversity: compliance monitoring period

In spring 2024, a cumulative total of 141 native flora taxa was recorded at the one-hectare RAM sites across the Carrapateena Operation area (Flora Sites 1-7, 9 – 13,15 – 22). This was the equal highest diversity recorded during the compliance monitoring period, that began in autumn 2018 (Table 3.2). During compliance monitoring, the total plant species diversity recorded at the flora sites has ranged from 111 species in spring 2018 to 141 species in both 2023 and 2024.

Since 2018, the variation in total species diversity has been almost entirely due to variations in short-lived species diversity (ranging from 52 to 83 species recorded), with long-lived perennial species diversity remaining within the narrow range of 58 – 62 species (Table 3.2). Pre-construction comparisons of total species diversity across the Carrapateena Operation area are not possible, as Sites 17 – 22 were established in 2018. A list of all species recorded in spring 2024, their frequency and their long-lived status is contained in Appendix B. A list of all species at each site, their abundance and grazing impact is contained in Appendix B2.

Table 3.2: Total species diversity recorded at RAM sites during compliance monitoring period (construction and operation)

Life Span	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring	2018 – 2024 range	2018 – 2023 Mean, St Dev
Long-lived[2]	58	59	61	59	62	60	58	60	58 – 62	60 (±1.4)
Short-lived	58	52	75	80	57	74	83[1]	81	52 – 83	70 (±12.4)
Totals	116	111	136	139	119	134	141	141	111 – 141	130 (±12.3)

[1] amended from 2023 report to remove duplicate records; [2] Long-lived woody perennials and long-lived grasses; rounded to nearest whole number

3.2.1.2 Total species diversity at control/impact sites: baseline and compliance monitoring period comparison

Flora sites 1-7, 9-13 and 15-16 were surveyed in all years both during pre-construction (baseline) and during the construction/operational phase (compliance monitoring period). Hence these sites are suitable to compare species diversity during these phases. Species diversity at all individual sites in 2024 was within the baseline range for each site. In 2024, total native plant diversity at six sites was the highest recorded during compliance monitoring (Table 3.3). During both baseline and the compliance monitoring period, there has been a wide range in total plant diversity within all sites, however the remaining eight sites were still within the compliance monitoring range (Table 3.3). The following sections show that the range in total native plant diversity is largely due to variations in short-lived plant diversity.

In 2024, the mean total species diversity for control and impact sites was 28.3 and 28.6, respectively, and not significantly different (t test, t = 0.9). The 2024 mean diversities for impact and control sites were at the upper end of the range for compliance monitoring (Table 3.3).

For analyses up to 2023, the Baseline Control Mean was 29.1 and the Baseline Impact Mean was 26.6 (Figure 3.2). For analyses from 2024, when Sites 4 and 6 were changed to control sites, the Baseline Control Mean was 27.2 and the Baseline Impact Mean was 28.1 (Figure 3.3). This again demonstrates that the 2024 results were well within the baseline range.

Table 3.3: Total native plant species diversity, baseline versus compliance monitoring period

Type	Baseline (2012-2016) and Compliance Total Diversity to (2018-2023)										Updated Treatment Baseline and Compliance 2024				
	RAM Site[1]	Baseline Min	Baseline Max	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	Type	RAM Site	Baseline Min	Baseline Max	2024 Spring
Control	1	18	40	24	17	23	18	25	27	31	Control	1	18	40	24
	2	9	35	14	15	21	21	14	19	21		2	9	35	28
	7	20	46	30	24	30	17	32	33	25		4	15	38	25
	9	21	42	21	18	30	34	31	34	40		6	15	38	21
	13	10	34	14	22	30	20	18	19	27		7	20	46	35
	Means	**15.6**	**39.4**	**20.6**	**19.2**	**26.8**	**22.0**	**24.0**	**26.4**	**28.8**		9	21	42	**41**
Impact	3	16	41	23	22	29	21	17	25	34		13	10	34	24
	4	15	38	14	25	19	17	23	25	26		**Means**	**15.4**	**39**	28.3
	5	13	41	21	14	25	19	17	23	25	Impact	3	16	41	37
	6	15	38	15	28	23	16	18	21	24		5	13	41	26
	10	26	56	22	15	28	23	16	18	21		10	26	56	24
	11	18	49	32	25	37	28	26	31	37		11	18	49	24
	12	9	32	17	14	29	22	16	25	30		12	9	32	36
	15	10	36	18	16	31	23	16	19	21		15	10	36	33
	16	10	36	17	16	27	15	17	16	24		16	10	36	20
	Means	**14.7**	**40.8**	**22.2**	**19.7**	**30.1**	**23.7**	**20.9**	**24.6**	**29.8**		**Means**	**14.6**	**41.6**	**28.6**

[1] Rangeland sites, as per previous reporting. Note: Comparable data for 2017 not available.

[2] In 2024, Sites 4 and Site 6 were transferred from impact to control sites due to the Southern Access Road no longer being in general use for mining activities, and there being no hydrogeological connection to the Tailings Storage Facility. The baseline mean (and min/max) values therefore change at 2024 as a result of these changes.

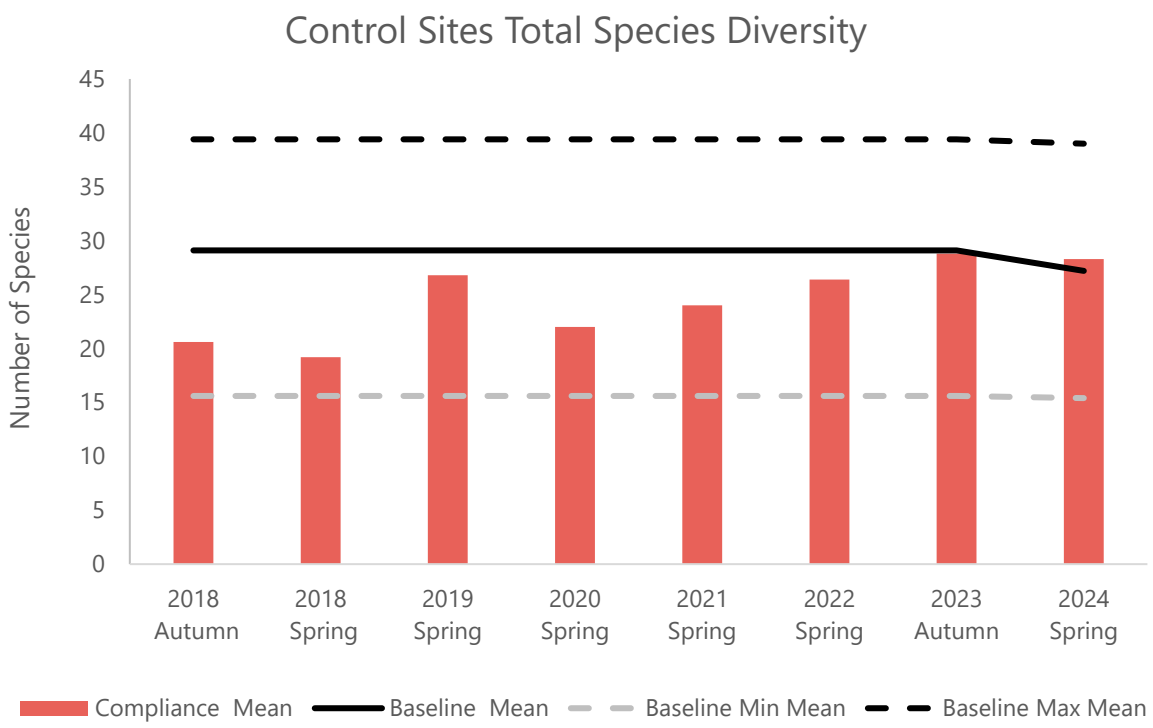

Figure 3.2: Mean total flora species diversity (long-lived and short-lived species) at control sites during compliance monitoring (compared to baseline mean, min, max, changed in 2024)

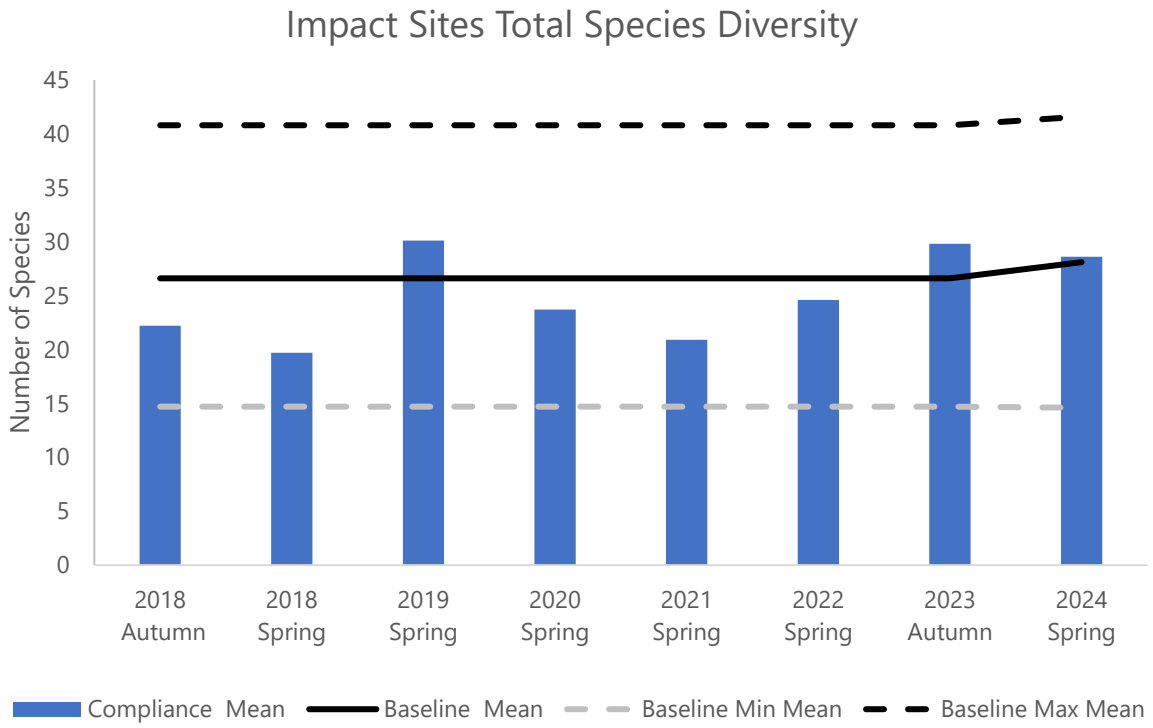

Figure 3.3: Mean total flora species diversity (long-lived and short-lived species) at impact sites during compliance monitoring (compared to baseline mean, min, max, changed in 2024)

3.2.1.3 Long-lived species diversity: baseline and compliance monitoring period comparison

Table 3.4 and Figure 3.4 show the range in long-lived native species diversity at sites surveyed in common during baseline (autumn 2012 to 2016) and during the compliance monitoring period (autumn 2018 to spring 2024). Mean diversity of long-lived species during spring 2024 exceeded the baseline means for both control and impact sites. For analyses up to 2023, the Baseline Control Mean was 11.5 and Baseline Impact Mean was 9.7 (Figure 3.4). For analyses from 2024 (Site 4 and 6 as control Sites), the Baseline Control Mean was 9.9 and the Baseline Impact Mean was 10.9 (Figure 3.5). The 2024 mean diversity of long-lived plant species for control sites was the highest recorded during compliance monitoring to date (2018 – 2024) and was at the upper end of the range for impact sites.

Control and impact sites have recorded similar directional changes in perennial species diversity during compliance monitoring. Namely, both control and impact sites recorded increases in mean perennial diversity in 2018, 2019, 2021 and 2022, and a decrease in mean perennial species diversity in 2020.

At individual impact and control sites, perennial species diversity has been very consistent between surveys, for all sites except impact Site 12 and control Sites 1 and 2. The latter have fluctuated between survey periods but show no obvious trends. Variations at these sites occurred prior to 2022, and are thought likely to be due to variation between observers in interpreting survey boundaries, rather than actual changes in perennial diversity.

Table 3.4: Long-lived perennial native species diversity, baseline versus compliance monitoring period

Type	Baseline (2012-2016) and Compliance Long-lived Diversity to (2018-2023)										Updated Treatment Baseline and Compliance 2024				
	RAM Site[1]	Baseline Min	Baseline Max	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	Type	RAM Site	Baseline Min	Baseline Max	2024 Spring
Control	1	10	14	12	10	13	7	15	12	11	Control	1	10	14	11
	2	4	8	4	7	9	6	3	7	7		2	4	8	7
	7	11	19	16	17	20	10	16	19	11		4	5	10	9
	9	13	21	15	14	19	16	18	16	19		6	4	8	9
	13	4	8	4	6	6	6	6	8	8		7	11	19	18
	Means	**8.4**	**14**	**10.2**	**10.8**	**13.4**	**9**	**11.6**	**12.4**	**11.2**		9	13	21	19
Impact	3	5	10	9	10	10	7	8	9	10		13	4	8	10
	4	5	10	7	7	8	7	7	8	7		**Means**	**7.3**	**12.6**	**11.9**
	5	8	14	10	10	11	8	9	11	10	Impact	3	5	10	11
	6	4	8	7	6	7	7	6	6	6		5	8	14	9
	10	17	29	22	26	26	21	27	25	24		10	17	29	23
	11	11	16	18	16	17	14	15	17	19		11	11	16	18
	12	3	7	4	8	8	6	4	10	9		12	3	7	7
	15	6	10	6	7	8	10	7	7	6		15	6	10	8
	16	6	10	6	7	7	5	5	7	9		16	6	10	9
	Means	**7.2**	**127**	**9.9**	**10.8**	**11.3**	**9.4**	**9.8**	**11.1**	**11.1**		**Means**	**8**	**13.7**	**12.1**

*In 2024, Sites 4 and 6 were transferred from impact to control sites due to the Southern Access Road no longer being in general use for mining activities, and there being no hydrogeological connection to the Tailings Storage Facility. The baseline mean (and min/max) values therefore change at 2024 as a result of these changes.

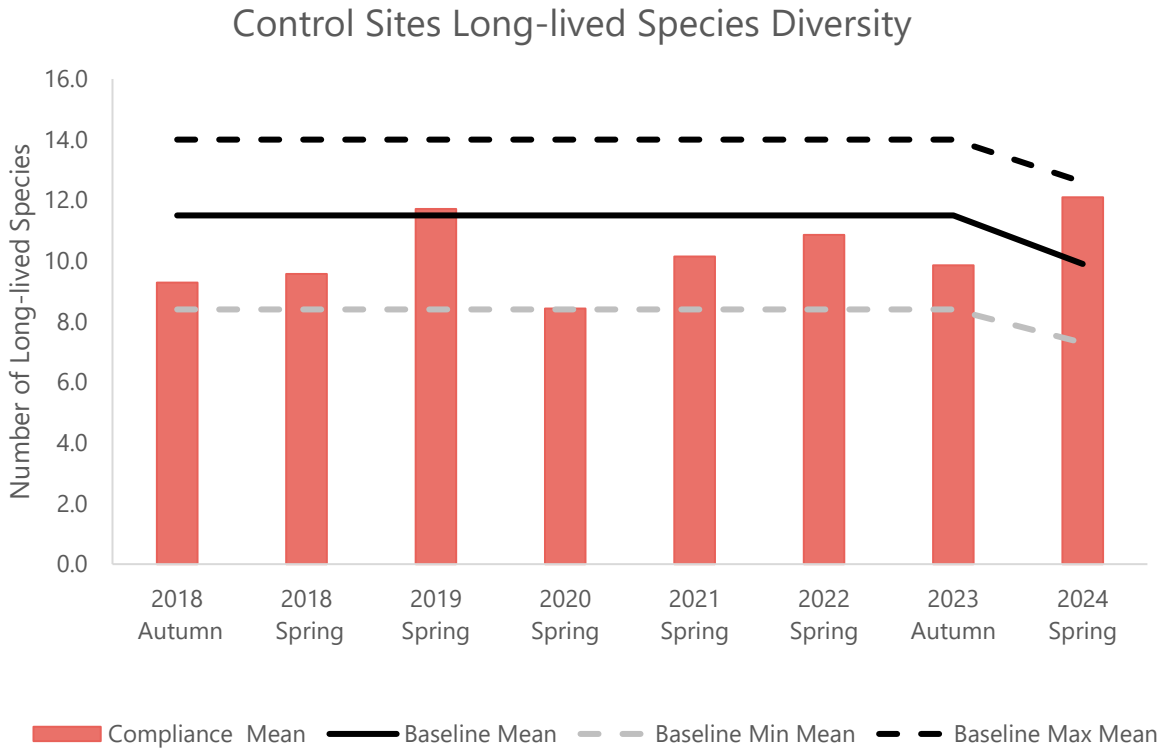

Figure 3.4: Mean diversity of long-lived flora species at control sites during compliance monitoring (compared with baseline mean, min, max, changed in 2024)

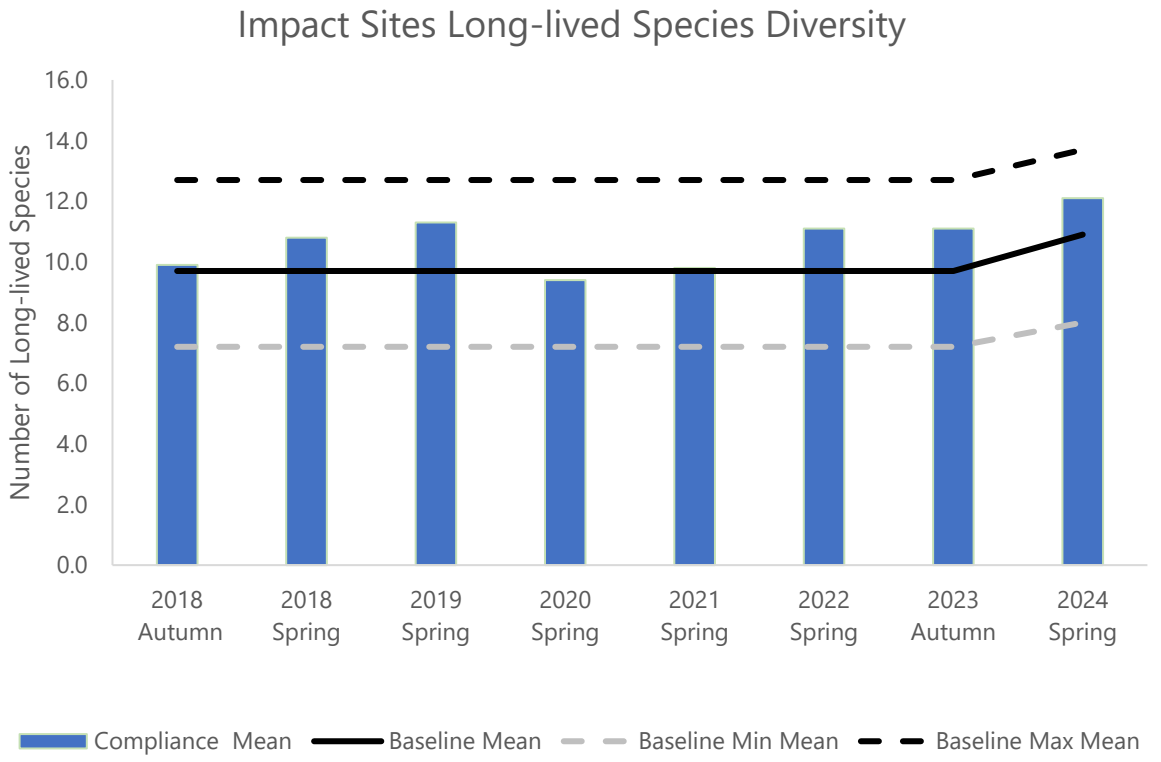

Figure 3.5: Mean diversity of long-lived flora species at impact sites during compliance monitoring (compared with baseline mean, min, max, changed in 2024)

3.2.1.4 Short-lived species diversity: baseline and compliance monitoring period comparison

During compliance monitoring, the mean short-lived species diversity for both control and impact sites has fluctuated yearly, largely in response to fluctuations in rainfall patterns. In 2024, the mean short-lived species diversities for control sites (17.0 species) and for impact sites (16.3 species) were the second highest and third highest, respectively recorded during compliance monitoring, and at the upper end of the range for baseline monitoring. The tallies for all individual sites were also within the baseline ranges (Table 3.5). Three control sites and two impact sties recorded the highest short-lived species diversity tallies for the compliance/operational period. For analyses up to 2023 (Site 4 and 6 as Impact), the Baseline Control Mean was 16.4 and the Baseline Impact mean was 18.2 (Figure 3.6). For analyses in 2024 (Site 4 and 6 as Control) the Baseline Control Mean was 16.9 and Baseline Impact Mean was 18.2 (Figure 3.6). These results also well within the baselines ranges, regardless of site allocation to control of impact (for Site 4 and 6).

Table 3.5: Total diversity of short-lived native species, baseline versus compliance monitoring period

Type	Baseline (2012-2016) and Compliance Short-lived Diversity to (2018-2023)										Updated Treatment Baseline and Compliance 2024				
	RAM Site[1]	Baseline Min	Baseline Max	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	Type	RAM Site	Baseline Min	Baseline Max	2024 Spring
Control	1	6	28	12	7	10	11	10	15	20	Control	1	6	28	13
	2	4	31	10	8	12	15	11	12	14		2	4	31	21
	7	8	28	14	7	10	7	16	14	14		4	8	29	17
	9	2	25	6	4	11	18	13	18	21		6	11	24	15
	13	5	27	10	14	24	14	12	11	19		7	8	28	17
	Means	**5.0**	**27.8**	**10.4**	**8.0**	**13.4**	**13.0**	**12.4**	**14.0**	**17.6**		**9**	**2**	**25**	**22**
Impact	3	10	35	14	12	19	14	9	16	24		13	5	27	14
	4	8	29	14	7	17	12	10	15	18		Means	6.3	27.4	17.0
	5	4	32	12	10	14	12	9	10	16	Impact	3	10	35	26
	6	11	24	15	9	21	16	10	12	15		5	4	32	15
	10	8	28	6	9	14	21	18	18	26		10	8	28	13
	11	7	33	14	9	20	14	11	14	18		11	7	33	15
	12	6	25	13	6	21	16	12	13	21		12	6	25	13
	15	4	29	12	9	23	13	9	12	15		15	4	29	17
	16	4	30	11	9	20	10	12	9	15		16	4	30	15
	Means	**6.9**	**29.4**	**12.3**	**8.9**	**18.8**	**14.2**	**11.1**	**13.2**	**18.7**		**Means**	**6.1**	**30.3**	**16.3**

*In 2024, Sites 4 and Site 6 were transferred from impact to control sites due to the Southern Access Road no longer being in general use for mining activities, and there being no hydrogeological connection to the Tailings Storage Facility. The baseline mean (and min/max) values therefore change at 2024 as a result of these changes.

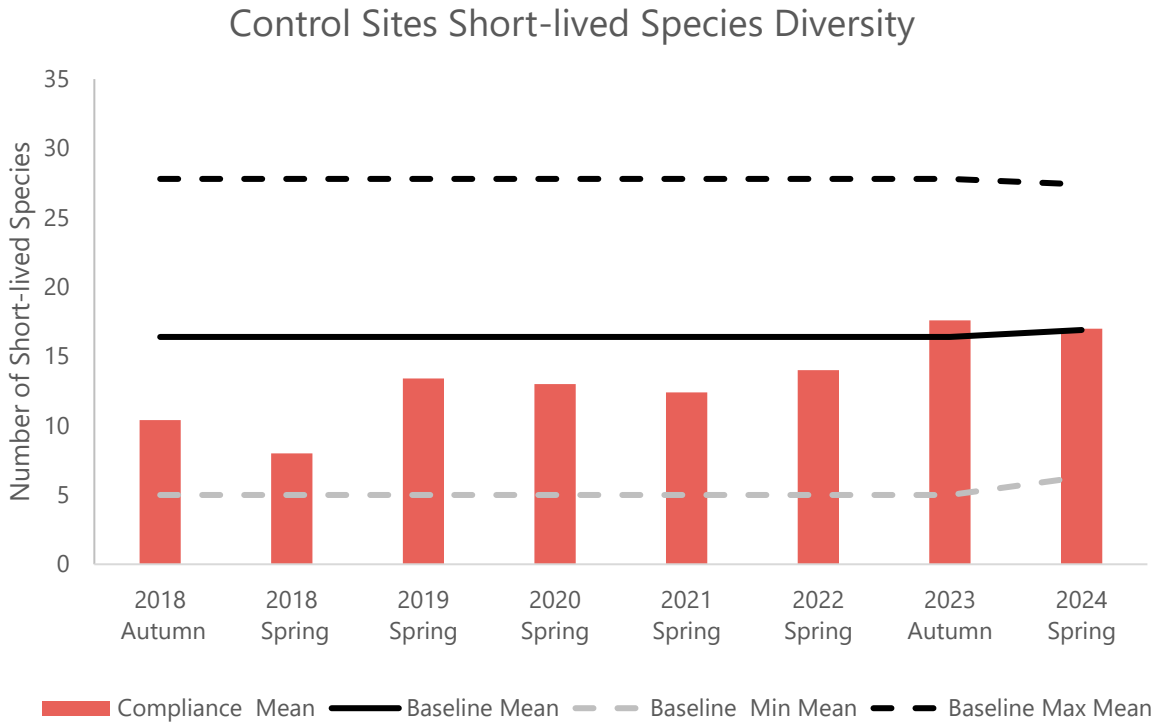

Figure 3.6: Mean diversity of short-lived flora species at control sites during compliance monitoring (compared with baseline mean, min, max, changed in 2024)

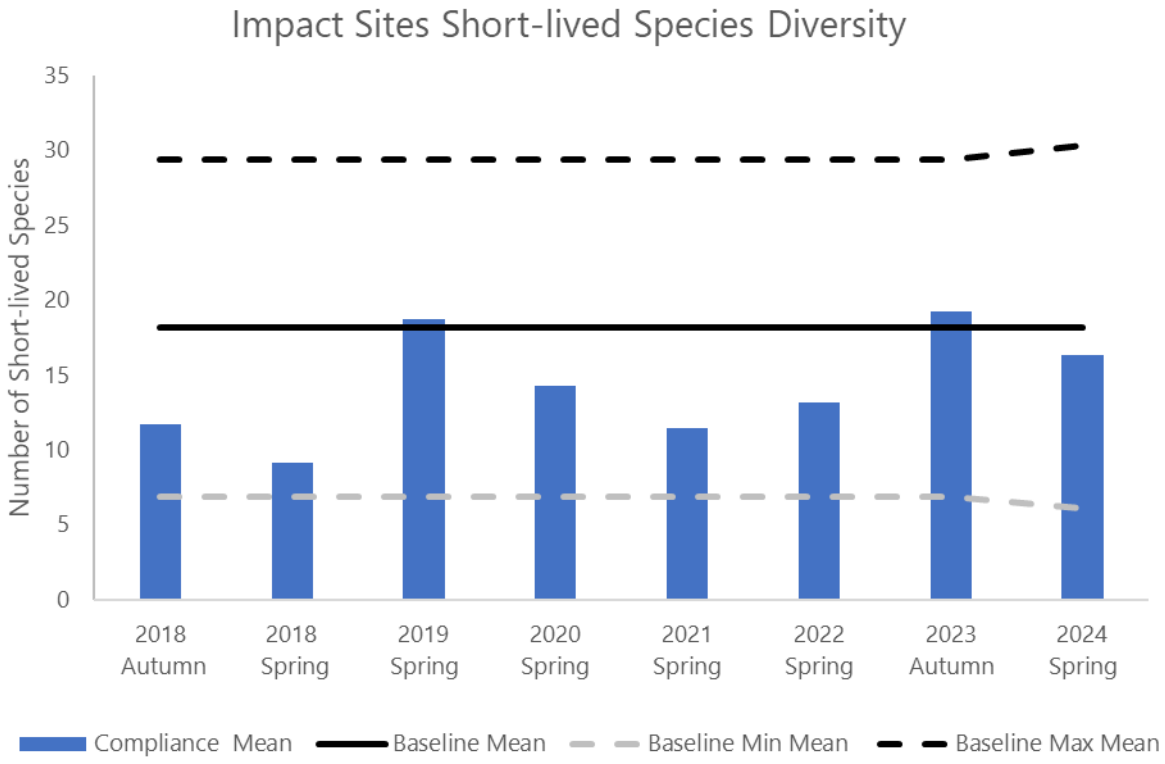

Figure 3.7: Mean diversity of short-lived flora species at impact sites during compliance monitoring (compared with baseline mean, min, max, changed in 2024)

3.2.1.5 Comparison of long-lived species diversity by habitat type and site

Four distinct habitats were recognised at the Flora Rangeland sites: Eliza Creek (major drainage line) sites, sand dune sites, gibber sites with no drainage line, and gibber sites with a drainage line. Trends in perennial species diversity were compared between sites of similar habitat. This was done to:

1. Determine the magnitude of inherent variation between sites of similar habitats, regardless of potential impact from mining, and
2. Detect potential changes in plant diversity associated with a particular habitat, regardless of distance from mining infrastructure; namely to detect possible stressors (mining related or otherwise), impacting species diversity in specific habitats.

Potential increasing or decreasing trends for individual sites were also assessed. This was done to detect possible trends at a site level, that were otherwise being masked at a control group or impact group level.

Long-lived species diversity at Eliza Creek sites

The Eliza Creek Sites 17, 18, 19 and 20 were established in autumn 2018, specifically to monitor the potential impacts of the tailings dam embankment on downstream vegetation. In addition, flora Site 10, established in 2012, is located on Eliza Creek, approximately 5 km downstream from the Tailings Storage Facility (TSF) and is therefore also a potential impact site from the TSF. The TSF construction began in 2018 and TSF commenced operations during February 2020. As such, the 2018 and 2019 survey data represent the best 'baseline' data available for Eliza Creek survey sites 17-20, noting that natural spatial and temporal variations in species diversity are present and due to inter alia: slight habitat differences (width and depth of channel); seasonal and yearly rainfall variations; and slight variations in area surveyed at each site for each survey.

Since 2018, there has been no distinct trend in species diversity for any of the Eliza Creek sites, with mean diversity since 2020 (namely, TSF operational) being similar to 2018 and 2019 tallies (Table 3.6 and Figure 3.8). Mean species diversity for each site post construction has either been greater than construction (2018 and 2019) means or within 5% of construction mean diversities. In addition to similar baseline and operational mean diversities, the range in species diversity recorded at individual sites has also been similar for construction and operational phases (Table 3.6). Mean perennial diversity between sites during operational monitoring has also been very similar, varying from a mean of 22 species at Sites 17 and 18 to 24 species at Sites 19 and 10.

In summary there is no clear pattern emerging in species diversity data relating to the time since TSF establishment and the distance from the TSF (Sites 17 being the closest and Site 10 being the furthest away). Site 17 is approximately 200 m downstream from the TSF and as at October 2024 had experienced no species loss, or evident decline in populations of any species.

Table 3.6: Long-lived perennial plant species diversity at Eliza Creek sites during compliance monitoring (all sites considered potential impact sites)

RAM Site[1]	Construction Long-lived Species Diversity			Operation Long-lived Species Diversity						
	Min	Max	2018-2019 Mean	2020	2021	2022	2023	2024	2020-2024 Range	2020-2024 Mean
17	19	24	21	18	20	27	24	22	18 - 27	22
18	22	25	23	21	20	23	21	24	20 - 24	22
19	16	19	18	23	24	25	24	23	23 - 25	24
20	21	26	24	20	21	23	25	25	20 - 25	23
10	22	26	25	21	27	25	24	23	21 - 27	24

[1] Flora sites (One hectare Rangeland) displayed by increasing distance from TSF, where flora Site 17 = CAR017, 18 = CAR018 and so on.

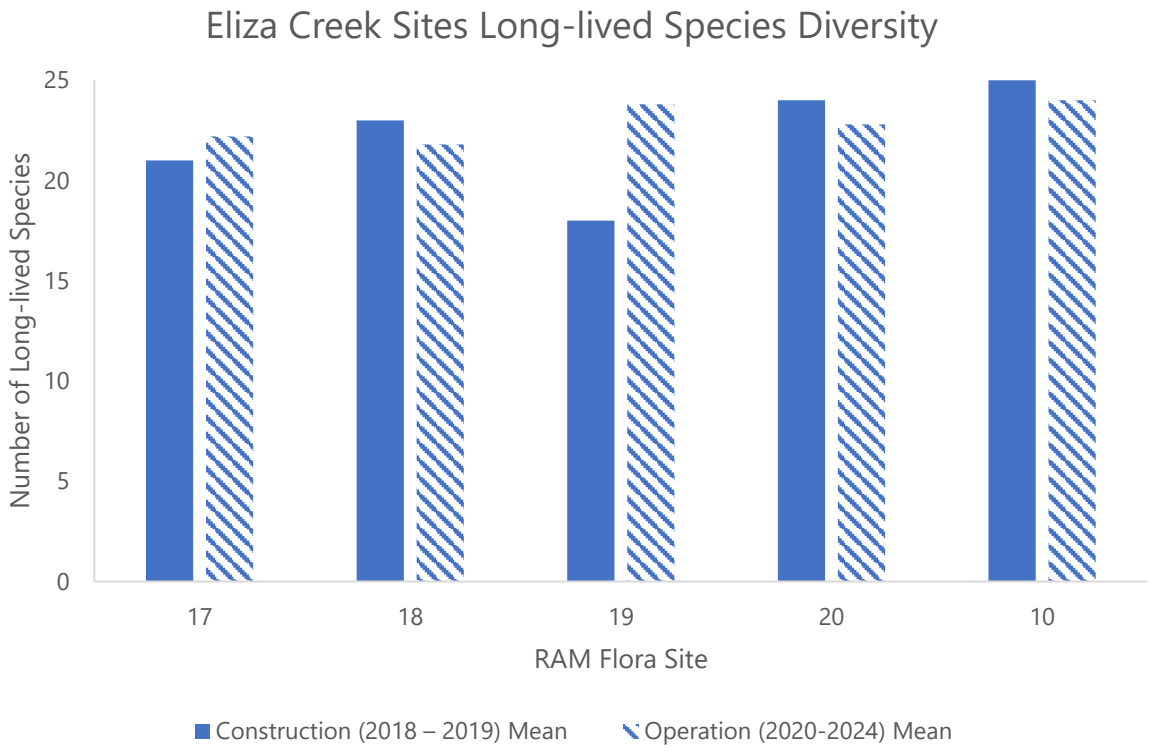

Figure 3.8: Mean native long-lived species diversity at Eliza Creek Rangeland Flora Sites (TSF construction (2018 and 2019) and operation (2020 – 2024)

Long-lived species diversity at sand dune habitat

Flora Sites 21 and 22 were established in May 2018 on sand dunes, a previously un-monitored habitat within the Carrapateena Operation area, but the control Site 21 was relocated in spring 2018 given proximity to proposed infrastructure. For both sites, perennial species diversity has fluctuated yearly (Table 3.7) without any clear trend emerging in either long-term increases or declines.

The sand dune sites are not defined on the ground. A central point is designated by an easting and northing coordinate and the site is surveyed by walking within an area defined by a 55 m radius from the central coordinate (namely an area equivalent to a 10 000 m^2 RAM site). Several species are present as isolated individuals only. Due to the undulating nature of the dunes and the absence of on-ground survey markers, it is possible that some perennial species of low abundance, are present but not detected during some surveys.

Table 3.7: Long-lived perennial plant species diversity at sand dune habitats during compliance monitoring

RAM Site	Site Type	Compliance Monitoring Long-lived Species Diversity						
		2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
21	Control	10	8	7	9	8	12	11
22	Impact	7	8	10	5	5	7	9

Long-lived species diversity at gibber habitats with no drainage line

Gibber habitat sites that contained no drainage line were control Sites 2, 4, 6 and 13, and Impact Sites 3, 5, 12,15 and 16. There has been no obvious trend in long-lived species diversity at any individual site (Table 3.8). Mean diversity at all sites during compliance monitoring has remained within the baseline range, and been similar to baseline diversity (Table 3.9).

Post-construction long-lived species diversity has fluctuated slightly at all sites with no consistent trend evident at any site, regardless of whether designated a control or potential impact site (based on distance from mining infrastructure). Of the gibber (non-drainage line) sites, site 3 recorded the highest perennial species diversity in both 2023 and 2024, noting that this site is closest to major mining infrastructure.

Table 3.8: Long-lived perennial plant species diversity at gibber sites (with no drainage lines) during compliance monitoring

RAM Site	Compliance Monitoring Long-lived Species Diversity Totals							
	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
2	4	7	9	6	3	7	7	7
3	9	10	10	7	8	8	10	11
4	7	7	8	7	7	9	7	9
5	10	10	11	8	9	8	10	9
6	7	6	7	7	6	11	6	9
13	4	6	6	6	6	10	8	10

RAM Site	Compliance Monitoring Long-lived Species Diversity Totals							
	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
12	4	8	8	6	4	6	9	7
15	6	7	8	10	7	7	6	8
16	6	7	7	5	5	7	9	9

*Sites 4 and 6 were changed from potential impact sites to control sites in 2024 due to operational changes around 2024.

Table 3.9: Long-lived plant perennial plant species diversity at gibber sites (with no drainage lines), means and ranges

RAM Site	Baseline Diversity (2012-2016)			Compliance Diversity (2018-2024)		
	Min	Max	Mean	Min	Max	Mean
2	4	8	5.3	4	9	6.3
3	5	10	7.3	7	10	9.1
4	5	10	7.6	7	9	7.6
5	8	14	9.7	8	11	9.4
6	4	8	6.3	6	11	7.4
13	4	8	6.6	4	10	7.0
12	3	7	4.7	4	9	6.5
15	6	10	7.9	6	10	7.4
16	6	10	6.7	5	9	6.9

The baseline mean (and min/max) values change at 2024 in the graph below as a result of changes in allocation of control and impact sites due to operational changes around 2024. Site 4 and Site 6 were designated as impact sites up until 2023 due to the proximity of the Southern Access Road. With the SAR no longer widely used for mine-related activities, and the absence of hydrological connectivity to the TSF, these sites have been re-designated as control sites.

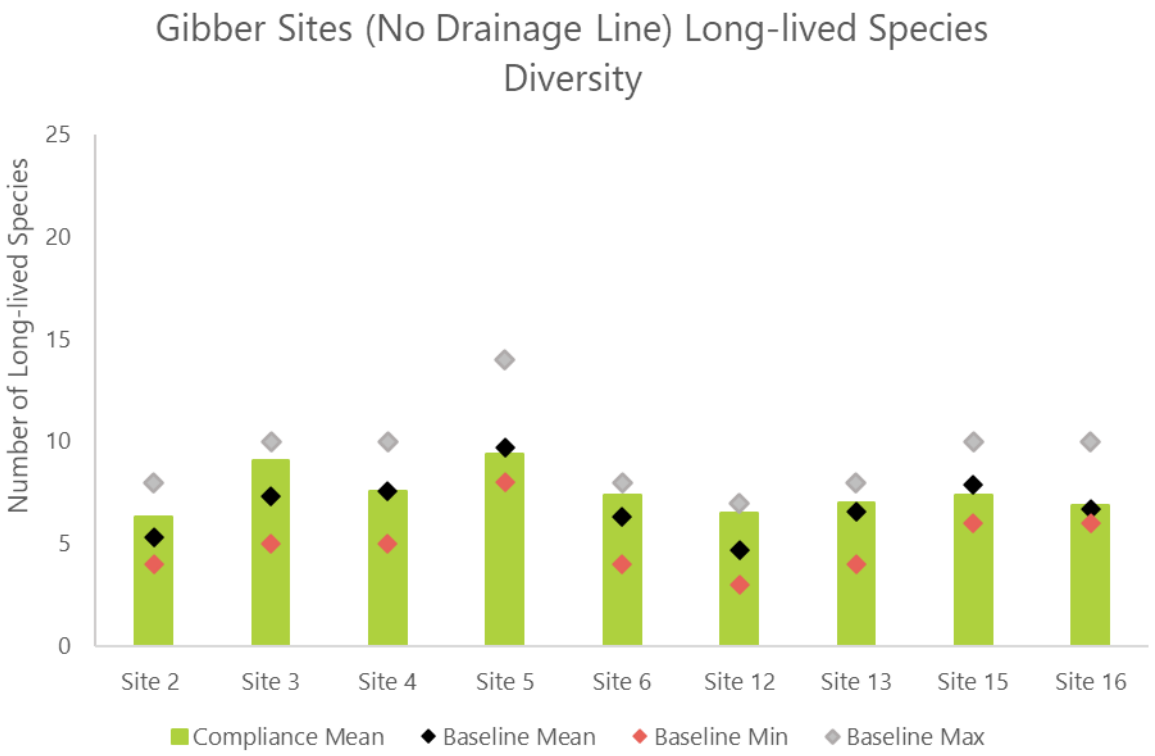

Figure 3.9: Mean species diversity of long-lived species at gibber sites (no minor drainage line in site)

*Sites 4 and 6 changed from potential impact sites to control sites in 2024, due to operational infrastructure changes.

Long-lived species diversity at gibber habitats that include a minor drainage Line

Gibber sites that contained a drainage line were Control Sites 1, 7 and 9, and Impact Site 11. Since 2018, there has been no obvious trend in long-lived species diversity at these sites (Table 8). During both baseline and post-construction/ operational monitoring, diversity has fluctuated quite widely at Control Sites 1 and 7, and to a lesser extent at Sites 9 and 11, but overall has shown no clear trends at these sites (Table 3.10). Variations in long-lived species diversity at these sites is thought to be largely due to slight variations in area surveyed at each survey: the presence of multiple habitats decreasing the ability to replicate survey areas precisely. Mean diversity at all sites during compliance monitoring has remained within the baseline range (Table 3.11 and Figure 3.10).

Table 3.10: Long-lived perennial plant species diversity at gibber sites with a minor drainage line during compliance monitoring

RAM Site	Compliance Monitoring Long-lived Species Diversity Totals							
	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
1	12	10	13	7	15	12	11	11
7	16	17	20	10	16	19	11	18
9	15	14	19	16	18	16	19	19
11	18	16	17	14	15	17	19	18

Table 3.11: Long-lived perennial plant species diversity at gibber sites with a minor drainage line; baseline and compliance monitoring means and ranges

RAM Site	Baseline Diversity (2012-2016)			Compliance Diversity (2018-2024)		
	Min	Max	Mean	Min	Max	Mean
1	10	14	12.2	7	15	11.4
7	11	19	15.4	10	20	15.9
9	13	20	18.0	14	19	17.0
11	11	16	14.4	14	19	16.8

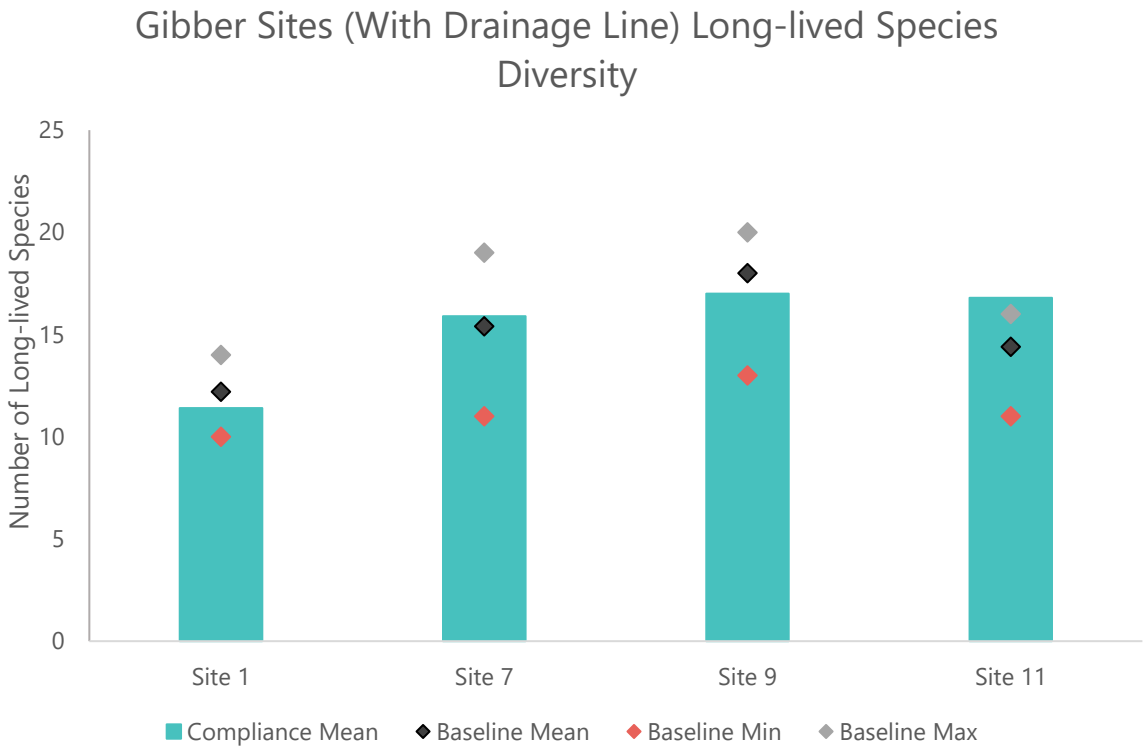

Figure 3.10: Mean long-lived species diversity at gibber sites that include a minor drainage line

3.2.2 Jessup transects – population structure of long-lived woody perennials

During compliance monitoring, Jessup transects were conducted at all 13 gibber habitat flora sites (Sites 1, 2, 3, 4, 5, 6, 7, 9, 11, 12, 13, 15 and 16) and at the five Eliza Creek flora sites (Sites 10, 17, 18, 19, 20). Appendix D1 contains all species data recorded for Jessup transects in 2024. Baseline Jessup site data is available for comparison for the 13 gibber sites for 2013 to 2025 surveys (Sites 15 and 16 were not surveyed in 2012).

3.2.2.1 Gibber habitat Jessup transects

Jessup data (Appendix D) shows the total number of adults and juveniles of long-lived woody perennials for the flora sites, recorded in spring 2024. Jessup transects conducted in gibber habitat during both the baseline and compliance periods were Sites 1 to 7, 9 to 13, 15 and 16.

For the gibber habitat Jessup sites three species have been chosen for a detailed comparison of baseline and compliance population levels: the two dominant species, *Atriplex vesicaria* and *Tecticornia* species, which are present at all gibber sites, and a third species, *Frankenia serpyllifolia*, which was also present at most sites.

- Bladder Saltbush (*Atriplex vesicaria*): Dominates the Jessup transects, scoring approximately eight times more individuals (adults and juveniles combined) than the next most abundant species.
- Samphire (*Tecticornia medullosa*): Widespread and abundant at most gibber sites, sometimes co-dominant with Bladder Saltbush.
- Sea-heath (*Frankenia serpyllifolia*): Chosen for analysis because it is widespread at gibber sites and the next most abundant species recorded in Jessup gibber sites, following Bladder Saltbush and Samphire species. Its relative unpalatability eliminates grazing impact as a cause of potential decline. Hence causes of potential changes in abundance can be narrowed down to climate and/or mining impact.

Further interrogation of the presence of these three species at control and impact sites, is provided below.

Bladder Saltbush

Bladder Saltbush is a long-lived woody perennial, and the dominant plant species at the gibber habitat Jessup transects (Sites 1 to 7, 9 to 13, 15 and 16). In this habitat due to the semi-saline soils, Bladder Saltbush is only moderately palatable.

During both baseline and compliance monitoring, the combined total population of Bladder Saltbush from all gibber sites has varied widely. Since compliance monitoring began in autumn 2018, the total number of adult and juvenile Bladder Saltbush from all gibber sites has ranged from 2,175 individuals in spring 2020 to 3,455 individuals in spring 2018. The total abundance recorded in 2024 was 3,146 individuals and near the upper end of the range recorded since 2018.

During compliance monitoring the greatest fluctuations in yearly population sizes occurred in control sites with large declines in 2020 and 2021, before steadily increasing in 2022, 2023 and 2024 (Figure 3.11). The fluctuations reflect changes in juvenile numbers, but also defoliation of shrubs during years of well below average rainfall. In 2024 the 374 juveniles recorded was the highest since construction monitoring began. At control sites, the mean number of Bladder Saltbush (adult and juvenile combined) in 2020, 2021, 2022 and 2023 were all below the baseline range but in 2024 had recovered to be once more just within the baseline range (Figure 3.12).

At impact sites the mean number of Bladder Saltbush plants has fluctuated less than at control sites, and during all compliance monitoring surveys remained within the baseline range for all but the 2020 survey (Figure 3.13).

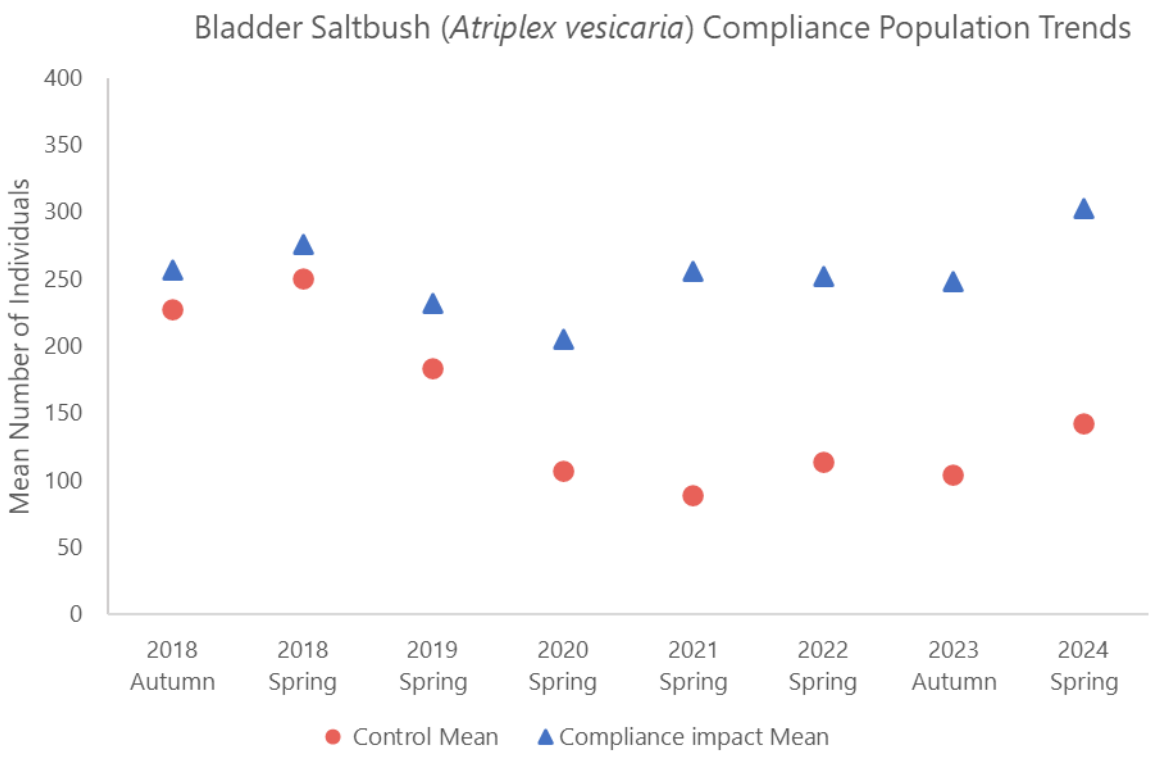

Figure 3.11: Population trends in Bladder Saltbush during compliance monitoring at control and impact sites

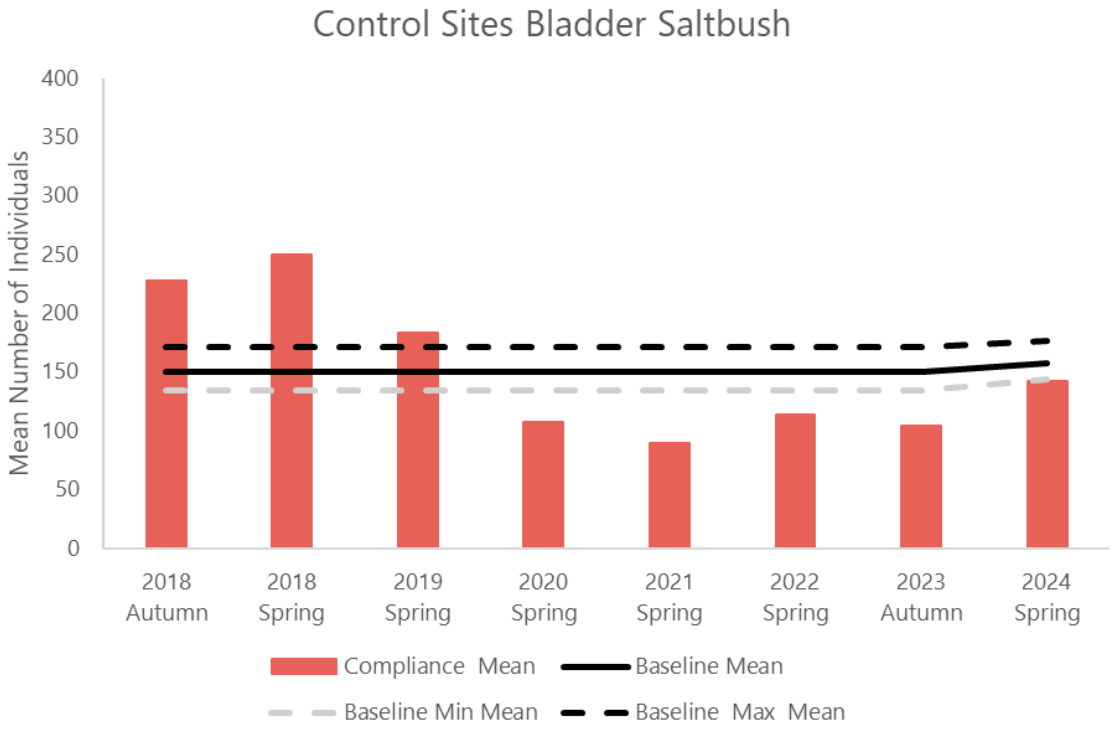

Figure 3.12: Mean abundance of Bladder Saltbush (adults and juveniles combined) at Jessup control sites, baseline versus compliance monitoring.

Note, baseline mean populations are for 2013 – 2015, given some sites not surveyed in 2012 and no data available for 2016 or 2017.

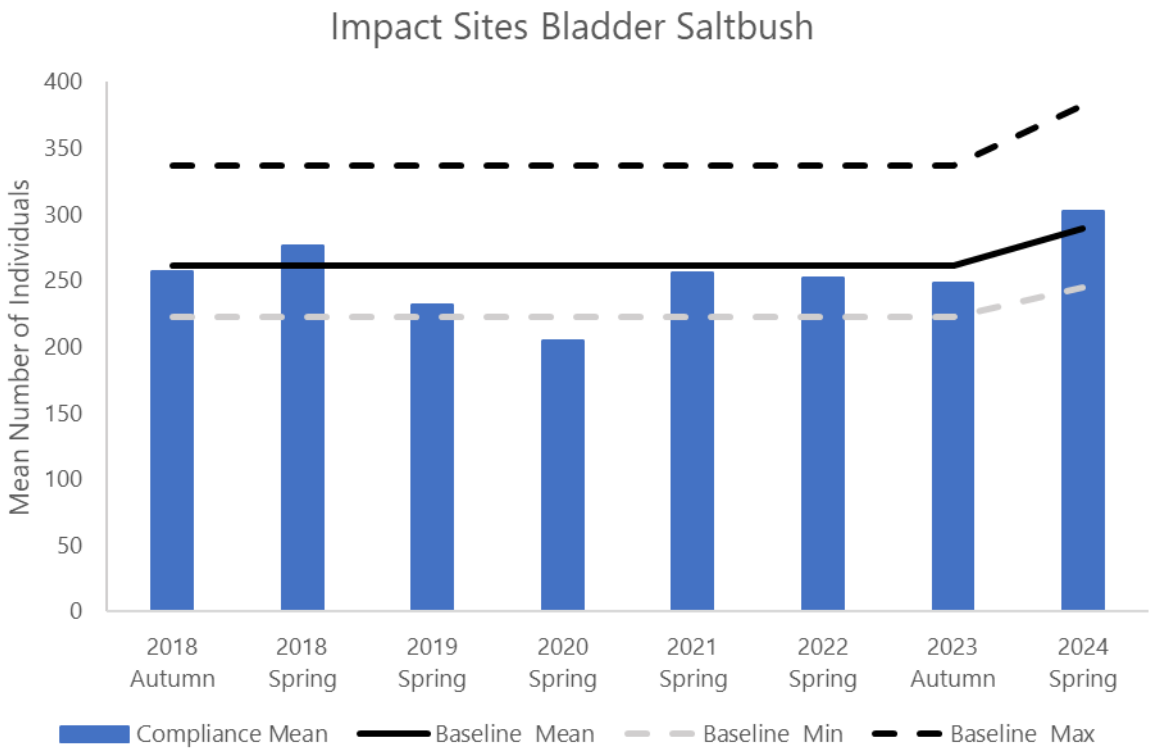

Figure 3.13: Mean abundance of Bladder Saltbush (adults and juveniles combined) at Jessup impact sites, baseline (2013-2015) vs compliance monitoring (autumn 2018 to spring 2024).

Note not all sites surveyed in 2012, and no data available for 2016 or 2017.

Samphire

All Samphire species were analysed collectively. The most widespread Samphire species at the Jessup sites is *Tecticornia medullosa*, with *T. pergranulata* and *T. tenuis* being associated with floodout areas of drainage lines. Samphire species were present at all 13 gibber Jessup sites.

As with all the long-lived woody perennials analysed since 2018, the abundance of Samphire was lowest in 2020/2021 and then increased in 2022, 2023 and 2024 (Figure 3.14). The 2024 combined tally of 400 adult and juvenile Samphire species, from 13 Jessup transects were the highest recorded during the compliance / construction period. Since 2018, the mean number of Samphire individuals at control sites has been within, or exceeded, the baseline range except in 2021 (Figure 3.15). The mean number of Samphire at impact sites was slightly below the baseline range in 2020, 2021 and 2022. In 2023 and 2024, the mean number of individuals at impact sites returned to being within the baseline range (Figure 3.16). It is noted for both impact and control, some sites were not surveyed in 2012, and there was no data available for 2016 or 2017.

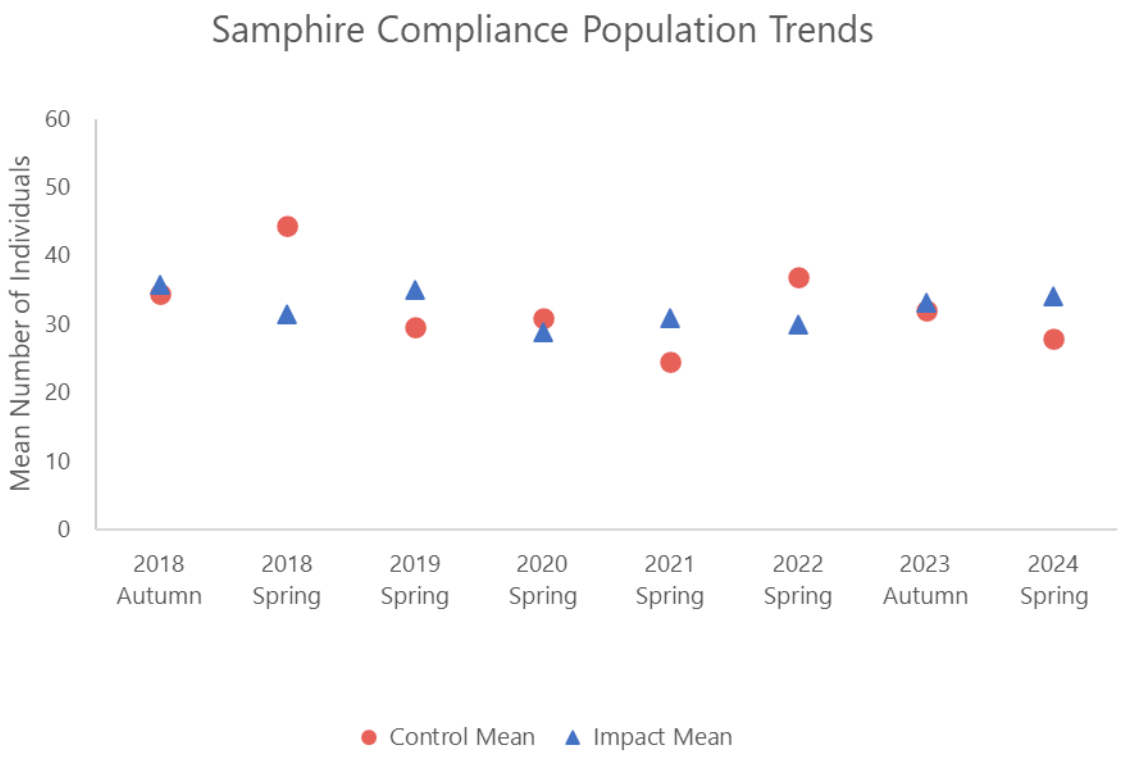

Figure 3.14: Population trends in Samphire during compliance period, control and impact sites

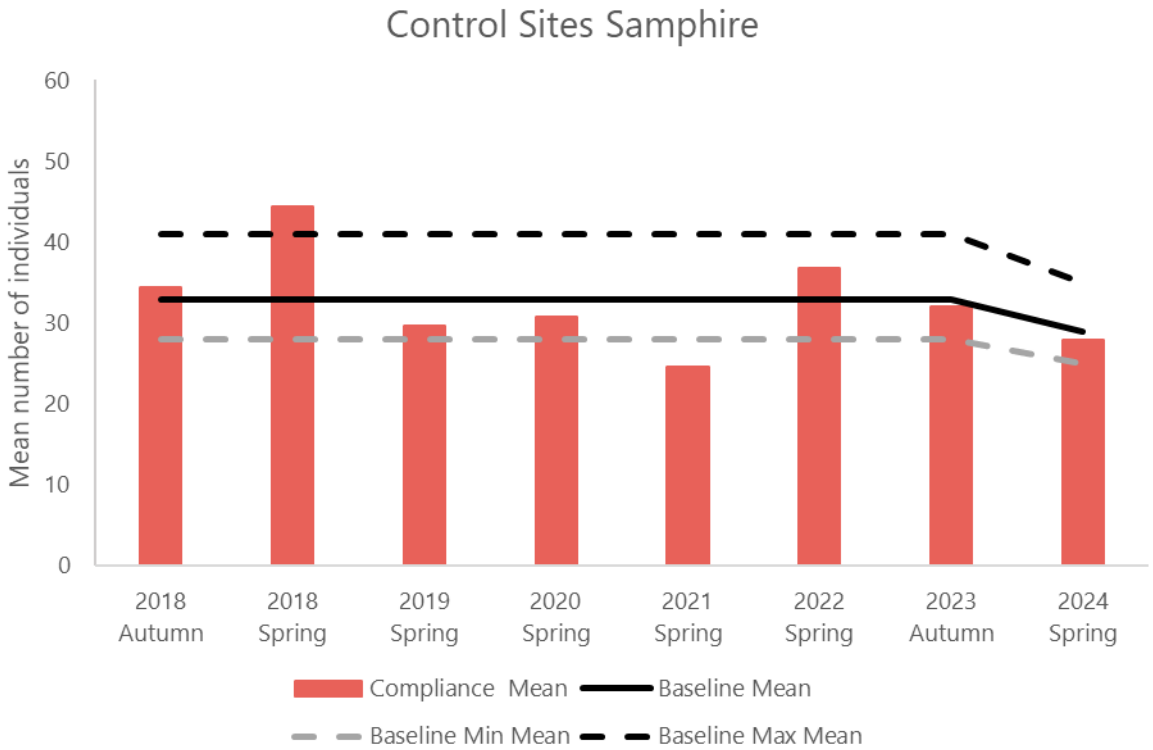

Figure 3.15: Mean number of Samphire at Jessup control sites, baseline (2013-2015) vs compliance monitoring (autumn 2018 to spring 2024).

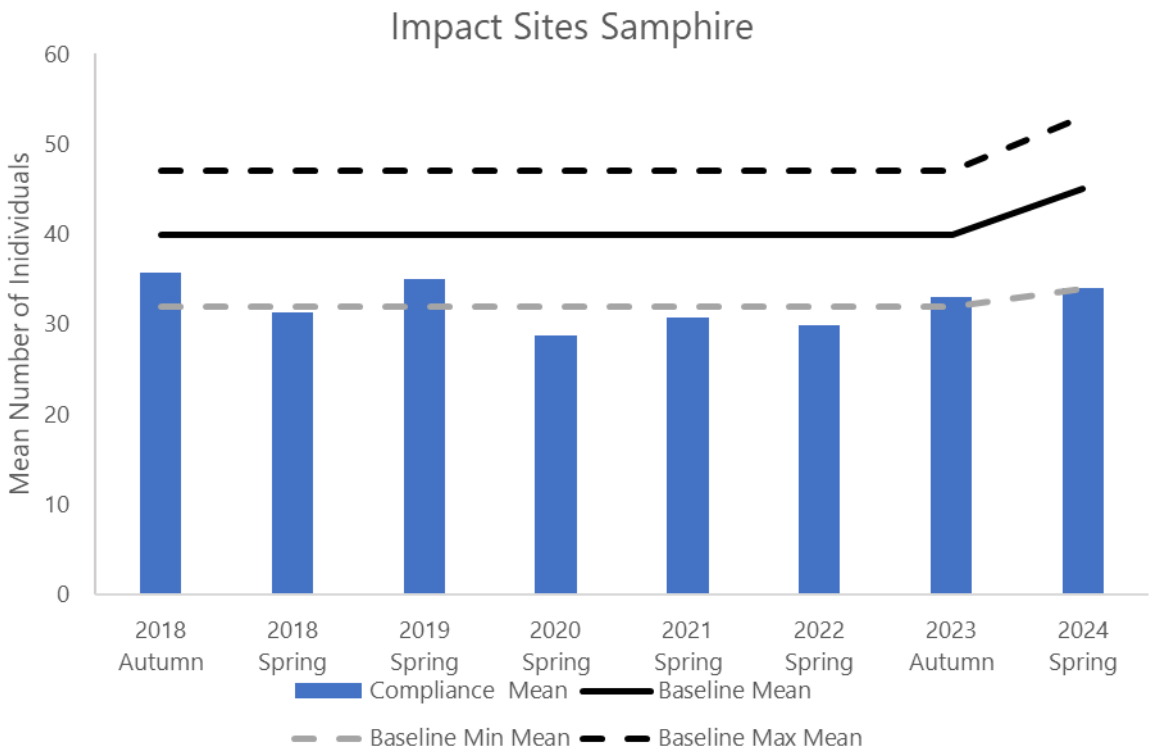

Figure 3.16: Mean number of Samphire at Jessup impact sites, baseline (2013-2015) vs compliance monitoring (autumn 2018 to autumn 2024).

Sea-heath

Sea-heath is also widespread in the gibber habitat, recorded from 12 of the 13 gibber Jesup sites. This species is tolerant of saline habitats and largely unpalatable. As with other long-lived woody perennials, abundance at Jessup transects has fluctuated during both baseline and compliance monitoring. The lowest Sea-heath totals for both control and impact sites were recorded in 2020 and 2021 (Figure 3.17). In 2024, 146 adults and 2 juveniles were recorded from 11 sites. This compares with 169 adults and no juveniles recorded from 10 Jessup transects in 2023 (Jacobs 2023h). In both 2023 and 2024, approximately 45% of all Sea-heath plants were recorded at Jessup transect Site 5. It is noted that Sites 4 and 6 changed from potential impact to control sites in 2024 due to infrastructure changes.

At control sites, the mean number of Sea-heath has been within, or exceeded, the baseline range for all survey periods except spring 2021 (Figure 3.18). At impact sites, the mean number of Sea-heath has remained within the baseline range during all compliance phase surveys (Figure 3.19). For all sites except Sites 1, 7 and 12, the compliance mean abundance has exceeded the baseline mean abundance (Table 3.12).

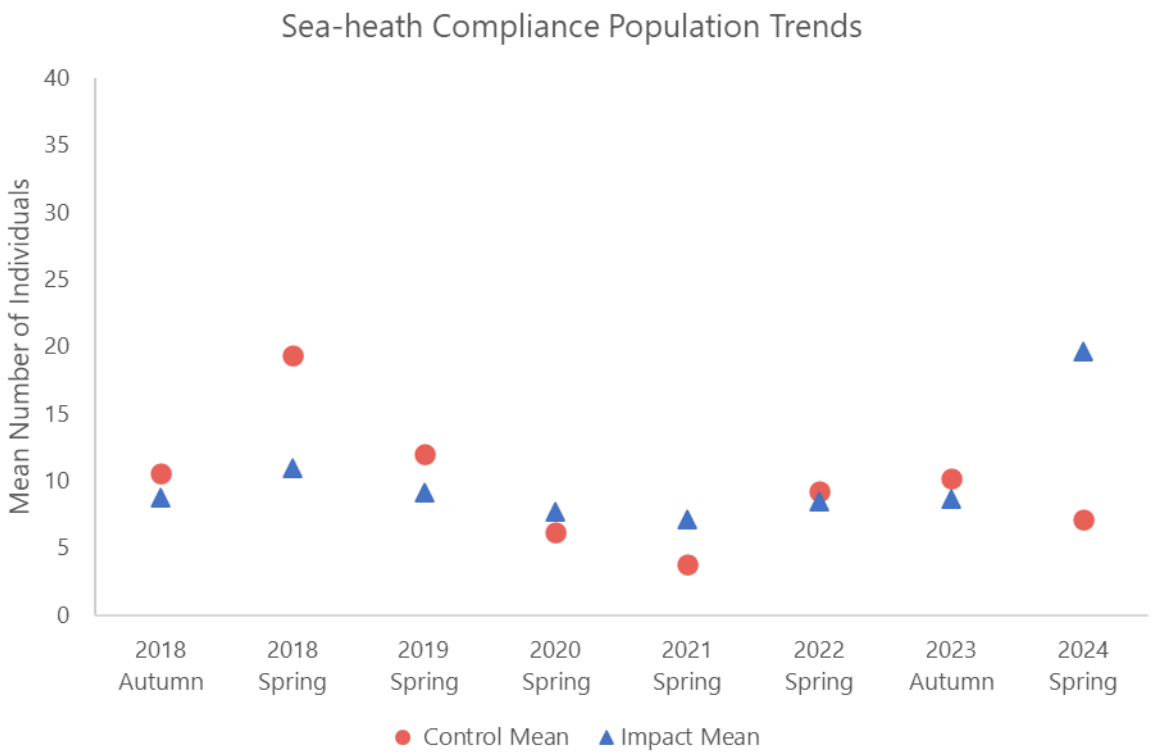

Figure 3.17: Population trends in Sea-heath during compliance period, control and impact sites

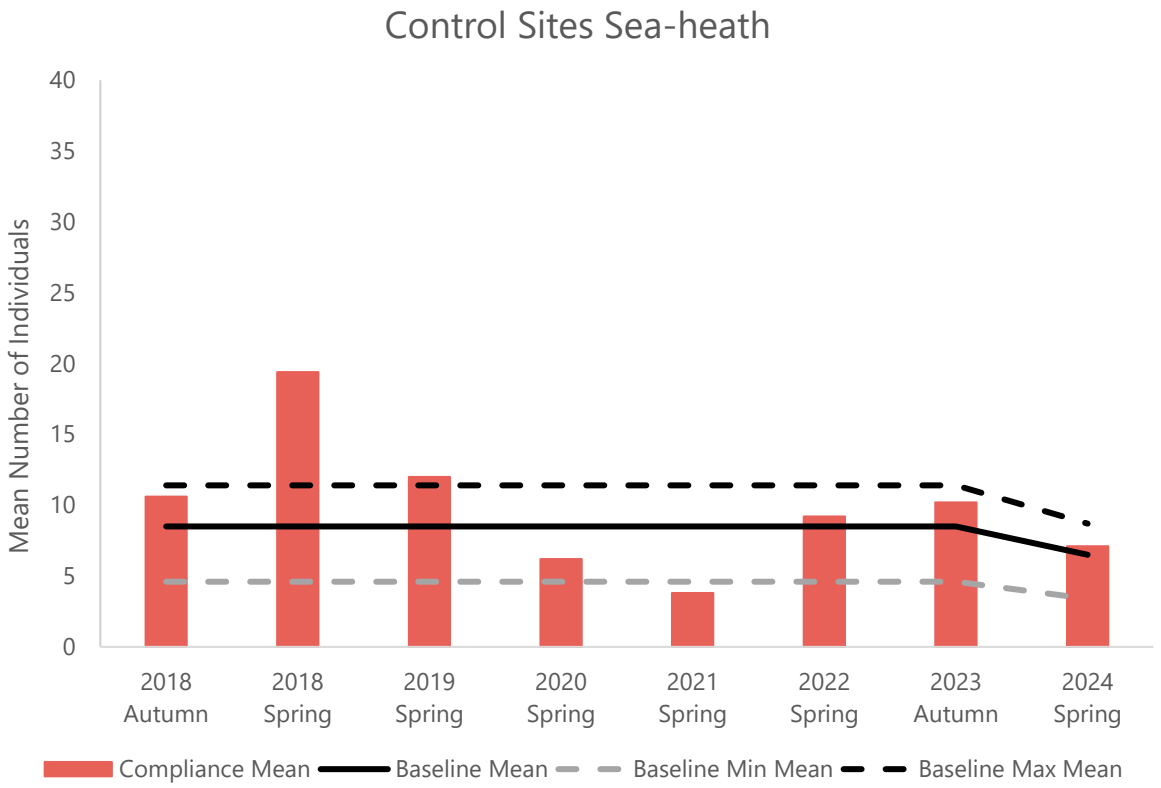

Figure 3.18: Mean number of Sea-heath at Jessup control sites, baseline (2013-2015) vs compliance monitoring (autumn 2018 to spring 2024).

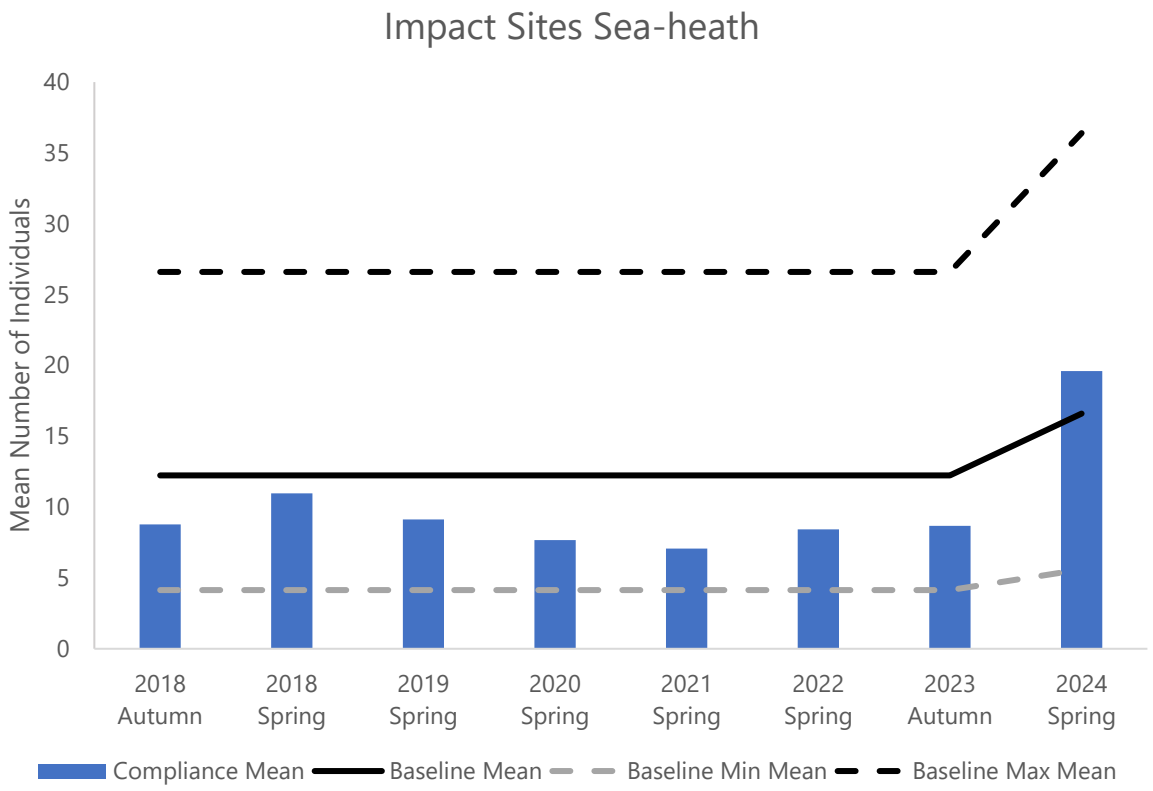

Figure 3.19: Mean number of Sea-heath at Jessup control sites, baseline (2013-2015) vs compliance monitoring (autumn 2018 to spring 2024).

Table 3.12: Sea-heath abundance (adults and juveniles) at individual sites, baseline (2013 – 2015) and compliance (2018 – 2024)

Jessup Site	Baseline Mean	Baseline Min	Baseline Max	Compliance Mean	Compliance Min	Compliance Max
1	8	4	14	1	0	4
2	1	0	2	1	0	5
3	22	9	39	26	9	45
4	1	0	3	2	0	12
5	54	9	135	77	14	116
6	1	0	2	2	0	5
7	17	11	20	11	3	21
9	3	0	5	13	2	28
11	2	1	3	10	0	65
12	2	1	3	1	0	2
13	14	6	27	23	1	58
15	4	0	21	6	4	8

Bush Minuria (*Minuria cunninghammii*) and Plains Lantern Bush (*Abutilon halophilum*)

Previous compliance reporting has compared the abundance of Bush Minuria and Plains Lantern Bush with baseline data. As with other Jessup data comparisons, baseline data available for Jessup transects is limited to a relatively short period (2013 – 2015) which did not reflect a wide range in rainfall extremes. Given there are high inherent spatial and temporal variability in the density of these two species, and the relatively small abundances at most Jessup sites, a comparison of compliance abundance levels with baseline abundance levels is somewhat spurious.

However, because Bush Minuria is relatively widespread at the gibber sites and is one of the larger long lived perennials present, abundance in 2024 at Jessup sites was briefly compared to baseline data. Bush Minuria is a long-lived shrub that is highly palatable in the Carrapateena region. Previous compliance reporting has shown that the abundance of Bush Minuria at Jessup sites has varied widely both between surveys and also within survey sites. This was attributed to both variation in yearly rainfall totals and also grazing impact.

The 2024 data, however, shows that the current population of Bush Minuria exceeds the baseline populations for both control and impact sites, and the extent of occurrence has also increased. The mean abundance at baseline control and impact sites (based on 2024 infrastructure) was 5 individuals and 4 individuals, respectively (with means ranging from 3.2 to 7 individuals per site at control sites, and from 1.2 to 8.8 individuals per site at impact sites). In 2024 the mean abundance at control and impact sites was 12.5 individuals and 6.8 individuals, respectively. During baseline surveys (2013 to 2015), Bush Minuria was recorded at 8 sites. During the 2024 survey, Bush Minuria was surveyed at 11 Jessup sites.

3.2.2.2 Jessup transects Eliza Creek Sites

To assess potential impacts on vegetation downstream of the Tailings Storage Facility (TSF), four sites were established in autumn 2018 progressively downstream from the TSF embankment within Eliza Creek. In addition, Site 10 was established in 2012 during baseline surveys, and is located downstream from site 20 (furthest from the TSF). At each site, the survey methods included a Jessup transect, which is a count of all adult and juvenile woody long-lived perennial species. Since 2018, all sites have recorded a net increase in the total number of long-lived woody perennials (Figure 3.20). Sites 17, 19 and 20 have recorded approximately 50% increase since 2018 and Sites 10 and 18 have recorded an increase of approximately 25%.

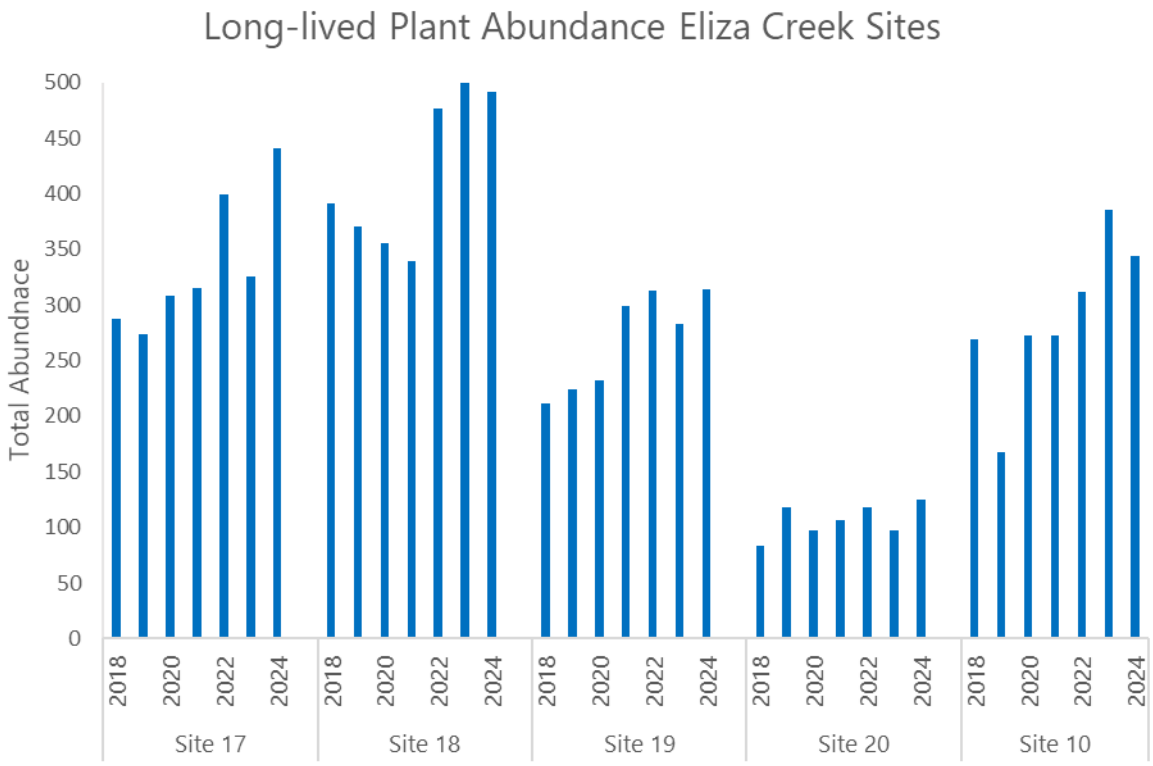

Figure 3.20: Combined abundance of all species recorded at Eliza Creek Jessup survey sites (adults and juveniles included)

3.2.2.3 Abundance of select long-lived perennials at Eliza Creek sites

To further analyse population trends in long-lived species at the Eliza Creek transects, the total number of individuals recorded for the most widespread and/or abundant long-lived species are presented in Figure 3.21 to Figure 3.30. Appendix D2 presents the data in tabular form.

Dead Finish *(Acacia tetragonophylla)*

The results show all species populations have either remained stable of recorded an upward trend since 2018. The only exception is a downward trend for Dead Finish at Site 10, which is the furthest site from the TSF.

At the Jessup sites, Dead Finish is most abundant at Site 10, with abundance ranging from 22 individuals in 2019 to 43 individuals in 2020 (Figure 3.21). Dead Finish occurs in dense clusters at Site 10, and fluctuating numbers may reflect differences in distinguishing individual plants between survey periods. At the Jessup transects upstream from Site 10 (closer to the TSF), populations of Dead Finish have remained stable since 2018. Noting Dead Finish does not occur in the Jessup transect for Site 17.

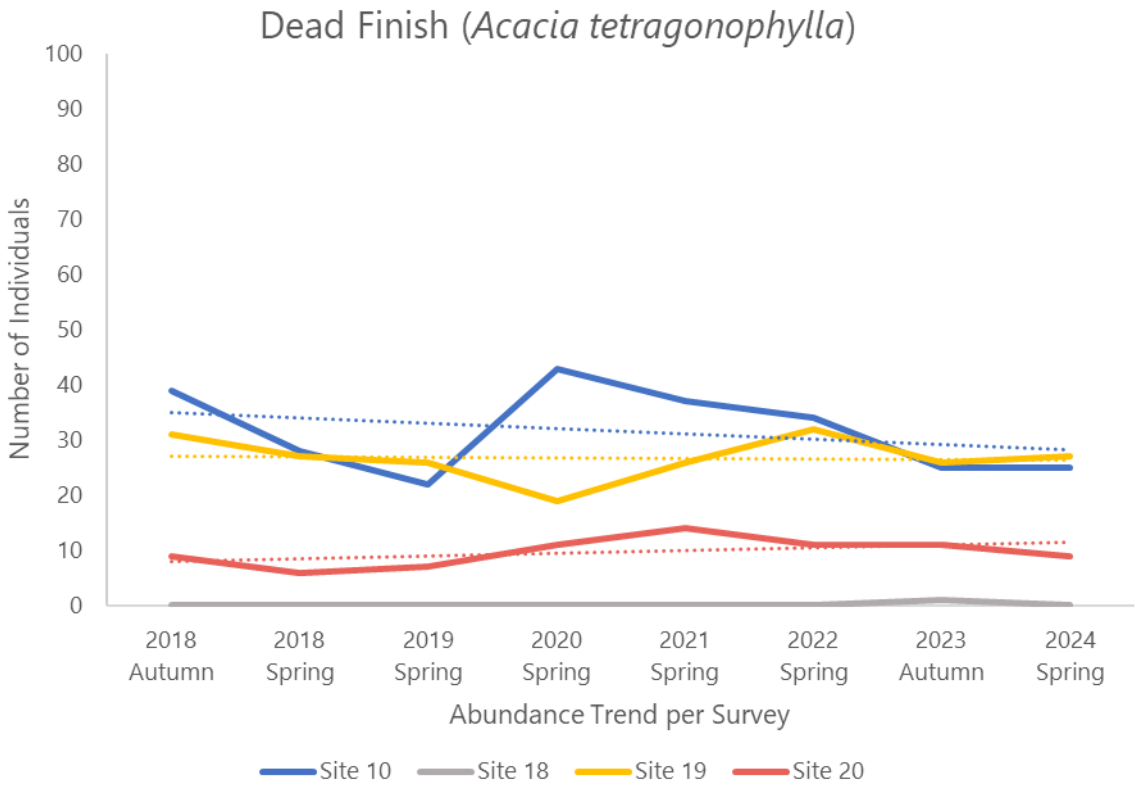

Figure 3.21: Abundance of Dead Finish (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

Western Myall *(Acacia papyrocarpa)*

Western Myall abundance has fluctuated widely at Site 18, largely due to fluctuations in seedling abundance (with some seedlings germinating but not surviving beyond a year). Regeneration of Western Myall has been widespread, and particularly at Site 17 where nine juveniles were recorded in 2024 (Figure 3.22). There is no notable decline in abundance of Western Myall which could be attributed to the TSF operation.

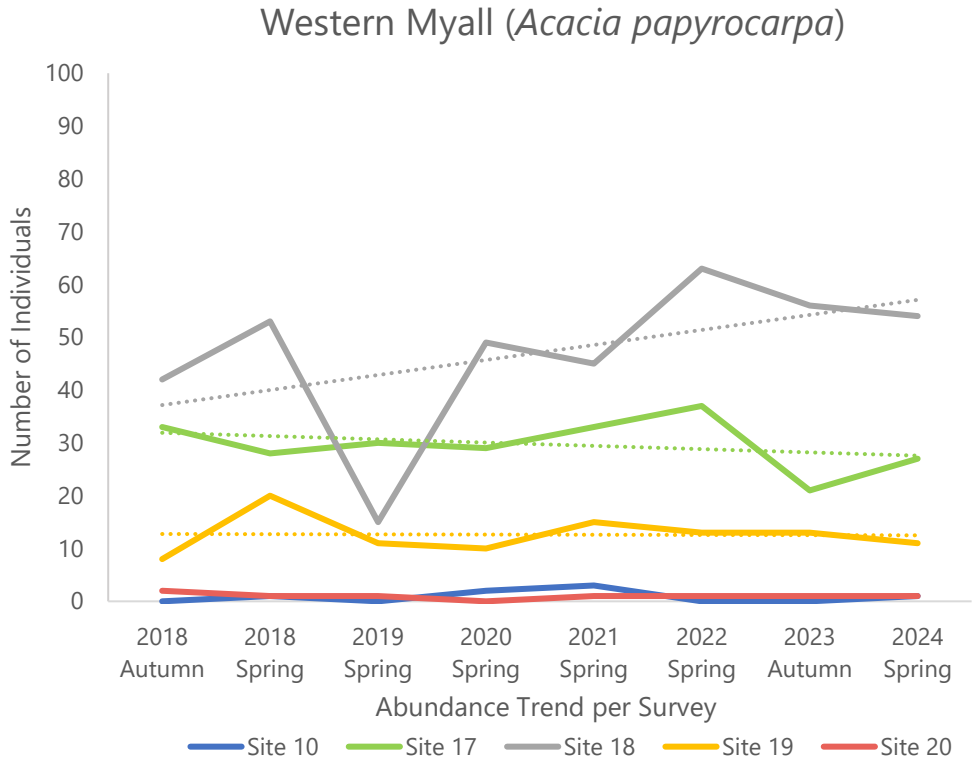

Figure 3.22: Abundance of Western Myall (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

Lobed-leaf Hopbush *(Dodonaea lobulata)*

Lobed-leaf Hopbush abundance has remained stable at Sites 10, 17, 18 and 20. At Site 19, population levels at the Jessup site have fluctuated but show no distinct long-term trends (Figure 3.23). In 2024, one juvenile was recorded, with the remaining 188 individuals being adults. There is no notable decline in abundance of Lobed-leaf Hopbush which could be attributed to the TSF operation.

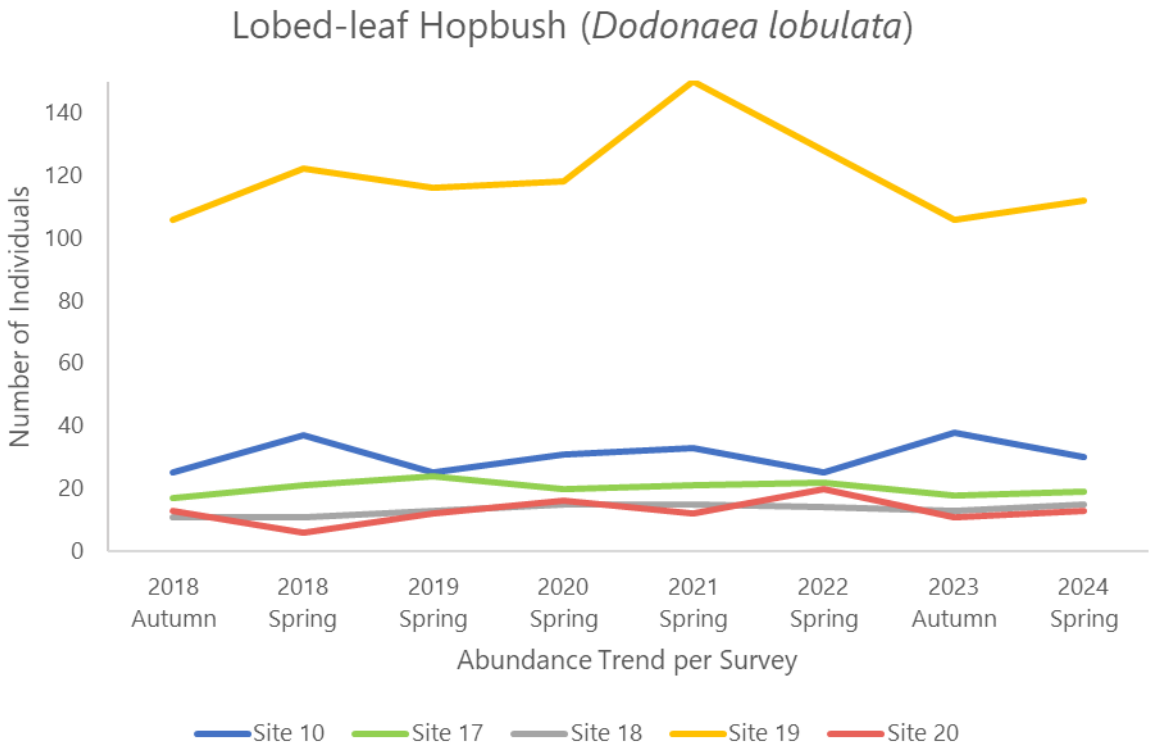

Figure 3.23: Abundance of Lobed-leaf Hopbush (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

Lignum *(Duma florulenta)*

Lignum is sparsely present at Sites 10 and 19, and more abundant at Site 21, but populations have remained stable at all sites (Figure 3.24). There is no notable decline in abundance of Lignum which could be attributed to the TSF operation.

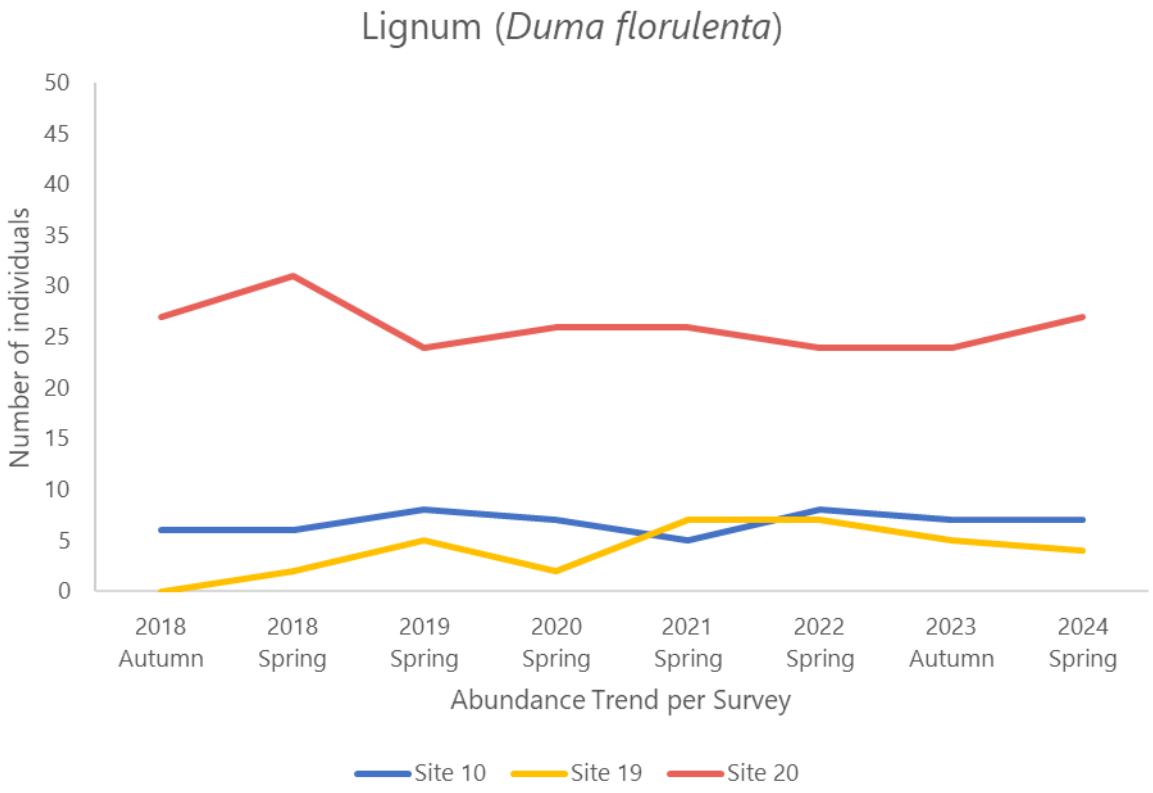

Figure 3.24: Abundance of Lignum recorded along Eliza Creek Jessup transects (2018-2024)

Crimson Emubush *(Eremophila latrobei)*

Crimson Emubush is sparsely present at Sites 10, 17 and 20, but has remained stable at these sites. At Jessup Site 18, the population has increased from 3 plants in 2018 to 9 plants in 2024 (Figure 3.25). There is no notable decline in abundance of Crimson Emubush which could be attributed to the TSF operation.

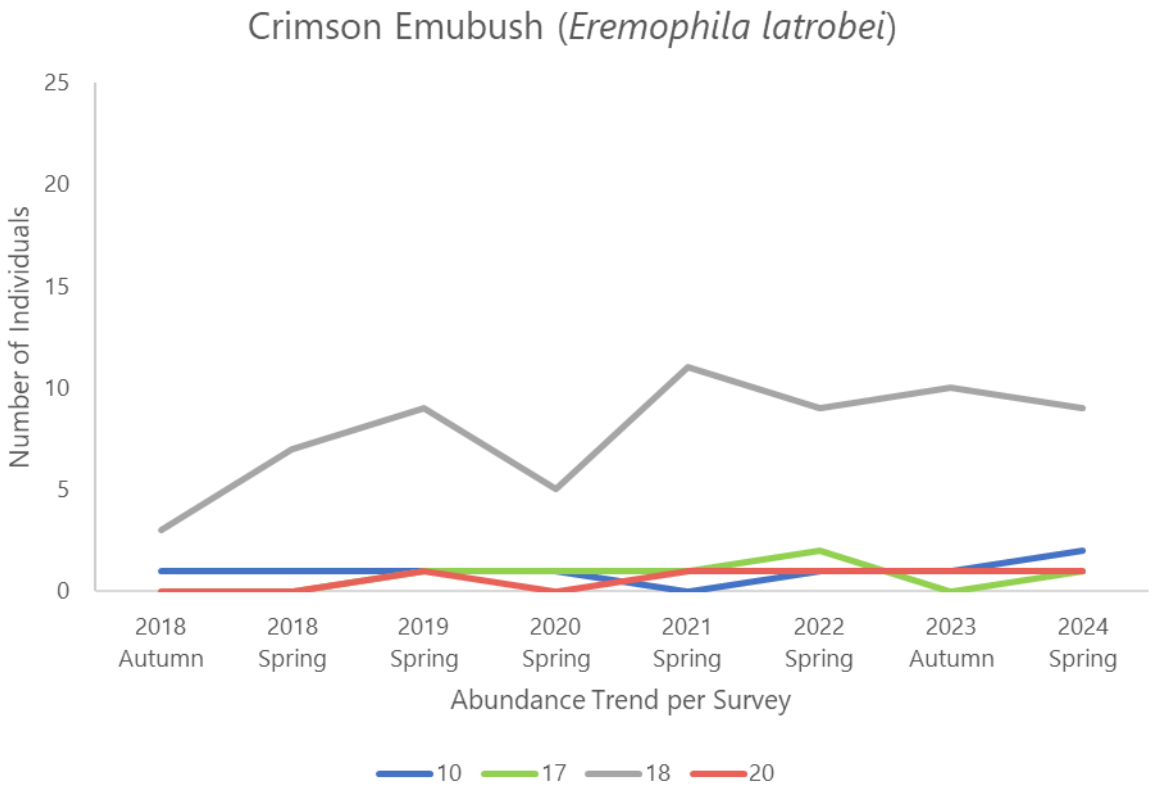

Figure 3.25: Abundance of Crimson Emubush (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

Spongy-fruit *Bluebush (Maireana spongiocarpa)*

Spongy-fruit Bluebush is highly palatable but the populations as Sites 17 and 18 have increased since 2018 (Figure 3.26). Note data for species was not collected in autumn 2018. There is no notable decline in abundance of Spongy-fruit Bluebush which could be attributed to the TSF operation.

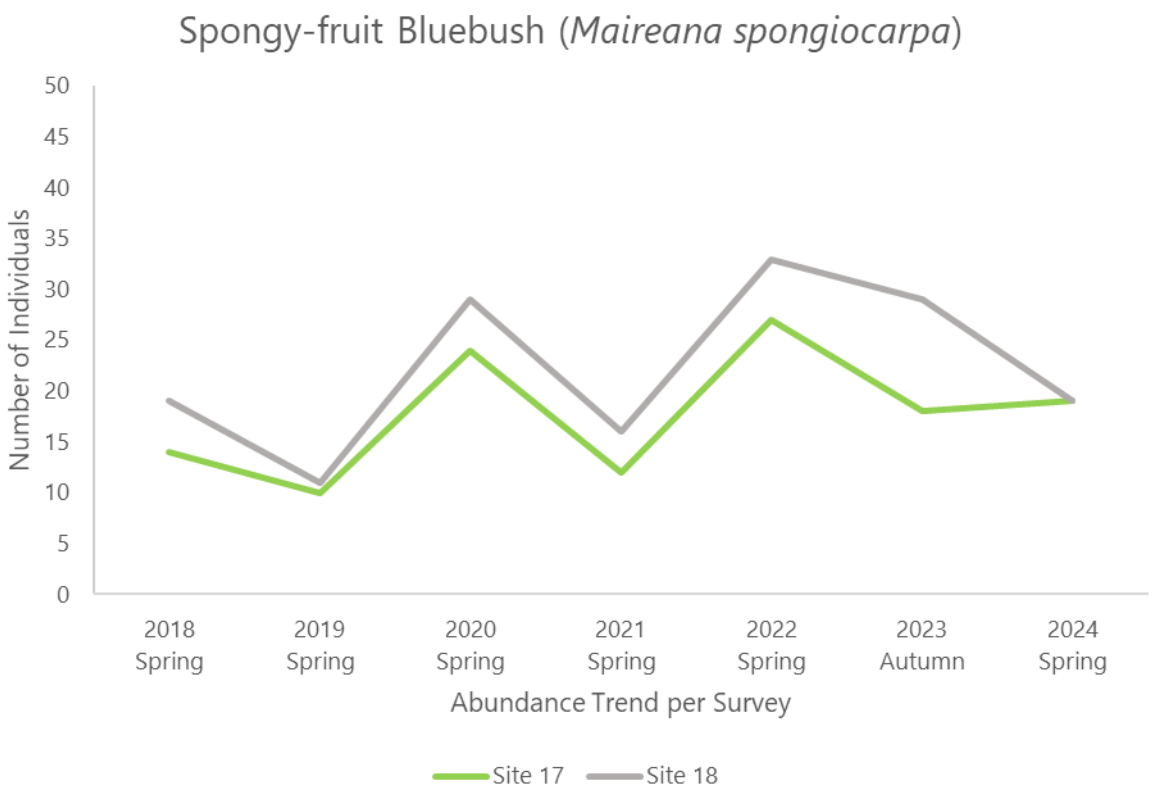

Figure 3.26: Abundance of Spongy-fruit Bluebush (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

Native Myrtle *(Myoporum montanum)*

In 2024, 75 adults and juveniles of Native Myrtle were recorded from Eliza Creek Jessup sites, the highest recorded since 2018 (Figure 3.27). Of these, 33 individuals were juveniles, likely accounting for at least part of the increased abundance in 2024. In 2023, only five Native Myrtle were recorded from Site 10, whereas 7 adults and 7 juveniles were recorded from Site 10 in 2024. There is no notable decline in abundance of Native Myrtle which could be attributed to the TSF operation.

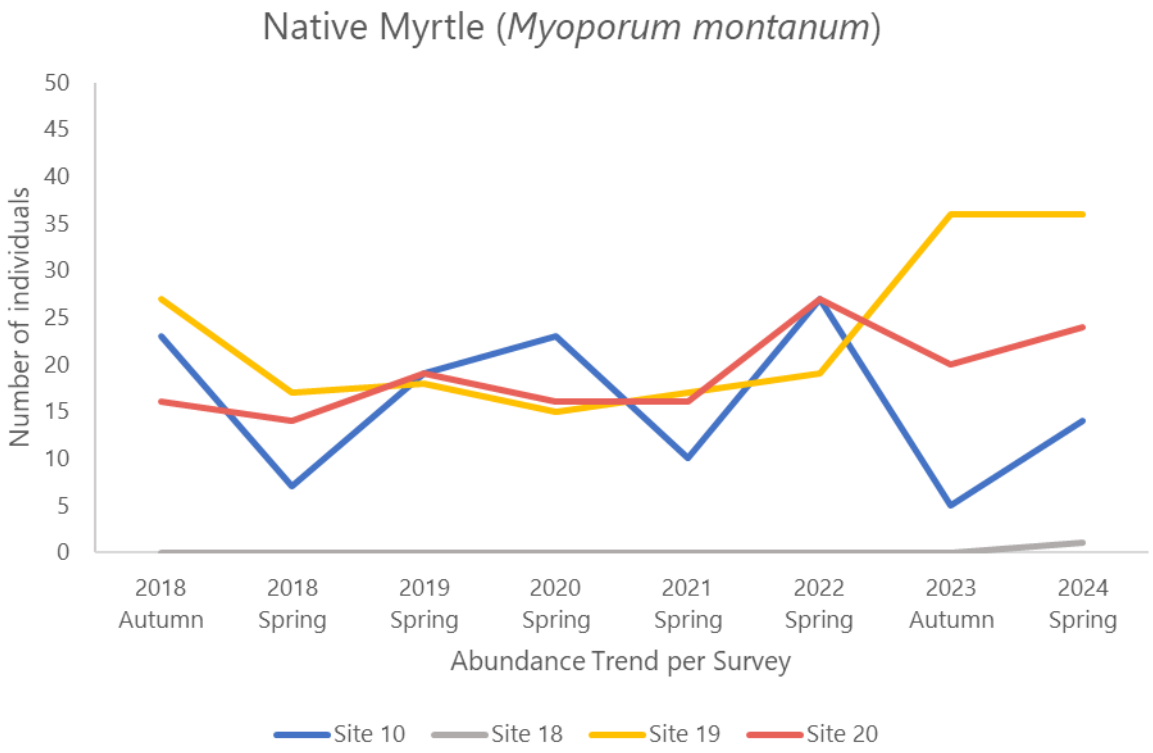

Figure 3.27: Abundance of Native Myrtle (adult and juvenile) recorded along Eliza Creek Jessup transects (2018-2024)

Silver Mulla Mulla *(Ptilotus obovatus)*

Silver Mulla Mulla has increased at each survey site, and especially at Site 10 and 17 where the species has at least doubled in abundance since 2018 (Figure 3.28).

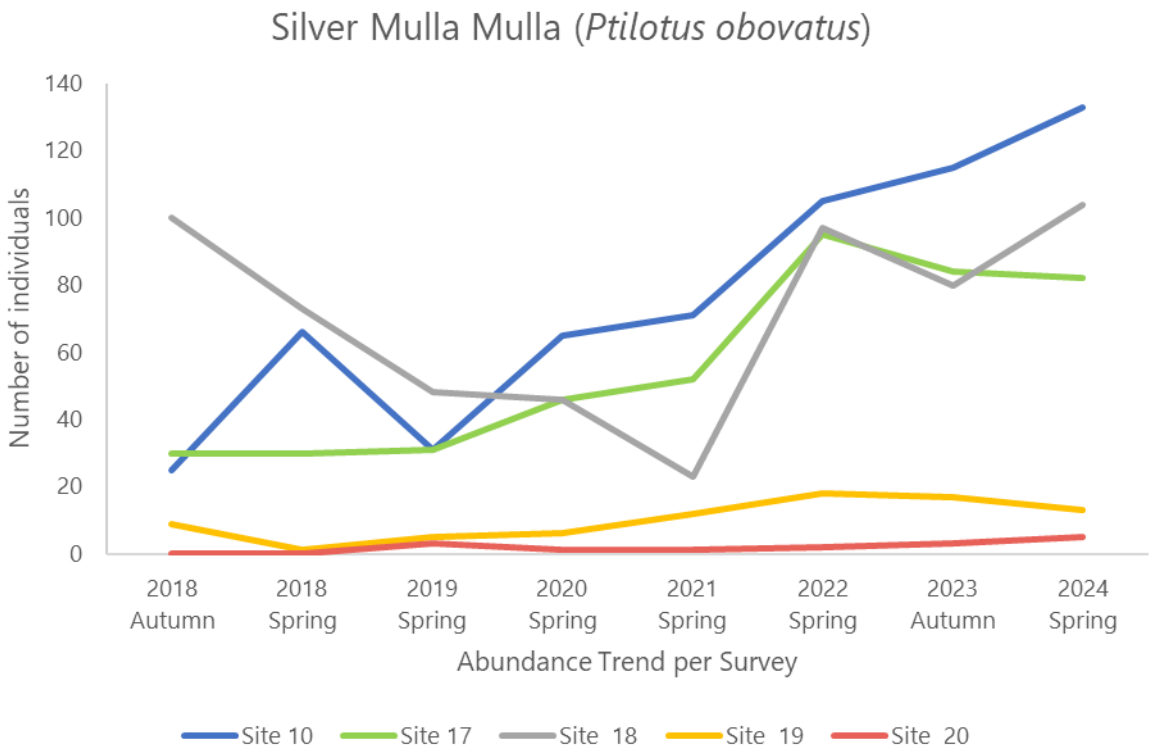

Figure 3.28: Abundance of Silver Mulla Mulla (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

Spiny Fanflower *(Scaevola spinescens)*

Spiny Fanflower has steadily increased at Sites 10 and 19, and remained stable at Site 17, Site 18 and Site 20 (Figure 3.29).

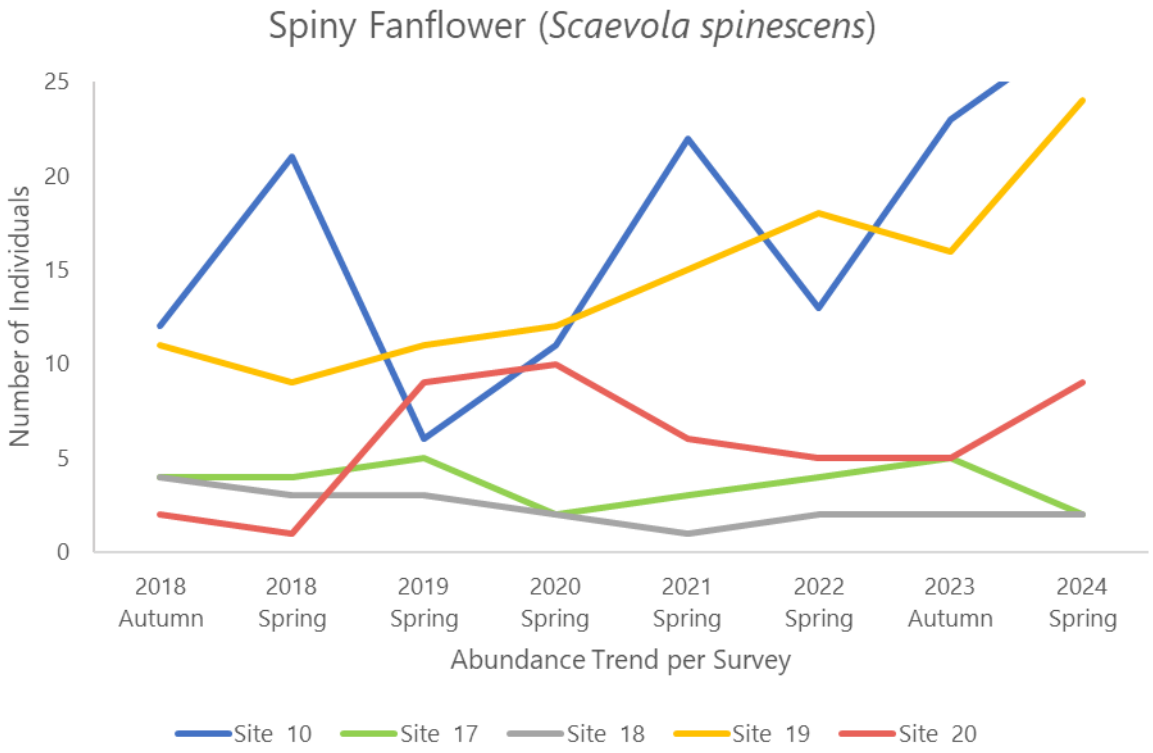

Figure 3.29: Abundance of Spiny Fanflower (adult and juveniles) recorded at Eliza Creek Jessup transects (2018-2024)

Senna sp.

Although recording yearly fluctuations, at each site, there have been no obvious increasing or decreasing trends for Senna species. The 2018 and 2024 populations varied by no more than two individuals at any one site (Figure 3.30). There is no noticeable decline in Senna, which could be attributed to the TSF.

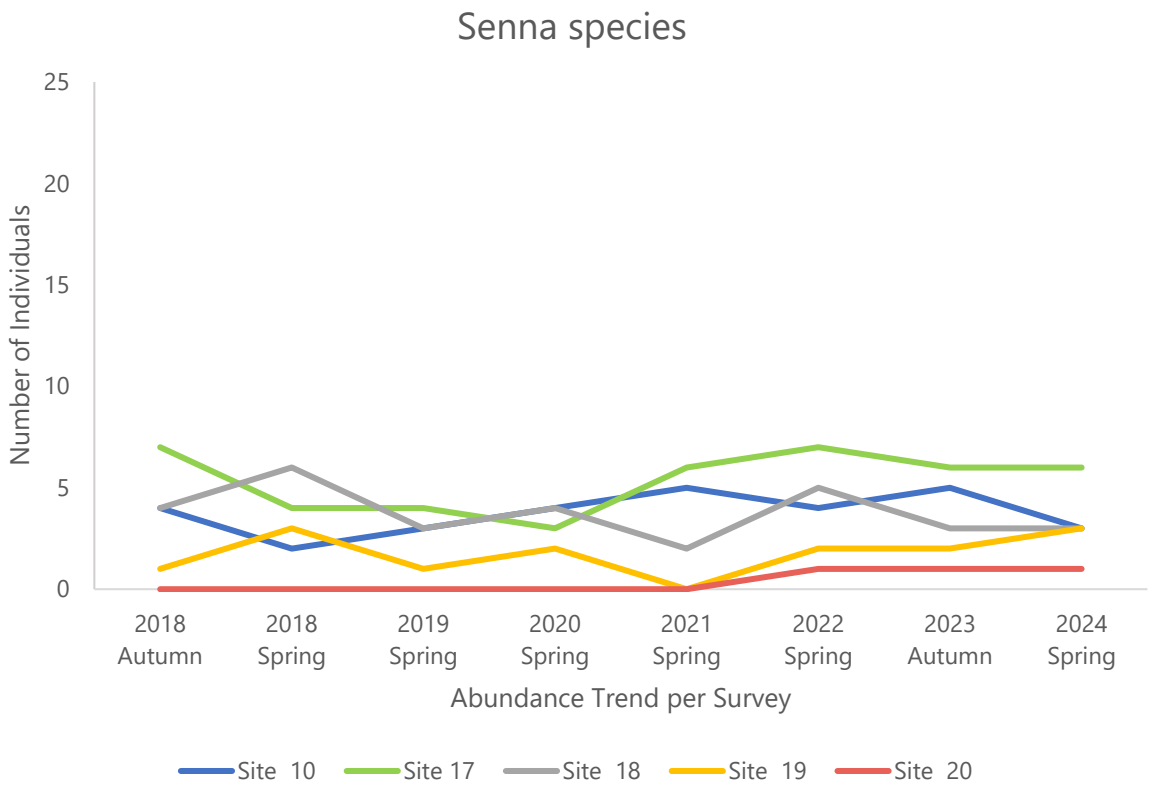

Figure 3.30: Abundance of Senna species (adult and juveniles) recorded along Eliza Creek Jessup transects (2018-2024)

3.2.3 Canopy cover tree health, Eliza Creek

In addition to Jessup transects, tree canopy cover was assessed at transects in the Eliza Creek sites to assess potential impacts on tree health due to seepage from the TSF or reduced water flows down the catchment as a result of the TSF. It is noted that Sites 17 and 18 are Western Myall sites and Sites 19 and 20 are River Red Gum dominant (refer Table 3.13 for approximate distance from TSF). No canopy cover sites were installed in Eliza Creek Site 10 because it was part of the original RAM / Jessup program and is furthest downstream, therefore least likely to demonstrate impacts from the TSF.

3.2.3.1 Canopy cover change

Table 3.13 summarises changes in canopy cover along each transect, since 2018, using two techniques: the densitometer, and visual estimates of individual canopy extent.

Table 3.13: Summary of canopy changes between 2018 to 2024

Transect, landscape position, trees in 2024	New Trees and Tree Death	Number of Foliage Intercepts	Net % Change in # of Foliage Intercepts	Tree Mean Canopy Extent	Net % Change in Mean Canopy Extent
17A, channel (270 m from TSF), WM: 12 live	New trees: 5 Deaths: 0	2018: 25 2024: 27	+8%	2018: 86% 2024: 86%	0
17B, bank (270 m from TSF), WM: 8 live	New trees: 1 Deaths: 0	2018: 17 2024: 16	-6%	2018: 90% 2024: 90%	0
18A, bank (930 m from TSF), WM: 17 live	New trees: 6 Deaths: 1	2018: 13 2024: 32	+146%	2018: 81% 2024: 80%	-1%
18B, channel (930 m from TSF), WM: 5 live	New trees: 1 Deaths: 1	2018: 7 2024: 7	0	2018: 42% 2024: 33%	-21%
19A, channel (3km from TSF), RG: 6 live WM: 8 live	RG New trees: 0 Deaths: 0 WM New trees: 6 Deaths: 0	RG 2018: 26 2024: 28	+8%	RG 2018: 59% 2024: 61%	+3%
19B, channel edge (3 km from TSF), RG: 5 live WM: 6 live, 0 dead	RG New trees: 1 Deaths: 1 WM New trees: 4 Deaths: 0	RG 2018: 16 2024: 12	-25%	RG 2018: 41% 2024: 47%	+15%
20A, channel edge (4.65 km from TSF), RG: 9 live WM: 1 live	RG New trees: 0 Deaths: 0 WM New trees: 0 Deaths: 0	RG 2018: 21 2024: 28	+33%	RG 2018: 39% 2024: 61%	+56%
20B, channel (4.65 km from TSF), RG: 4 live WM: nil	RG New trees: 0 Deaths: 0	RG 2018: 24 2024: 19	-21%	RG 2018: 51% 2024: 78%	+53%

[1]WM = Western Myall (*Acacia papyrocarpa/Acacia sp. Blyth Range*), RG = River Red Gum (*Eucalyptus camaldulensis subsp. arida*)

3.2.3.2 Live foliage estimates (densitometer data)

Comparing the total number of densitometer foliage records along a transect over time provides an indication of changes in total canopy cover along the transect. Potential changes in total canopy cover may be a combination of canopy expansion of individual trees (natural growth, improved canopy health), dieback; and/or recruitment of new trees.

Western Myall (Acacia papyrocarpa/ Acacia sp. Blyth Range)[2]

The total number of Western Myall foliage records for the two transects combined at each site has varied between survey periods, but Sites 17 (Western Myall), 18 (Western Myall) and 19 (River Red Gums and Western Myalls present) have trended strongly upwards (Figure 3.31). The increase in foliage records at each site is largely due to additional trees being recorded along each transect (refer below). At Site 20, there has been only one Western Myall tree intercepted at all recording periods, and the foliage records have been relatively constant. Figure 3.31 shows the sum of Western Myall foliage records for the two transects combined at each site. Figure 3.32 and Figure 3.33 show foliage records for individual transects at Site 17 and Site 18, respectively.

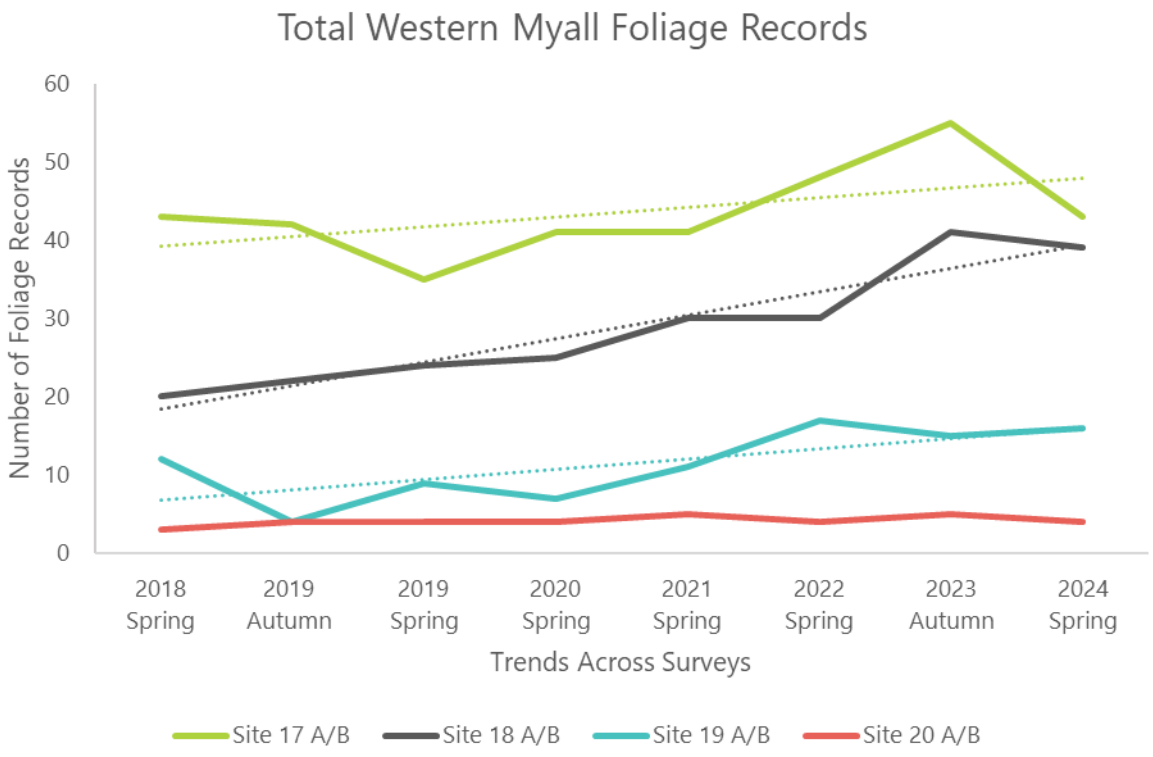

Figure 3.31: Total number of Western Myall foliage records 2018-2024 at each site

[2] Note that the Western Myalls in the Carrapateena operational area may be *Acacia papyrocarpa* and/or the very similar Acacia sp. Blyth (formerly *Acacia affinity papyrocarpa*). Distinction requires fruiting pods which were absent during surveys

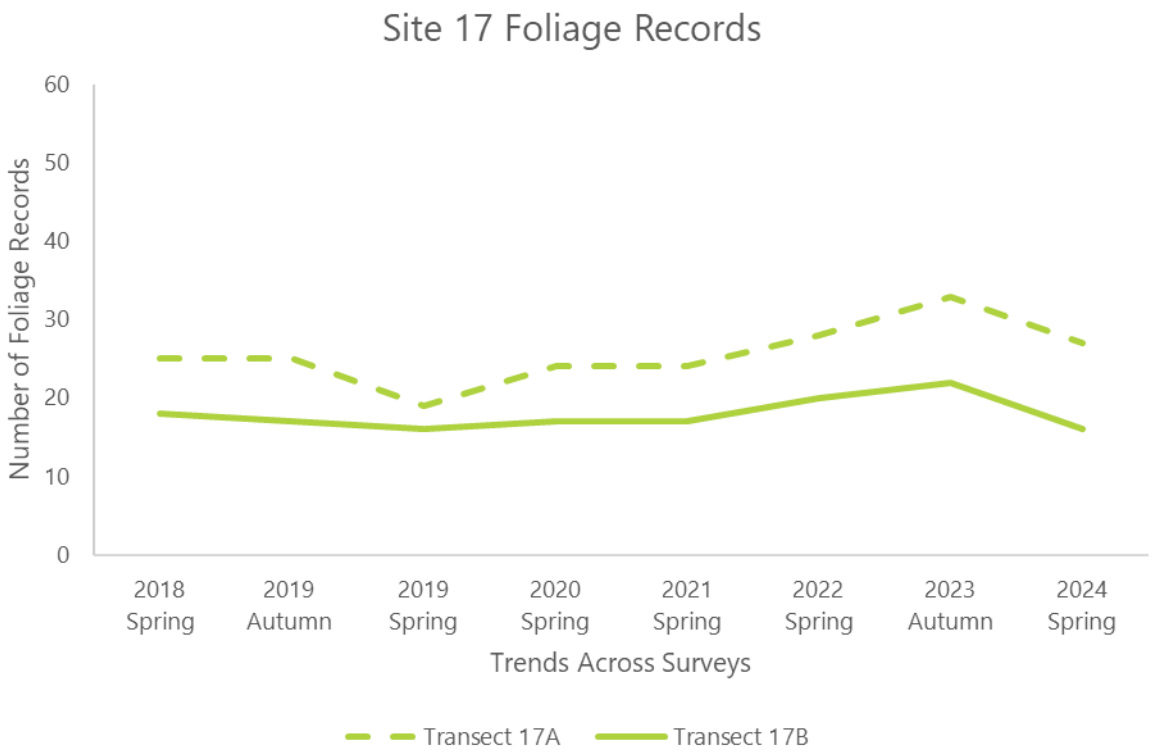

Figure 3.32: Number of Western Myall foliage hits along Site 17 transects (2018 to 2024)

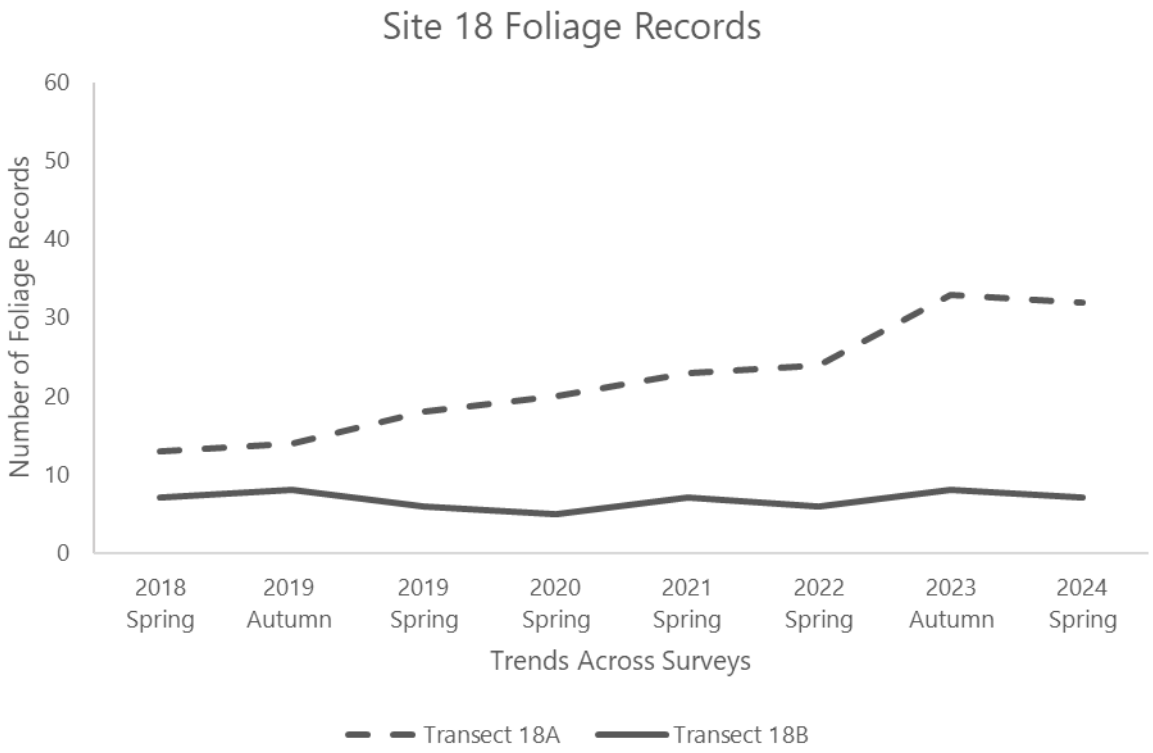

Figure 3.33: Number of Western Myall foliage hits along Site 18 transects (2018 to 2024)

Northern River Red Gum *(Eucalyptus camaldulensis* ssp. *arida)*

The number of foliage records for Sites 19 and 20 (for both transects combined at each site) has fluctuated, often quite markedly, between survey periods. However, there has been no trend apparent at Site 19 (nor for each individual transect at Site 19), and an upward trend in total foliage records at Site 20 (and also for each individual transect at Site 20). At Site 19, the total number of foliage records declined sharply during 2019 to 2021 before recovering between 2022 and 2024, to 2018 levels. Similarly, at Site 20, following declines in canopy foliage in 2019 and 2020, canopy foliage records recovered in 2021 to 2024 to 2018 levels.

Figure 3.33 shows the River Red Gum foliage records for the two transects combined at each site. Figure 3.35 and Figure 3.36 show River Red Gum foliage records for individual transects at Sites 19 and 20, respectively.

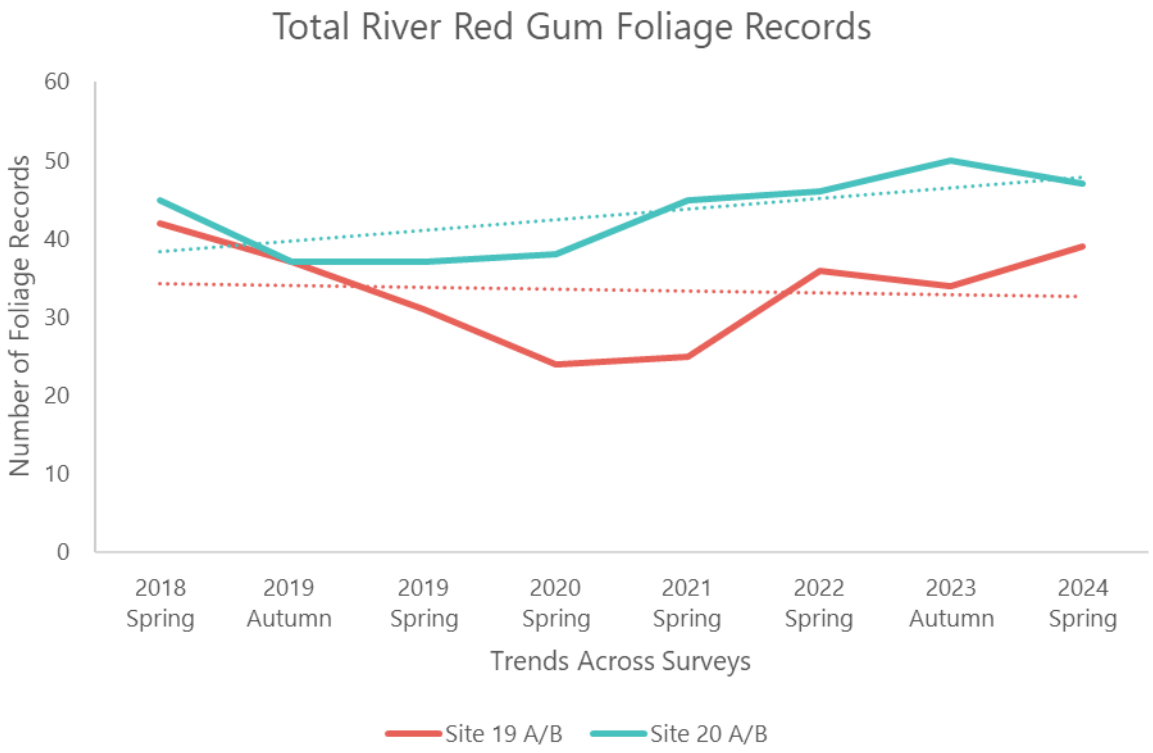

Figure 3.34: Total number of River Red Gum foliage hits for each site (autumn 2018 to spring 2024)

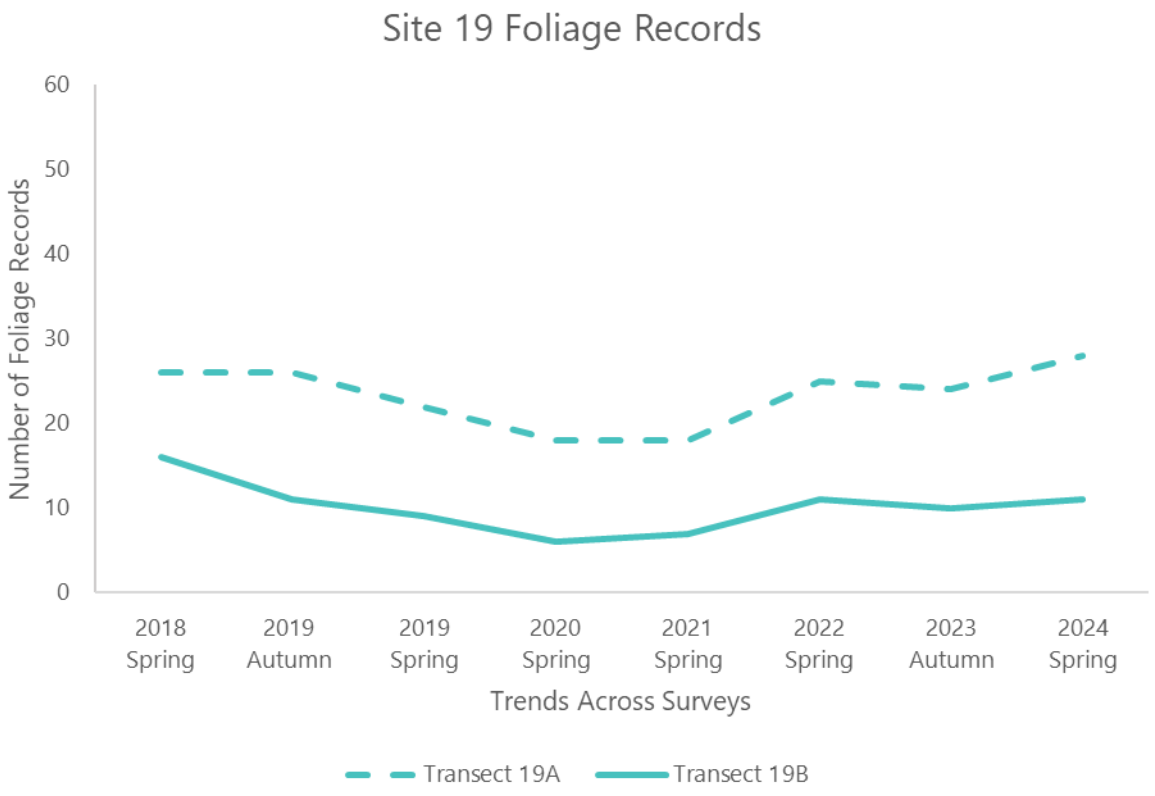

Figure 3.35: Number of River Red Gum foliage hits along Site 19 transects (2018 to 2024)

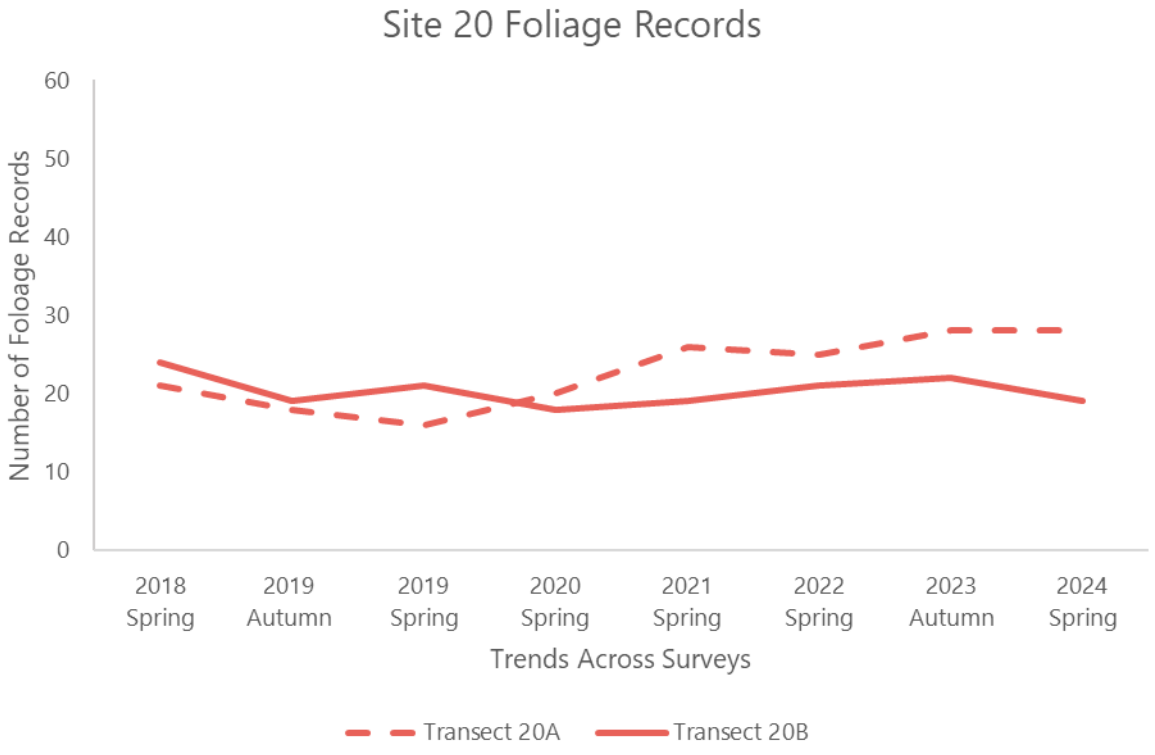

Figure 3.36: Number of River Red Gum foliage hits along Site 20 transects (2018 to 2024)

3.2.3.3 Tree death and new trees

Given the surveyed trees are individually numbered along each transect (initiated in 2019), it is possible to identify: individual tree death, canopy loss resulting in trees no longer being recorded along the alignment, and tree canopies that are intercepted along the alignment for the first time. New trees are recorded as a result of expansion of mature tree canopies onto the transect alignment and/or younger trees that newly meet the survey criteria for densitometer recordings (i.e. minimum plant height of 1 m and intercepting the transect).

Western Myall

In 2024, 4 new Western Myall trees were recorded along the transects (one at Site 17, two at Site 18 and one at Site 19). No tree deaths were recorded (Figure 3.37).

Since 2018, there have been two Western Myall tree deaths and 23 new Western Myall trees recorded along the combined transects. The two deaths both occurred at Site 18. These trees were estimated to have retained less than 10% of their canopy foliage prior to the operation of the TSF (see Jacobs 2020a report for full details). There have been no Western Myall deaths at Sites 17, 19 or 20. The great majority of new trees intercepted along transects have been juveniles that have increased in size, namely whose canopy had expanded to a sufficient degree to be intercepted along the alignment and/or whose height of canopy above the ground met the survey criteria (as above).

The number of existing, new and dead Western Myall trees recorded at each site (transects combined) is shown in Figure 3.37 and Appendix E, respectively, noting that Site 17 is the closest to the TSF.

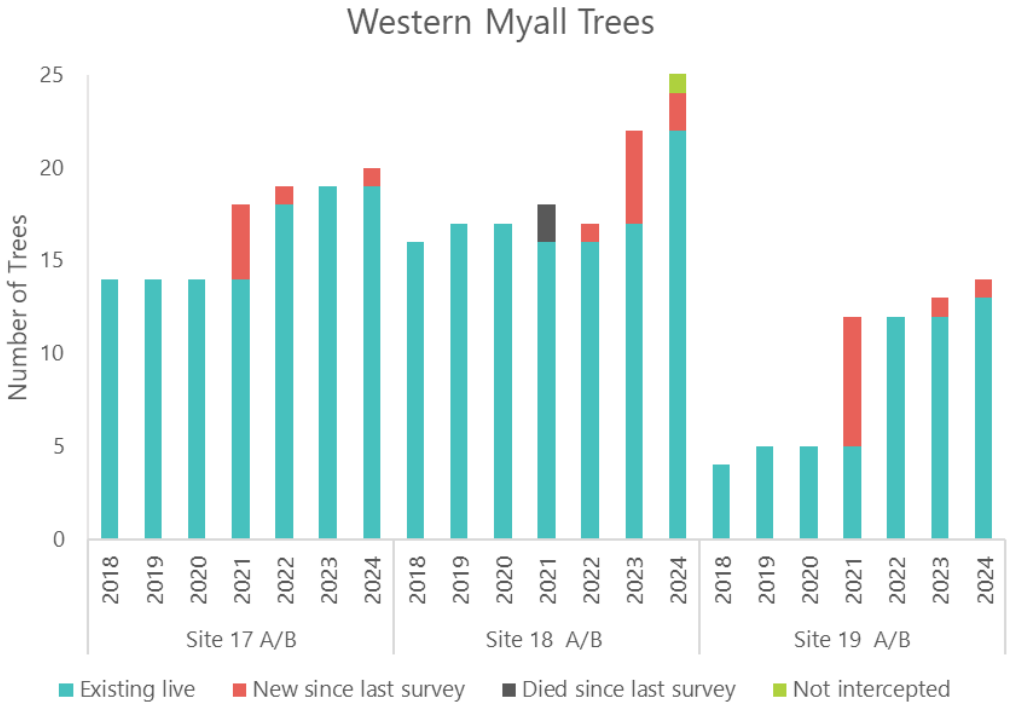

Figure 3.37: Change in Western Myall abundance (new = meets criteria, not intercepted = tree present but not intersecting transect yet)

Site 20 not shown, given only one Western Myall present at all survey periods.

River Red Gums

In 2024 one new Red Gum was recorded (Site 19) and there were no River Red Gum deaths. Since 2018, one River Red Gum has died (at Site 19) and one new tree has been intercepted along the transects (also at Site 19). The dead tree recorded in 2021 at Site 19 had a visually estimated canopy extent of approximately 50% in 2019 and 3% in 2020. Transect 19 is 3,000 m downstream of the TSF.

In 2020, loss of a large branch resulted in one tree not intercepting the transect at CC20. However, by 2022, this tree had regained canopy, resulting in it once again being intercepted along the transect, and recorded in 2022, 2023 and 2024. Figure 3.38 shows the number of live Red Gum trees, deaths and new trees for each survey period since 2018.

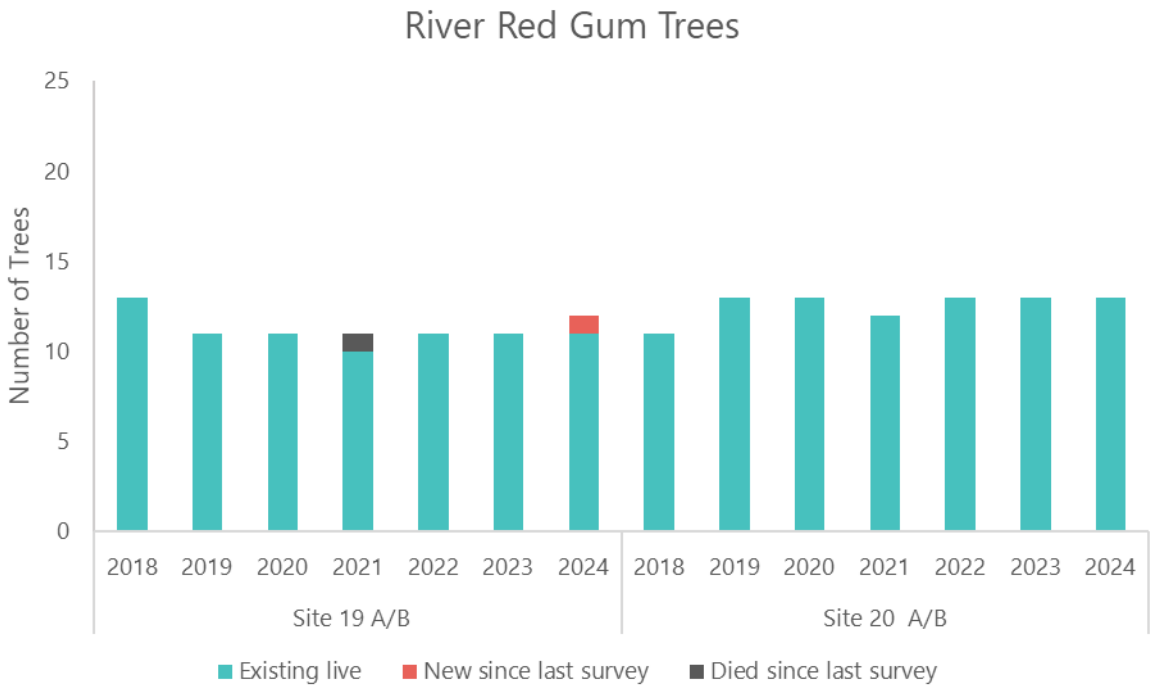

Figure 3.38: Change in River Red Gum abundance (new = met criteria, not intercepted = tree present, but not intersecting transect yet)

3.2.3.4 Visual estimates of canopy intactness

Visual estimates of canopy intactness for individual trees commenced in 2019 as an additional alternate means of estimating overall tree health. Results for all trees are shown in Appendix E. Mean canopy intactness for each transect is shown in Figure 3.39, Figure 3.40, and summarised in Table 3.14 and Table 3.15.

Western Myall

For all transects, there has been no obvious decline in canopy intactness (Figure 3.39). At all transects except 18B and 19B, the majority of Western Myall trees retain almost complete canopies, with canopy intactness estimated at close to 90% or higher (Figure 3.21 and Figure 3.39). This includes both transects at Site 17, which is closest to the TSF (approximately 250 to 350 m downstream).

Mean canopy intactness has remained between 68% and 86% at Transect 19B and has remained stable (from a relatively low base) at Transect 18B. Some variation between survey periods is likely due to observer variation (different observers are likely to differ slightly in their estimates of canopy extent).

Table 3.14: Visual estimates of canopy intactness for Western Myall trees

Transect	Mean % Canopy Intact[1] Western Myall Trees					
	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
17A	86	87	94	90	92	86
17B	90	92	93	91	97	90
18A	81		72	80	89	80
18B	42		18	28	35	33
19A	100	100	96	99	100	97
19B	69	68	75	77	86	79
20A	100	90	77	100	100	70

[1]Visual estimate of canopy extent compared with expected canopy extent for tree in optimum health. No Western Myall on transect 20B.

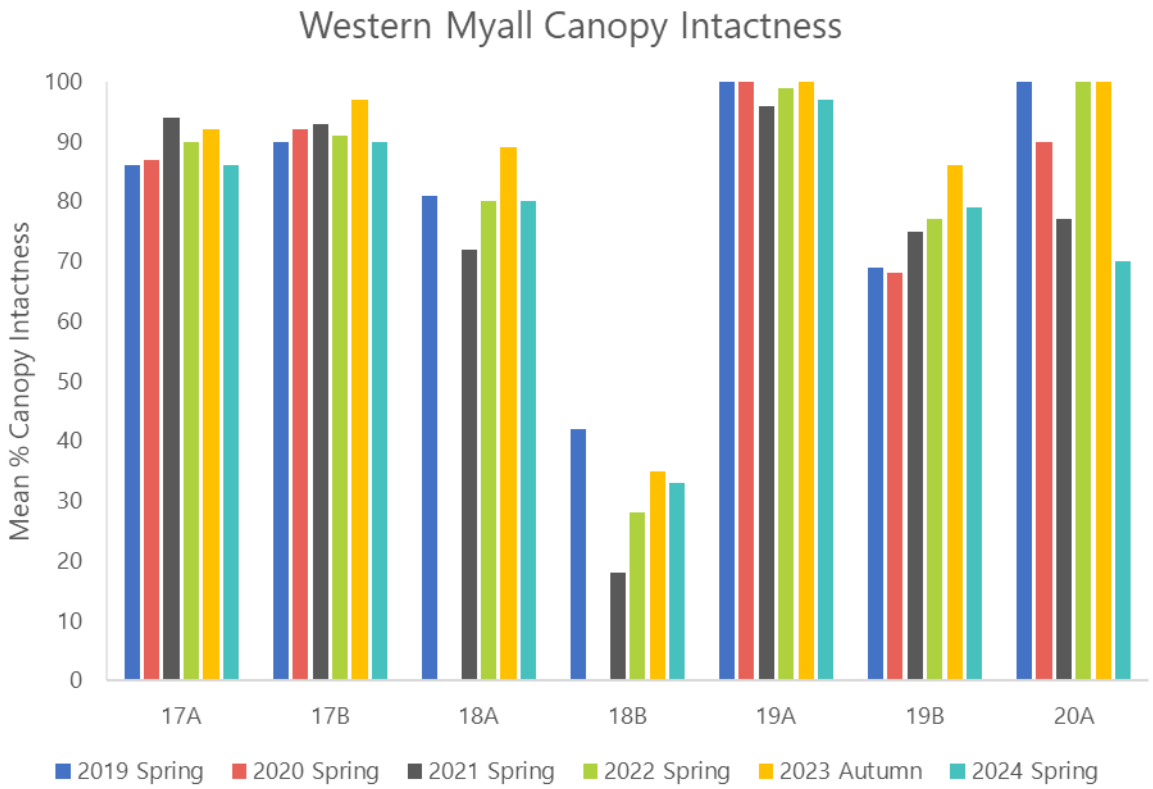

Figure 3.39: Visual estimates of mean canopy intactness for Western Myall trees (2019-2024)

[Canopy intactness not recorded in 2020 for transects 18A and 18B. In the above graph, 2019 values have been used for transects 19A and 18B transects].

River Red Gum

Canopy intactness for all the Red Gum transects fluctuated between survey periods, generally being relatively low until 2021, before 50% to 90% increases in canopy intactness in 2022 and 2023. In 2024, all transects recorded declines in mean canopy intactness of Red Gums but intactness levels were still mid-range for the recording period 2019 to 2024 (Table 3.15, Figure 3.40).

Table 3.15: Visal estimates of canopy intactness for River Red Gum trees

Transect	Mean % Canopy Intact[1] River Red Gum Trees					
	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
19A	70	63	60	72	87	61
19B	54	47	43	42	67	47
20A	49	40	47	80	91	61
20B	63	46	46	75	85	78

[1]Visual estimate of canopy extent compared with expected canopy extent for tree in optimum health

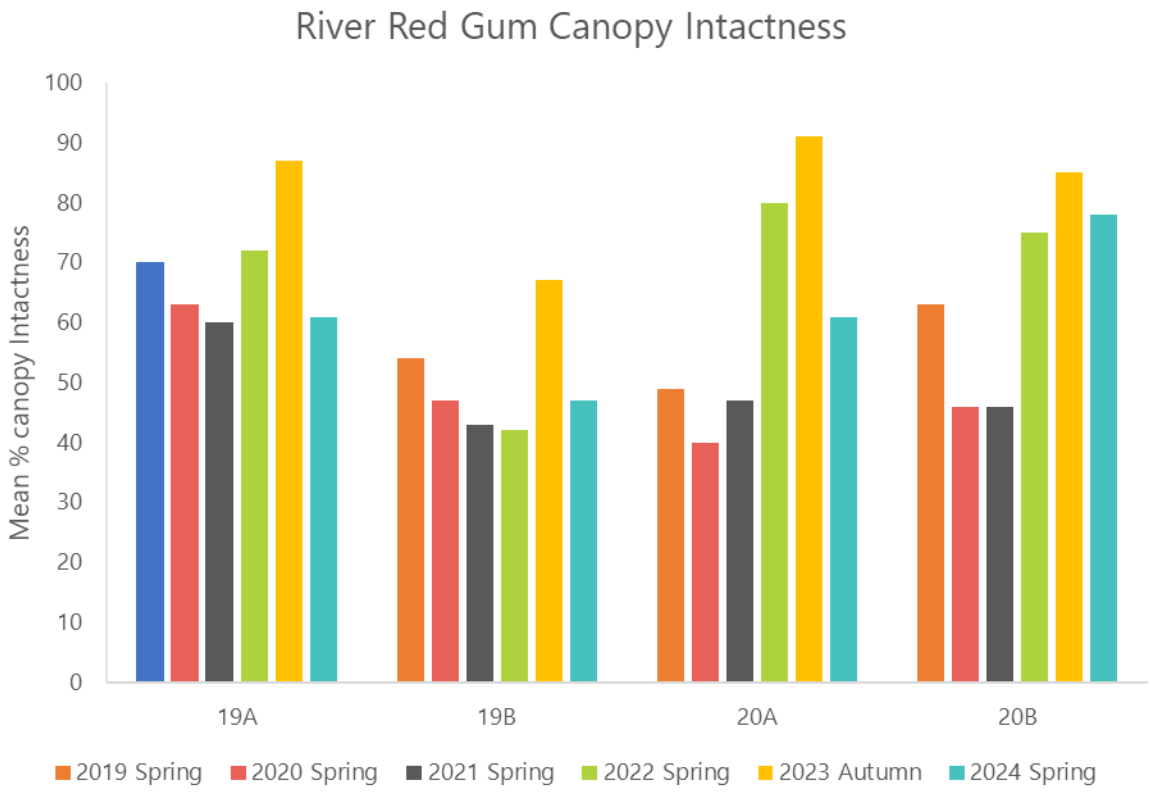

Figure 3.40: Visual estimates of canopy intactness for River Red Gum trees

3.2.4 Weed diversity and abundance

Weeds were surveyed at standard flora sites, designated weed transects, targeted sites (dams and villages), and opportunistically. All weed species recorded during baseline surveys (2012 to 2016) and compliance monitoring (2018 to 2024) are summarised in Appendix G1 and Appendix G2.

Although Dawson Dam, South Eliza Dam, North Eliza Dam and Anzac Dam are outside of existing mineral leases, weed species are documented at these locations to:

- Identify potential sources of new weed infestations into the mineral leases and/or
- Document potential spread of weeds from the mineral leases into dams.

3.2.4.1 New weed species

No new weed species were recorded during the 2024 spring survey.

3.2.4.2 Increase in abundance

Compared with surveys conducted between 2019 and 2023, Smooth Mustard (*Sisymbrium erysimoides*) had increased in abundance in October 2024, particularly on the sand dune flora Site 22. At this site, Smooth Mustard was recorded with a CSR density of 5 for over 50% of the survey area, and CSR 4 over the remainder of the survey area. Previous surveys have recorded the highest CSR cover rating of 4 at this site (and CSR of 2 in 2023). Site 22 is within 200 m of the WAR, hence a designated impact site. At the other dune flora Site, 21, no change in the density of Smooth Mustard was recorded between 2023 and 2024, remaining sparsely distributed but with localised patches of CSR 4. In 2024, Smooth Mustard was also of greater abundance at Dawson Dam and at weed transects CWM05 and CWM06 compared with previous levels. Conversely Smooth Mustard was not recorded in 2024 at RAM Sites 10, 12 and 17 (where it has been previously recorded during operational monitoring).

3.2.4.3 Species recorded at previously unreported locations

Six weed species were recorded in 2024 at previously unreported locations.

Wards Weed (Carrichtera annua)

Two plants were recorded on the northern shoulder of the WAR at the 500 m survey point of weed transect CWM05 (within 25 m of Easting 701080 Northing 6518800). Within the Carrapateena operational area, Wards Weed has only previously been recorded along the SAR; in 2021 an isolated patch was recorded along weed transect CWM01. Wards Weed has not subsequently been recorded along CWM01. The 2024 location of Wards Weed was near the western end of the WAR (approximately 5.5 km from the Stuart Highway), which was constructed/upgraded in 2022, specifically for vehicle access to the Carrapateena Mine site.

Maltese Thistle (Centaurea melitensis)

In 2024, Maltese thistle was recorded for the first time along weed transect CWM01; one plant was located at a culvert along the SAR (Easting 737045 Northing 6517110) and numerous plants were recorded where the Whitata Creek crosses the SAR. Maltese thistle has previously been recorded during baseline and compliance surveys in Eliza Creek and at Dawson Dam.

Mallow (Malva parviflora)

In 2024 a few plants were recorded at North Eliza Dam. This species has previously been recorded at South Eliza Dam, Anzac Dam and ephemeral watercourses along weed transects CWM01 and CWM02.

Smooth Mustard (Sisymbrium erysimoides)

Several plants were recorded at flora Site 20 (Eliza Creek) for the first time in 2024.

Scarlet Pimpernel (Lysimachia arvensis)

A few plants were recorded for the first time at North Eliza Dam. This species has previously been recorded from the Expo Village Effluent Irrigation Area and along weed transects CWM001 (culvert area) and CWM06 (ephemeral drainage line).

Trailing Verbena (Verbena supina)

One plant was recorded at North Eliza Dam for the first time. This species has previously been recorded at Anzac Dam.

Appendix G1 and Appendix G2 contain further details on weed records during baseline and compliance monitoring.

3.2.4.4 Weeds recorded at RAM sites (Control and Impact)

Only three species of weeds were recorded at Rangeland flora sites:

- Maltese Thistle (*Centaurea melitensis*) – small isolated clusters at Eliza Creek Site 20. This species was also recorded at Site 20 in 2020 and 2023.
- Smooth Mustard (*Sisymbrium erysimoides*) - recorded at both dune sites (21 and 22) scattered plants to locally common at Site 21 and widespread and abundant at Site 22. Smooth Mustard has been recorded every year since 2020 at Site 21 and every year since 2019 at Site 22. In 2024 a few plants were also recorded at Eliza Creek Site 20 (refer above).
- Sow Thistle (*Sonchus oleraceus*) – one or two plants were recorded at Eliza Creek Sites 18 and 19. Sow Thistle has been previously recorded as sparsely present at these sites.

These results are very similar to previous surveys during compliance (operational) monitoring (and noting that the dune sites and Eliza Creek sites were not surveyed during baseline monitoring). Maltese Thistle and Smooth Mustard have been consistently recorded at the Eliza Creek and dune sites, respectively, and at similar levels of abundance since 2018. Sow Thistle occurs infrequently and sporadically at RAM sites, and at very low levels of abundance.

3.2.4.5 Northern Wellfields lease area

Within the Northern Wellfield Lease area, operational monitoring sites are weed transects NWM01, NWM02, NWM03, and RAM Sites 1, 2 and 7. These were all surveyed in spring 2024 by Lathwida ecologists, and no weeds were recorded (similarly no weeds were recorded at these sites during annual surveys from 2020 to 2023).

3.2.4.6 Weeds of National Significance

Prickly Pear *(Opuntia species)*

The isolated population of Prickly Pear near the Yeltacowie homestead has been actively managed by poisoning with cochineal since 2021.

A cluster of *Opuntia* was first observed during operational monitoring in 2018 near the Yeltacowie homestead, occurring within an area of approximately 10 m x 10 m (Easting 724000 Northing 6530688 Zone 53). A few plants remain in this cluster, but it has not expanded since 2023.

Athel Pine *(Tamarix aphylla)*

Athel Pine has been recorded as clustered trees around Yeltacowie Homestead and the nearby dam. These trees are being actively controlled with numerous dead trees and/or cut trees. In 2024 it was noted that a few trees remain at the site.

3.2.4.7 Declared Weeds

In addition to being Weeds of National Significance, Prickly Pear and Athel Pine are also Declared species under the Landscape Act 2019. Athel Pine is declared for control within 100 m of a watercourse.

Bathurst Burr (Xanthium spinosum)

In 2024, Bathurst Burr was recorded within the operational area only at previously recorded locations: Dawson Dam, South Eliza Dam, and weed transects CWM01 (including Whittata Creek) and CWM02 both transects adjoining the Southern Access Road. No new populations, and no expansion of existing populations, were recorded.

The population of Bathurst Burr at Dawson Dam remains extensive, and similar to that recorded in 2021, 2022 and 2023. The 20 m wide drainage line adjoining the north-west and north-east aligned dam walls contains patches of densely spaced plants (possibly 1000's of individuals) over approximately 150 m. The circular depression, approximately 30 m in diameter, and southeast of the dam wall also contained densely spaced plants when observed in October 2024. It is noted that Dawson Dam resides is excluded from ML6471, hence managed by the landholder and management and control is ongoing.

Bathurst Burr has been recorded since 2021 along and near Whittata Creek, which intercepts Weed Transect CWM011. In 2024, approximately 30 seedlings were present in a culvert 130 m north of where Whittata Creek crosses the Southern Access Road. A few seedlings were also recorded where the main channel crosses the Southern Access Road.

Bathurst Burr was recorded along weed transect CWM02 in 2021 and 2023 (approximately 10 plants recorded adjoining the Southern Access Road in the vicinity of South Eliza Creek). In 2024, isolated plants were recorded near a culvert crossing the SAR and near the waters' edge (overflow from the dam). In 2024 the South Eliza Dams were overflowing due to pumping in of waste treatment water. Bathurst Burr was recorded as sparsely present, in the drainage channel south of the main dam wall, and also sparse near the SAR.

3.2.4.8 Other weeds of high environmental threat

Tobacco Bush (*Nicotiana glauca*)

Although not a Declared Weed, an extensive population of Tobacco Bush persists at South Eliza Dam (in the drainage channels behind the dam). Due to is high rate of fruit and seed set, high viability of seeds and successful survival of seedlings, it forms dense stands and has the potential to increase still further in this location.

Couch (*Cynodon dactylon*)

Patches of couch grass were recorded on the banks / floodout area of Whittata Creek, which was surveyed as part of the weed transect CWM01. Couch was recorded as moderately dense patches within an area of approximately 30 m x 10 m, when surveying the 50 m radius of a designated survey point in the weed transect.

3.2.5 Assessment of grazing impacts

An indication of grazing impact at each site was obtained to enable potential mining and/or climate related impacts to be separated from baseline impacts due to grazing. Grazing was first reported on in 2018 when the operation survey area was still being widely grazed by domestic stock. Since 2018, the operation area has been largely destocked. However, ongoing grazing continues at some sites, including the dunes. Although total grazing pressure has been reduced since 2018, ongoing grazing occurs largely through kangaroos and feral animals.

The Rangeland Assessment Method (RAM) (NVC 2024a) provides a single index of grazing impact called the Site Vegetation Utilisation Score (hereafter referred to as the Site Utilisation Score) and is based on a combination of the proportion of a species' population that is grazed (either heavily or severely) and the palatability of that species, and whether juveniles are present. The lower the Site Utilisation Score, the heavier the grazing impact and/or lower regeneration levels. Heavy grazing that has modified the habit of a plant is referred to as Modified impact. Severe grazing results in removal of more than 50% of the leaves and twigs, and impairs the reproductive function of a plant; referred to as Over Utilised impact (Native Vegetation Council 2024). Site utilisation scores were lowest (indicating heaviest grazing) in 2018 and 2019 before increasing in 2020 – 2023 and decreasing slightly in 2024 (Figure 3.41). However, in 2024 Site Utilisation Scores were still well above those of 2018 and 2019. Noting that for 2018-2023 Sites 4 and 6 were classified as Impact sites and swapped to Control sites in 2024.

The heaviest grazing impact (lowest Site Utilisation Scores) was recorded at the sand dune flora sites, and for gibber Sites 2, 6 and 13 (Figure 3.42). Cattle dung was present at the sand dune sites and sheep dung was present at the gibber habitat Sites 6 and 13; a large flock of sheep observed at Site 6 during the survey (18 and 19 October). At Site 2 only seven long-lived perennials were recorded, of which two were heavily grazed grasses, strongly influencing the Site Utilisation Score.

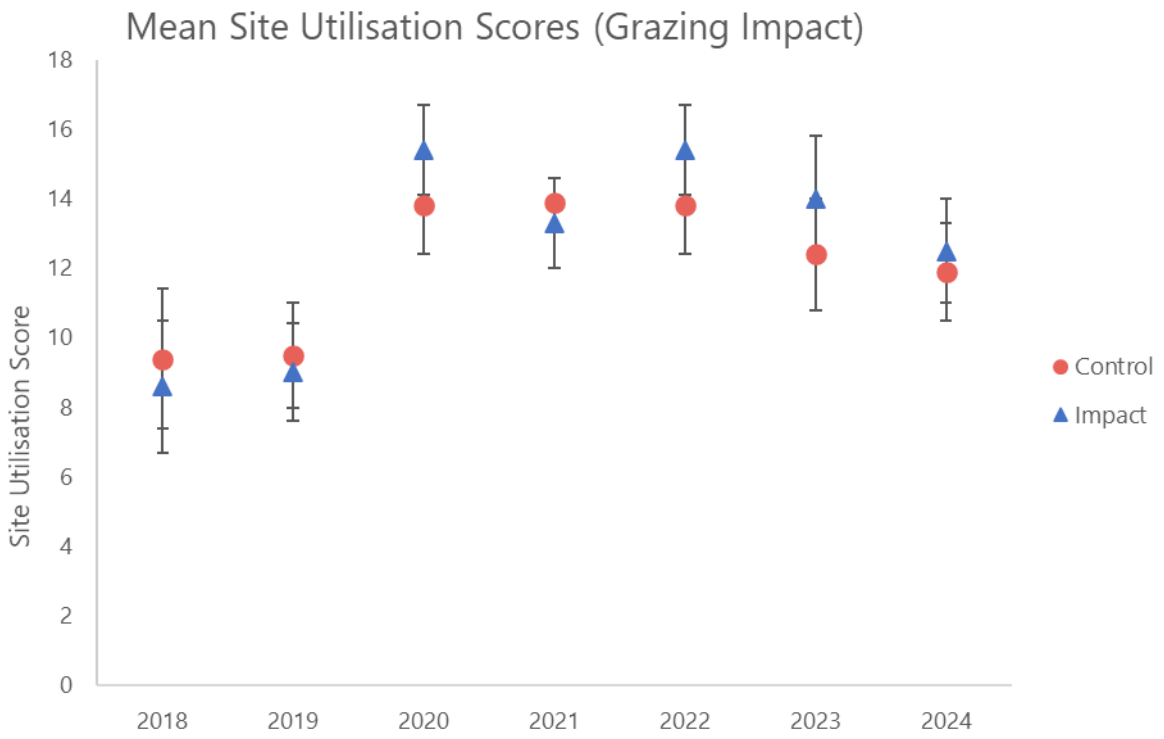

Figure 3.41: Mean site utilisation scores for control and impact sites during compliance monitoring, 2018-2024

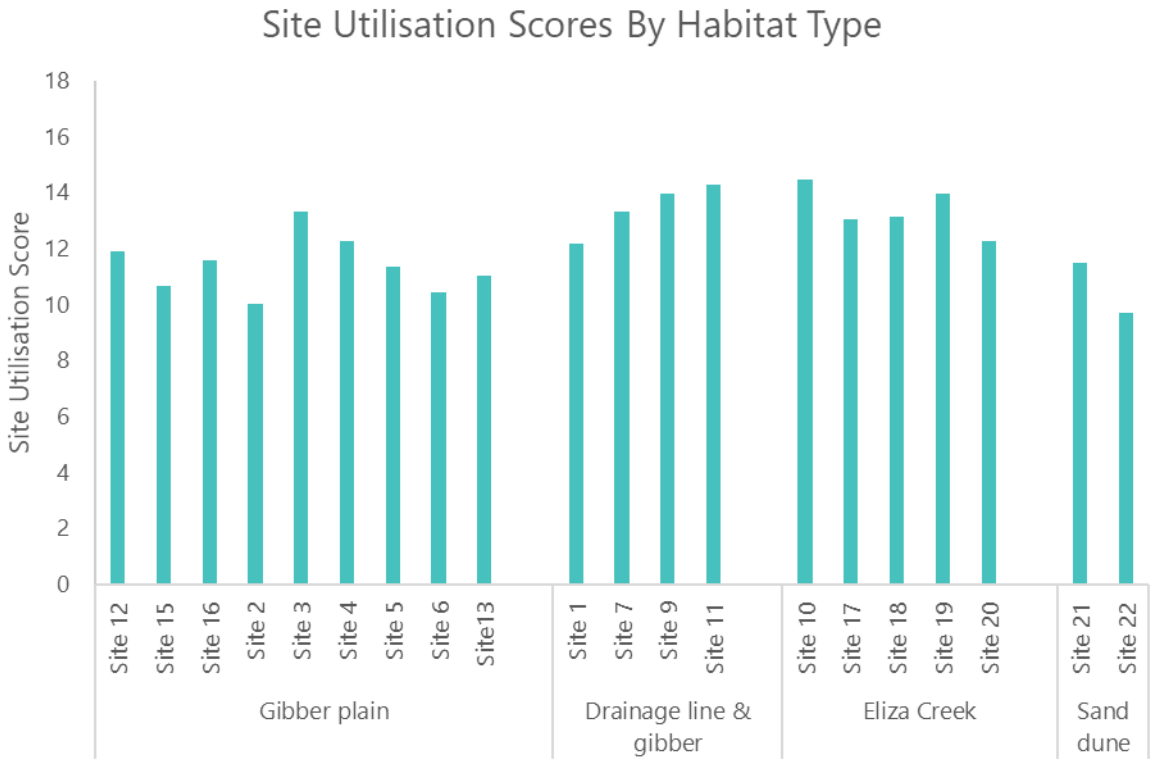

Figure 3.42: Mean site utilisation scores (grazing impact) for each site, grouped by habitat

Table 3.16 lists the species where over-utilised grazing impact was recorded at RAM sites. For the gibber habitat (stony tableland) and creek sites, heavy grazing of > 50% of the population was largely restricted to a relatively few highly palatable species e.g. Spongy-fruit Bluebush (*Maireana spongiocarpa*), Bush Minuria (*Minuria cunninghammii*), Kangaroo Grass (*Themeda triandra*), Bristly Love-grass (*Eragrostis setifolia*) and Twiggy Sida (*Sida intricata*). However, there has been no loss of these species at any site, nor decline in population recorded at Jessup transects and/or as indicated by Crown Separation Ratio estimates of abundance (refer Appendix B for 2024 CSR values). Where domestic stock grazing is absent, grazing of palatable shrubs was much reduced. For example, at Site 3 which adjoins the Processing Plant / car park and main administration areas, all shrubs of the highly palatable, Bush Minuria were ungrazed.

Several species were heavily grazed in the creeklines, but for the majority of species, < 50% of individuals were heavily grazed at a site. The exception was Opposite-leaved Emubush (*Eremophila oppositifolia*), where only a few individuals were present at each of two sites, but numbers were not declining.

At the dune sites, no species were recorded as being over-utilised. Although grazing was considered to have modified some species such as Horse Mulga (*Acacia ramulosa*), grazing had not removed more than 50% of the canopy/stems and the individual plant's regeneration potential was not impacted.

Table 3.16: Species with evidence of grazing impact

Scientific Name	Common Name	# flora sites where recorded	% of flora sites where > 50% of individuals were over-utilised	% of flora sites where any individuals were over-utilised
Astrebla pectinata	Barley Mitchell-grass	8	25	38
Atriplex vesicaria	Bladder Saltbush	16	0	19
Dodonaea lobulata	Lobed-leaf Hop-bush	5	0	20
Eragrostis australasica	Cane-grass	1	100	100
Eragrostis setifolia	Bristly Love-grass	13	23	54
Eremophila oppositifolia ssp. oppositifolia	Opposite-leaved Emubush	2	100	100
Eulalia aurea	Silky Brown-top	4	0	75
Maireana aphylla	Cotton-bush	11	0	9
Maireana appressa	Pale-fruit Bluebush	12	8	8
Maireana astrotricha	Low Bluebush	1	0	100
Maireana spongiocarpa	Spongy-fruit Bluebush	8	13	25
*Maireana turbinata/ Maireana georgei**	Top-fruit Bluebush/ Satiny Bluebush	3	33	67
Minuria cunninghamii	Bush Minuria	13	23	69
Sida intricata	Twiggy Sida	10	0	50

*Identification uncertain due to absence of fruit is some plants

3.2.5.1 Impact versus control site grazing impact

In 2020 and 2022, the mean Site Utilisation Scores for impact sites was significantly higher than for control sites. But for all other survey periods, there has been no significant difference between mean Site Utilisation Scores for impact and control sites (Table 3.17). Noting that Site 4 and 6 were designated as Impact sites from baseline to 2023 and swapped to Control sites in 2024.

Table 3.17: Site Utilisation Scores* (grazing intensity) for each flora site

Type	Landform	Site	2018	2019	2020	2021	2022	2023	2024
Control	Gibber Plain	2	7.3	8.2	15.8	14.6	15.8	14.79	9.9
	Gibber Plain	4							12.3
	Gibber Plain	6							10.25
	Gibber Plain	13	11.4	11.4	14	14.3	14	12.42	10.58
	Drainage Line & Gibber	1	10.5	9.6	12	12.7	12	11.45	12.89
	Drainage Line & Gibber	7	11.5	11	13.5	14.5	13.5	11.64	13.06
	Drainage Line & Gibber	9	8.3	8.1	12.5	14	12.5	13.66	13.97
	Sand Dune	21	7.2	8.4	14.9	13.4	14.9	10.3	11.5
Control		**Mean**	**9.4**	**9.5**	**13.8**	**13.9**	**13.8**	**12.4**	**11.9**
		St Dev	**2**	**1.5**	**1.4**	**0.7**	**1.4**	**1.6**	**1.4**
Impact	Gibber Plain	4	9.5	8.7	16.6	11.7	16.6	13.5	
	Gibber Plain	6	7.2	8.9	14.5	14.4	14.5	14	
	Eliza Creek	10	9.6	8.9	15.8	13.3	15.8	14.34	14.33
	Eliza Creek	17	8.7	9.3	16.7	10.8	16.7	14.45	13.15
	Eliza Creek	18	9.6	9.3	16.5	12.1	16.5	15.76	13.16
	Eliza Creek	19	12.8	12.6	16.8	13.9	16.8	14.19	13.96
	Eliza Creek	20	10.1	9.9	15.4	12.4	15.4	15.52	12.48
	Gibber	12	7.5	7.5	14.6	14	14.6	13.25	11.89
	Gibber	15	9.4	9.1	15	14	15	12.15	10.65
	Gibber	16	9.8	10.7	15.6	16	15.6	16.56	11.49
	Gibber Plain	3	5	7	17.6	14.1	17.6	15.9	13.34
	Gibber Plain	5	6.7	7.8	12.9	12.8	12.9	13.75	11.18
	Drainage Line & Gibber	11	7.3	8.2	13.6	13.7	13.6	12.49	14.11
	Sand Dune	22	7.8	7.7	14.6	12.9	14.6	9.5	9.72
Impact		**Mean**	**8.6**	**9.0**	**15.4**	**13.3**	**15.4**	**14.0**	**12.5**
		St Dev	**1.9**	**1.4**	**1.3**	**1.3**	**1.3**	**1.8**	**1.5**
		t-test p value[2]	**0.47**	**0.52**	**0.04**	**0.19**	**0.04**	**0.08**	**0.34**

[1] Based on the sum of all Utilisation Scores for individual species – which incorporates grazing intensity and presence of regeneration, scores rounded to one decimal point

[2] Two-tailed T-test assuming equal variances comparing control means and impact means. Values greater than 0.05 indicate not significantly different.

Given the widespread destocking of Rangeland sites, grazing is not considered to be causing loss of abundance of species (compared to baseline levels). This is supported by Jessup results (refer Section 3.2.2) that indicated a widespread increased abundance of widespread palatable species (e.g. *Atriplex vesicaria,* including an increase in abundance of juveniles.

3.2.6 Landscape Function Analysis

The following provides a summary of changes in key parameters – plant density and diversity for Landscape Function Analysis transects. Each LFA site comprised 2 transects, each 50 m long. Photos taken at the start and end of each transect are contained in Appendix A.

3.2.6.1 Site 1: Aerodrome (LFAAL1)

Aerodrome transect 1A: LFA established method

Transect 1A comprised two zones, namely one patch type 'vegetation' and one interpatch 'rocky/ soil'. In 2024, Transect 1A continued to show increases in vegetative cover with an increase in the width of vegetation patches, and the continued emergence of long-lived plant species.

The proportion of transect occupied by patches in 2024 was very similar to 2023 but the width of patches increased by approximately 50%. Vegetation patches comprised 21% of the linear transect in 2022, 29% in 2023 and 30% in 2024 (the remainder being rocky inter patch). The mean patch width increased from 73 cm in 2022 to 135 cm in 2023 to 198 cm in 2024. The number of intercepted plants that were long-lived perennials had increased from 2 plants in 2022, 3 plants in 2023, to 7 plants in 2024. In 2024 long-lived perennial plants comprised 23% of all plants recorded along the transect. The long-lived plant species present in 2024 were: Samphire (*Tecticornia medullosa*) and Bladder Saltbush (*Atriplex vesicaria*), the dominant species in the adjoining non-cleared vegetation, as well as Plains Lantern Bush (*Abutilon halophilum*). The majority of vegetation patches were Salt Sclerolaena, (*Sclerolaena ventricosa*), a prominent component of the Bladder Saltbush community is this region. The first 15 m of the transect, however, remained devoid of vegetation (Plate 3.1). Species recorded along LFA linear transects are shown in Table 3.18.

Plate 3.1: Aerodrome transect 1A showing re-establishment of vegetation largely concentrated in the second half of the transect

Aerodrome transect 1A: PCQ method

Due to the high number of vegetation patches recorded along the transect, and notable changes being detected by the LFA method, the PCQ was no longer considered a necessary supplementary method to show yearly changes.

Aerodrome transect 1B: LFA established method

Transect 1B also comprised two zones, namely one patch type 'vegetation' and one interpatch 'rocky/ soil'. In 2024, there were continued increases in the percentage of the transect comprised of vegetation patches and the number of patches intercepted along the transect (Plate 3.2). The number of patches had increased from 7 patches in 2021 to 19 patches in 2024. Mean patch width was 117 cm in 2022, 47 cm in 2023 and 86 cm in 2024. Up to 2023, patches comprised only short-lived perennials (mainly *Sclerolaena* species and *Atriplex holocarpa*). However, in 2024, two long-lived perennial species were in patches that intercepted the transect in addition to nine short-lived perennial species (Table 3.18).

Aerodrome transect 1B: PCQ method

As with Transect 1A, due to the increased number of vegetation patches and notable changes being detected by the LFA method, the PCQ was no longer considered a necessary supplementary method to show yearly changes.

Plate 3.2: Aerodrome transect 1B. From 0 m at start, facing the end. Moderately dense vegetation covers much of the first half of the transect

3.2.6.2 Site 2: Ventia (LFAVOL2)

Ventia transect 2A

This transect was decommissioned in 2024 due to approximately half of the transect being recently graded and used as a temporary laydown area for construction/widening of the adjoining road (Plate 3.3). In October 2024, no plants were present along the entire transect alignment and less than 10 plants were present within 10 m of the alignment. In 2023, nine patches represented by only short-lived perennials, intercepted the transect, hence re-establishment of vegetation at this site had been sparse.

Plate 3.3: Ventia transect 2A. The majority of the transect has been recently graded and no vegetation remains along the alignment

Ventia transect 2B: LFA established method

Transect 2B comprised two zones, namely one patch type 'vegetation' and one interpatch 'rocky/ soil'. The number of vegetation patches increased from no patches in 2021 to 5 patches in 2023. However, in 2024 only one patch was intercepted along the transect – the short-lived species Pop Saltbush (*Atriplex holocarpa*) (Plate 3.4). The percentage of transect comprised of vegetation patches showed a corresponding decline from 1.3% of the linear transect in 2023 to just 0.8% in 2024.

Ventia transect 2B: PCQ method

In 2024, the PCQ recorded only short-lived perennials (no long-lived perennials), and in particular Pop Saltbush (*Atriplex holocarpa*). As with the LFA results the PCQ data also recorded a decline in plant density with the mean distance between plants increasing from 2.3 m in 2023 to 2.46 m in 2024. The 2024 density, however, was an increase on the 2020 and 2021 plant densities of 5.3 m and 5.2 m respectively. Similarly, the mean number of plants per m^2 showed a net increase since 2020 (0.03 to 0.16), but a slight decline between 2022 (0.18 plants per m^2).

In 2024 Pop Saltbush was the most common species recorded, representing a shift from previous years where the slightly longer-lived Salt Bindyi (*Sclerolaena ventricosa*) was dominant.

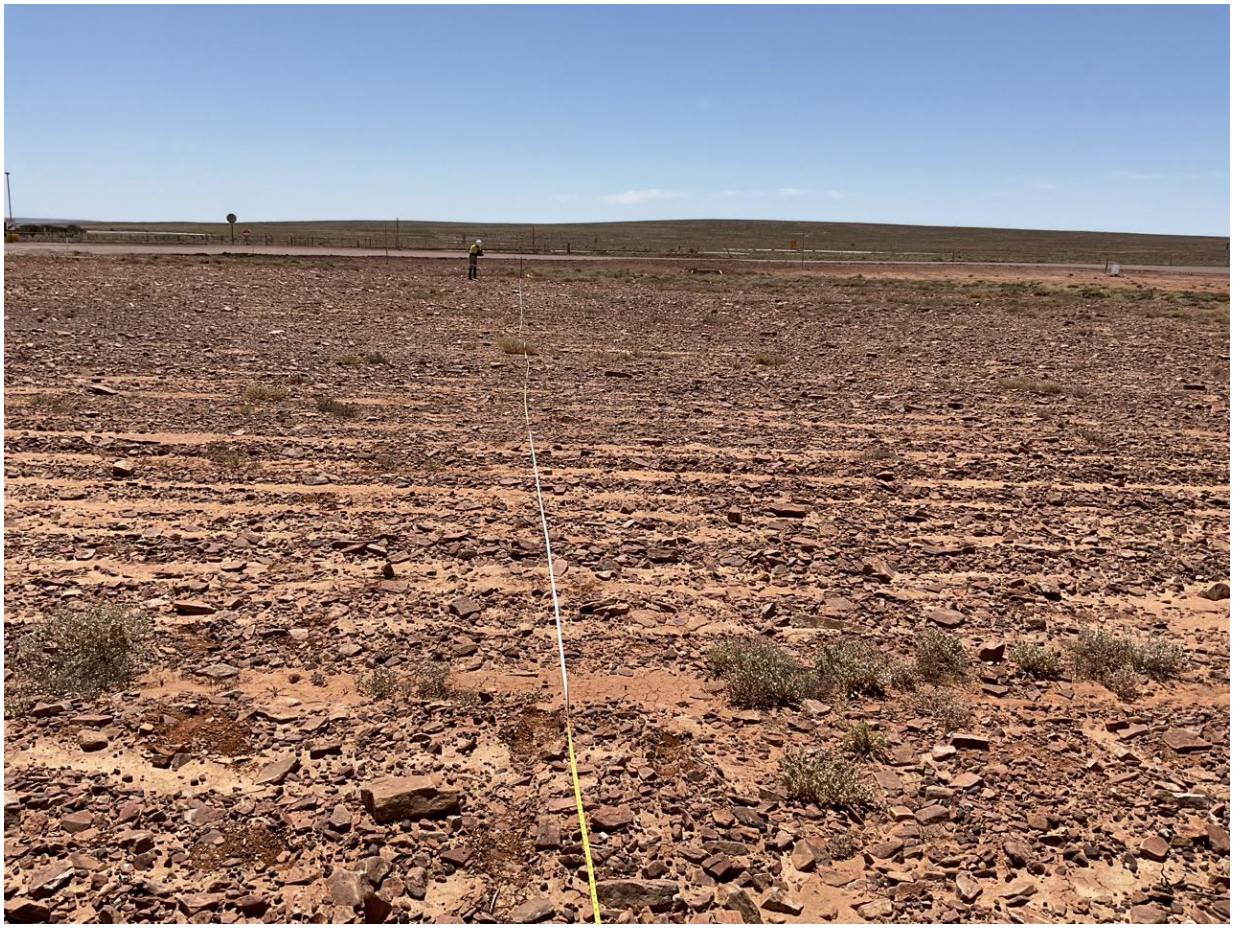

Plate 3.4: Ventia transect 2B: Only one vegetation patch was intercepted along the transect

3.2.6.3 Site 3: Midway Quarry (LFAQUA3)

Midway Quarry Transects 3A and 3B: LFA established method

Transects 3A and 3B are located adjacent each other on relatively flat deeply ripped ground and both comprised two zones, namely one patch type 'vegetation' and one interpatch 'rocky/ soil'.

In 2022, the sites were assessed using the LFA Bank and Trough Method whereby the trough created by ripping is equivalent to a patch (e.g. collects deposited materials and nutrients to encourage recruitment). The deep-ripped troughs comprised the majority of the transects in 2022 (72% for 3A and 60% for 3B). By 2023, however, the troughs had eroded and were no longer deep enough to be considered effective patches (Plate 3.5 and Plate 3.6), and both transects were assessed using the established LFA method. It is noted that a dense patch was also observed just off transect 3A (Plate 3.7).

Between 2023 and 2024, the LFA recorded an increase in both density and size of plant patches. Three patches were recorded along Transect A, compared with no patches in 2023. The 3 patches were all short-lived perennials and occupied 2% of the linear transect. In 2024, 8 patches were recorded comprising 4.4% of the linear transect, compared with 4 patches comprising 1.1% of the transect in 2023. Mean patch width also increased from 28 cm in 2023 to 43 cm in 2024.

Midway Quarry transects 3A and 3B: PCQ method

In 2022 the PCQ method was not conducted due to the transect and adjoining 10 m being devoid of plants. By May 2023, however, plants were recorded in most PCQ quadrats. The PCQ method was also conducted in 2024. Plant density increased between 2023 and 2024. Along transect A, the mean distance between plants decreased from 4.1 m in 2023 to 3.0 m in 2024 (mean number of plants increased from 0.06 plants per m2 to 0.11 plants per m^2). Transect B recorded an even greater increase in plant density. The mean distance between plants decreased from 2.9 m in 2023 to 1.4 m in 2024 (mean number of plants increased from 0.12 plants per m^2 to 0.51 plants per m^2).

Plate 3.5: Midway Quarry transect 3A from start (0 m) facing end. Most re-establishment of short-lived perennials has occurred near the start of the transect.

Plate 3.6: Midway quarry transect 3B, the contours have levelled out, now < 10 cm deep and plants have sparsely revegetated. Although still sparse, plant density is notably denser than in 2023

Plate 3.7: Dense patch of vegetation just off Midway Quarry transect 3A

3.2.6.4 Site 4: Tjungu to WAR (LFATJU4)

Tjungu transects 4A and 4B: LFA established method

Transects 4A and 4B are in one linear alignment sloping toward a minor drainage line. Due to the deep troughs and almost complete absence of plants, in 2022 the sites were assessed using the LFA Bank and Trough Method whereby the trough is equivalent to a patch (e.g. collects deposited materials and nutrients to encourage recruitment). In 2022, the troughs (patches) comprised 64% and 61% for transects 4A and 4B, respectively.

However, between spring 2022 and autumn 2023, there had been prolific plant establishment along both transects and were assessed using the established LFA method. Both transects comprised two zones, namely one patch type 'vegetation' and one interpatch 'rocky/ soil'.

Transects A and B comprised similar plant densities. In 2024, transect 4A rand 4B recorded 37 vegetation patches and 33 patches, respectively; both representing increases from 2023 when 26 patches and 28 patches were recorded. Vegetation patches comprised 23% of Transect 4A and 33% of Transect B, also representing an increase form 15% and 16% of Transects A and B in 2023. Mean patch width increased from 43 cm in 2023 to 78 cm in 2024 for Transect A, and from 42 cm to 70 cm for Transect B.

Long-lived perennial species comprised 24% of plant records recorded along Transect A, including eight records of Bladder Saltbush (*Atriplex vesicaria*), the dominant species of the reference vegetation type. Long-lived perennials comprised 22% of Transect B including 10 records of Bladder Saltbush.

Tjungu transects 4A and 4B: PCQ method

Due to the high number of vegetation patches recorded along the transects in 2023 and 2024, notable changes between survey periods were detected using the LFA method. Hence, in 2024 the PCQ was no longer considered a necessary supplementary method to show changes and was not conducted at the Tjungu to WAR site.

Plate 3.8: Tjungu transect 4A: From start at 0 m facing end. Large and abundant surface rock is present due to the deep ripping and vegetation is densely spaced

Plate 3.9: Transect 4A close up showing densely spaced vegetation in rip lines

Plate 3.10: Tjungu t transect 4B from start (0m). Densely spaced vegetation. Plant diversity comparable with adjoining non-cleared vegetation

Emergence of species used in hand-seeding at Tjungu LFA sites

Following deep-ripping of the area in 2022, the following species were hand-seeded at site LFATJU4 (Transect 4A and 4B) Pop Saltbush (*Atriplex holocarpa*), a Saltbush (*Atriplex lindleyi*), Lagoon Saltbush (*Atriplex suberecta*) Sandhill Saltbush (*Atriplex velutinella*), Bladder Saltbush (*Atriplex vesicaria*), Grey Bluebush (*Maireana appressa*), Fleshy Bluebush (*Maireana erioclada*), Black Bluebush (*Maireana pyramidata*), Nitrebush (*Nitraria billardierei*), Thorny Saltbush (*Rhagodia spinescens*), Desert Cassia (*Senna artemisioides*) and Shrubby Twinleaf (*Roepera aurantiacum*).

Of these species only Pop Saltbush and Bladder Saltbush were recorded during the LFA and/or PCQ surveys in 2023 and 2024. Species recorded along LFA linear transects are shown in Table 3.18.

Table 3.18: Species recorded along LFA transects 2024

Species	Number of patches species was recorded in along each transect						
	1A	1B	2B	3A	3B	4A	4B
Short-lived Perennials							
Atriplex holocarpa	1	1	1	2	8	26	14
Cullen cinereum		1					
Dissocarpus biflorus		6					
Dissocarpus paradoxus	1	1				1	
Enneapogon avenaceus		1					
Panicum decompositum		1					
Salsola australis						2	
Sclerolaena brachyptera		2					
Sclerolaena divaricata	2	3				1	3
Sclerolaena ventricosa	19	16		1		3	10
Sclerolanea intricata						1	9
Long-lived Perennials							
Tecticornia medullosa	3	2				1	
Atriplex vesicaria	3	3				8	10
Abutilon halophilum	1					1	
Maireana spongiocarpa						1	
Short-lived total number of patches	23	32	1	3	8	34	36
Short-lived patches as % of total	77	86	100	100	100	76	78
Long-lived total number of patches	7	5	0	0	0	11	10
Long-lived patches as % of total	23	14	0	0	0	24	22
Total number of patches	30	37	1	3	8	45	46

3.2.6.5 Indices of Rehabilitation Success

Results for 2019 when the Bank and Trough Method was used are detailed in Jacobs (2023h). As discussed above, the Bank and Trough method was used immediately following ripping of the sites and prior to plants re-establishing. In 2019, the sites were a combination of troughs and rock/soil inter-troughs with no plants present.

The following results compare data at the rehabilitation sites, surveyed using the LFA Established Method (2020 to present) with 'analogue' (reference) sites that were also surveyed using the LFA Established Method. Six analogue sites were surveyed prior to the compliance/operational period (by EBS Ecology). The LFA indices reviewed below are:

- Plant density, the mean number of plants per $10m^2$;
- The Landscape Organisation Index, which is the total length of patches/length of the transect. This is considered a key parameter as it encapsulates vegetation cover. Patch density (mean number of patches per $10m^2$) and total patch area are also presented below; and

- LFA Surface Soil Assessment, where the three indices derived from the Surface Soil Assessment are stability, infiltration and nutrients.

Plant density

Plant density at both the Tjungu and Aerodrome sites has exceeded the analogue mean since 2022 (Aerodrome site) and since 2023 (Tjungu site) (Figure 3.43). Plant density at the Aerodrome Site has increased only slightly since 2022. Plant density at the Tjungu site increased from no plants present in 2022 to well above the analogue mean in 2023 and further increasing almost 50% in 2024. At the Aerodrome site, most re-establishment to date occurred between 2021 and 2022, with a slight decline recorded in 2023. This reflects the majority of re-establishment to date comprises short-lived perennial species, and hence there will be year to year fluctuations, but with an expected long term trend of increasing plant matter. At the Midway Quarry Site 3, plant density has increased slowly since 2024 but remains sparse at just over 1 plant per $10m^2$ compared with the analogue mean of 3 plants per $10m^2$. At Ventia, only one transect was still active, and only one plant was present along the transect.

The Landscape Organisation Index for the Tjungu to WAR site and the Midway Quarry site have also increased since the sites were established. In 2024 the Landscape Organisation Index reached the analogue range of values (but still remains below the analogue mean (Figure 3.43). However, the Landscape Organisation Index remains very low for the Ventia site and the Aerodrome site.

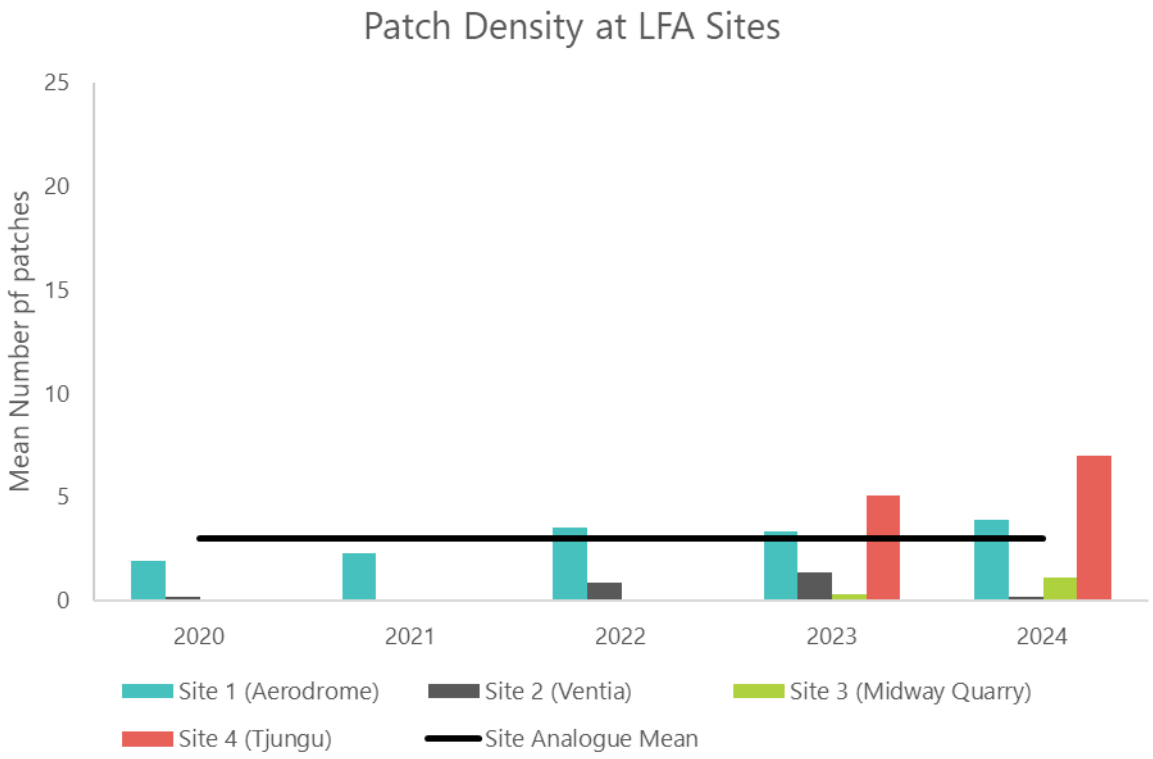

Figure 3.43: Plant density, mean number of patches (transect average for site) based on LFA Established Method 2020 to 2024.

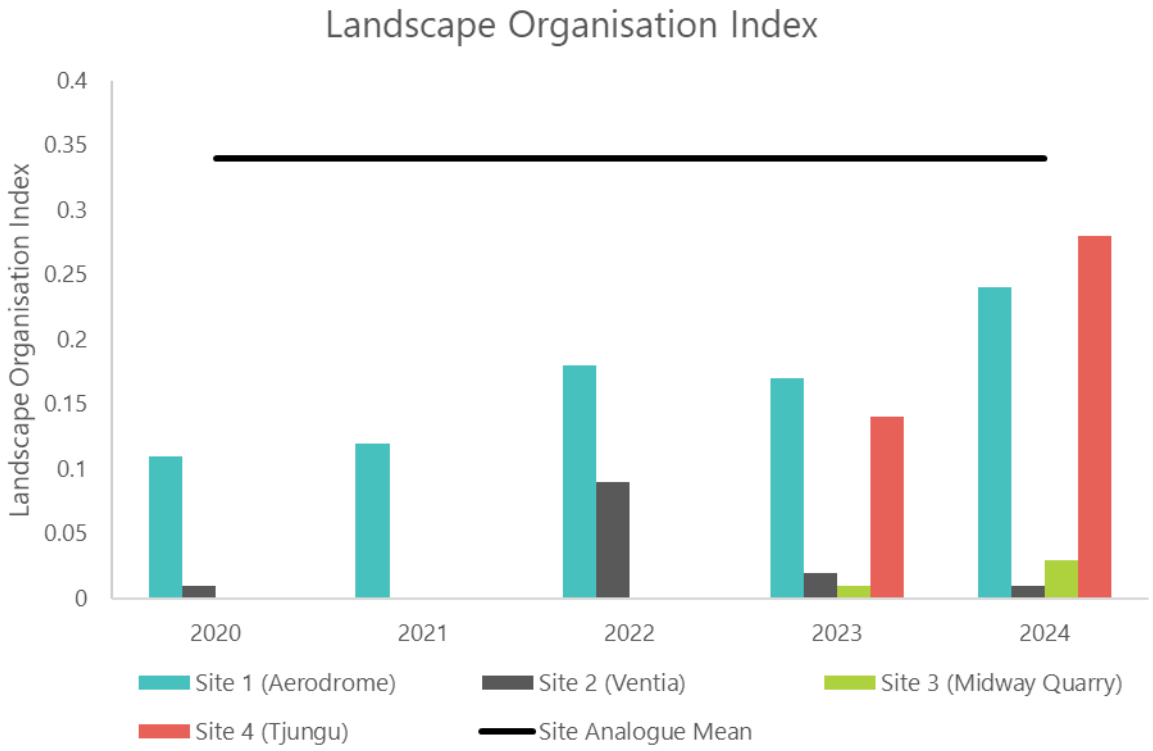

Figure 3.44: Mean Landscape Organisation Index (transect average for site) based on LFA Established Method 2020 to 2024.

Soil stability

Soil stability index is derived from the following parameters scored in the field: soil cover, litter cover, cryptogram cover, crust broken-ness, erosion, deposited materials, surface resistance to disturbance and slake test.

Soil stability scores decreased between 2023 and 2024, and were slightly below the analogue mean (Figure 3.45, Table 3.19). This is because for most sites, a cryptogram cover has not yet developed and materials are not obviously coming into the sites. Leaf litter is still largely confined to beneath the canopy of each plant.

Soil infiltration

The soil infiltration is derived from the following parameters scored in the field: vegetation cover, litter cover, surface roughness, surface resistance to disturbance, slake test and soil texture. For the Aerodrome Site LFAAL1 the soil infiltration has remained very similar since 2021, and very close to the analogue mean value (Figure 3.46). At the Ventia and Midway Quarry LFA Sites, the soil infiltration index has declined (Table 3.19). This is likely due to the evening out of troughs reducing soil roughness, while vegetation and litter cover remaining low. Soil infiltration values at Tjungu have fluctuated since 2022, but in 2024 were approaching the analogue mean value.

Nutrient cycling

The nutrient cycling index is derived from the following parameters scored in the field: vegetation cover, litter cover, cryptogram cover and surface roughness. The results show that the Aerodrome Site has scored close to the analogue mean since 2021, albeit slightly declining in 2023 and 2024 (Figure 5). Results for the other three LFA Sites remain below the analogue mean and have been variable between survey periods. Sites 2 (Ventia) and 3 (Midway Quarry) recorded the lowest nutrient cycling indices, reflecting that these sites have the lowest vegetation cover, litter cover, cryptogram cover and surface roughness.

Table 3.19: LFA Surface Soil Indices[1]

Year	Sites									
	Aerodrome		Ventia	Midway Quarry		Tjungu		Analogue		
	1A	1B	2B	3A	3B	4A	4B	Mean	Std Dev Upper	Std Dev Lower
Soil Stability										
2020	38	45	50					46	67	26
2021	46	43	43							
2022	45	45	45	40	41	36	37			
2023	42	39	41	47	47	45	46			
2024	41	38	38	38	37	36	41			
Soil Infiltration										
2020	19	18	16					29	43	15
2021	23	34	27							
2022	24	31	26	32	29	38	38			
2023	33	27	24	20	20	22	22			
2024	30	29	15	16	17	27	28			
Soil Nutrient Cycling										
2020	14	14	12					19	27	10
2021	18	19	16							
2022	20	26	15	14	14	17	16			
2023	26	16	9	9	9	15	15			
2024	20	17	9	12	12	15	16			

[1]Higher indices (percentages), reflect better landscape function

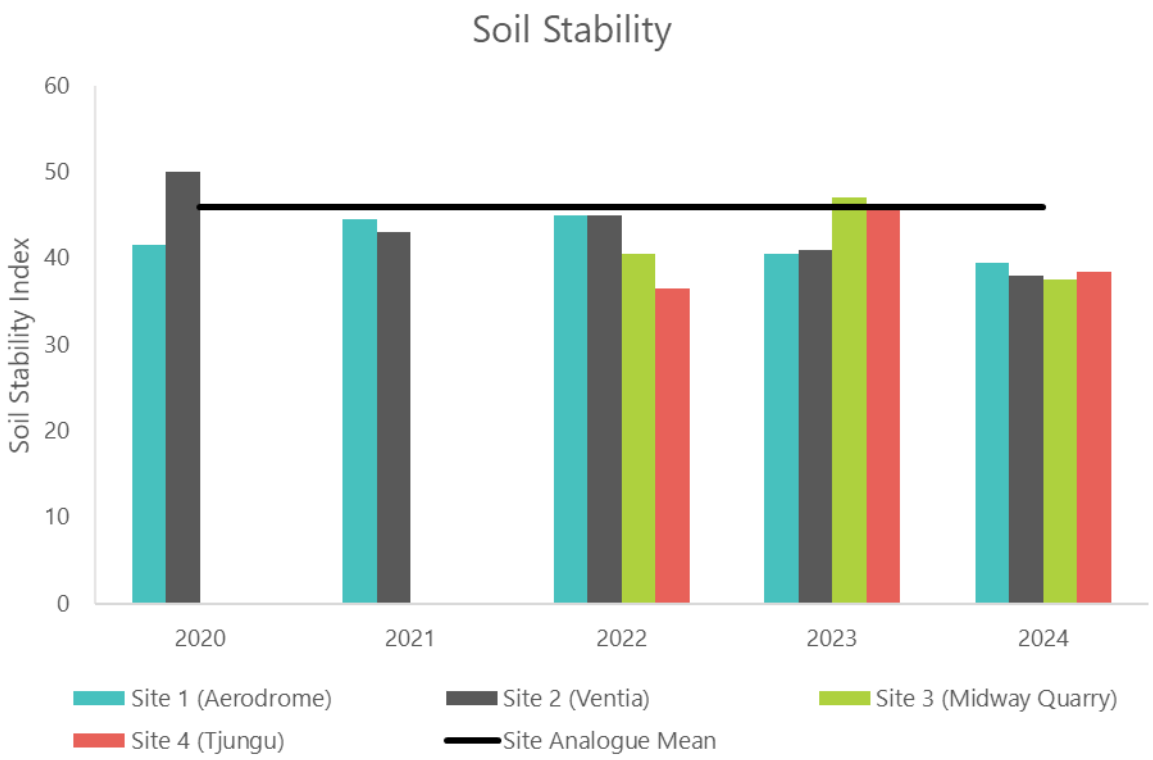

Figure 3.45: Mean soil stability index of transect based on combined patch and interpatch at LFA sites (2020 to 2024)

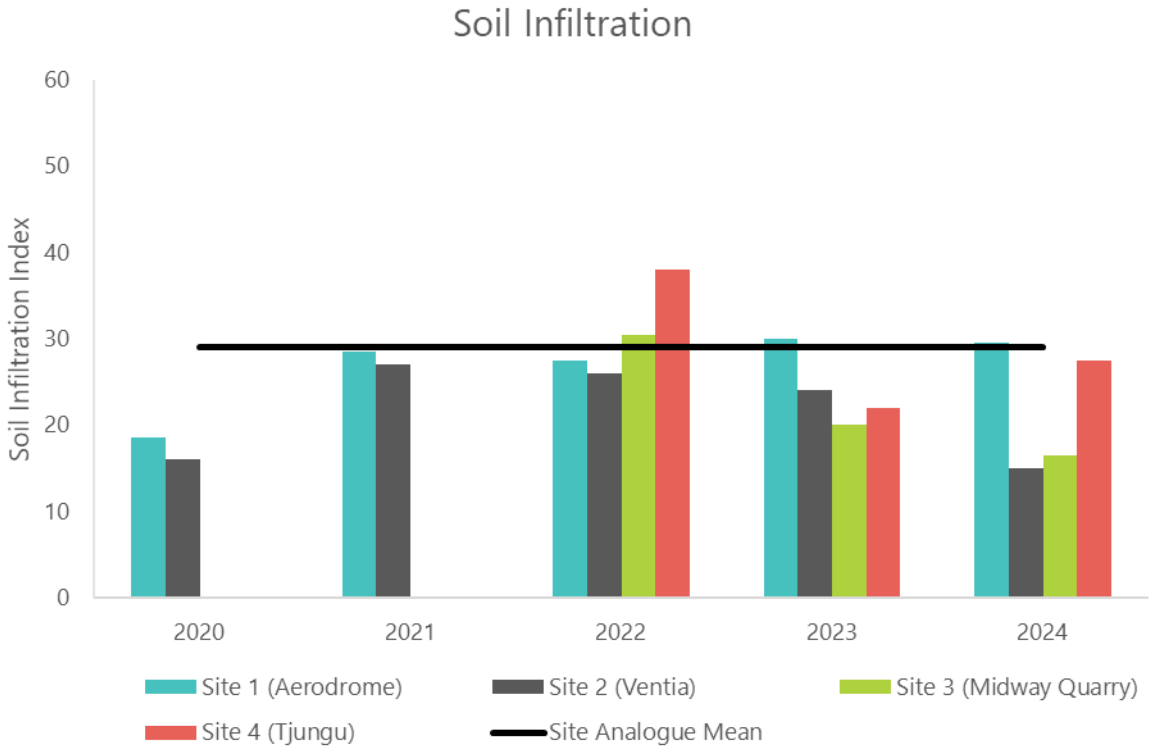

Figure 3.46: Mean soil infiltration index of transect based on SSA (combined patch and interpatch) at LFA sites (2020 to 2024)

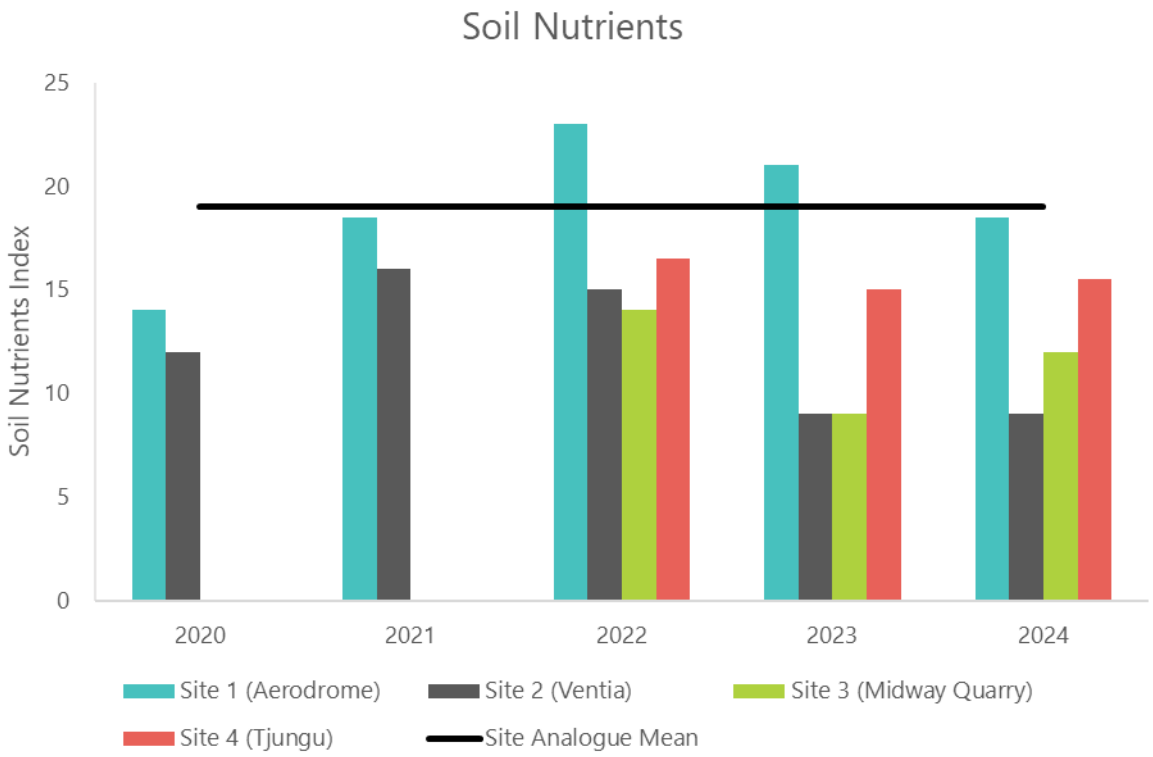

Figure 3.47: Mean nutrient cycling index of transect based on SSA (combined patch and interpatch) at LFA sites (2020 to 2024)

3.3 Fauna

3.3.1 Survey effort and capture rates

As per Section 2.6, fauna survey methods during compliance monitoring broadly followed the SA Vertebrate Survey guidelines (Owens 2000), with modifications aligning with the objectives of this survey, and based on recommendations from earlier surveys. The broadly accepted guidelines recommend a minimum of four trapping nights to ensure sufficient trapping effort for the purposes of documenting key faunal assemblages across a study area. A trapping line set up is shown in Plate 3.11.

Table 3.20 provides a summary of total trapping effort across the spring 2024 survey. Survey effort has been calculated by number of trapping nights (number of traps multiplied by the number of nights the traps were set for) and the total number of active surveys and searches. Active reptile searches / opportunistic observations and bird surveys were undertaken at all eight fauna sites, the four sites in Eliza creek, the dune Flora sites (21 and 22) and at opportunistic sites. Spotlighting was undertaken at sites 10 (creekline / drainage line); camera trapping and Song Meter deployment at fauna trapping sites also provided opportunity for capturing nocturnal activity.

Plate 3.11: Site 16 fauna trapping set up

Table 3.20: Fauna Survey Effort, Spring 2024

Location	# of Trap Nights		Total Trap Effort Per Site
	Funnel trap	Pit Trap	
Fauna Site 1	16	24	40
Fauna Site 2	16	24	40
Fauna Site 3	16	24	40
Fauna Site 4	16	24	40
Fauna Site 5	16	24	40
Fauna Site 6	16	24	40
Fauna Site 15	16	24	40
Fauna Site 16	26	24	40
Total	**128**	**192**	**320**

3.3.1.1 Capture rates

The spring survey returned a total of 577 observations, captures or evidence of fauna (excludes exact numbers for sheep, kangaroos, goats, rabbits and birds which were not counted). This included 344 detections / observations of birds, 73 of mammals and 160 of reptiles (excludes 64 Song Meter duplicate detections). Of the observations, 142 were pit or funnel trap captures. The highest capture rates were made in pitfall traps (93) and there were 49 captures in funnel traps. Capture rates for the number of pits and funnels deployed at each site are summarised in Table 3.21.

Total spring 2024 trapping capture rate for funnel and pit traps was calculated by dividing total captures by total trap effort (141/320 = 0.44). The total trapping capture rate was well above the 2018-2022 spring capture rates (~0.23) and the autumn 2023 capture rate (0.11). The 2024 total capture rate is well within the range reported during baseline surveys (0.14 to 0.97), where the lowest rates were recorded in autumn 2013 (0.14) and 2014 (0.13), and the highest rate was recorded in spring 2016 (0.97) (EBS 2017b). Capture rate numbers during the current survey are considered to be positive, particularly given the drier conditions preceding the survey. The diversity for small mammals was low, but within the range of baseline and previous construction monitoring surveys. Specific results per animal group and diversity results are presented further below.

As per above, both funnel and pit captures (142 in total) increased from the 2022 spring and 2023 autumn surveys, with only 10 recaptures (reptiles only) recorded. When reviewing trends across the control and impact site, as well as including captures and observations of additional species (opportunistic, spotlighting, bird surveys) there are no clear trends emerging between control and impact sites. It is noted that Impact Site 3 and new Control Site 4 had the highest overall fauna detection (39 and 38) and Control Site 1 and 2 had the lowest total species detection (19). Impact sites had variable numbers of bird species, varying levels of mammal / reptile captures and there are no clear trends when compared with spring 2022 and autumn 2023 results (Figure 3.48). Noting this comparison primarily relates to point of time comparison across the sites.

A summary of total fauna capture by site for the different survey methods (funnel, pitfall, opportunistic detection) is provided in Table 3.21, Table 3.22 and Table 3.23.

Table 3.21: Fauna (trapping only) capture rates per site, spring 2024

Site	Funnel Trap		Pit		Total Capture Rate	Total Capture Rate Comparison to Autumn 2023	Total Capture Rate Comparison to Spring 2022
	Captures	Capture Rates	Captures	Capture Rates			
Control							
Fauna Site 1	4	0.25	8	0.33	0.333	increase	Slight decrease
Fauna Site 2	7	0.44	6	0.25	0.325	increase	same
Fauna Site 4	9	0.56	18	0.75	0.675	increase	increase
Fauna Site 6	3	0.19	15	0.625	0.45	increase	increase
Impact							
Fauna Site 3	11	0.69	12	0.5	0.575	increase	increase
Fauna Site 5	6	0.375	10	0.42	0.4	increase	increase
Fauna Site 15	5	0.31	15	0.625	.5	increase	decrease
Fauna Site 16	4	0.25	9	0.375	0.325	increase	same

As per Section 2.3.2, Site 4 and Site 6 have been changed from Impact to Control sites.

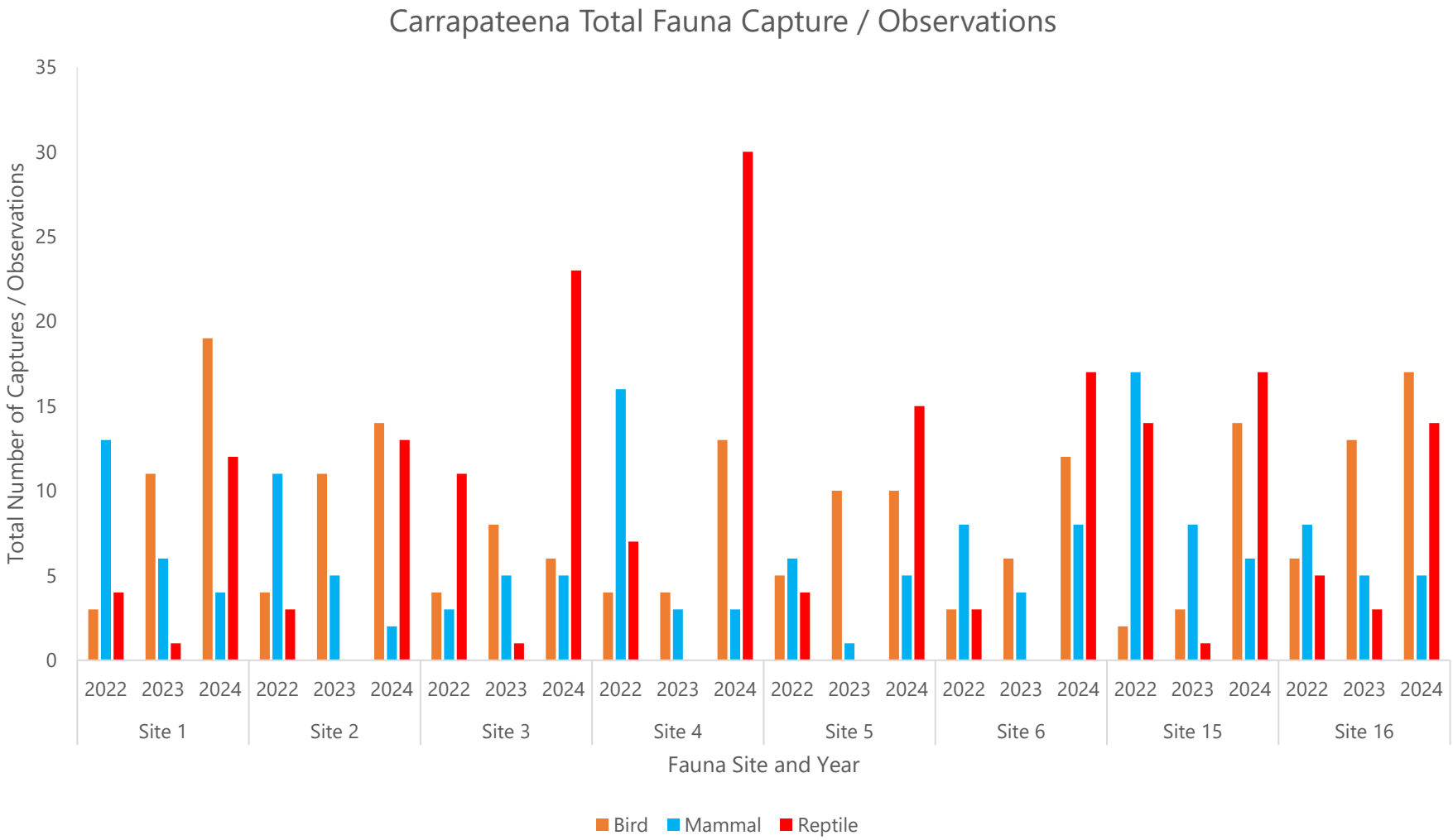

Figure 3.48: Total fauna capture/observation (bird are species only), spring 2022, autumn 2023 and spring 2024

3.3.2 Fauna diversity summary

During the 2024 spring fauna survey a total of 107 vertebrate species were detected from the 8 fauna survey sites, 20 bird survey sites and opportunistically within the study area. Of these 107 species, five species had not been observed / detected since the baseline surveys (2012-2017); Southern Four-toed Slider (*Lerista dorsalis*), Australian Pratincole *(Stiltia isabella*), Inland Forest Bat (*Vespadelus baverstocki*), Inland Free-tailed Bat (*Ozimops petersi*, previously only identified to genera *Mormopterus sp.*), and Lesser Long-eared Bat (*Nyclophilus geoffroyi*). Gould's Wattled Bat (*Chalinolobus gouldii*) was likely present in 2023, but calls could only be identified to genus rather than species level. In addition, three species which were detected during the current survey had not been detected at the site previously; Australian Pelican (*Pelecanus conspicillatus*), Rufous Songlark (*Cincloramphus mathewsi*), Red-necked Avocet (*Recurvirostra novaehollandiae*). The site occurs within the known range for these species (Menkhorst et al. 2019; Davies et al. 2022). The vertebrate species detected in the study area are summarised below:

- 74 bird species (53 at fauna sites and bird sites, 54 at opportunistic locations)
- 18 reptile species (13 fauna trapping captures, 15 camera trap / spotlighting / opportunistic observation)
- 15 mammal species (4 fauna trapping captures; 11 opportunistic including 3 exotic species, 5 microbat species) (excludes Sheep).

No NPW Act-listed as threatened species were detected, two EPBC listed were detected; Sharp-tailed Sandpiper (*Calidris acuminata*) listed as Threatened (Vulnerable) and Migratory, and Common Sandpiper (*Actitis hypoleucos*) listed as Migratory. Three Sharp-tailed Sandpipers and one Common Sandpiper were detected at the South Eliza Dams. This includes the original dam, overflow dam and temporary ponds that have developed following the release of surplus Class A treated wastewater from the Tjungu WWTP. This water source is temporary as the first use would be in the processing plant, only excess water is released to South Eliza Dam for livestock and wildlife. Previously Sharp-tailed Sandpipers and other waterbirds were detected in the WWTP irrigation areas, that are no longer active. Other shorebirds that were present included Banded Lapwing, Black-fronted Dotterel, Red-Kneed Dotterel, Black-winged Stilt and Red-necked Avocet. New records for the site included the Australian Pelican (one dead bird found at Site 4 over 2 km from the TSF), Rufous Songlark and Red-necked Avocet.

Introduced birds or mammals observed at the site included, House Sparrows (in similar numbers with previous years), live European Rabbits (observed at Site 15, North Eliza Dam, Site 21 and track / scats at five other locations) and Feral Cats (Site 21 tracks). There is still an active Rabbit Warren near Site 15, that requires ongoing management. Evidence of Feral Cats has decreased since the previous survey. Rock Doves (Feral Pigeon) were not detected.

The following sections provide detail on each faunal group identified, including summary tables of species.

Given the nature of fauna data from individual surveys, movement of species, the variations in weather conditions between surveys, variations in trapping effort (to baseline) and capture rates across surveys and sites, fauna data is reflective of high level trends over time only. Broadly, Figure 3.49 shows the total species diversity for mammals, birds, reptiles / frogs that were captured, recorded during dedicated bird surveys and recorded opportunistically across the Carrapateena site during spring baseline (2012 - 2017) surveys compared with data from the construction/operation period (2018 - 2024). Results indicate similar trends for some fauna types and increasing trends for other, with 2024 total diversity falling above the spring range reported from previous years, and snap shot autumn surveys from early baseline (2012), late baseline (2017) and early compliance monitoring (2017) (Figure 3.49). Similar to spring 2022 and autumn 2023 dams were full, plus South Eliza Dam had excess temporary ponds of Class A wastewater, where numerous waterbirds were present. There were increases in detection of bird species and families as a result of survey effort at these wetted areas, along with Song Meter detection.

Similar to previous years, there was evidence of breeding activity across the site. Given the arid environment, the breeding of many species is stimulated by climate conditions, hence breeding can occur throughout the year. The small mammals showed some evidence of breeding, however sample sizes were small for some species (e.g. Fat-tailed Dunnart, Sandy Inland Mouse). Stripe-faced Dunnarts were captured in higher numbers than Fat-tailed Dunnarts, as per previous surveys. Over 10 bird species were in breeding pairs / groups or had young present, which is a notable sign that species are persisting within the Operations area environment. Fauna with evidence of recent breeding included: multiple family groups of two fairywren species, numerous juvenile reptiles (Earless Dragon, Bynoes geckos, Four-toed Slider), various parrots in pairs or flocks or pairs (e.g. Mulga Parrots, Australian Ringneck, Blue Bonnets), pairs of Wedge-tailed Eagles and pregnant Stripe-faced Dunnart captured via camera trap (Plate 3.12).

No evidence of a significant reduction in species diversity was observed in spring 2024, with species numbers similar or greater than baseline and spring time compliance monitoring results, and with only the capture numbers of rodents reflective of the dry climate conditions preceding the survey (refer Section 3.1). House Mouse were captured in small numbers at Control Site 1 and Impact Site 16 during the survey (1 captured at each site). Survey for microbat species has not been undertaken every year, however with minimal survey effort in spring 2024 at three suitable sites (Flora Site 7, Flora Site 10 and South Eliza Dam), five microbat species were detected, three of these had not been detected since the baseline surveys.

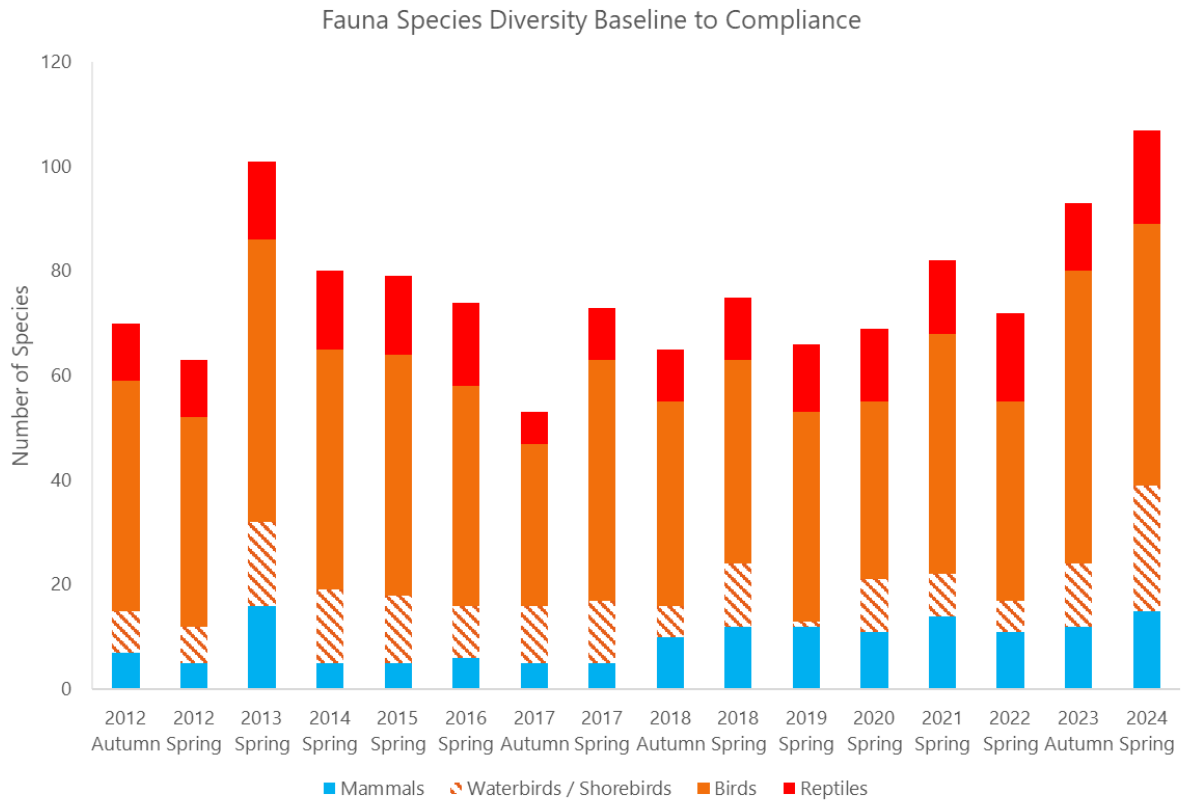

Figure 3.49: Vertebrate total species diversity, during baseline (2012-2017), and compliance monitoring (2018- spring 2024).

Plate 3.12: Pregnant Stripe-faced Dunnart captures via camera trap at Site 5

3.3.2.1 Bird diversity

A total of 74 bird species were detected during the spring 2024 survey across the Carrapateena site (see Appendix F). Of these species, 53 were recorded during dedicated bird surveys across 20 sites and the additional species were recorded opportunistically when driving along tracks, around camp, effluent irrigation areas, during weed surveys and at dams. At the time of the spring survey all of the dams had water including coffer dams, and waterbirds and resident shorebirds were present, similar to previous years when all the dams were full. Two EPBC listed Migratory species were detected, and one of these is also EPBC listed as threatened; Sharp-tailed Sandpiper (Vulnerable) and Common Sandpiper (both observed at the South Eliza Dams). No State listed species were recorded.

There were three new records for the site; Pelican (one dead bird at Site 4 near the TSF), Rufous Songlark (heard at the South Eliza Dam) and Red-necked Avocet (seen at the South Eliza Dam). Whilst the Red-necked Avocet has not been detected before, this endemic shorebird is known to occur in small numbers across the broader region, e.g. small numbers observed at the Roxby Downs Wastewater Treatment Plant (WWTP) and near Olympic Dam in a small dam in 2024 as part of other surveys (Z. Bull pers. comm.). The Pelican is likely an overfly species that died as a result of lack of suitable habitat at the site (i.e. deep water with fish).

Bird families were well represented, with birds from 37 different families observed (increased from 22 in spring 2022 and 34 in autumn 2023). Many families were only represented by one species (20 families) or by two species (9 families). Meliphagidae (honeyeaters and chats) were the most represented (7 species), with Anatidae (ducks) represented by 6 species, Charadriidae (shorebirds) by five species and Psittacidae (parrots) by four species.

The species detected at the most fauna sites during site targeted bird surveys were the Australian Raven (17 sites), followed by Australian Pipit (15 sites), Rufous Fieldwren (14 sites), Singing Honeyeater (14 sites), White-winged Fairywren (13 sites), Black-faced Woodswallow (13 sites) and the Australian Magpie, Galah and Zebra Finch (all with 10 sites).

Family groups of two different types of Fairywren (White-winged and Purple-backed (Variegated) were present at a number of sites. White-winged Fairywren groups (males and females) were commonly observed across the Carrapateena Operation area in Chenopod habitats close to Western Myall Creeklines (e.g. Impact Site 3 adjacent the admin). Other species also showed breeding plumage, had juveniles present, were in breeding groups or nesting (e.g. Australasian Grebes, Black Swans, Black-fronted Dotterel, Orange and Crimson Chats, Eurasian Coots, Hooded Robin, Inland Dotterel, Wedge-tailed Eagle). The South Eliza Dams provided temporary nesting site for a number of waterbird species.

The House Sparrow (*Passer domesticus*) was again observed around both site camps in 2024, as per previous years. Both males and females were present, in similar numbers than previously, numbers are not declining. No Rock Dove (feral pigeon) (*Columba livia*) were detected.

Plate 3.13: Sharp-tailed Sandpipers at South Eliza Dam

Comparison with baseline data – birds

Mean bird species diversity per bird site in spring 2024 was 13.17 (increased from 5.6 spring 2022, 9.65 2023), with total diversity per site ranging from 4 to 35 species. More species were generally observed in creekline sites (e.g. Site 7, Site 10), or sites with Western Myall Woodland nearby (i.e. sites with a tree canopy in addition to shrubland understorey, such as Site 1, Site 16). Mean diversity per site in spring 2024 was well above the mean diversity observed in 2018-2023 (5-9.65). Species diversity per bird site was also well above the range recorded for baseline surveys (e.g. ranging from 4.1 in 2016, to 7.9 in 2013). This is likely related to the optimal conditions to detect birds (fewer windy days, warmer temperature and presence of water in dams), as well as the use of Song Meters to complement bird surveys. Noting that the lowest number of species detected was at Site 18, where a Song Meter was not deployed (also not deployed at Site 17, 19 and 20) and conditions were less suitable on the day this site was visited (warm and windy).

Total spring (74) bird species diversity across the site was above the range of diversity reported during baseline surveys (e.g. species diversity ranged from 42 in autumn 2017 to 70 in spring 2013; EBS 2017), and well above compliance monitoring numbers observed to date (2018 autumn to spring (46-51), 2019 (45), 2020 (44), 2021 (54), 2022 (37), 2023 (68)). Total number of bird families (37) represented across the site was within the range recorded during baseline survey results (e.g. families recorded ranged from 29 in spring 2012 to 38 in spring 2014 (EBS 2017)), and was also above results from previous compliance monitoring to date (e.g. 2018 (28-26), 2019 (21), 2020 (26), 2021 (29), 2022 (22), 2023 (34)). Given the

presence of water in all of the dams, the temporary excess Class A wastewater at South Eliza Dam, rainfall event in winter, and use of Song Meters to enhance survey effort, it is not unexpected that an increased diversity of species and families were detected. Although, noting only 10 additional species were detected via Song Meter. A variety of nomadic species were detected that had been rarely detected since baseline or early compliance monitoring (e.g. Rufous Fieldwren, Australian Pratincole). The variety of species and families of different types detected in 2024 and the ongoing evidence of numerous species breeding reflects stable conditions for an arid environment. In addition, the detection of Nationally listed shorebird species is a good indicator of stable conditions. Regardless, there is no evidence to suggest mining activities are impacting bird presence across the site.

Plate 3.14: Male Red-capped Robin near South Eliza Dam

Plate 3.15: South Eliza Dam, excess temporary water source

3.3.2.2 Reptile diversity

Eighteen reptile species from 160 detections were recorded across the sites during the spring 2024 survey (Table 3.22). During 2024, 73% of the records (116 out of 160) were through physical trapping, with the remainder detected opportunistically, including via spotlighting and via camera trap. In terms of diversity, 83% of species were detected opportunistically, and 72% of species were detected via pit / funnel captures (noting the overlap with some species detected through both pathways). The main species recorded in traps was the Salt-bush Ctenotus (*Ctenotus olympicus*) with the greatest numbers being detected at Site 4 (18) and Site 15 (15). The very high number of trap captures is likely due to the warmer temperatures during spring (refer Table 3.22).

Five common reptile families were well represented during the survey; including seven skink species, three dragon species and four gecko species. Juveniles of several species were detected during the survey (e.g. Earless Dragons, Bynoes Gecko, Salt-bush Ctenotus and Southern Four-toed Slider (Plate 3.16) indicating ongoing successful breeding activity across the site.

One species that has not been detected since baseline surveys (in 2016), the Southern Four-toed Slider (*Lerista dorsalis*), was detected at Site 6 through capture of a single juvenile individual. This species was detected during baseline surveys at Site 2, 3, 6, 15 and 16 (between 2012-2016), and detection of a juvenile individual during the current survey is a positive indication that the species persists in the area.

It is noted that in 2023 it was reported that the Eyrean Skink (*Ctenotus taeniatus*) was captured at Site 16, however there has been further taxonomic revision of this genus and the species was in fact the Short-legged Ctenotus (*Ctenotus strauchii*) (Mark Hutchinson pers. comm.) (refer Plate 3.17). This species was detected at Site 3 during 2024, previously detected in smaller numbers during baseline surveys and during previous compliance surveys in 2018, 2020 and 2023.

Also of note were detection of three snake species (Mulga Snake via camera trap (Plate 3.18), Curl Snake via funnel traps and Western Brown opportunistically in the Tjungu Village).

Plate 3.16: Juvenile (indicated by red tail) *Lerista dorsalis* (Southern Four-toed Slider)

Plate 3.17: Short-legged Ctenotus (*Ctenotus strauchii*)

Table 3.22: Reptiles observed at Carrapateena in spring 2024

Family Name	Scientific Name	Common Name	Fauna Site								OP/SP/CT Total[1]	All Total
			1	2	3	4	5	6	15	16		
Agamidae	*Tympanocryptis sp.*	Earless Dragon	[1 CT]			[1 OP, 1CT]	[1CT]				[4]	4
Agamidae	*Tympanocryptis tetraporophora*	Eyrean Earless Dragon	1 (P), [2 OP]	1 (P)	2(P), 1(F), [1 OP]	2(P), [2 OP]	1(P)	2(P), [1OP]	2(P)		[6]	18
Agamidae	*Tympanocryptis intima*	Smooth-snouted Earless Dragon	1 (P), [1 OP]			[1 OP]				1(P)	1 LFA TJU, [3]	5
Agamidae	*Pogona vitticeps*	Central Bearded Dragon		[1 OP]							1 CWM03 [2]	2
Elapidae	*Pseudechis australis*	Mulga Snake								[1CT]	[1]	1
Elapidae	*Pseudonaja mengdeni*	Western Brown Snake									1 TJU Village [1]	1
Elapidae	*Suta suta*	Curl Snake	1 (F)	1 (F)				1(F)				3
Gekkonidae	*Diplodactylus tesselatus*	Tesselated Gecko	1 (F)	2 (P), 1 (F)		5(P)		[2CT]			[2]	11
Gekkonidae	*Gehyra versicolor*	Eastern Tree Dtella									5 SP [5]	5
Gekkonidae	*Heteronotia binoei*	Bynoe's Gecko	1 (P)				1(F)			1(P), 2(F)	1 SED [1]	6
Gekkonidae	*Underwoodisaurus milli*	Common Barking Gecko	1 (P)									1
Scincidae	*Ctenotus olympicus*	Saltbush Ctenotus	2 (F)	2(P), 4(F), [1 OP]	3(P), 9(F)	9(P), 9(F)	6(P), 5(F)	8(P),1(F), [1CT]	9(P), 5(F)	2(P), 1(F), [2OP,1CT]	1 LFA TJU [6]	82
Scincidae	*Ctenotus robustus*	Eastern Striped Skink								1(P)		1
Scincidae	*Ctenotus strauchii*	Short-legged Ctenotus			2(P), [2]						[2]	4
Scincidae	*Lerista dorsalis*	Southern Four-toed Slider						1(F)				1
Scincidae	*Menetia greyii*	Common Dwarf Skink					[1OP]			2(P)	[1]	3
Scincidae	*Morethia adelaidensis*	Adelaide Snake-eye			1(P), [1 CT]						1 at S17, S19, SED [4]	5
Scincidae	*Tiliqua rugosa*	Sleepy Lizard			1(F)						1 at S17, tracks at S21, S22, SED [4]	5
Varanidae	*Varanus gouldii*	Sand Goanna									Tracks at S21, S22 [2]	2
	Totals detected	160	12	13	23	30	15	17	17	14	44	
	Total species[1]	18	7	5	5	4	4	5	2	6	14	

[1] OP/SP/CT = opportunistic (OP) / spotlighting / camera trap (CT), [X] = totals; all others captured in pit (P) or Funnel (F); total excludes *Tympanocryptus sp.* as most likely *T. tetraporophora*, but unable to confirm from camera trap footage.

Comparison with baseline data – reptiles

Total reptile captures / observations for spring 2024 (160) was well above autumn 2023 (39) and spring 2022 (88), and within the range for baseline spring surveys (49 in 2016, 184 in 2014 and 117 in spring 2017 (EBS 2017, site fauna database), and well above previous spring compliance monitoring totals (ranging from 39 to 112).

Results in 2024 for total species diversity (18) were above the baseline monitoring range, which ranged between 10 to 16 species (EBS 2017), suggesting firstly that there is no notable impact from the reduction in trapping effort and the number of trap lines deployed since 2017 (i.e. only one trap line per site), and secondly, that there is no evidence from the data for impacts to reptile diversity across the sites as a result of mining activity. Warmer daytime and overnight temperatures, and a storm event during the 2024 survey likely contributed to the result, presenting optimal conditions for a range of species. Regardless, detection of juveniles and species not recorded since baseline, suggests mining is not impacting reptile fauna at the site.

Total reptile species diversity across the Carrapateena location in 2024 (18 species) was just above spring of 2022 (17 species), and above the range of the previous compliance monitoring spring surveys in 2018, 2019, 2020, 2021 (12, 13, 14, 14 species respectively) and above the range of total species diversity reported during all baseline surveys between 2012 – 2017 (which ranged between 10 to 16 species, EBS 2017). All families previously detected in baseline and compliance monitoring were represented, with the exception of the Pygopodidae; however only one individual has previously been recorded across the Carrapateena location during the 2013 baseline survey (EBS 2013a) whilst spotlighting (*Pygopus nigriceps*, Black-headed Scalyfoot). The Pernatty Knob-tailed Gecko (Carphodactylidae family) and Centralian Blind Snake (Typhlopidae family) remain undetected since 2014, but these species were only previously reported during spotlighting (presumably in dune habitats, which are not part of the compliance monitoring program).

Similar to autumn 2023 compliance monitoring, detection of species that have not been detected since baseline is always a positive for the monitoring program. In 2024 the species not detected since baseline was the Southern Four-toed Slider. This species was only detected at Site 6, now classed as a control Site.

Mean reptile species diversity per fauna site was 4.8 in spring 2024, ranging from 2 to 7 species (Table 3.22). This has increased from 2022 (3.13) and 2021 (2.13) and is just within the baseline range (4.8 in 2012 to 6.6 in 2014). It is noted that mean diversity was not calculated in 2023 due to low reptile captures and was not reported in the baseline report in 2017. These results are positive, and despite a drier season, local climatic effects appear to be favouring certain species with warmer temperatures and humidity during the survey.

Plate 3.18: Mulga Snake captured via camera trap at Site 16

3.3.2.3 Mammal diversity

Fifteen mammal species were detected across the Carrapateena site during the spring 2024 survey (refer Table 3.23), excluding Sheep. Four mammal species were captured via trapping; Fat-tailed Dunnart, Stripe-faced Dunnart, Sandy Inland Mouse and House Mouse (28 captures in total). Rodents were recorded in lower numbers (1 and 2 respectively). No Forrest's Mouse or Planigales were detected during the current survey. Other animals detected include pest or exotic fauna, three Kangaroo species and five species of microbats.

Similar to 2021 to 2023, the Stripe-faced Dunnart was the most abundant small mammal captured at all sites (19 in total), slightly above 2023 (16) and 2021 (18), but lower than 2022 when conditions were more optimal (46) (Jacobs 2019a, 2023d, 2023h). Both males and females were captured, and a range of age classes were present with some evidence of pouch activity. One female captured via camera trap appeared to be pregnant (Plate 3.12). Fat-tailed Dunnarts represented the next highest number of records, with only five animals detected via fauna trapping and one detected via camera trap (Plate 3.19).

The White-striped Free-tail Bat is the only bat in South Australia that is audible to the human ear. This larger micro bat was not heard during spotlighting in Eliza Creek (Site 10) and was not detected via Song Meter at that site, however the species was detected at South Eliza Dam via Song Meter. Four other microbat species were also detected via Song Meter; Gould's Wattled Bat, Lesser Long-eared Bat, Inland Forest Bat and Inland Free-tailed Bat. There were a total of 25 detections of microbats at the three locations (Site 7, Site 10 and South Eliza Dam) across four nights, the majority at South Eliza Dam. Three species were detected at Site 7, three at Site 10 and all five species were detected at South Eliza Dam (Specialised Zoological 2025).

Minimal evidence of pest fauna species was observed at the fauna trapping sites and as mentioned in Section 3.2.5 evidence of grazing was limited at flora sites. Goats were not observed during this survey, but a small group is known to occur across the broader Carrapateena site. Rabbit scats, diggings and live animal were detected opportunistically, and an active warren was recorded on the track to Site 15. Foxes have been recorded on the site previously (2012, 2013, 2015, den in Eliza Creek 2019, dead fox at Anzac Dam in 2019). Similar to 2023, foxes were not detected during 2024. Cats are known to occur at the site and have increased slightly in recent times, particularly around administration areas, and management of the species is ongoing. No cats were detected at the fauna sites, but tracks and scats were detected at Flora Site 21.

Grazing management has changed across the site, with less areas under grazing and more fencing delineating grazed areas; flocks of sheep were only observed / detected (Song Meter) at Site 6. As a result, kangaroos are also being managed more effectively across the site and there is likely less competition for resources. Red Kangaroos, Euros and one Western Grey Kangaroo were observed across the study area and were noted to be in excellent health. Euros were recorded in similar smaller numbers than previous years and similar numbers of Red Kangaroos.

Plate 3.19: Fat-tailed Dunnart detected by camera trap at Site 15

Plate 3.20: Native Mouse, likely Sandy Inland Mouse at Site 5

Plate 3.21: Prey of Sandy Inland Mouse, key resource when grass seed is unavailable

Table 3.23: Mammals recorded at Carrapateena during spring 2024 survey

Family Name	*Scientific Name*	Common Name	Site								OP [Total]1	Total[2]
			1	2	3	4	5	6	15	16		
Bovidae	*Ovis aries*	Sheep (Feral Sheep)						Flock				NA
Dasyuridae	*Sminthopsis crassicaudata*	Fat-tailed Dunnart	1			1	1		3			6
	Sminthopsis macroura	Stripe-faced Dunnart	2	2	4	1	2	5	1	2		19
Felidae	*Felis catus*	Cat (Feral Cat)									[S21[4]]	1
Leporidae	*Oryctolagus cuniculus*	Rabbit (European Rabbit)							Active Warren		[S17, S22, LFA QUA, SED][3]; 1 x S21, 2 x NED, 1 x S19 [8]	8
Macropodidae	*Macropus (Osphranter) robustus*	Euro								[2]	[2]	2
	Macropus (Osphranter) rufus	Red Kangaroo			[1]	[3]		[1]		[4]	S21, DD, S7 [11]	NA
	Macropus fuliginosus	Western Grey Kangaroo									S22 [1]	1
Muridae	*Mus musculus*	House Mouse	1							1		2
	Pseudomys sp.	Native Mouse[4]					[1 CT][3]				[1]	1
	Pseudomys hermannsburgensis	Sandy Inland Mouse					1					1
Vespertilionidae[5]	*Nyctophilus geoffroyi*	Lesser Long-eared Bat									3 x S7, 1 x S10, 3 x SED [7]	7
	Vespadelus baverstocki	Inland Forest Bat									3 xS7, 1 x S10, 4 x SED [7]	7
	Chalinolobus gouldii	Gould's Wattle Bat									1 x S10, 4 x SED [5]	5
Molossidae	*Austronomus australis*	White-stripe Free-tailed Bat									1 x SED [1]	1
	Ozimops petersi (Mormopterus planiceps)	Inland Free-tailed Bat									2 x S7, 3 x SED [5]	5
	Total Trap Captures		4	2	4	2	4	5	4	3		
	Total Species Detected		3	1	2	3	3/4	3	3	5		

[1]OP = Opportunistic, SED = South Eliza Dam, DED = North Eliza Dam, LFA QUA = Mid-way Quarry, DD = Dawson Dam; S21 = Site CAR021, S22 = Site CAR022, S11 = CAR011 etc.; [2]Not Accurate given kangaroos / sheep were not always counted; CT –recorded on Camera Trap. [3] fresh tracks and / scats. Excludes recaptures.[4] Rodent captured via camera cannot confirm *Pseudomys* to species level, but not Plains Mouse or *Leggadina*; [5]All microbats recorded on Song Meter, mice and dunnarts caught in pitfall trap unless otherwise mentioned as CT.

Comparison with baseline data – mammals

Small mammal species diversity from trapping effort alone during spring 2024 (4 small mammal species) was within the compliance monitoring range (3 – 5) and within the baseline range (4 – 6). Two House Mice were caught in traps in 2024, at Site 1 and Site 16. The Narrow-nosed Planigale was recorded in previous surveys in low numbers, but is an elusive species that is more active during warmer temperatures. This species was not detected in 2024 despite warm nights and a rainfall event. Forrest's Mouse were also previously detected in small numbers and were not detected in 2024. There were however five microbat species detected in 2024 opportunistically via acoustic methods at three sites with water and / or roosting habitat (e.g. Site 7 (men's site), Site 10 (Eliza Creek, dry at time of survey) and South Eliza Dam (water present).

In general, mammal species diversity did not differ notably from previous surveys. Red Kangaroos were present across the site, and similar to 2022/2023 remain in good health compared to previous years and were observed in moderate numbers (not counted). Evidence of feral goats was present (scats) and other feral animals still present in low numbers on par with baseline numbers. There were ongoing signs / evidence of rabbits and also live sightings at an established warren near Site 15, as well as North Eliza Dam and Site 19 (Plate 3.22).

Mean small mammal species diversity per fauna trapping site was 1.9, down from 2.4 in autumn 2023 and from 2.75 in spring 2022, but still ranging from 1 to 3 species per site, which is on par with previous compliance monitoring surveys (small mammal captures only) and within the baseline surveys results presented in EBS (2017). These results are considered satisfactory given the low number of small mammal captures for the autumn 2023 survey. There was very little difference between small mammal species diversity and captures across sites, with the highest diversity recorded at both control and impact sites (Site 1 and Site 5 both with 3 species). Captures ranged from 2-5 individuals, with four of the sites recording 4-5 captures (Site 1, 3, 6, 15).

Total diversity of mammals (15) observed or captured throughout the survey was above the range of mammal diversity reported during baseline surveys, which ranged from 4 to 6 (small mammals only), Figure 3.49). It is however noted that baseline surveys did not always report on presence of microbats, Kangaroos, Fox, Cow, Euro, Bat, Sheep, but occasionally recorded rabbit (e.g. spring 2014), hence it is difficult to compare data.

In terms of small mammal diversity and abundance, there were more Stripe-faced Dunnart captures (19) than Fat-tailed Dunnarts (6). This follows the trend observed during baseline and compliance monitoring (Table 3.24). Males and female dunnarts were recorded as present for both these species, some with evidence of brood patch, suggesting that at least one round of breeding may have occurred prior to the survey. Two small mammals that were not detected in 2024 include Forrest's Mouse (*Leggadina forresti*) and Planigale (Giles (*Planigale gilesi*) or Narrow-nosed (*P. tenuirostris*)). These small mammals have been detected in smaller numbers or not at all some years during baseline and compliance monitoring (Table 3.24), hence the lack of detection in 2024 is not cause for concern. Similarly, no Plains Mouse were detected, continuing the trend of no detections since the commencement of the compliance monitoring. Only two rodent species were detected, the Sandy Inland Mouse (one captured and one likely via camera) and the House Mouse, both in very low numbers. Low numbers of rodents in general is likely reflective of

drier conditions in the preceding months before the survey, given rodents require sustained rainfall and associated resources to breed in larger numbers. The one rainfall event in July unlikely to sustain rodent numbers.

Microbat data collection and analysis were increased in 2024 (e.g. data collected at three sites, over several nights) and analysed using new methods (Specialised Zoological 2025). This resulted in detection of five microbat species in total, of which three had not been detected since the baseline monitoring (2007 and/or 2013); Lesser Long-eared, Inland Forest Bat and Inland Free-tailed (Figure 3.50). The Inland Free-tailed Bat was detected as a species in 2024, likely due to advances in acoustic analysis, previously only detected to genus level (*Mormopterus sp.*). Similarly, the Gould's Wattled Bat was detected to genus level in 2023.

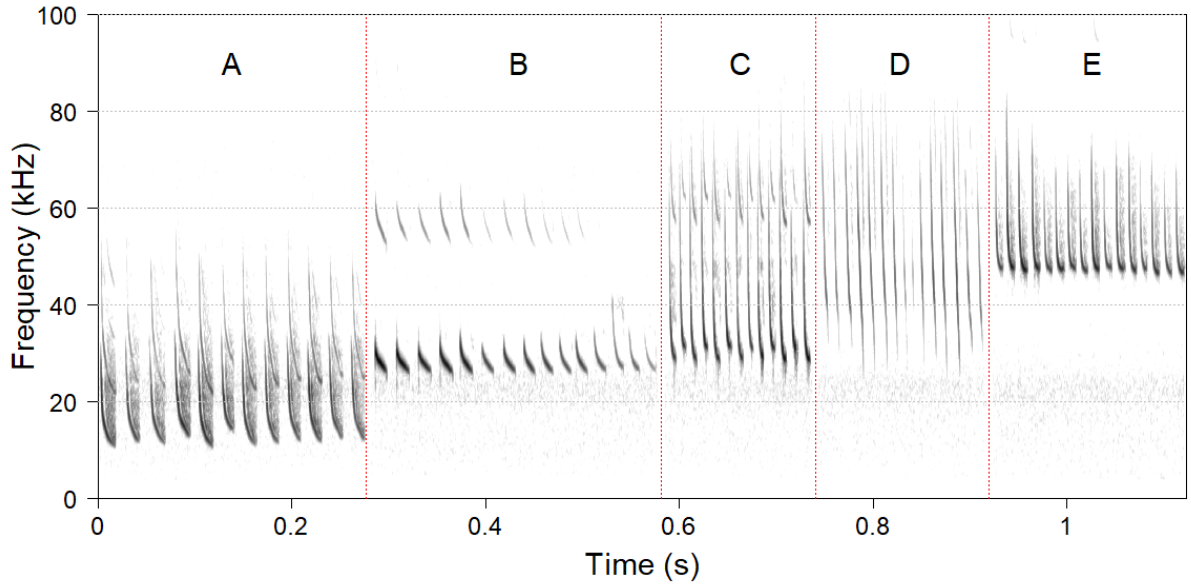

Figure 3.50: Representative echolocation call sequence portions of the species identified; (A) White-stripe Free-tailed Bat, (B) Inland Free-tailed Bat, (C) Gould's Wattled Bat; (D) Lesser Long-eared Bat, (E) Inland Forest Bat (time between pulses compressed).

Plate 3.22: Active rabbit warren at Site 15

Table 3.24: Summary of small mammal captures, baseline (2012-2017) versus compliance monitoring (2018-2024)

Family Name	*Scientific Name*	Common Name	Baseline (2012-2017)			Compliance (2018-2024)		
			Total[1]	Range per survey	Mean per survey	Total[1]	Range	Mean
Dasyuridae	*Sminthopsis crassicaudata*	Fat-tailed Dunnart	217	4-30	18	71	3-20	9
	Sminthopsis macroura	Stripe-faced Dunnart	610	8-95	51	124	3-47	16
	Planigale gilesi	Giles Planigale	56	0-10	<3	22	0-10	3
	Planigale tenuirostris	Narrow-nosed Planigale						
		Planigale sp.						
Muridae	*Leggadina forresti*	Forrest's Mouse	65	0-19	<7	23	0-8	3
	Pseudomys sp.	Native Mouse[5]	16	0-4	<2	4	0-2	<1
	Pseudomys hermannsburgensis	Sandy Inland Mouse						
	Pseudomys bolami	Bolam's Mouse						
	Pseudomys australis	Plains Mouse	37	0-20	3	0	0	0
	Mus musculus	House Mouse	11	0-10	<1	7	0-3	<1

Note: Numbers are rounded and do not account for recaptures as limited information is available for baseline data. [1]Number reflect totals, acknowledging that baseline totals include two surveys per year running two to four traplines per site and compliance surveys were reduced to one trapline per site and one survey per year from 2019 (two in 2018).

3.3.3 Control versus impact

Results from spring 2024 indicate that when combining total diversity of bird species observed, mammal species captured and reptile species captured / observed at fauna trapping sites, the mean species diversity is higher for impact sites than control sites using the original treatments (Table 3.25). However, when updating the treatments (Site 4 and 6 swapped to control Sites as explained in Section 2.3.2) the mean diversity is higher for control than impact. These results are summarised below in Table 3.25 and Table 3.26, respectively. A comparison of the mean total fauna diversity between control and impact sites (original treatment) using un-paired t-tests indicated no statistically significant difference (Control Mean +/- Standard Error (SE) = 32 +/- 3, Impact Mean +/- SE = 36.67 +/- 2.17, P = 0.3098). Similarly, comparison of means using the updated treatments, was also not statistically significant (Control Mean +/- Standard Error (SE) = 37 +/- 3.54, Impact Mean / SE = 34 +/- 1.41, P = 0.4608).

The mean number of total captures was higher at impact sites than control sites for the original treatment (Table 3.25) and the same for the updated treatment (Table 3.25). A comparison of mean total fauna captures (reptiles and mammals only) between control and impact sites using un-paired t-tests indicated no statistically significant difference for the original treatment, Control Mean +/- SE = 15.5 +/- 0.5, Impact Mean +/- SE = 24.5 +/- 2.17, P = 0.064; and for the updated treatment, Control Mean +/- SE = 22.25 +/- 4.23, Impact Mean +/- SE = 22.25 +/- 2.02, P = 1.0000.

These results indicated there are no differences in fauna species diversity or capture rates between impact and control sites with either of the treatment arrangements used (original or updated). This suggests there is no evidence that mining activity is impacting fauna diversity or trap capture rates. Whilst the differences for both diversity and captures were not statistically significant, the trends for the updated treatment suggest slightly higher at control Sites and aligns with the reallocation of treatment to Site 4 and 6. Similarly in the future there may be a need to reallocate control Site 1 and 2 to impact Sites, depending on influence of increased Khamsin Road traffic, Northern Wellfield activities. Regardless, overall diversity (birds, mammals and reptiles) and capture rates are within baseline ranges, and sites in closest proximity to the mine site (e.g. Site 3, 15 and 16) and camps provide good evidence that fauna impacts as a result of mining activity are not currently evident at Carrapateena.

Table 3.25: Comparison of fauna diversity and captures at control and impact sites (original treatment)

Site	Treatment	Diversity number of bird, reptile, small mammal captures / observed[1,2]	Average diversity at fauna sites by treatment type	Captures number of reptile, small mammal captures/ observed[1]	Average captures at fauna sites by treatment type
1	control	35	32	16	15.5
2	control	29		15	
3	impact	34	36.67	28	24.5
4	impact	46		33	
5	impact	30		20	
6	impact	38		25	
15	impact	36		22	
16	impact	36		19	

([1]Excludes kangaroos, goat, rabbit, [2]bird species only counted once)

Table 3.26: Comparison of fauna diversity and captures at control and impact sites (updated treatment)

Site	Treatment	Diversity number of bird, reptile, small mammal captures / observed[1,2]	Average diversity at fauna sites by treatment type	Captures number of reptile, small mammal captures/ observed[1]	Average captures at fauna sites by treatment type
1	control	35	37	16	22.25
2	control	29		15	
4	control	46		33	
6	control	38		25	
3	impact	34	34	28	22.25
5	impact	30		20	
15	impact	36		22	
16	impact	36		19	

([1]Excludes kangaroos, goat, rabbit, [2]bird species only counted once)

3.3.4 EPBC Act Protected Matters

The conditions of the PEPR require that records of three EPBC listed threatened species are reported if they a recorded during ecological surveys at site, namely Thick-bill Grasswren, Plains Mouse and Night Parrot. In addition, observations of the Migratory / Critically Endangered Curlew Sandpiper are to be noted as per EPBC referral commitments.

3.3.4.1 EPBC1 – Thick-billed Grasswren (Vulnerable)

No evidence of the Thick-billed Grasswren (TBGW) (*Amytornis modestus indulkanna*) (calls, direct observations) were observed during the 2024 survey, including bird surveys at 20 sites, or during opportunistic observations at dams and other likely habitat during the survey. As per 2023, Song Meters were deployed at all dedicated fauna sites, a pastoral dam (South Eliza Dam), Eliza Creek (Site 10) and a small patch of potentially suitable Thick-bill Grasswren habitat within the Carrapateena Wellfield Expansion area (Site 7). There was no evidence of the distinctive high pitch calls on the Sonogram outputs, only calls of White-winged Fairywrens and Purple-backed Fairywrens.

A total of 74 bird species were observed throughout the survey including other similar sized species, such as two species of Fairy-wren (White-winged, Purple-backed) and the Rufous Fieldwren.

Whilst captures for mammals were reduced, bird detection was increased due to both Song Meter detection and presence of water in dams.

3.3.4.2 EPBC2 – Plains Mouse (Vulnerable)

No evidence of Plains Mouse was recorded during pitfall and camera trapping at eight fauna sites during the spring 2024 survey, despite trapping effort within proximity to isolated patches of cracking clay habitat. However, it is noted that many gilgais did not show a large amount of activity, cracks and fauna runs into cracks. Native rodents were only captured on nocturnal cameras and in a pitfall trap at one site during the survey (Site 5). As per 2023, Plains Mice have also been detected in the region at the South Gap offset area (Nature Conservation 2025), and inside / outside the arid recovery area adjacent Olympic Dam, however in low numbers (i.e. only one at South Gap in 2024, Nature Conservation 2025). At South Gap it is considered the population has been undergoing a low, since mid-2022, and other small mammals have also been detected in low yet stable rates. The decline in detection in 2024, particularly given the survey effort (12 permanent camera sites, recording throughout the year) continues to suggest the population is currently declining (Nature Foundation 2025). The species was most recently caught at Carrapateena in 2017 (only 3 captured) prior to commencement of the compliance monitoring phase. Detection at South Gap in very low numbers, but not at Carrapateena us likely related to additional factors (reduced impacts from grazing and predators compared with Carrapateena). In addition, detection may also have been affected by the preceding climate conditions, reduced sustained rainfall that rodents require.

3.3.4.3 EPBC3 – Night Parrot Records (Endangered)

During the annual flora and fauna survey (spring 2024) at the Carrapateena Mine site, there was no evidence of Night Parrot (calls, direct observations or distinct feathers) at eight flora and fauna monitoring sites, 20 bird survey sites and a number of opportunistic observations at dams, during spotlighting. There was also no detection via Song Meter at the fauna sites or other opportunistic locations deployed (e.g. South Eliza Dam, Eliza Creek (Site 10, Site 7). A total of four parrot species were detected throughout the survey including four common parrot species (Eastern Blue Bonnet, Mulga Parrot, Australian Ringneck and Budgerigar).

No EPBC listed Parrots were detected during the spring 2024 survey.

3.3.4.4 Curlew Sandpiper (Critically Endangered)

The EPBC listed Critically Endangered and Migratory Curlew Sandpiper (*Calidris ferruginea*) is not covered by the PEPR conditions for Carrapateena, but is one of the four EPBC species that was considered in the Operation's EPBC referral. Whilst it was considered unlikely to occur at the site, there is potential the shorebird could visit water habitats at the site.

No evidence of Curlew Sandpiper (calls, direct observations) were detected during the 2024 spring survey, whilst undertaking bird surveys at 20 sites, or during opportunistic observations at dams or on Song Meter outputs. All dams contained water during the survey period and were quite full with little exposed mud areas. The South Eliza Dams had overflow and temporary wetland conditions, with large numbers of water bird species presence. A total of 74 bird species was observed throughout the survey; with two EPBC listed as Migratory shorebirds detected; Common Sandpiper and Sharp-tailed Sandpiper (also EPBC Vulnerable). A number of waterbird species and resident or endemic shorebirds were also recorded in water habitats; Banded Lapwing, Masked Lapwing, Black-fronted Dotterel, Red-kneed Dotterel, Red-necked Avocet, Inland Dotterel and Australian Pratincole).

3.3.5 Vouchers

For the spring survey no trap deaths occurred, hence no vouchers were provided as specimens to the SA Museum as required.

3.3.6 Pitfall line integrity

As mentioned earlier, the trapping effort at the site has been reduced over the years from four pit lines to one pit line per site being opened during each survey. The reduction in number of lines was undertaken to align the survey effort undertaken with the requirements of the PEPR (i.e. focus on species diversity and not focus on measures of abundance or a need for high capture rates). There has been some flexibility in the pits and lines opened during compliance monitoring to date, using only 6 of the 7 pits in a line, and potentially using different pit lines at a site over different surveys. Previously some of the pit lines contained pits that required maintenance or permanent removal as the integrity of the pit bases did not meet ethics standards. These holes were likely related to historical Planigale presence and potentially extraction of small skinks that had managed to get under the base liner. In 2019 it was recommended

that a whole pitfall line be removed from Site 5 which was completed by site environmental staff. In 2019 it was also recommended that other lines either have existing semi-permanent pits reinstated or maintenance of pit bases be added to the site enviro maintenance program which was undertaken. Initially, site environmental staff have replaced metal mesh bases (previously attached with large rubber bands / gaffer tape prior to inserting pit tube into the hole) with a similar size plastic mesh that could be attached with hot glue / selastic. This was required given the effort to extract the pit tubes which are wedged into the clay holes. The upgraded bases worked well in 2021 and 2022, but some still required further maintenance given Planigales and House Mice ongoing capture and damage of pit bases. Following the 2023 survey, the site environmental team began replacing damaged pit bases with custom-made stainless steel bases with numerous holes (2-3 mm) drilled in, to reduce ongoing maintenance and improve pitfall trap integrity across the mine site. The new bases were easy to install and can be removed with narrow-nosed pliers and a rubber mallet.

As per above regarding pit maintenance, data on pitfall traps and lines that still require new bases is provided to the BHP environment team at the end of the survey and maintenance is undertaken in the cooler months. During the maintenance schedule the pit lids are also checked to ensure that they are secure and there are no gaps where animals (particularly very small skinks, geckos, juvenile mammals) can squeeze into cracks can get in and become trapped outside of the survey period. This is required six monthly as per the Wildlife Ethics Permit. The process for securing the lid involves: digging around the top of the pit, below the lip of the pit lid (e.g. ~10cm), then aligning pit lid, banging the lid down and inserting the tech screw through the lip of the UV stable lid and the UV stable pit liner. Prior to this process the pit is checked that it is free of any fauna, particularly if pits are left open for a short time for maintenance or pit bases. These steps are required because the mine site has been approved to close pits with a tech screw rather than filling the traps with non-perishable material (e.g. rocks, sand or sandbags) at the end of the survey, as is the protocol associated with the permit for this Operation and in the Wildlife Ethics Guideline (DEW 2023). Rocks are also placed on top of closed pits to reduce UV exposure to the lid. Ethics require photos of the closed pits, and GPS coordinates of all pits, are provided in the annual Wildlife Ethics Report (due 1 February each year - Lathwida prepares on behalf of BHP), for the Permit requirements.

4 Discussion

4.1 Summary of Spring 2024 results

4.1.1 Assessment of mining impacts

Potential impacts from mining activity on vegetation would be represented by a decline in the number of native species present; a decline in the abundance of individuals within a species; a decline in plant health (e.g. due to potential raised dust settling on plants, saline seepage from tailings dam and/or altered groundwater levels) and/or an increase in weed presence. The discussion below outlines why the 2024 survey results do not indicate impacts on vegetation from mining at Carrapateena.

4.1.2 Native flora species diversity (RAM sites)

Monitoring of perennial species diversity (number of species present) provides an indication of long-term trends in plant populations. Prior to operational monitoring, baseline monitoring was conducted between 2012 and 2017. This period included years of average, well above-average and well below-average rainfall, hence providing a wide range of data, against which compliance data can be compared.

At the Carrapateena operational area, long-lived species diversity is monitored at the scale of individual one-hectare sites, at a habitat scale (stoney tableland, dunes, drainage lines) and at a landscape scale (number of plant species present across the whole operational area). Long-lived plant diversity is relatively constant in undisturbed environments. In contrast, ephemeral diversity varies greatly in response to rainfall in arid rangelands. Long-term monitoring of short-lived plant diversity however is also important because short-lived plant species often comprise most plant species in arid rangelands (Davies et al. 2018). Long-term changes (10+ years) in short-lived species diversity may indicate possible irreversible changes such as due to climate change, loss of soil seed bank, grazing impacts.

4.1.2.1 Flora diversity across the whole Carrapateena operational area

In spring 2024, a cumulative total of 141 native flora taxa was recorded at the RAM flora sites across the Carrapateena Operation area. This was the equal highest diversity recorded during the any of the compliance monitoring surveys, which began in autumn 2018. The high species diversity was due to the high diversity of short-lived species: the total of 81 short-lived species in 2024 was the second highest recorded during the compliance monitoring to date, while the long-lived species diversity was within the range recorded during the previous compliance monitoring surveys. Long-lived plant diversity has been very stable, with yearly totals ranging from 58 to 62 since autumn 2018, and 60 species recorded in 2024. The very high number of short-lived species recorded in 2024 is likely to be the result of above-average rainfall received in June, July and August preceding the survey. For the stoney tableland flora sites, much of the short-lived species diversity is contained in the small gilgais (and as documented by Davies et. al. 2018), re-enforcing the importance of this micro-habitat. In 2024 the mean total species diversity for impact sites and for control sites was not significantly different (29 and 28 species, respectively), and within the baseline range. Given post-construction monitoring results have not shown clear trends

emerging in long-lived or short-lived species diversity, and no significant difference between control and impact site mean diversity, it is considered that there has been no impact on perennial or short-lived species diversity from mining.

4.1.2.2 Flora diversity for individual habitats

Eliza Creek sites. Flora Site 10 was the only site on Eliza Creek to be established during the baseline survey period. To provide additional data against which to monitor potential impacts of the TSF dam embankment on downstream Eliza Creek habitats, flora Sites 17, 18, 19 and 20 were established in autumn 2018. Given the TSF became operational in 2020, the 2018 and 2019 surveys represent pre-construction species diversities. Since 2018, there has been no distinct trend in species diversity for any of the Eliza Creek sites, with mean diversity for 2020 to 2024 surveys (namely, TSF operational) being similar to 2018 and 2019 tallies.

Dune habitats. No dune habitat flora sites were included in baseline monitoring. Hence, flora Sites 21 and 22 were established to determine potential impacts from mining on sand dune habitat. Site 21 is considered a control site (> 2 km from mining infrastructure) and Site 22 a potential impact site as it adjoins the Western Access Road (< 2 km from mining infrastructure). Since 2018, no clear trend in long-lived species diversity has emerged at either site, hence species diversity in the dune habitat is not considered to have been impacted by mining activities.

Gibber (stony tableland habitat). As at spring 2024, there were also no trends emerging in species diversity at either control or impact sites in gibber (stony tableland) habitats, the dominant habitat within the mining lease.

4.1.2.3 Flora diversity for individual sites

At individual impact and control sites, perennial species diversity has been very consistent between surveys, for all sites except impact Site 12 and control sites 1 and 2. The latter have fluctuated between survey periods, but show no obvious trends. Variations at these sites occurred prior to 2022, and are thought likely to be due to variation between observers in interpreting survey boundaries, rather than actual changes in perennial diversity. Given that there have been no consistent trends in plant diversity for individual sites, it is considered that there has been no impact on mining at either the site level, habitat level or landscape level.

4.1.3 Long-lived woody perennial species diversity and abundance (Jessup transects)

To analyse potential mining impacts population trends (abundance) in long-lived woody plants, Jessup transects have been surveyed during baseline and construction monitoring. Since 2018, the population of the three most abundant and widespread shrubs have been analysed in detail, namely: Bladder Saltbush, Sea-heath and Samphire. Following declines in the abundance of all three species in 2019 and 2020/2021, the abundance of all three species across all sites, has increased or remained stable since 2021/2022. The widespread declines were associated with below average rainfall in 2017, 2018 and 2019, with the total rainfall in 2019 being 30% of the long-term mean, and with widespread dieback of shrubs noted during the 2019 and 2020 surveys. During prolonged drought, Bladder Saltbush drops its leaves and hence even

if still present may have become less obvious in the Jessup transects. The increases in population abundance since 2021 have been associated with average or near-average long term rainfall totals. In 2024, the populations of the above four species either remained within the baseline range, or had recovered to once again be within the baseline range.

Bladder Saltbush is the dominant shrub and plant cover at all gibber sites and is slightly to moderately palatable in this environment. Bladder Saltbush has a lifespan of approximately 25 to 30 years and is recognised as an important species for ecosystem stability in rangelands of southern Australia (Walsh et. al. 2005). Widespread regeneration of Bladder Saltbush was recorded at the Jessup sites, in both 2023 and 2024, largely contributing to the recovery of Bladder Saltbush populations since 2020. In 2024 the number of juveniles recorded was the highest since construction monitoring began. Although many of the juveniles in 2024 were less than 10 cm tall, not woody and unlikely to survive an extended hot dry period, the survival of even a small percentage is likely to assist in there being a sustainable population. At control sites, the mean number of Bladder Saltbush (adult and juvenile combined) in 2020, 2021, 2022 and 2023 were all below the baseline range but in 2024 had recovered to be once more within the baseline range. Bladder Saltbush appears to germinate readily in cooler months, after good rains. The widespread regeneration in 2023 and 2024 correlates with average to near-average yearly rainfall totals. Since 2018 (compliance monitoring) the correlation of population size with rainfall and the greater recovery at impact sites (compared with control sites) indicates that rainfall totals rather than mining has influenced Bladder Saltbush populations.

As with Bladder Saltbush, the abundance of Samphire plants in Jessup sites declined in 2020/2021 following below average rainfall years. The population means for both impact and control sites returned to being within baseline ranges, in 2023 and 2024. As with Bladder Saltbush, the greater recovery at impact sites rather than control sites indicates that Samphire abundance has not been affected by mining related activities. During compliance monitoring, the population of Sea-heath recorded at Jessup transects also declined during the below average rainfall years of 2018 – 2020 but has increased since 2021 with increased yearly rainfall. During compliance monitoring the mean population of Sea-heath at impact sites has remained within the baseline range, while the mean population at control sites has been within the baseline range for all years except 2021. Samphire and Sea-heath are unpalatable species not grazed by stock, kangaroos or feral animals. Hence changes in abundance are potentially due to mining activities or climate changes. Impact sites, however, have either shown similar trends to control sites, or even increased population trends. Changes in abundance also show a strong correlation with rainfall totals - with increased populations recorded since 2021. Hence this suggests that changes in abundance in these species are related to climatic changes rather than impacts from mining. Plains Lantern Bush and Bladder Saltbush are moderately palatable and their increased abundance may be due to both increased rainfall and widespread destocking across the lease area.

In 2024, the Plains Lantern Bush population at Jessup transects was the highest recorded during both baseline and compliance surveys, and largely due to increases at impact sites. Juveniles were present indicating the recovery was due to increased rainfall stimulating germination and/or reduced grazing pressure (Plains Lantern Bush is moderately palatable).

Bush Minuria, although relatively resistant to dry periods, it is moderately palatable, and normally found in the protection of woody shrubs such as Bladder Saltbush. As with other long-lived shrubs recorded at the Jessup sites, Bush Minuria abundance declined (or remained at very low levels) in 2020 and 2021 but increased in 2023, by at least 200% at all sites, and recorded further increases in 2024. As with Plains Lantern Bush and Bladder Saltbush (also moderately palatable), the recovery of Bush Minuria coincided with increased rainfall and widespread destocking.

In summary, the population abundance of the five most abundant and/or widespread long-lived shrubs declined during 2018/2019 to 2020, but have all increased since 2021/2022. At control sites, the declines were either similar or greater than at impact sites. This indicates that the declines were due to factors other than mining impacts. The population fluctuations in the long-lived shrubs are attributed to fluctuations in yearly and longer- term rainfall totals rather than mining impacts. Exceptionally dry conditions in 2018 and 2019 are likely to have caused widespread dieback and decline of long-lived shrubs. Samphire and Sea-heath are non-palatable, removing grazing as a cause of the decline experienced in these species. Grazing impact has declined across all the study sites since 2018 (refer Section 3.2.5) which removed grazing as a possible cause of reduced abundance of the more palatable long-lived shrubs (Bladder Saltbush, Bush Minuria and Plains Lantern Bush). Widespread recovery of shrub health and increased germination since 2020/2021 has coincided with average or above-average yearly rainfall totals for the region.

To provide data against which to assess potential impacts on vegetation downstream of the TSF, four flora sites, which included Jessup transects, were established in autumn 2018, located progressively downstream from the TSF embankment within Eliza Creek. A fifth site was established during baseline surveys, located furthest from the TSF on Eliza Creek. At all sites, the total number of long-lived woody perennials present in the Jessup transect, has increased since 2018. Ten of the most abundant long-lived woody perennials recorded at the Eliza Creek Jessup transects were separately analysed. All 10 species have shown yearly fluctuations, but have either recorded no long-term change in abundance, or an increasing abundance trend. The only exception was Dead Finish which has recorded a downward trend at Site 10, since 2021. Dead Finish occurs in dense clusters at Site 10, and fluctuating numbers may reflect differences in distinguishing individual species between survey periods. At the Jessup transects upstream from Site 10 (namely, closer to the TSF than Site 10), populations of Dead Finish have remained stable since 2018.

Western Myall is the dominant tree at Jessup Sites 17 and 18. Western Myall abundance has fluctuated yearly at these sites, but without displaying a downward trend. The population fluctuations are largely due to fluctuations in seedling abundance (including some seedlings likely germinating, but not surviving beyond a year). Regeneration of Western Myall has been widespread. In 2024 most regeneration was recorded at the Jessup Site 17 where there were nine juveniles. This is notable as Site 17 is less than 300 m from the TSF and the adult and juvenile Western Myall trees remain healthy with regular recruitment and/or growth of trees.

The Eliza Creek Jessup transects have shown an increase in total perennial species abundance, as well as no decline in individual species abundance. Hence, no impact from mining activities is considered evident at the Eliza Creek flora sites.

4.1.4 Plant health

During the survey, there was no dust layer noted on plants. This aligns with findings of the Dust Impact study (Jacobs 2020b) which recorded no significant decline in plant health or vigour at distances greater than 10 m from roads. No new impact on plant health due to salinity was recorded.

In 2024, qualitative observations of Bladder Saltbush noted that dieback/ leaf loss was much reduced compared to 2020 levels, and that almost all shrubs were heavily in fruit, perhaps the most since compliance monitoring began (pers obs. S Croft who has conducted all surveys since 2018).

At the Eliza Creek flora sites, qualitative observations noted that the only species with reduced vigour were Green Emubush (*Eremophila serrulata*) and Crimson Emubush (*Eremophila latrobei*). These species displayed leaf yellowing in approximately 25% of the population. No species death was noted and there appeared to be no decline in abundance as indicated by Jessup data.

In summary, 2024 survey results indicate that there are no current detectable impacts from mining on flora, i.e. no long-term decline in the number of native species present; no long-term decline in abundance of any species, no differential decline between control and impact sites in the abundance of individuals within a species; and no decline in plant health (e.g. due to potential raised dust settling, saline seepage)..

4.1.5 Tree health (canopy cover)

The canopy health of the dominant tree species at Eliza Creek sites (17, 18, 19 and 20) has been assessed since 2018 using both a GRS densitometer and visual estimates of canopy intactness. Canopy cover was also assessed at transects in the Eliza Creek sites to assess potential impacts on tree health due to seepage from the TSF or reduced water flows down the catchment. Comparing the total number of densitometer foliage records along a transect over time provides an indication of changes in total canopy cover. Potential changes in total canopy cover may be a combination of canopy expansion of existing trees; recruitment of trees and/or canopy decline of existing trees. At each Eliza Creek site, there are two nearby parallel transects. Along each 100 m transect, readings were taken every metre, hence the number of readings showing canopy cover equates to the percent canopy cover along the transect. Additionally, visual estimates were made (with no tool) of the entire canopy of individual trees, to assess the extent of foliage compared to the potential extent of foliage expected of a tree in good health (after Souter et al 2009).

4.1.5.1 Western Myall trees

At sites 18, 19 and 20, the total number of Western Myall foliage records for each site has trended upwards since 2018. The increase in densitometer foliage records at each site is largely due to additional trees recorded along each transect. Visual estimates of tree canopy extent have remained stable for each site. For all transects combined there has been a net increase of 21 live Western Myall trees with a loss of two trees, but 23 new trees recorded since 2018. In 2024 four new Western Myall trees were recorded along the transects (one at Site 17, two at Site 18 and one at Site 19) and no deaths. The two Western Myall trees that have died since 2018 were trees with pre-existing very high levels of canopy loss prior to operation monitoring. In summary, since 2018, there has been an increase in Western Myall foliage recorded along the transects, and the very high levels of canopy intactness of existing trees has remained

constant. These results indicate that there has been no decline in Western Myall tree health collectively for each site, and there has been strong recruitment and/or growth of juvenile trees. As at 2024, mining related activities (impacts from TSF) have not impacted Western Myall abundance or health along the Eliza Creek canopy cover transects.

4.1.5.2 River Red Gums

During the compliance monitoring (2018 to present), the canopy intactness levels of River Red Gums has varied considerably, both within individual trees, transects and between survey periods. However, the number of River Red Gum densitometer foliage records in 2024 was similar to the number of records in 2018. The records declined during and following the low rainfall years of 2018 and 2019/2020, followed by gradually increasing foliage trends. Well-below average rainfall was recorded in 2018 - 2020, followed by two years of average rainfall, but which included exceptional rainfall events in spring and summer.

Site 19 is 3 km from the TSF, and the first occurrence of River Red Gums downstream from the TSF. Site 20 is 4.6 km from the TSF. For both of these sites and transects, the number of foliage records have been relatively stable since 2022, and 2024 records are similar to those in 2018/2019. In 2024, the number of live River Red Gums present at Sites 19 and 20 was the same as in 2019.

Changes in the cover of River Red Gum canopies during operation monitoring is likely to reflect seasonal conditions, which in turn, will have varying impacts depending on unquantified variables such as age and size of tree (which will determine root depth and access to water). The impact of well above-average or well below-average rainfall on River Red Gums seems to be apparent within 12 months, with foliage shedding occurring in 2019 (low rainfall year) and increased foliage being recorded in 2021. Foliage records for transects at Site 19 and 20 in both 2023 and 2024 showed that River Red Gums had regained canopy losses in 2018-2020. However, there has been no recruitment of River Red Gums recorded along the transects.

To date, no potential impacts resulting from the construction and operation of the TSF to the dominant trees within Eliza Creek are evident.

4.1.6 Weed diversity and abundance

There were no new weeds recorded in 2024 and no overall increase in abundance or extent of weeds declared under legislation. Although not declared, Wards Weed was recorded along the Western Access Road for the first time. This introduction may be due to mine related activities. Further details are provided below.

4.1.6.1 Weed species Declared or listed under legislation (*Landscape South Australia Act 2019*)

Declared weed species recorded during compliance/operational surveys were Bathurst Burr (*Xanthium spinosum*), Athel Pine (*Tamarix aphylla*) and Prickly Pear (*Opuntia* species). These species have been recorded during all operational surveys. Athel Pine and Prickly Pear species are also considered to be Weeds of National Significance (WoNS).

To date during operational monitoring, Athel Pine has only been recorded as clustered trees around Yeltacowie Homestead and the nearby dam. These trees are being actively controlled with numerous dead trees and/or cut trees present in 2023 and 2024. In 2024 it was noted that a few trees remain at the site. The Carrapateena station falls within the Kingoonya group of the South Australian Arid Land landscape board. Land managers are required to control Athel Pine within 100 m of watercourses and waterholes (up to 3 Athel Pine at Carrapateena are within 100 m of a watercourse), but land managers are encouraged to monitor success of control and carry out follow up control of all trees, as necessary. It is recommended that existing control efforts be consolidated by lopping or otherwise killing remaining trees and trees that have resprouted.

Up until 2023, Prickly Pear was documented from only one location (near the Yeltacowie homestead) within the Carrapateena operational area. This small population has been actively managed during operational monitoring and the population has been reduced to several square meters. In 2024, however, BHP environmental staff have reported additional occurrences of Prickly Pear. These are recommended as high priority for control.

In 2024, Bathurst Burr was recorded within the operational area only at previously recorded locations: Dawsons Dam, South Eliza Dam, and weed transects CWM01 (including Whittata Creek) and CWM02 both transects adjoining the Southern Access Road. No new populations, and no expansion of existing populations, were recorded. Plants were again recorded in the overflow area of South Eliza Dam, but in 2024 this area contained surface water due to pumping of waste treatment water into South Eliza Dam. The extra water has created and enhanced habitat for numerous bird species, but conversely has the potential to increase the spread of weeds.

In South Australia, Bathurst Burr is Declared under the Landscape South Australia Act 2019. In the SA Arid Lands, control is not enforced but landholders are encouraged to manage infestations (Government of South Australia (2021). Weed transect CWM02 occurs within Mineral Lease 6172 and CWM01 falls within the Southern Access Road and Radial Wellfield MPL 154. It is recommended that BHP work with the station owner to manage infestations at Dawson Dam and South Eliza Dam.

4.1.6.2 Non-declared Weeds

New Weeds

No new species of weeds were recorded during the 2024 survey.

Increases in abundance and/or new locations of existing weeds

Six species were recorded at previously unreported locations. These species are either annuals or require moist habitats, and have been consistently and widely recorded during baseline and/or construction surveys. Annuals may persist in the soil seed bank and only germinate when conditions are favourable. Hence, some widespread annual weeds were recorded at new locations, and conversely some annual weeds were absent from previously recorded locations. Since monitoring began, there have been yearly fluctuations in the locations of annual herbs or grasses, including Smooth Mustard, Sow Thistle, Bitter Melon. These fluctuations reflect seasonal rainfall patterns rather than mining impacts. Their occurrence at any particular location is likely to vary from year to year and un-related to mining activities.

The annual species, Smooth Mustard was recorded in greater abundance at the designated impact flora site in dune habitat (Site 22), and at a flora site on Eliza Creek (Site 20) for the first time. Conversely, however, it was not recorded at several sites where previously recorded. Smooth Mustard is an annual species that has been consistently and widely recorded during baseline and construction surveys. Its occurrence at any particular location is likely to vary from year to year. Greater abundance of this weed at some locations is likely a reflection of rainfall received and also the time of survey, the October 2024 survey being approximately 4 months later than previous autumn surveys. Since operational monitoring began in 2018, the overall population of Smooth Mustard is not considered to have increased.

Two Wards Weed (*Carrichtera annua*) plants were recorded on the shoulder of the WAR approximately 5.5 km from the Stuart Highway. It has only previously been recorded within the Carrapateena operational area along the SAR as an isolated patch. This was in 2021 when the SAR was the main access to the mine site. The WAR was constructed/upgraded in 2022, specifically for vehicle access to the Carrapateena Mine site. Wards Weed therefore may have been introduced to the WAR as a result of mine-related activities. It is recommended that this small population be located in winter when it is actively growing and eradicated.

In 2024, Maltese thistle (*Centaurea melitensis*) was recorded for the first time along weed transect CWM01 adjoining the SAR. Maltese thistle has previously been recorded during baseline and compliance surveys in Eliza Creek and at Dawsons Dam. Its presence in 2024 in a SAR culvert and in Whittata Creek, is likely due to seeds being transported by water from the Whittata Creek complex, and not as a result of mine-related activities.

A few plants Mallow (*Malva parviflora*) were recorded at North Eliza Dam. This species has previously been recorded at South Eliza Dam, Anzac Dam and ephemeral watercourses along weed transects CWM01 and CWM02. Mallow is associated with high nutrient, moist soils and its presence at North Eliza Dam is likely due to the moist habitat, enhanced soil nutrients from stock grazing, and unrelated to mining activities. Scarlet Pimpernel (*Lysimackia arvenis*) was recorded for the first time at North Eliza Dam, but has

previously been regularly recorded at the Expo Village Effluent Irrigation area and along weed transects CWM001 (culvert area) and CWM06 (ephemeral drainage line). Its presence is strongly linked to wet habitats and its occurrences other than at the Effluent areas is unrelated to mining. Weeds associated with the Effluent Irrigation area rely on this moist environment and are unlikely to spread beyond the irrigated area. Trailing Verbena (*Verbena supina*) was recorded at North Eliza Dam for the first time. This species has previously been recorded at Anzac Dam. Its presence is due to presence of surface water rather than mining related activities.

Non-declared weeds with potential to spread

Couch grass was recorded near the SAR, associated with Whittata Creek. Couch is present in the wider region associated with dams, watercourses and settlements, with the nearest public database records being Roxby Downs, Stuart Creek Homestead Dam, Curdimurka railway siding and watercourses at Witchelina and Flinders Ranges (ALA 2024). Although drought tolerant, Couch grass prefers moist locations, and colonises sites subject to disturb ace such as grazing. Its origin at Whittata Creek is unknown, but because the occurrence along Whittata Creek was approximately 35 m from the SAR, it seems unlikely to have been transported in by mining vehicles. Couch grass however has the potential to spread aggressively along the creek, by rhizomes and stolons, and sensitive environmental control is recommended.

4.1.7 Landscape Function Analysis

The spring 2024 survey was the sixth assessment of Landscape Function at two sites prepared for rehabilitation in 2019 (Aerodrome and Ventia sites), and the third assessment at two sites (Midway Quarry and Tjungu) prepared for rehabilitation in 2022. All sites were devoid of plants when initially prepared for rehabilitation and were on sites that would have formerly supported Bladder Saltbush +/- Samphire low shrubland on stony tableland. The Point-Centred Quarter (PCQ) method has been used to complement the LFA survey, to additionally record plant density and diversity in the early stages of rehabilitation when plant density along the LFA transect line is sparse. PCQ monitoring began in 2020 for the Aerodrome and Ventia sites, and in 2023 for the Midway Quarry and Tjungu sites.

For the LFA established method, successful rehabilitation has occurred when various plant cover and soil parameters that contribute to capturing nutrients in the landscape, are equal to those measured in reference (analogue) habitats. By 2023, the Tjungu LFA site had already exceeded plant densities recorded at analogue sites, despite only being established in 2022. In 2024 mean patch density at the Tjungu site increased still further to 7 patches per $10m^2$ (compared with the analogue mean of 3 patches per $10m^2$). In 2024, the Tjungu vegetation patches comprised between 23% and 33% of the linear transects. The species composition was also comparable with reference Bladder Saltbush communities. Ten native species were recorded including 4 long lived perennials, which in turn included several plants of Bladder Saltbush. Further, plant density was relatively even along the transects, there being no major gaps with no vegetation patches. The rehabilitation success of this site correlates with the deep ripping that occurred, not only providing deep trenches to capture water and seed, but also to create high volume surface rock cover that also assists in trapping nutrients. This site is considered to have been successfully and sustainable restored and further monitoring is not considered necessary.

Since 2022, the Aerodrome LFA site has also reached and slightly exceeded mean vegetation patch densities recorded for the reference (analogue) sites, the Aerodrome LFA recording 3 to 4 patches per $10m^2$. In 2024, 9 short-lived perennials and 3 long-lived plants were recorded at the Aerodrome LFA. The long-lived species were recorded along the LFA for the first time in 2024. Unlike the Tjungu site however, the Aerodrome transects each comprised extensive lengths of the transect where no vegetation patches were present. The relative success of rehabilitation at the Aerodrome correlates with the depth of trenches prepared and volume of surface rock – trench depth and surface rock volume were less than Tjungu LFA, but greater than Ventia and Quarry LFA sites.

The Midway Quarry site since its establishment in 2022 has recorded increases in plant density in 2023 and 2024, but the patch density of one plant per $10m^2$ is below the analogue mean of 3 patches per 10m2. Trench ripping at the midway Quarry site was relatively shallow and very little surface rock was present. Only two species were recorded along the transects, both short-lived perennials. This site should be continued to be monitored for rehabilitation success using both the LFA and at least in the short-term, the PCQ method.

The Ventia site trenches were very shallow and in 2024 only one patch comprising a short-lived biennial was recorded along one transect. The other transect at this site had been graded and was being used as a temporary laydown area for adjoining road construction. It is recommended that these sites be prepared again for rehabilitation with deep ripping.

Of the species that were hand-seed to prepare the Tjungu site, only two were recorded in 2024: Pop Saltbush (*Atriplex holocarpa*) and Bladder Saltbush. These species were also present at other rehabilitation sites. Although all of the hand-seed species have been recorded within the Carrapateena Operation survey area, in the rehabilitation habitat (stony tableland) the hand-seeded species most likely to naturally occur are: Pop Saltbush, Grey Bluebush (*Maireana appressa*), Bladder Saltbush and Shrubby Twinleaf (*Roepera aurantiacum*). Within the Operation survey area, the remaining hand-seeded species are more commonly associated with major creek lines, floodouts/clay depressions and/or dunes.

Soil properties

The LFA established method also reports on soil stability, infiltration and nutrients. Since the first LFA assessment at each site, the four rehabilitation sites have all recorded a soil stability index approaching the reference (analogue) mean. This is largely due to the heaver soil texture (high clay component) of the sites. However, the soil stability index declined slightly for all 4 sites in 2024, perhaps reflecting the flattening out of the trenches. Further improvement is expected however, as patch cover, litter cover, and deposited materials increase. For the soil infiltration index, in 2024, the indices recorded at the Aerodrome and Tjungu sites were approaching the analogue means. At the Ventia and Midway Quarry sites, the soil infiltration index has declined. This is likely due to the evening out of troughs reducing soil roughness, while vegetation and litter cover remaining low. Further improvement is still required at all sites to meet the analogue mean.

The nutrient index for each site has been highly variable between surveys, without showing a distinct trend. This index is heavily influenced by leaf litter which currently is highly patchy. The nutrient index the Aerodrome LFA has remained very close to the analogue mean, and at Tjungu is approaching the analogue mean, reflecting the high vegetative cover at these sites. At the Midway Quarry and Ventia sites,

the nutrient index was approximately 50% of the analogue site means, reflecting the sparse vegetative cover at these sites.

In summary, soil stability for all sites are approximately 70% of analogue means, soil infiltration indices are similar to the analogue mean at Tjungu and Aerodrome LFAs (and 50% of the analogue mean at Ventia and Midway Quarry LFA sites), and soil nutrient indices range from 50% (Ventia site) to 90% (Aerodrome site) of the analogue mean. Given the soil indices are based on dependent variables, which have different trajectories (e.g. vegetation cover is likely to increase whereas surface roughness is likely to decrease), longer term data is likely needed to determine trends.

Given the variability of results, the establishment of plants and patches may be a more effective early measure of improvement, whilst the SSA may provide more value of long term function over future years of monitoring (provided there is no drastic loss of function observed during monitoring or anecdotally).

LFA summary and recommendations

At the Tjungu site, rehabilitation vegetation is considered to be compliant and complete, the plant density and floristic composition resembling analogue sites. Further monitoring is not considered necessary.

At the Aerodrome site rehabilitation is compliant, but still ongoing. Overall patch density resembles analogue sites, but because of the unevenness of plant cover, rehabilitation is not yet complete and further monitoring is recommended for at least one more year.

At the Midway Quarry site, rehabilitation is compliant as patch density has increased each survey period. However, patch density is still sparse and ongoing monitoring is recommended for several more years.

At the Venetia site, one transect had been substantially altered by mechanical grading and no plants were present. At the other site only one plant was present. It is unlikely to substantially improve further and site preparation should be re-done with deep ripping.

OMC LUP4 is considered to be in-progress / compliant at Tjungu, Aerodrome and Midway Quarry sites, but not at Ventia.

4.1.8 Fauna

4.1.8.1 Diversity and abundance

The 2024 spring fauna survey detected a total of 107 vertebrate species from the eight survey sites and opportunistically within the broader study area. Total species diversity (birds, mammals and reptiles) was generally within or above the range of baseline survey results. The capture rates for small mammals and reptiles combined (0.44) were above the previous spring compliance monitoring rates (~0.23, between 2018 and 2022) and within the range reported during baseline surveys (0.17 to 0.97). The high rate was largely attributable to the high number of reptile captures and warmer temperatures during the survey. The highest reptile diversity (above baseline and compliance) was also recorded for the 2024 survey, with 18 species detected (including the less common Eastern Striped Skink (*Ctenotus robustus*) captured again at Site 16 (Plate 4.1).

Whilst the site has previously experienced ongoing drought conditions and below average rainfall, above average rainfall events in summer of 2023 and winter of 2024, interspersed with periods of well below above average rainfall along with warmer temperatures during the spring survey likely influenced these results. Presence of water in all of the dams would have contributed to increased bird diversity, a winter rainfall event and presence of short-lived flora would have provided resources to the resident dunnart and reptiles species. For small mammals, rodent diversity and numbers were low and this is reflective of fluctuating rainfall throughout the preceding years. Regardless, there was evidence of all fauna breeding, in family groups or pairs, some small mammals had evidence of brood patches and one Stripe-faced Dunnart that appeared heavily pregnant was recorded via camera trap. In addition, a number of species were detected that were either a new record or species had not been detected since baseline / early compliance monitoring (e.g. juvenile Southern Four-toed Slider and several microbats). Overall, these results are positive and suggest that the reduced survey effort compared with baseline surveys has not influenced the capture rates or diversity, particularly for small mammals and reptiles. Hence the refinements to the trapping effort made during the course of the baseline survey work (2012 – 2017), and at the commencement of the compliance monitoring in 2018 to align with the requirements of the PEPR and mine lease conditions is sufficient. The presence of species that have not been recorded since the baseline monitoring and high bird and reptile diversity is also a positive sign for the overall condition of the Carrapateena site.

Mammals

In terms of small mammal diversity, several species were not detected in 2024, however these species have historically been recorded in lower numbers (Forest's Mouse, Planigales), and have not been recorded during all previous surveys. In addition, no Plains Mouse were detected. Similar to previous years, small mammals are likely influenced by preceding climate. It is well known that there are varying responses to climate and trapping response for small mammals in arid areas (Read 1988). For example, Pseudomys species have been shown to respond to significant weather events 3-10 months after the event, with the variability in response dependent on both pre-existing population abundance and resource availability (Dickman et. al., 1999, cited in EBS 2017).

Of the small mammal captures, Stripe-faced Dunnarts were represented in greater numbers than Fat-tailed Dunnarts, aligning with trends observed during baseline and compliance monitoring prior to 2024. Stripe-faced Dunnarts are more influenced by weather and habitat conditions and may have breaks or fewer litters. Stripe-faced Dunnarts also prefer habitats with greater plant diversity and healthier (denser) understorey (Animalia 2018, OEH 2020). Stripe-faced Dunnarts were present in several age classes and larger numbers, suggesting conditions were suitable for that species, whereas Fat-tailed Dunnarts were present in much lower numbers and may not have commenced breeding. Fat-tailed Dunnarts are known to continue to breed for to up 6 months without breaks once the breeding season commences, hence smaller numbers may suggest drier conditions earlier in the season may have limited the opportunity for a continuous breeding cycle. Similarly, dunnarts are known to use daily torpor to thrive in adverse environmental conditions and exploit resource poor environments and they are known to adjust the breeding period depending on climatic conditions. There is no evidence to suggest mining is impacting small mammal presence across the site.

While the survey effort used for detection of microbats has not been consistent across compliance monitoring and when compared with baseline monitoring, a number of species were detected during the baseline monitoring and it is considered good practice to occasionally monitor for these species to confirm ongoing existence at the site. During the 2024 survey five microbat species were detected at two Flora Sites and one Opportunistic Site. These sites were surveyed because they had suitable roosting or feeding habitat. Two of these species have been regularly detected at site (White-stripe Free-tailed Bat, audible to the human ear, and the Lesser Long-eared Bat). The other three species had not been detected since baseline surveys; Gould's Wattled Bat, Inland Forest Bat and Inland Free-tailed Bat.

Comparisons between mean species diversity and capture rates between control and impact sites showed slightly higher diversity and capture rates for impact sites for the original treatment, and slightly higher diversity for control site for the updated treatment. For the updated treatment, mean captures were the same for control and impact sites. Regardless, both treatments indicated no statistically significant differences for control and impact means for diversity and captures. As suggested in 2023, the updated treatment provides more statistical rigour having an equal number of control sites (4) compared with impacts sites (4) and aligns more with delineation of control and impacts sites (previously related to dust contour monitoring, distance to infrastructure) in relation to the operations phase, now that the WAR has been completed, and traffic along the SAR is greatly reduced. The findings for fauna also align with the flora results. Regardless, significant mining related impacts to common fauna are not evident from the 2024 data or when making comparisons to previous baseline and compliance data.

Birds

Splendid Fairywrens were not detected in bird surveys between 2019 to 2022, however they were detected in the sand dune habitats and nearby during the autumn 2023 survey. Similarly, they were also recorded during baseline surveys with higher rainfall (e.g. 2012, 2014 and 2016) and during early compliance monitoring (2018). This species was also not detected in 2024. Whilst resident White-winged Fairywrens and Purple-backed (Variegated) Fairywrens have been generally detected every year during baseline and compliance monitoring, Splendid Fairywrens were not recorded every year, suggesting transient presence, or population fluctuations. Similarly, Rufous Fieldwren are not detected every year and were absent (2020) or limited detection (2021). However, this species was detected at most fauna sites in 2024 and regularly recorded on Song Meters.

Similar to spring 2022 water was present in all the dams, and the, which influenced the records for waterbirds / shorebirds across the site in water and non-water habitats. Water in the South Eliza temporary watersource also attracted many species and waterbirds were nesting and breeding at the site. One species, the Australian Pratincole had not been detected since baseline and was present at a number of sites. Three new species were detected; Pelican, Rufous Songlark and Red-necked Avocet. The total number of bird species was increased from 2023, and within the upper range of baseline, and is likely reflective of the presence of water across the site, preceding rainfall beneficial impacts on short-lived vegetation and Song Meter detection (extra survey effort) at some sites. Noting only 10 additional species were detected via Song Meter that were not detected via bird survey and Song Meters were also deployed in 2023.

EPBC listed species

Only one EPBC listed threatened fauna was detected throughout the spring 2024 survey; Sharp-tailed Sandpiper (Vulnerable), also listed as Migratory. This species has been recorded at the site previously, most recently in 2021. In 2024, three individuals were detected at the South Eliza Wetland. Previously similar small numbers have been detected at the North Eliza Dam and the Tjungu Village Effluent Irrigation Area (which is no longer in use). One other EPBC Migratory species was also detected at the South Eliza Dam; Common Sandpiper, also previously detected on site at North Eliza Dam (in 2018). EPBC listed Plains Mouse were not detected (via trapping or camera), and there was limited evidence of surface activity around gilgais. This species has not been detected since 2017 (via standard fauna trapping) and is detected typically following a prolonged period of good rainfall. Similar to previous compliance surveys, whilst not detected at Carrapateena, Plains Mouse were detected during baited camera trapping at the South Gap offset site in 2024; however, only one Plains Mouse was detected (cameras deployed at 12 sites ongoing). The offset area, located southeast of Carrapateena on the banks of Lake Torrens, received 212 mm of rainfall, with most falling in July and November of 2024. This follows an ongoing decrease in numbers. The single South Gap detection was in June, hence none were detected during the timing of the spring survey at Carrapateena. Similarly, other small mammals were detected in low but stable rates, lower rates in Oct 2024 (<2), higher rates in July -August (1-8 detections per 100 trap nights). Whist Plains Mice were originally detected at Carrapateena via annual pitfall trapping, future consideration could be given to establishing a bait camera trap program, similar to South Gap to increase detection. In addition, review of rainfall conditions preceding the next annual survey should be considered, prior to deciding whether the annual 2025 survey should be in autumn or spring. One option may be to deploy cameras in autumn through to the physical trapping survey in spring. Autumn deployment of cameras would need to follow suitable sustained rainfall and could coincide with other monitoring that is not season dependent (e.g. LFA, weed monitoring).

Pest species

Whilst evidence of pest species was noted (House Sparrows at camps, Rabbits at several locations), there was no major increase in presence of pest fauna species was observed as part of the survey, i.e. observations of rabbits, sparrow numbers and cats was maintained / less than previous and House Mice were detected in low numbers (captured at Site 1, and Site 16). However, it is noted that the rabbit warren at Site 15 remains active and requires management. No Feral Pigeons or foxes were detected. All of these species have been recorded previously, in low numbers and hence does not constitute an increase in pest species present, therefore the site is considered compliant against OMC criteria related to pests.

Plate 4.1: The less common Eastern Striped Skink captured again at Site 16

4.2 Compliance against Obligations

As indicated in Section 1.1.1 above, the approved PEPR for ML 6471 outlines a number of monitoring commitments required to demonstrate compliance against the mine lease 6471 conditions (Table 1.1) and the approved environmental outcomes (Table 1.2) for the Operation. Table 4.1 below provides a summary of compliance against the conditions and outcomes based on the results of the spring 2024 survey.

All mine lease conditions and outcomes are currently being met.

Table 4.1: PEPR ML 6471 Compliance Reporting, spring 2024

Date	Monitoring Requirement/s	Achievement Value	Locations	Compliant / Non-Compliant	Evidence	Actions / Recommendations
October 2024 (spring)	ML 6471 Schedule 6, Condition 6, Condition 28.1 MPL 149 Schedule 6, Condition 10, MLP 152 to 154 Schedule 6 Condition 6 MLP 156 Schedule 6 Condition 3 OMC WP1 / WP2 Annual (spring) survey	No introduction of • new species of weeds declared or listed under relevant legislation • plant pathogens • pests (including feral animals) when compared to previously recorded weed species and introduced fauna. No sustained increase in the abundance of existing weed or pest species in the land compared to previous survey records.	Weed monitoring transects (CWM01-CWM07, NWM01-NWM03) Flora Sites 1- 7; 9 – 13; 15 - 22 Opportunistic and targeted observations across Operation area	Compliant	No new species of weeds declared or listed under relevant legislation were recorded at flora sites, weed transects, or elsewhere within the Operational area in October 2024. Existing known Declared weeds are Bathurst Burr, Athel Pine and Prickly Pear. No new populations of Bathurst Burr recorded, although existing known populations remain high. No increase in size of the known small populations of Athel Pine, which is being actively controlled. No increase in the size of the existing documented small population of Prickly Pear, which is being actively controlled. In 2024, new locations of existing weeds were recorded for 2 perennial species and 4 annual herbaceous species; annual species Maltese Thistle (*Centaurea melitensis)*, Mallow (*Malva parviflora*) and Scarlet Pimpernel (*Lysimachia arvensis*) (previously recorded at dams, effluent irrigation areas and/or watercourses). New 2024 locations include high moisture habitats and coincided with the non-occurrence of these species at some previously recorded sites. Hence, there was no net increase in these weeds. These locations are outside of mining lease activities and their occurrence is habitat related rather than due to mining activities. Smooth Mustard (*Sisymbrium erysimoides*), an annual has been abundant and regularly recorded within the operational area during baseline and compliance monitoring. Its occurrence at a new location coincided with its non-occurrence at some previously recorded locations and there was no net increase in the population across the operational area. The perennial herb, Trailing Verbena (*Verbena supina*) was recorded in 2024 at North Eliza Dam for the first time. However, it was not recorded in 2024 at Anzac Dam where it has been previously recorded. Its preferred habitat is high moisture environments and its occurrence at North Eliza Dam is likely due to increased water in the dam, rather than to mining-related activities. Wards Weed (*Carrichtera annua*) is not declared but has the potential to spread rapidly. Two plants were recorded along the WAR for the first time in 2024, and its presence is likely related to being introduced on tyres of mine-related vehicles. Its only previous occurrence within the operational area was on the Southern Access Road. This population has not been re-recorded, hence to date there has been no net or sustained increase in Wards Weed. The population of Tree Tobacco (*Nicotiana glauca*) remains high at South Eliza dam, with potential to increase due to the disturbed and higher soil moisture habitat of the dam (rather than due to mining related activities). An extensive population of Bitter Melon (*Citrullus lanatus*) was recorded in 2022 and 2023 along the Western Access Road shoulder. It is likely that the population increased due to soil disturbance during the WAR construction. However, in 2024, its population along the WAR at designated weed transects was much reduced. In summary, to date there has been no net or sustained increases in the population of any weed species recorded. House Sparrow numbers slightly reduced at the exploration camp, where worker occupancy was high at the time of survey. House Sparrow recorded previously during baseline. Rabbit presence observed at more sites, presence is sustained. Cats only detected at one location (sand dunes).	Ongoing weed monitoring at flora sites 1-22 and weed transects CWM01 - CWM07, and opportunistic and targeted observations (camp, effluent irrigation areas, spill areas, dams). Ongoing opportunistic observations, including revisiting sites where weeds have been identified in spring 2024. Weed management by BHP in response to data reported here, in particular continued ongoing management of Bathurst Burr. Any new individuals to be controlled by environmentally sensitive methods, including manual grubbing and disposal of vegetative matter or spraying where appropriate and will not impact drainage lines / water habitats. Continue control of Athel Pine (support station owner) and monitoring of Opuntia at homestead. Control all newly located populations of Opuntia (as reported by BHP ecology staff). Bitter Melon be environmentally controlled along the exposed shoulder of the WAR. Wards Weed, if detected, to be environmentally controlled along the exposed shoulder of the WAR. Ongoing monitoring of birds, including House Sparrows. Monitoring of rabbit / cat population and control as required (e.g. active warren at Site 15).

Date	Monitoring Requirement/s	Achievement Value	Locations	Compliant / Non-Compliant	Evidence	Actions / Recommendations
October 2024 (spring)	ML 6741 Schedule 6 Condition 14 OMC AQ2 Annual (spring) survey	No adverse impacts on the diversity and abundance of native vegetation at monitoring sites directly attributed to dust deposition from mining operations or mine related activities when compared to baseline native vegetation conditions unless an SEB has been approved in accordance with the relevant legislation	Flora Sites 1-22 See Figure 9.3 of the PEPR. Figure 2.1	Compliant at Monitoring Sites.	Specific dust transects established and surveyed in 2020 covering a range of habitats including sites downwind from spoil heap. No dust detected on all transects except those downwind of spoil heap. No death of vegetation noted in 2020 due to dust. Previously existing flora survey sites (1-16, excluding 8 and 14, plus 17- 22) were monitored for native plant species diversity (RAM) and abundance (Jessup transects) in spring 2024 and data collected was compared with baseline data. Results indicated a trend in species diversity that correlates with seasonal conditions. While the diversity of long-lived drought-resistant species has remained stable since 2018, and in line with baseline data, short-lived species diversity has correlated with seasonal rainfall but has remained within the baseline range. Similar to autumn 2023, in spring 2024, the equal highest short-lived species diversity during compliance monitoring was recorded. There is no clear difference in species diversity between control and impact sites. No adverse impacts on the diversity and abundance of native vegetation at monitoring sites due to mining activities have been detected.	Ongoing vegetation monitoring at general flora sites and vegetation data comparison with baseline data continued. Ongoing analysis of control vs impact sites against baseline monitoring data and compliance monitoring data during operation phase.
October 2024 (spring)	ML 6471 Schedule 6 Condition 17 OMC TSF6 / SWRF1 Annual survey	No adverse impact on the diversity and abundance of native vegetation and water dependent ecosystems attributed to tailing seepage when compared to baseline native vegetation conditions (unless an SEB has been approved). No adverse impact on the diversity and abundance of native vegetation and water dependant ecosystems attributed to reduced surface water flows caused by mining operations when compared to baseline conditions (Appendix C5 Ecological Baseline) unless a significant environmental benefit has been approved in accordance with the relevant legislation. Linked to Native Vegetation Outcome (Schedule 6 Condition 11)	Eliza Creek monitoring (Flora Sites 10, and 17-20 (which include Canopy Cover transects). See Figure 9.3 of the PEPR (BHP 2024).	Non-compliant / ongoing / SEB to be paid	<u>Decant Dam seepage event</u> In spring, adverse impact on native vegetation immediately downstream of the TSF was recorded. In late 2022 / early 2023 saline seepage from the TSF extended beyond the approved impact zone. The area impacted by the saline seepage was surveyed in May 2023, and April 2024, and damage to native vegetation (death and dieback) was recorded over an area of approximately 0.4 ha beyond the approved impact zone. No impact on vegetation was noted at monitoring Site 17, 270 m downstream from the TSF and within 50 m of the impacted vegetation. The impact area was again surveyed In October 2024, when no further damage to Eliza Creek vegetation had been detected since April 2024, and no further extent of damage was anticipated. Refer separate report to BHP. <u>Regular monitoring sites</u> Eliza Creek monitoring results indicate no adverse impact on the diversity and abundance of native vegetation due to mining activities. Vegetation is monitored at Flora Sites 17-20 established in Eliza Creek at increasing distance from the proposed TSF dam wall, covering both Western Myall and Red Gum habitat. RAM, Jessup transects and Canopy Cover data is collected at all four sites, representing current (baseline) condition, species diversity, abundance and tree health prior to TSF construction. Monitoring at Flora Site 10 (furthest distance from TSF, in Eliza Creek), also includes Jessup and RAM (baseline 2012-2017; compliance 2018 until present). Jessup transect results indicate no obvious trends in abundance of long-lived perennial species, RAM site results indicated no obvious trends in total flora species diversity; Canopy Cover transect results indicate no obvious trends in canopy cover of dominant species. Tailings dam storage facility Stage 1 construction completed just prior to spring 2019 survey, and now operational. Eliza Creek has not flowed since pre TSF construction, there was however a controlled release from the decant dam in June 2019, with flow only recorded to 600m downstream of the TSF and no adverse impact on flora at the downstream monitoring sites has resulted from this controlled release. Baseline vegetation condition data of all Eliza Creek monitoring sites saved within baseline database for future comparison.	Ongoing vegetation monitoring at Flora Sites 17-20 for RAM, Jessop transects and Canopy Cover (which reflects a leading indicator of tree health) to enable monitoring of potential impacts, and trends in diversity and abundance of native vegetation. Adaptive management of monitoring program as required if leading indicators indicate potential impacts (e.g. canopy cover measures in close proximity to tailings dam wall). Consideration of repeat of remote sensing vegetation cover estimates on a periodic basis, as a cost-effective way to track changes in vegetation cover downstream of the TSF embankment. No further formal monitoring of Decant Dam seepage is considered necessary as no further extent of damage is considered likely. An SEB offset (required under the Native Vegetation Act 1991) will be paid as per the NVMP associated with the PEPR (Appendix C BHP 2024). In formal monitoring is suggested at the same time as annual formal canopy cover survey of Site 17 to note any further decline or regeneration of the area and conduct a RAM if there is any evidence of increase in the area that is offset via SEB.

Date	Monitoring Requirement/s	Achievement Value	Locations	Compliant / Non-Compliant	Evidence	Actions / Recommendations
October 2024 (spring)	ML 6471 Schedule 2 Condition 28.2 MPL 152 Schedule 2 Condition 13.2 OMC EPBC1 Annual survey or opportunistic sighting	Any records of sightings and recordings of the Thick-billed Grasswren are provided to the BDBSA to enable effective monitoring and record keeping, as per the Recovery Plan Actions.	Bird monitoring Sites 1-22 (which overlap with Flora Sites 1-22, and include Fauna sites 1-6, 15, 16). See Figure 9.2, 9.3 of the PEPR (BHP 2024). Opportunistic observations across project area.	Compliant	EPBC1: No records of the Thick-billed Grasswren were reported during the spring 2024 survey at any of the 20 bird survey locations or opportunistically, including sites where Song Meters were deployed, so no records were provided to the BDBSA to facilitate effective population monitoring and record keeping. Song meters were deployed at 7 fauna sites (excluded site 3), South Eliza Dam, Eliza Creek (Site 10) and Site 7 in Bosworth creek.	Ongoing bird surveys across all flora sites 1-22 and opportunistically to establish trends with baseline and compliance data. Report any future records of Thick- billed Grasswren to the BDBSA.
October 2024 (spring)	ML 6471 Schedule 2 Condition 28.2 MPL 152 Schedule 2 Condition 13.3 OMC EPBC 2 Annual survey or opportunistic sighting	Any records of sightings or captures of the Plains Mouse are provided to the BDBSA to enable effective monitoring and record keeping, as per the Recovery Plan Actions.	Fauna sites 1-6, 15, 16 for fauna trapping. See 9.2 of the PEPR (BHP 2024).	Compliant	EPBC2: No records of the Plains Mouse were reported during the spring 2024 survey at any of the 8 established fauna trapping sites, so no records were provided to the BDBSA to facilitate effective monitoring and record keeping.	Ongoing pitfall trapping at 8 established fauna trapping sites to demonstrate species ongoing presence at site during periods of irruptive population growth and that refuge habitat continues to be effective despite mine operation. Report any future records of Plains Mouse to the BDBSA.
October 2024 (spring)	ML 6471 Schedule 2 Condition 28.2 MPL 152 Schedule 2 Condition 13.4 OMC EPBC 3 Annual survey or opportunistic sighting	Any records of sightings or recordings of the Night Parrot are provided to the Night Parrot Recovery Team to enable effective monitoring and record keeping.	Bird monitoring sites 1-22 (which overlap with Flora Sites 1-22, and include Fauna sites 1-6, 15, 16). See Figure 9.2 of the PEPR (BHP 2024). Opportunistic observations across project area.	Compliant	EPBC3: No records of the Night Parrot were reported during the spring 2024 survey at any of the 20 bird survey locations or opportunistically or via Song Meter, so no records were provided to the Night Parrot Recovery Team to facilitate effective monitoring and record keeping. Noting two EPBC listed species were detected opportunistically at South Eliza Dam (Sharp-tailed Sandpiper and Common Sandpiper and results will be provided to the BDBSA as part of permit renewal process.	Ongoing bird surveys across all flora sites 1-22 and opportunistically to establish trends with construction now underway. Report any future records of Night Parrot to the BDBSA.
October 2024 (spring)	ML 6471 Schedule 6 Condition 1, 5, 8, 9 OMC LUP4 Annual LFA monitoring	Rehabilitation has achieved, or is likely to achieve, a landscape function equivalent to that of adjacent analogue LFA sites.	Baseline (analogue) LFA data from sites CEF1-CEF7 (shown in Figure 9.3 of the Carrapateena PEPR BHP 2024). Rehabilitation monitoring at four locations (Airport Laydown and Ventia Laydown, Midway Quarry, Tjungu).	Compliant	Baseline LFA data established from analogue sites. Site rehabilitation monitoring continued in spring 2024. LFA sites established at four locations (LFAAL1, LFAVOL2, LFQUA3, LFATJU4) with two transects at each site. LFA trends are established and show improvement at all sites. With the original airport site (deep ripped) and new Tjungu site (deep ripped and hand seeded), showing the best results. Use of PCQ method and LFA Established Method enabled.	Continue LFA monitoring at rehabilitation sites. Given demonstration of positive trends, plan to establish new analogue sites adjacent sites that are performing well (e.g. airport). Suggest Tjungu has reached analogue and no longer requires monitoring.

4.3 Suitability of Data for Informing Compliance

4.3.1 Overview

The data collected during the spring 2024 survey is considered to provide meaningful data to determine compliance against the mine conditions and approved outcomes. The survey methods employed enabled comparison between impact and control sites, as well as comparison with baseline data. Construction / operational compliance monitoring data has now been collected since 2018. Results have been presented as text, tables and graphs, enabling demonstration of compliance against the established outcomes and measurement criteria, and representation of initial construction/operational compliance data trends.

4.3.2 RAM quadrats

The RAM data provided quantitative data on species diversity present within each of the Flora Survey sites assessed. Further details added to the data here regarding woody long-lived perennial species enables a more thorough examination of the difference between climate and/or grazing impacts against potential impacts from mining operations. Comparison with the range of species diversity values collected during the baseline survey period has enabled an easy visual indication of current site diversity. Well defined survey sites have meant the survey area has been accurately repeatable, providing consistent results. Long-lived perennial diversity has been very stable, while short-lived species diversity has shown a very strong correlation with yearly rainfall totals, indicating the survey method provides accurate and meaningful data. Since 2021, data has been further explored further by comparing species diversity for sites of similar habitat, regardless of distance to mining infrastructure. This was done to determine if there were any trends in species diversity emerging regardless of distance to mining infrastructure.

4.3.3 Jessup transects

The Jessup transects provided quantitative data on the number of adults and juveniles present for long-lived perennial shrubs. This provides information on the health and vitality of individuals within a population, for example, it indicates if recruitment is occurring, or whether the population is declining, increasing, or staying the same. Combined with qualitative observations made on plant health (including defoliation and/or presence of dust on foliage) this will help inform if there has been an adverse impact on the diversity and abundance of long-lived woody native vegetation directly attributed to dust deposition from mining operations or mining related activities when compared to baseline native vegetation conditions. Results from these surveys enables reporting against compliance conditions. In 2020, the number of species analysed increased from two (Bladder Saltbush and Plains Lantern Bush) to four species (additionally, Samphire and Sea-heath), in response to widespread foliage loss of the two dominant species (Bladder Saltbush and Samphire) at the Stony Tableland sites. In 2021, 2022, 2023 and 2024, the key three species were analysed in detail, providing insightful data on trends in population abundance in both palatable and non-palatable species, and species that are widespread across the lease. Plains Lantern Bush was not analysed due increased variability in the baseline and compliance data. In 2023 and 2024, the population trends during compliance monitoring of another species were also analysed, but in less detail; Bush Minuria (a daisy). Qualitative observations suggested high variability of this moderately palatable and moderately drought-resistant species between survey periods, including

apparent declines in 2019 and 2020. The results showed that the three most common and widespread species have continued to increase since 2020, following declines in 2019. Similarly, the Jessup data has been very effective in reflecting population changes of Bush Minuria due to climate.

Prior to the 2021 survey, at the Eliza Creek sites, analysis was confined to comparison of net perennial species diversity between recording periods, which had remained relatively stable between 2018 - 2020. In 2021, the analysis was expanded to compare trends in the abundance of individual perennial species, namely the nine most abundant species at Eliza Creek Jessup transects. This analysis was continued in 2022 and further expanded in 2023 and 2024 to include a total of 10 species. This has proven a valuable tool for determining potential trends in populations of individual species, rather than simply comparing total species diversity.

4.3.4 Canopy cover transects

The canopy cover transects record the presence of canopy foliage along a fixed 100 m transect. Within individual canopies, there may be from 1 to 10 or more recordings, depending on the width of the canopy. The technique is objective and does not rely on observer estimations of individual tree canopy intactness. By repeating the survey along a fixed transect, it is estimated that the technique can detect changes in both individual canopy "completeness" and canopy cover for the whole tree stand, where there is a change in foliage extent of as little as 20%. Tree stress or death is expected to show up in densitometer results.

The technique is considered suitable for informing whether there has been a change in the health of the dominant trees on Eliza Creek and is seen as a leading indicator of tree stress. Results from these surveys will therefore contribute to the reporting against compliance conditions related to impacts in Eliza Creek.

Since 2019 visual estimates of canopy cover are also undertaken to complement the densitometer canopy cover assessments. Visual estimates of individual tree canopies enable identification of individual tree canopy health and provide a time frame for potential canopy loss. Results to date show that the densitometer results are broadly in alignment with visual estimates.

Since 2021 additional trees have been recorded along the transects. These were trees whose canopy intercepted the canopy but had not done so previously and/or which now met the criteria for recording. By including new trees that meet the survey requirements as the trees along the transects mature, the transition in age classes and maturation of new recruits has been effectively demonstrated by the surveys of the canopy cover transects as part of the overall health of tree vegetation within Eliza Creek.

The canopy cover data is considered to provide an objective method of determining trends in canopy health across the whole of the transect, including documenting tree deaths and recruitment. The trial in 2019 of using remote sensing of aerial imagery to estimate vegetative cover in increments downstream from the TSF embankment is considered a useful additional tool to monitor vegetation health within Eliza Creek.

4.3.5 Weed transects

Weed transects represent a repeatable, temporal examination of weed diversity and abundance at the site and are not time consuming to conduct. They are aligned along roads and intersect drainage lines and dam outlets, which are considered to be the key sources and/or vectors of seed spread. As such, the weed transects represent a key method (when coupled with weed data from rangelands assessments and opportunistic observations) to directly address a number of mine conditions and outcomes.

4.3.6 LFA transects

LFA at two rehabilitation sites at the mine site commenced in 2019, and two more were introduced in 2022. In 2023, all sites were surveyed using the established LFA method (as opposed to the Bank and Trough method applicable only for the very early stages of assessment). Introduction of the PCQ Method (an extension of the Established Method) has proven very useful for reporting on the density of vegetation as it establishes within the rehabilitation sites, and especially when vegetation along the LFA transect has been absent or very sparse. The current methods are considered suitable to demonstrate change at the rehabilitation sites over time, as vegetation trends towards the 'baseline' / analogue condition. Current methods have already been successful in detecting notable differences in the success of the four sites, reflective of the different rehabilitation methods applied on the ground. For example, the deep cross ripped / handed seeded Tjungu site no longer requires monitoring and the deep ripped Aerodrome site only requires the LFA established method moving forward. This data is useful for future rehabilitation around the broader mining lease area and meeting OMC requirements.

4.3.7 Fauna surveys

Fauna trapping undertaken during spring 2024 was comparable to the effort undertaken in spring 2018-2023, on the basis that the most important data is species diversity rather than species abundance. Despite warmer conditions and a thunderstorm during mid spring, overall fauna diversity was comparable with previous baseline survey periods and with the spring/autumn 2018-2023 survey numbers. Dams were full, and there was an increase in bird diversity detection across Carrapateena that was likely related to water presence (South Eliza Dam), vegetation condition, as well as complementary methods for detection (e.g. Song Meter, also used in 2023). The overall capture rates increased from 2023, was above the compliance capture rate to date and well within the baseline range. For mammals, however diversity rates were at the lower end of baseline ranges, primarily given limited detection of rodents and no captures of Planigales. For reptiles, captures were high and the diversity was the highest to date, above compliance and baseline; 18 species detected. Fauna trapping represents the greatest opportunity to definitively record the EPBC listed Plains Mouse, and to demonstrate persistence of this species at the site throughout mining operations, which is an important outcome for BHP. As such, fauna trapping is still considered a requirement for informing impacts of the mining operation on conservation significant fauna. As suggested in the 2020 survey report, camera trapping at the designated fauna sites (outside of the fauna trapping project) may provide improved results, however this would need to align with preceding rainfall conditions. During the annual compliance surveys non-baited camera trapping has been used in 2021 - 2024 concurrently with open pitfall sites and a range of species detected (e.g. during 2024 species include Fat-tailed Dunnart, Stripe-faced Dunnart, Tessellated Gecko, Mulga Snake and small *Pseudomys sp*. likely

P. hermannsburgensis, given captured at the site two days prior). Baited camera trapping without opening pits similar to the South Gap EPBC offset program may detect Plains Mouse, particularly following suitable rainfall events. It is noted that Plains Mouse were again detected via baited camera traps at the South Gap in 2024, however in 2024, following substantially reduced rainfall, only one Plains Mouse was detected (June at one site). It is suggested that the population is declining as occurs naturally in response to climatic factors (e.g. lower rainfall) (Nature Conservation 2025).

Bird surveys continue to provide good indications of overall site species diversity, with numbers increasing from 2020-2023 and reflective of baseline conditions. Most of the historic sites are relatively homogeneous from a habitat perspective, but greater diversity observed at some sites appears to align with creek line sites, drainage lines and dune sites with taller and diverse vegetation. There are no historic records of any EPBC listed threatened birds at the site (apart from newly listed Blue-winged Parrot, Southern Whiteface and Sharp-tailed Sandpiper), but regardless, the mine conditions require reporting of future records of EPBC listed species. This would not be possible without some level of bird survey. In some years State-listed species are also detected, however no State-listed species were detected in 2024. A number of waterbirds and shorebirds were detected at dams and the South Eliza temporary wetland during the survey, including Sharp-tailed Sandpiper (EPBC Vulnerable and Migratory) and Common Sandpiper (EPBC Migratory), both species have been recorded in the Carrapateena dams previously. Many resident birds were breeding, and different types of bird families were well represented. Resident White-wing Fairy Wrens, Purple-backed Fairywrens and Rufous Fieldwrens were present across the site at multiple locations, however the nomadic Splendid Fairywrens were not detected. New bird records for the site included Pelican (although dead, not far from the TSF), Rufous Songlark and Red-necked Avocet. Australian Pratincoles were also present at a number of sites and these had not been detected at the site since baseline surveys. The bird survey results are in compliance with the OMC and provide a positive story at Carrapateena for balancing mining and the environment in arid conditions.

Opportunistic reptile observations provide a good return on investment, and are considered an important part of the overall fauna survey program to inform diversity data. As per active fauna trapping, opportunistic reptile observations are considered suitable for informing overall impacts of the mining operation on fauna diversity. Both reptile and mammal diversity was in the range of baseline surveys, with reptile diversity increased from previous years. In 2024, the bulk of the reptile diversity was from trap captures, given the warmer day time temperatures, this data contributes to the 'capture rate' as a snapshot measure of abundance. Of the reptiles that were detected, several species had juveniles present (e.g. Earless Dragons, Bynoe's Gecko, Southern Four-toed Slider). Of note, the Four-toed Slider (a juvenile) has not been detected baseline and not previously recorded during compliance monitoring. In addition, during the 2021 spring survey the Eastern Stripe Skink was detected at Site 16, not previously recorded since baseline and this species was detected again in 2024 at Site 16.

Feral mice were detected in low numbers at two fauna sites (control Site 1 and impact Site 16), no cats were detected, aside from tracks in the dunes of Site 21. Rabbits were detected at several locations and a warren remains active near Site 15. Hence ongoing feral animal control is required.

4.4 Recommendations for future surveys and data analysis

Construction / operational compliance monitoring has been conducted since autumn 2018, involving two surveys in 2018, and annual surveys thereafter. Hence there have been eight complete fauna and flora surveys, and additionally, a separate dust impact survey and separate Eliza Creek flora and canopy cover survey. There have been two autumn and seven spring surveys. The period 2018 to 2024 has covered extreme low rainfall years (2018 and 2019 when yearly rainfall totals for the year were in the 10% decile), average rainfall years and well above average seasonal rainfall events. This compares well with the baseline survey duration and climate patterns, namely 2012 to 2017 when rainfall totals varied from below average to well above average. During the compliance monitoring period to date, there has been no evidence of impact from mining activity on any of the PEPR Leading Indicators that relate to fauna and flora outcome measurement criteria. Fauna and flora species diversity has been within the baseline range, there have been no new declared weeds or increase in abundance of declared or listed weeds and no long-term population trends evident in existing weeds. The health of Eliza Creek vegetation has remained stable. All short-term changes to date in flora and fauna diversity, perennial plant population abundances, and canopy health at Eliza Creek transects have been attributed to variation in seasonal and/or yearly rainfall.

The compliance OMC require annual monitoring to occur at the sites. However, the formal fauna trapping surveys could be conducted every two years and supplemented annually with other techniques such as camera trapping, Song Meter deployment and bird surveys. It is recommended that as a minimum, bird surveys, cameras (baited, if not trapping) Song Meters continue to be used annually, which require less survey effort. If bird surveys are conducted without fauna trapping, the program could occur in late autumn or early spring and target EPBC listed species such as Blue-winged Parrot, previously detected at the site during autumn surveys.

It is recommended that all sites surveyed in 2024 be re-surveyed in either autumn or spring 2025, using the same survey techniques (without fauna trapping if conducted in autumn 2025 and with fauna trapping if conducted in spring 2025). It is recommended that the seasonal timing of the survey remain flexible. In the arid zone, flora diversity, and often fauna diversity, reflects rainfall events, rather than a specific season. Mean monthly rainfall for the nearest long-term weather station, Woomera indicates highest rainfall means occur between November and March rather than winter; but can be extremely variable year to year. Hence for compliance monitoring, comparison of data across the operation for sites undergoing the same climatic conditions, as well as comparison of baseline and previous compliance monitoring ranges for a range a climatic and grazing conditions is good practice, rather than a focus on comparisons to baseline data alone.

The spring 2024 survey was conducted in October 2024, when conditions were very warm and there was an extreme wind event and thunderstorms. Reptile diversity and abundance was high, bird diversity was high and mammal diversity and abundance was within the baseline range. For the small mammals, rodents were in low numbers, but this is reflective of the climate in the months preceding the survey (i.e. fluctuating rainfall, below average). Rodents have also historically been detected in lower numbers in the baseline and compliance surveys, with the exception of higher rainfall years (e.g. 2012, 2014, 2017 and 2022). Flora diversity was very high due to the diversity of short-lived species. It is recommended that surveys be conducted in either September/October or late March to April, when daily temperatures are not extreme and compliant with animal ethics requirements. The preference for an autumn or spring survey should be determined by seasonal conditions in the previous six months, namely consideration

should be given to conducting the survey in response to particular climatic conditions (i.e., good rainfall) in order to maximise the chance of demonstrating compliance against some conditions (in particular, the presence of Plains Mouse).

Baseline data in Eliza Creek commenced in 2018 and includes conducting eight surveys of on ground canopy cover data recording. This has provided an indication of the inherent variability in the data, and the dynamic response of Red Gum canopies to seasonal conditions. At Eliza Creek medium to longer term trends in plant health are of major concern, rather than seasonal changes. Given that monitoring has been established since 2018, and additional reporting of individual tree health has been established, yearly surveys of Eliza Creek are considered sufficient. It is recommended that additional remote sensing reporting be continued, to supplement on-ground data.

Further details regarding future recommendations are provided below.

4.4.1 RAM quadrats

RAM sites represent a key measure of flora species diversity, abundance (as per Crown Separation Ratio categories) and grazing impact and should continue across the site, annually, as per the outcome measurement criteria for the mine lease (OMC SWRF1, TSF6, AQ2). To date, the construction / operational phase monitoring data results have indicated species diversity has remained within the baseline range. This survey technique used during compliance monitoring reports upon both long-lived and short-lived species diversity, the latter largely influenced by weather events.

Flora Sites 21 and 22, were established on dunes in autumn 2018 to monitor this previously un-surveyed dune habitat within the Operation area. This monitoring should continue annually to address potential impacts from the WAR on dune habitat to address the agreed outcomes for OMCs WP1 and WP2. Given that Jessup transects are not undertaken at these sites, consider which current OMCs these dune sites are addressing.

The Jessup transects monitor populations only of long-lived perennial shrubs and trees. Despite the longevity of the species monitored, compliance monitoring has shown relatively large fluctuations in populations that correlate with large variations in yearly rainfall totals. Some species monitored have relatively small populations. Annual monitoring is considered necessary for early detection of changes in populations that may result in the potential loss of a species at a site.

For all sites excluding site 21 and 22, Jessup monitoring should continue annually to address the agreed outcomes for the Operation (OMC SWRF1, TSF6, AQ2).

4.4.2 Data analysis of RAM quadrats and Jessup transects

To date compliance monitoring has categorised sites as either control or impact sites, defined as sites either greater than 2 km or less than 2 km, respectively from mining infrastructure. The 2 km criteria was based on a literature review of the likely potential distance of dust and/or noise impact upon vegetation and dust impact modelling. All sites along Eliza Creek, however, were deemed to be potential impact sites, regardless of distance downstream from the TSF. During compliance monitoring, however, the WAR has been developed, the Northern Wellfield Supply Road (Khamsin Road) receives greater usage, and the SAR is no longer widely used. The 2023 reporting (Jacobs 2023) recommended a review of the classification of

sites as impact or control. In particular, recommended that impact Sites 4 and 6 be changed from impact to control. This recommendation has been implemented in the current report.

In addition to analysing results collectively for control sites and collectively for impact sites, past and current reporting analysis has included plant species abundance and diversity trends at a site level, by habitat, and at a landscape level for the whole Operational Area. Do date there are not emerging trends related to mining, and there is climate related variation for some species. It is recommended that these analyses are scaled back and only undertaken if leading indicators are triggered to detect potential trends in abundance and diversity that may otherwise be masked, and/or to detect trends due to impacts that may operate at different scales.

4.4.3 Canopy cover transects

Canopy cover assessment should continue, given transects have been assessed in Eliza Creek on nine occasions since 2018. This has provided an indication of variability in the data – both actual variation in tree canopy health (due to long term change and/or seasonal variability) and inherent variability or "noise" in the method. The numbering of individual trees and installation of permanent posts along each transects has increased the precision of the transect alignment each survey. This has reduced the inherent "noise" in the data. The continued use of the densitometer rather than relying purely on visual estimates of crown intactness, is strongly recommended. The canopy cover transects are 100 m long, providing a sufficient number of densitometer canopy readings to provide precision and accuracy in quantifying canopy cover for the transect as a whole. The method is relatively objective as it does not rely on "eyeball" estimates of whole canopy intactness where there is often variation between observers' estimates. For assessment of individual tree canopy intactness, "eyeball" assessments (no tools) of canopy intactness provide data on population trends – detecting loss of trees or tree gain along the transect and perhaps more accurate estimates of individual canopy intactness than provided by a densitometer which provides only a few foliage recordings per canopy.

The densitometer method, and visual estimates of individual canopy intactness, therefore are complementary, and both methods should be used to assess tree health at each survey. It is recommended than annual surveys are sufficient.

Continuation of the Eliza Creek canopy cover data is expected to detect potential tree stress and death overtime and will contribute to addressing the agreed outcomes for the Operation (OMC SWRF1, TSF6, AQ2).

In addition to the formal canopy cover monitoring, it is recommended as good practice to visit the Decant Dam impact area that is upstream from Site 17 in Eliza Creek and briefly document status (photos and description). While the impact is being offset with an SEB, future decline and / or regeneration of the area should be briefly documented and further assessment (e.g. RAM) undertaken if required.

4.4.4 Weed transects

The 2021 survey increased the number of weed transects surveyed to also include Northern Wellfield locations, and a weed transect towards the western end of the newly constructed WAR. These were re-surveyed in 2022, 2023 and 2024. The location of weed transects is considered to be a good

representation of sites across the mineral leases that capture locations for potential spread of weeds due to mining related activities. There are three weed transects along the Western Access Road including alongside the Gatehouse, near the administration and spoil heap area, and along minor access roads. Targeted locations, where weed populations are considered most likely on site (particularly dams, effluent irrigation areas, and the villages) were also re-surveyed recording the general location and densities of all weeds present. Weed transects CWM01 and CWM02 are located along the SAR, which now receives very little mining-related vehicle traffic. However, the transects are still within current mineral leases, and include populations of the declared weed, Bathurst Burr, plus several non-declared weeds that favour high moisture habitats. For this reason, it is recommended that these two transects continue.

The weed transects and targeted survey locations are considered a very efficient way of detecting new weeds or an increase (or decline) in existing weed populations, as evidenced by the post-construction data. Collection of weed data should continue as per the spring 2024 survey at assigned transects and opportunistically around the site to address the agreed outcomes for the Operation (Outcome measurement criteria WP1, WP2) and Mineral Lease condition 6 (sixth schedule) and MPL 156 conditions. Populations of Bathurst Burr should be revisited and monitored to determine success of control efforts.

4.4.5 LFA

The LFA data collected presents a simple means to graphically show changes in indices, and to also compare the indices with previously collected data from analogue sites considered broadly representative of natural conditions across the mine lease. The establishment of the Midway Quarry and Tjungu sites in 2023 provided a greater opportunity to monitor rehabilitation success as well as variation in techniques (e.g., deep cross ripping, plus hand seeding). Continued data collection will enable opportunities for ongoing data analysis, and a determination of when recorded indices approach or reach the range of the analogue data.

The LFA data collected (and PCQ data) indicates that the Tjungu site has successfully rehabilitated to a level comparable with, or even exceeding reference habitat. Likewise, plant and soil parameter data at aerodrome site shows that this site is approaching reference site means. The LFA established and PCQ data at the Midway Quarry shows the site is beginning restoration and LFA indices have improved annually since 2022, when the site was established. In contrast, the LFA data at the Ventia site recorded no successful restoration in 2024, and the PCQ data recorded only the very initial stages of habitat restoration along one transect. In addition, one Ventia transect has been decommissioned, as the transect had been compromised.

It is recommended that LFA is not needed at the Tjungu site because it is successfully rehabilitated. It is also recommended that the Ventia site be prepared for restoration again by deep ripping of trenches. LFA and PCQ should continue at the Midway Quarry site in 2025. At the Aerodrome site, only the LFA established method should continue, given the plant density, the PCQ is no longer required.

4.4.6 Fauna surveys

Similar to 2018 -2023, single pitfall trapping lines provided suitable capture of small mammals and reptiles during the 2024 survey. The most common mammal species that have been captured across all baseline surveys were still detected, with all small mammal captures made in pitfall traps. It is recommended that

pitfall trapping is retained in order to detect presence or absence of Plains Mouse as per PEPR condition EPBC2, in addition to continuing to monitor habitat condition (flora monitoring). As suggested following the spring 2022 survey, increased rainfall in the region (spring and summer) resulted in an autumn survey in 2023 instead of spring survey, however Plains Mouse were not detected. Similarly, Plains Mouse were not detected in 2024. As per 4.3.7 above, Plains Mouse has been detected via baited camera trap at the South Gap offset area, but in low numbers since mid- 2022, so detection at Carrapateena may still occur in the future, but more likely following periods of above average rainfall.

To increase the chance of detection of Plains Mouse at Carrapateena, particularly at control sites 1 and 2, options may include:

- increasing the number of lines and pits open at fauna sites during the next survey
- setting up targeted baited Elliot traps at good quality gilgais, at the established fauna sites. E.g. 5 baited Elliot traps at 10 sites, 100m apart, for a standard four night survey
- setting up baited camera traps similar to South Gap (noting there would be greater success at sites where predators (e.g. cats) are under control. Flora site 12 is noted to have good areas of gilgais. These could be set up away from fauna trap lines, if trapping occurs concurrently.
- as per above consider whether bi-annual survey should be undertaken moving forward (i.e. consider during PEPR update).

As mentioned in Jacobs (2022, 2023), some pits within lines were decreasing in integrity and it is noted that the site environmental team have undertaken activities to replace pit bases and or patch holes. Initially pit bases were replaced by using silicon to attach a plastic mesh base, whilst these were suitable for dunnarts and native mice in the short-term, they may not withstand presence of Planigales or House Mice or increased numbers of small mammals (as occurred in 2022), given the tendency for these species to chew holes in the bases, hence regular maintenance / checking is still required. As per 3.3.6 above, replacement metal bases have been installed in the pitfall traps for the majority of the lines. These bases were highly successful and even facilitated capture of the elusive Dwarf Skink (Plate 4.2). The bases drain well, do not get too hot (remain at least 2-5 degrees lower than ambient temperature) and are also easy to see the trapped fauna (given 60 cm deep). As per previous surveys, the lids of the semi-permanent pits need to be pushed down correctly before tech screws are applied to ensure there are no gaps that enable small mammals or reptiles to get through and be trapped outside of a survey period. The site environmental team have ordered more pit bases for the remaining sites and these will be installed by the site environmental team prior to the 2025 annual survey or during the 2025 survey, given ease of installation.

Results for single pit line trapping continues to be comparable to baseline results and in general, mid-late spring is a suitable time to undertake an annual survey. For 2025, spring is probably ideal given the dry preceding summer of 2024/2025, an autumn survey would only be an option if there was heavy steady rainfall in later summer and early autumn, to maximise the chance of demonstrating compliance with the PEPR conditions. Double pit lines for a subset of impact and all control sites, and opening 7 traps, may also maximise detection, however this would require extra effort and may increase the length of the survey. Fauna trapping should continue at the mine site until such time as it can be clearly demonstrated that conservation significant species (in particular) persist alongside the operational mine, but this should be considered and discussed following the next PEPR update. Noting that two EPBC listed species were

detected in spring 2024 opportunistically, rather than via formal trapping. Camera trapping outside the survey period, given the success at South Gap offset area, using alternate, less labour-intensive methods (without baits) or more labour intensive (with baits) may also be an option, i.e. aligning cameras with short lengths of fauna fence line to direct fauna into view. However, given the presence of cats at the site, regular checks would be required to avoid increasing predation of small mammals at trapping sites.

Whilst reptile diversity is interesting and provides a good indicator for overall site conditions, it does not specifically relate to PEPR conditions, and therefore use of funnel traps could be ceased in the future and reptile diversity could be collected opportunistically and via pitfall captures alone, particularly during the spring surveys when reptiles are more active. However, setting and checking funnel traps requires minimal additional effort compared with additional pitfall lines and provides opportunity to trap snakes where present, it is suggested that funnel trapping be retained at the current time.

The bird surveys at fauna sites, flora sites and water points currently provide valuable data regarding overall avifauna diversity at the sites, and birds are expected to respond to mine impacts such as noise and traffic if levels are unacceptable to them. In addition, pest bird species are also monitored e.g. House Sparrows still present (low numbers). For this reason, bird surveys should be continued during operational compliance monitoring until data patterns are clear, and to meet PEPR conditions related to Thick-billed Grasswren and Night Parrot records (EPBC1 and EPBC 3) as well as conditions related to pests (WP1, WP2). Survey at water points (particularly pre-dawn and post dusk) as well as spotlighting / night call detection is also an important survey technique to detect whether the Night Parrot is present at the site. A value-add for 2023/2024 included deployment of Song Meters to detect nocturnal, dawn and dusk species at both chenopod shrubland sites and representative creekline sites (e.g. Eliza Creek Site 10, Bosworth Creek Site 7). Noting that threatened species were detected via Song Meter in autumn 2023 (e.g. Blue-winged Parrot). In 2024 Song Meter results included detection of one common dusk species; Owlet Night Jar (*Aegotheles cristatus*). This species was also detected in 2023 via Song Meter, but had not been detected during bird surveys. No other nocturnal / dusk bird species were detected. Five diurnal microbat species were also detected on Song Meters that can be deployed to capture both bird and bat call data. Detection via acoustic methods is far more efficient than trapping or spotlighting for microbat fauna and useful to regularly compare against baseline data.

Plate 4.2: Dwarf Skink, stubbie holder refuge, new metal bases and temperature data-logger

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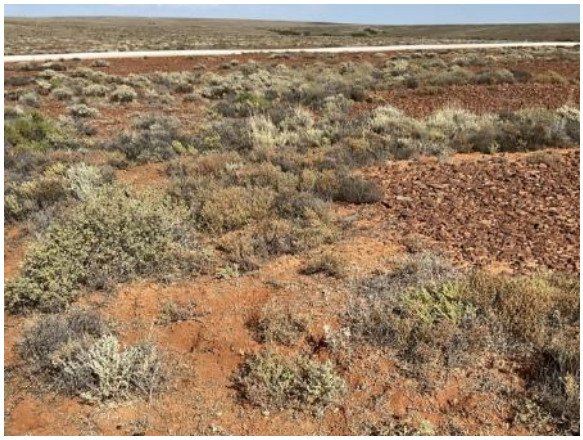
Appendices

Appendix A. Photologs spring 2024

Appendix A1. Photolog, Rangeland Flora Sites

CAR001	
Appendix Plate A1.1: Facing north	Appendix Plate A1.2: Facing east
	
Appendix Plate A1.3: Facing west	Appendix Plate A1.4: Facing south

CAR002	
Appendix Plate A1.5: Facing north	Appendix Plate A1.6: Facing east
Appendix Plate A1.7: Facing west	Appendix Plate A1.8: Facing south

CAR003	
Appendix Plate A1.9: Facing north	Appendix Plate A1.10: Facing east
Appendix Plate A1.11: Facing west	Appendix Plate A1.12: Facing south

CAR004	
Appendix Plate A1.13:Facing north	Appendix Plate A1.14: Facing east
Appendix Plate A1.15: Facing west	Appendix Plate A1.16: Facing south

CAR005	
Appendix Plate A1.17: Facing north	Appendix Plate A1.18: Facing east
Appendix Plate A1.19: Facing west	Appendix Plate A1.20: Facing south

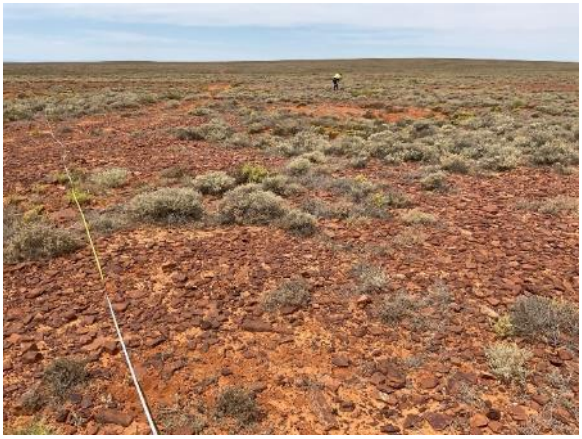
CAR006	
Appendix Plate A1.21: Facing north	Appendix Plate A1.22: Facing east
Appendix Plate A1.23: Facing west	Appendix Plate A1.24: Facing south

CAR007	
Appendix Plate A1.25: Facing north	Appendix Plate A1.26: Facing east
Appendix Plate A1.27: Facing west	Appendix Plate A1.28: Facing south

CAR009	
Appendix Plate A1.29: Facing north	Appendix Plate A1.30: Facing east
Appendix Plate A1.31: Facing west	Appendix Plate A1.32: Facing south

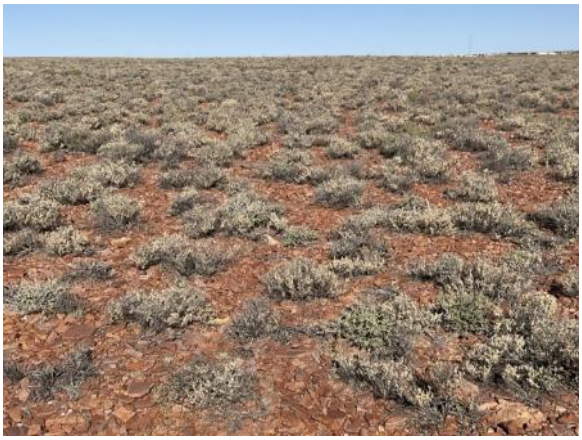
CAR010	
Appendix Plate A1.33: Facing north	Appendix Plate A1.34: Facing east
Appendix Plate A1.35: Facing west	Appendix Plate A1.36: Facing south

CAR011	
Appendix Plate A1.37: Facing north	Appendix Plate A1.38: Facing east
Appendix Plate A1.39: Facing west	Appendix Plate A1.40: Facing south

CAR012	
	
Appendix Plate A1.41: Facing north	Appendix Plate A1.42: Facing east
Appendix Plate A1.43: Facing west	Appendix Plate A1.44: Facing south

CAR013	
Appendix Plate A1.45:Facing north	Appendix Plate A1.46: Facing east
Appendix Plate A1.47: Facing west	Appendix Plate A1.48: Facing south

CAR015	
Appendix Plate A1.49: Facing north	Appendix Plate A1.50: Facing east
Appendix Plate A1.51: Facing west	Appendix Plate A1.52: Facing south

CAR016	
	
Appendix Plate A1.53: Facing north	Appendix Plate A1.54: Facing east
Appendix Plate A1.55: Facing west	Appendix Plate A1.56: Facing south

CAR017	
Appendix Plate A1.57: Facing north	Appendix Plate A1.58: Facing east
Appendix Plate A1.59: Facing west	Appendix Plate A1.60: Facing south

CAR018	
Appendix Plate A1.61: Facing north	Appendix Plate A1.62: Facing east
Appendix Plate A1.63: Facing west	Appendix Plate A1.64: Facing south

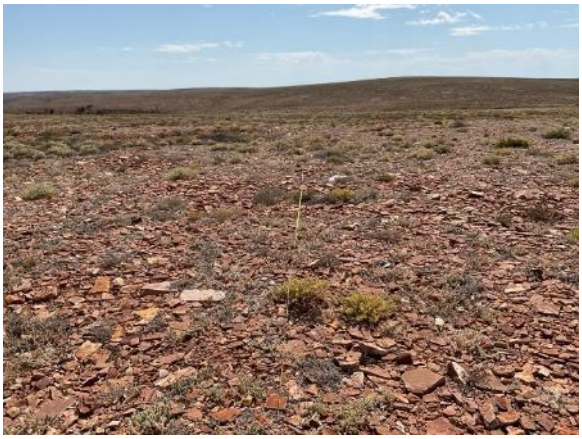
CAR019	
Appendix Plate A1.65: Facing north	Appendix Plate A1.66: Facing east
Appendix Plate A1.67: Facing west	Appendix Plate A1.68: Facing south

CAR020	
Appendix PlateA1.69: Facing north	Appendix Plate A1.70: Facing east
Appendix Plate A1.71: Facing west	Appendix Plate A1.72: Facing south

CAR021	
Appendix Plate A1.73: Facing north	Appendix Plate A1.74: Facing east
Appendix Plate A1.75: Facing west	Appendix Plate A1.76: Facing south

CAR022	
Appendix Plate A1.77: Facing north	Appendix Plate A1.78: Facing east
Appendix Plate A1.79: Facing west	Appendix Plate A1.80: Facing south

Appendix A2. Photolog, Jessup Transects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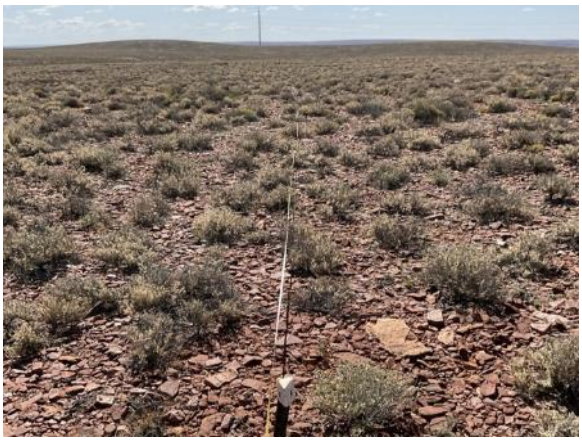
Appendix Plate A2.3: CAR003	Appendix Plate A2.4: CAR004

Appendix Plate A2.5: CAR005	Appendix Plate A2.6: CAR006

Appendix Plate A2.7: CAR007	Appendix Plate A2.8: CAR009

Appendix Plate A2.9: CAR010	Appendix Plate A2.10: CAR011

Appendix Plate A2.11: CAR012	Appendix Plate A2.12: CAR013

	
Appendix Plate A2.13: CAR015	Appendix Plate A2.14: CAR016

Appendix Plate A2.15: CAR017	Appendix Plate A2.16: CAR018

Appendix Plate A2.17: CAR019	Appendix Plate A2.18: CAR020

Appendix A3. Photolog, Canopy Cover Transects Eliza Creek

CAR017	
Appendix Plate A3.1: Transect A	Appendix Plate A3.2: Transect B

CAR018	
Appendix Plate A3.3: Transect A	Appendix Plate A3.4: Transect B

CAR019	
Appendix Plate A3.5: Transect A	Appendix Plate A3.6: Transect B

Appendix Plate A3.7: Transect A	Appendix Plate A3.8: Transect B

Appendix A4. Photolog, Weed Survey

CWM01 0m	
Appendix Plate A4.1: Western side of road, facing north	Appendix Plate A4.2: Western side of road, facing south
Appendix Plate A4.3: Eastern side of road, facing north	Appendix Plate A4.4: Eastern side of road, facing south

CWM01 250m	
Appendix Plate A4.5: Western side of road, facing north	Appendix Plate A4.6: Western side of road, facing south
Appendix Plate A4.7: Eastern side of road, facing north	Appendix Plate A4.8: Eastern side of road, facing south

CWM01 500m	
Appendix Plate A4.9: Western side of road, facing north	Appendix Plate A4.10: Western side of road, facing south
Appendix Plate A4.11: Eastern side of road, facing north	Appendix Plate A4.12: Eastern side of road, facing south

CWM01 750m	
Appendix Plate A4.13: Western side of road, facing north	Appendix Plate A4.14: Western side of road, facing south
Appendix Plate A4.15: Eastern side of road, facing north	Appendix Plate A4.16: Eastern side of road, facing south

CWM01 1000m	
Appendix Plate A4.17: Western side of road, facing north	Appendix Plate A4.18: Western side of road, facing south
Appendix Plate A4.19: Eastern side of road, facing north	Appendix Plate A4.20: Eastern side of road, facing south

CWM02 0m	
Appendix Plate A4.21: Northern side of road, facing east	Appendix Plate A4.22: Northern side of road, facing west
Appendix Plate A4.23: Southern side of road, facing east	Appendix Plate A4.24: Southern side of road, facing west

CWM02 250m	
Appendix Plate A4.25: Northern side of road, facing east	Appendix Plate A4.26: Northern side of road, facing west
Appendix Plate A4.27: Southern side of road, facing east	Appendix Plate A4.28: Southern side of road, facing west

CWM02 500m	
Appendix Plate A4.29: Eastern side of road, facing north	Appendix Plate A4.30: Eastern side of road, facing south
Appendix Plate A4.31: Western side of road, facing north	Appendix Plate A4.32: Western side of road, facing south

CWM02 750m	
Appendix Plate A4.33: Eastern side of road, facing north	Appendix Plate A4.34: Eastern side of road, facing south
Appendix Plate A4.35: Western side of road, facing north	Appendix Plate A4.36: Western side of road, facing south

CWM02 1000m	
Appendix Plate A4.37: Eastern side of road, facing north	Appendix Plate A4.38: Eastern side of road, facing south
Appendix Plate A4.39: Western side of road, facing north	Appendix Plate A4.40: Western side of road, facing south

CWM03 0m	
Appendix Plate A4.41: Northern side of road, facing east	Appendix Plate A4.42: Northern side of road, facing west
Appendix Plate A4.43: Southern side of road, facing east	Appendix Plate A4.44: Southern side of road, facing west

CWM03 250m	
Appendix Plate A4.45: Northern side of road, facing east	Appendix Plate A4.46: Northern side of road, facing west
Appendix Plate A4.47: Southern side of road, facing east	Appendix Plate A4.48: Southern side of road, facing west

CWM03 500m	
	Missing image
Appendix Plate A4.49: **Northern side of road, facing east**	**Appendix Plate A4.50:** **Northern side of road, facing west**
Appendix Plate A4.51: **Southern side of road, facing east**	**Appendix Plate A4.52:** **Southern side of road, facing west**

CWM03 750m	
Appendix Plate A4.53: Northern side of road, facing east	Appendix Plate A4.54: Northern side of road, facing west
Appendix Plate A4.55: Southern side of road, facing east	Appendix Plate A4.56: Southern side of road, facing west

CWM03 1000m	
Appendix Plate A4.57: Northern side of road, facing east	Appendix Plate A4.58: Northern side of road, facing west
Appendix Plate A4.59: Southern side of road, facing east	Appendix Plate A4.60: Southern side of road, facing west

CWM04 0m	
Appendix Plate A4.61: Eastern side of road, facing north	Appendix Plate A4.62: Eastern side of road, facing south
Appendix Plate A4.63: Western side of road, facing north	Appendix Plate A4.64: Western side of road, facing south

CWM04 250m	
Appendix Plate A4.65: Eastern side of road, facing north	Appendix Plate A4.66: Eastern side of road, facing south
Appendix Plate A4.67: Western side of road, facing north	Appendix Plate A4.68: Western side of road, facing south

CWM04 500m	
Appendix Plate A4.69: Eastern side of road, facing north	Appendix Plate A4.70: Eastern side of road, facing south
Appendix Plate A4.71: Western side of road, facing north	Appendix Plate A4.72: Western side of road, facing south

CWM04 750m	
Appendix Plate A4.73: Eastern side of road, facing north	Appendix Plate A4.74: Eastern side of road, facing south
Appendix Plate A4.75: Western side of road, facing north	Appendix Plate A4.76: Western side of road, facing south

CWM04 1000m	
Appendix Plate A4.77: Eastern side of road, facing north	Appendix Plate A4.78: Eastern side of road, facing south
Appendix Plate A4.79: Western side of road, facing north	Appendix Plate A4.80: Western side of road, facing south

CWM05 0m	
Appendix Plate A4.81: Northern side of road, facing east	Appendix Plate A4.82: Northern side of road, facing west
Appendix Plate A4.83: Southern side of road, facing east	Appendix Plate A4.84: Southern side of road, facing west

CWM05 250m	
Appendix Plate A4.85: Northern side of road, facing east	Appendix Plate A4.86: Northern side of road, facing west
Appendix Plate A4.87: Southern side of road, facing east	Appendix Plate A4.88: Southern side of road, facing west

CWM05 500m	
Appendix Plate A4.89: Northern side of road, facing east	Appendix Plate A4.90: CWM05 500m Northern side of road, facing west
Appendix Plate A4.91: Southern side of road, facing east	Appendix Plate A4.92: Southern side of road, facing west

CWM05 750m	
Appendix Plate A4.93: Northern side of road, facing east	Appendix Plate A4.94: Northern side of road, facing west
Appendix Plate A4.95: Southern side of road, facing east	Appendix Plate A4.96: Southern side of road, facing west

CWM05 1000m	
Appendix Plate A4.97: Northern side of road, facing east	Appendix Plate A4.98: Northern side of road, facing west
Appendix Plate A4.99: Southern side of road, facing east	Appendix Plate A4.100: Southern side of road, facing west

CWM06 0m	
Appendix Plate A4.101: Northern side of road, facing east	Appendix Plate A4.102: Northern side of road, facing west
Appendix Plate A4.103: Southern side of road, facing east	Appendix Plate A4.104: Southern side of road, facing west

CWM06 250m	
Appendix Plate A4.105: Northern side of road, facing east	Appendix Plate A4.106: Northern side of road, facing west
Appendix Plate A4.107: Southern side of road, facing east	Appendix Plate A4.108: Southern side of road, facing west

CWM06 500m	
Appendix Plate A4.109: Northern side of road, facing east	Appendix Plate A4.110: Northern side of road, facing west
Appendix Plate A4.111: Southern side of road, facing east	Appendix Plate A4.112: Southern side of road, facing west

CWM06 750m	
Appendix Plate A4.113: Northern side of road, facing east	Appendix Plate A4.114: Northern side of road, facing west
Appendix Plate A4.115: Southern side of road, facing east	Appendix Plate A4.116: Southern side of road, facing west

CWM06 1000m	
Appendix Plate A4.117: Northern side of road, facing east	Appendix Plate A4.118: Northern side of road, facing west
Appendix Plate A4.119: Southern side of road, facing east	Appendix Plate A4.120: Southern side of road, facing west

CWM07 0m	
Appendix Plate A4.121: Facing north	Appendix Plate A4.122: Facing south

CWM07 250m	
Appendix Plate A4.123: Facing north	Appendix Plate A4.124: Facing south

CWM07 500m	
Appendix Plate A4.125: Facing north	Appendix Plate A4.126: Facing south

CWM07 750m	
Appendix Plate A4.127: Facing north	Appendix Plate A4.128: Facing south

CWM07 1000m	
Appendix Plate A4.129: Facing north	Appendix Plate A4.130: Facing south

NWM01 0m	
Appendix Plate A4.131: Facing east	Appendix Plate A4.132: Facing west

NWM01 250m	
Appendix Plate A4.133: Facing east	Appendix Plate A4.134: Facing west

NWM01 500m	
Appendix Plate A4.135: Facing east	Appendix Plate A4.136: Facing west

NWM01 750m	
Appendix Plate A4.137: Facing east	Appendix Plate A4.138: Facing west

NWM01 1000m	
Appendix Plate A4.139: Facing east	Appendix Plate A4.140: Facing west

NWM02 0m	
Appendix Plate A4.141: Facing east	Appendix Plate A4.142: Facing west

NWM02 250m	
Appendix Plate A4.143: Facing east	Appendix Plate A4.144: Facing west

NWM02 500m	
Appendix Plate A4.145: Facing east	Appendix Plate A4.146: Facing west

NWM02 750m	
Appendix Plate A4.147: Facing east	Appendix Plate A4.148: Facing west

NWM02 1000m	
Appendix Plate A4.149: Facing east	Appendix Plate A4.150: Facing west

NWM03 0m	
Appendix Plate A4.151: Facing north	Appendix Plate A4.152: Facing south

NWM03 250m	
Appendix Plate A4.153: Facing north	Appendix Plate A4.154: Facing south

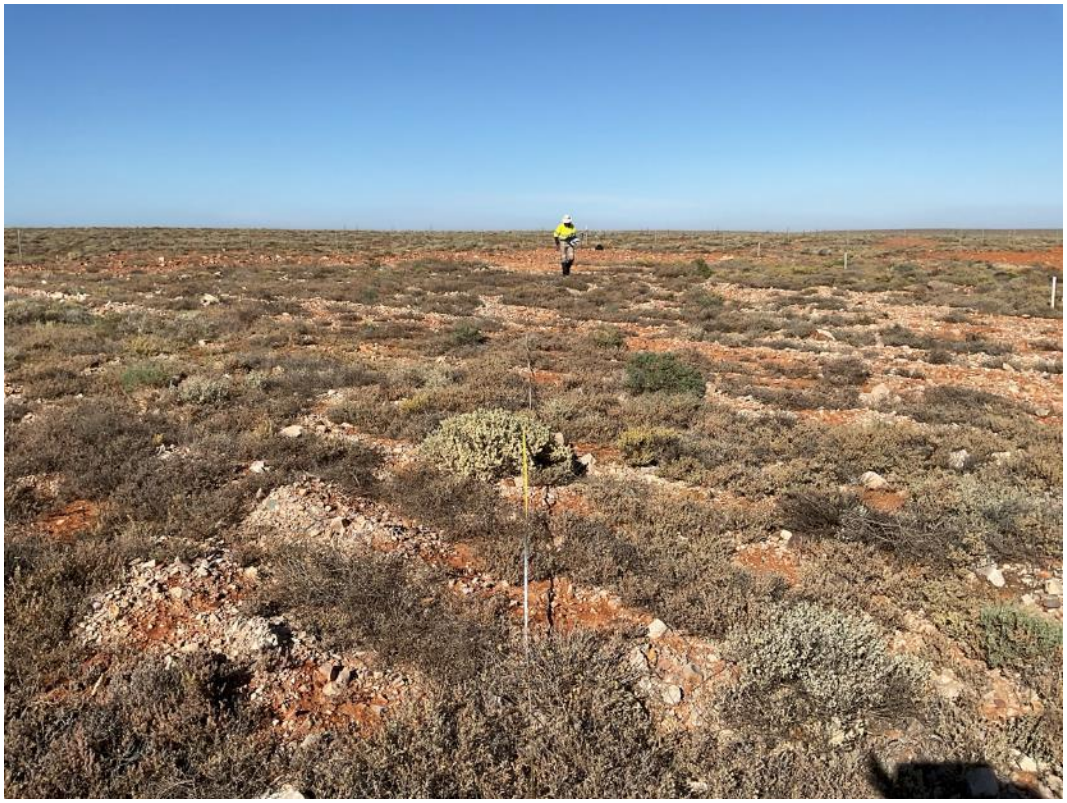
NWM03 500m	
Appendix Plate A4.155: Facing north	Appendix Plate A4.156: Facing south

NWM03 750m	
Appendix Plate A4.157: Facing north	Appendix Plate A4.158: Facing south

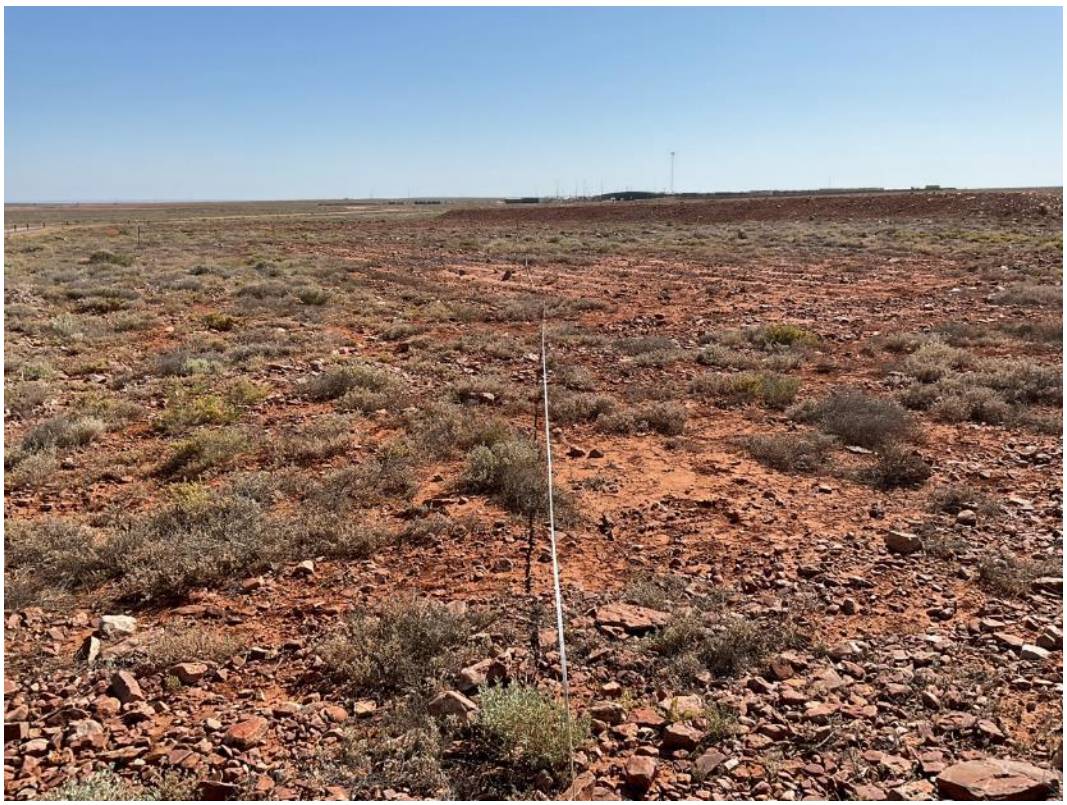
NWM03 1000m	
Appendix Plate A4.159: Facing north	Appendix Plate A4.160: Facing south

Appendix A5. Photolog, LFA Sites

Appendix Plate A5.1: LFA Site Aerodrome, transect 1A, start facing north (2024)



Appendix Plate A5.2: LFA Site Aerodrome, transect 1A, end facing south (2024)



Appendix Plate A5.3: LFA Site Aerodrome, transect 1B, start facing northwest (2024)

Appendix Plate A5.4: LFA Site Aerodrome, transect 1B, send facing southeast (2024)

Appendix Plate A5.5: LFA Site Ventia, transect 2A, start facing north, transect decomissioned (2024)

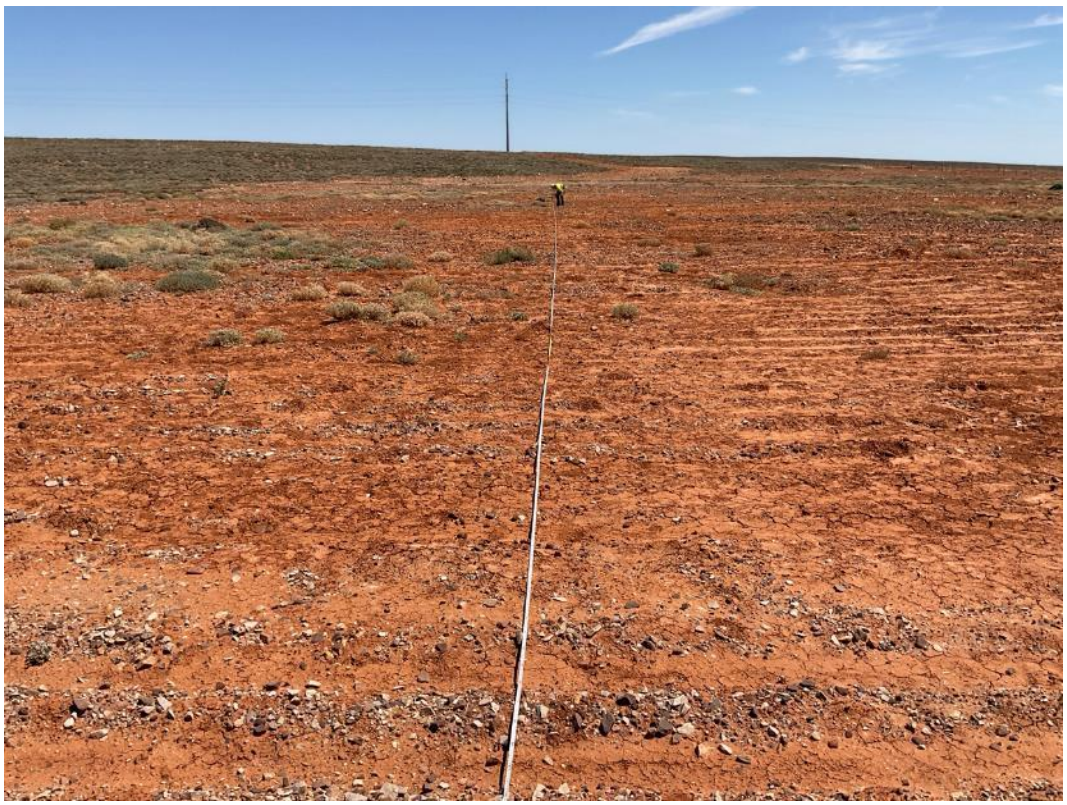
Appendix Plate A5.6: LFA Site Ventia, transect 2B, start facing north (2024)

Appendix Plate A5.7: LFA Site Ventia, transect 2B, end facing south (2024)

Appendix Plate A5.8: LFA Site Ventia, transect 2B, vegetation patch off transect (2024)

Appendix Plate A5.9: LFA Site Midway Quarry, transect 3A, start facing end (2024)

Appendix Plate A5.10: LFA Site Midway Quarry, transect 3A, dense patch off transect (2024)



Appendix Plate A5.11: LFA Site Midway Quarry, transect 3A, end facing start (2024)

Appendix Plate A5.12: LFA Site Midway Quarry, transect 3B, start facing end (2024)

Appendix Plate A5.13: LFA Site Midway Quarry, transect 3B, end facing start (2024)

Appendix Plate A5.14: LFA Site Tjungu, transect 4A, start facing end (2024)

Appendix Plate A5.15: LFA Site Tjungu, transect 4A, end facing start (2024)

Appendix Plate A5.16: LFA Site Tjungu, transect 4A, off transect diversity (2024)

Appendix Plate A5.17: LFA Site Tjungu, transect 4B, start facing end (2024)

Appendix Plate A5.18: LFA Site Tjungu, transect 4A, end facing start (2024)

Appendix B. Rangeland (RAM) Data

Appendix B1. Cumulative species list

The following is a cumulative list of flora species recorded at RAM sites (Flora Sites 1 – 22), spring 2024, including life span status, and the number of sites at which they were recorded.

Table B1.1: Cumulative flora list (RAM sites) for Carrapateena, spring 2024

Family	Scientific Name	Common Name	Number of Records	
			Long-lived	Short-lived
MALVACEAE	*Abutilon halophilum*	Plains Lantern-bush	11	
MALVACEAE	*Abutilon otocarpum*	Desert Lantern-bush	4	
FABACEAE	*Acacia aneura*	Mulga	1	
FABACEAE	*Acacia ligulata*	Umbrella Bush	2	
FABACEAE	*Acacia oswaldii*	Umbrella Wattle	1	
FABACEAE	*Acacia papyrocarpa/ Acacia* sp. *Blyth*[1]	Western Myall	7	
FABACEAE	*Acacia ramulosa* var.	Horse Mulga	1	
FABACEAE	*Acacia tetragonophylla*	Dead Finish	4	
SAPINDACEAE	*Alectryon oleifolius* ssp. *canescens*	Bullock Bush	1	
AMARANTHACEAE	*Alternanthera denticulata*	Lesser Joyweed		1
ANACAMPSEROTACEAE	*Anacampseros australiana*	Australian Anacampseros		5
POACEAE	*Aristida contorta*	Curly Wire-grass		1
POACEAE	*Aristida holathera* var.	Tall Kerosene Grass		2
ASPARAGACEAE	*Arthropodium fimbriatum*	Nodding Vanilla-lily		2
POACEAE	*Astrebla pectinata*	Barley Mitchell-grass	8	
AMARANTHACEAE	*Atriplex fissivalvis*	Gibber Saltbush		2
AMARANTHACEAE	*Atriplex holocarpa*	Pop Saltbush		10
AMARANTHACEAE	*Atriplex velutinella*	Sandhill Saltbush		2
AMARANTHACEAE	*Atriplex vesicaria*	Bladder Saltbush	16	
NYCTAGINACEAE	*Boerhavia* sp.	Tar-vine		1
ASTERACEAE	*Brachyscome ciliaris* var.	Variable Daisy		3
ASPHODELACEAE	*Bulbine semibarbata*	Small Leek-lily		9
ASTERACEAE	*Calotis hispidula*	Hairy Burr-daisy		7
ASTERACEAE	*Centaurea melitensis**	Malta Thistle		1
ASTERACEAE	*Centipeda crateriformis ssp.*	Sneezeweed		2
PTERIDACEAE	*Cheilanthes lasiophylla*	Woolly Cloak-fern		1
AMARANTHACEAE	*Chenopodium curvispicatum*	Cottony Goosefoot	3	
AMARANTHACEAE	*Chenopodium desertorum* ssp.	Desert Goosefoot	3	
ASTERACEAE	*Chrysocephalum pterochaetum*	Shrub Everlasting		1
CONVOLVULACEAE	*Convolvulus remotus*	Grassy Bindweed		1
AMARYLLIDACEAE	*Crinum flaccidum*	Murray Lily		4
FABACEAE	*Crotalaria eremaea* ssp.	Loose-flowered Rattle-pod		1
FABACEAE	*Cullen cinereum*	Annual Scurf-pea		5
FABACEAE	*Cullen pallidum*	White Scurf-pea		2
POACEAE	*Dactyloctenium radulans*	Button-grass		1
APIACEAE	*Daucus glochidiatus*	Native Carrot		5
POACEAE	*Digitaria brownii*	Cotton Panic-grass	4	
AMARANTHACEAE	*Dissocarpus biflorus* var.	Two-horn Saltbush		4
AMARANTHACEAE	*Dissocarpus paradoxus*	Ball Bindyi		8
SAPINDACEAE	*Dodonaea lobulata*	Lobed-leaf Hop-bush	5	
SAPINDACEAE	*Dodonaea viscosa* ssp. *angustissima*	Narrow-leaf Hop-bush	3	
POLYGONACEAE	*Duma florulenta*	Lignum	3	
AMARANTHACEAE	*Einadia nutans* ssp.	Climbing Saltbush	6	
AMARANTHACEAE	*Enchylaena tomentosa* var. *tomentosa*	Ruby Saltbush	9	
POACEAE	*Enneapogon avenaceus*	Common Bottle-washers		8
POACEAE	*Enteropogon acicularis*	Umbrella Grass		1
POACEAE	*Eragrostis australasica*	Cane-grass	1	
POACEAE	*Eragrostis setifolia*	Bristly Love-grass	13	
SCROPHULARIACEAE	*Eremophila glabra* ssp. *glabra*	Tar Bush	1	
SCROPHULARIACEAE	*Eremophila latrobei* ssp. *glabra*	Crimson Emubush	3	

Family	Scientific Name	Common Name	Number of Records	
			Long-lived	Short-lived
SCROPHULARIACEAE	*Eremophila oppositifolia* ssp. *oppositifolia*	Opposite-leaved Emubush	2	
SCROPHULARIACEAE	*Eremophila serrulata*	Green Emubush	5	
MYRTACEAE	*Eucalyptus camaldulensis* ssp. *arida*	Northern River Red Gum	3	
POACEAE	*Eulalia aurea*	Silky Brown-top	4	
EUPHORBIACEAE	*Euphorbia drummondii group*	Spurge		2
EUPHORBIACEAE	*Euphorbia stevenii*	Bottletree Spurge		6
EUPHORBIACEAE	*Euphorbia tannensis* ssp. *eremophila*	Desert Spurge		7
SANTALACEAE	*Exocarpos aphyllus*	Leafless Cherry	4	
FRANKENIACEAE	*Frankenia serpyllifolia*	Thyme Sea-heath	13	
FRANKENIACEAE	*Frankenia subteres*	Frankenia	1	
ASTERACEAE	*Glossocardia bidens*	Native Cobbler's-pegs		1
ASTERACEAE	*Gnephosis arachnoidea*	Spidery Button-flower		8
GOODENIACEAE	*Goodenia fascicularis*	Silky Goodenia		2
AIZOACEAE	*Gunniopsis quadrifida*	Sturt's Pigface		1
MALVACEAE	*Hibiscus krichauffianus*	Velvet-leaf Hibiscus		1
POACEAE	*Iseilema membranaceum*	Small Flinders-grass		1
BRASSICACEAE	*Lepidium phlebopetalum*	Veined Peppercress		12
FABACEAE	*Lotus cruentus*	Red-flower Lotus		5
SOLANACEAE	*Lycium australe*	Australian Boxthorn	1	
PHYLLANTHACEAE	*Lysiandra fuernrohrii*	Sand Spurge	1	
AMARANTHACEAE	*Maireana aphylla*	Cotton-bush	12	
AMARANTHACEAE	*Maireana appressa*	Pale-fruit Bluebush	12	
AMARANTHACEAE	*Maireana astrotricha*	Low Bluebush	1	
AMARANTHACEAE	*Maireana astrotricha*	Low Bluebush	1	
AMARANTHACEAE	*Maireana eriantha*	Woolly Bluebush	4	
AMARANTHACEAE	*Maireana georgei*	Satiny Bluebush	1	
AMARANTHACEAE	*Maireana pyramidata*	Black Bluebush	3	
AMARANTHACEAE	*Maireana spongiocarpa*	Spongy-fruit Bluebush	8	
AMARANTHACEAE	*Maireana turbinata*	Top-fruit Bluebush	2	
MALVACEAE	*Malvastrum americanum var. americanum*	Malvastrum		5
MARSILEACEAE	*Marsilea drummondii*	Common Nardoo		3
ASTERACEAE	*Minuria cunninghamii*	Bush Minuria	13	
SCROPHULARIACEAE	*Myoporum montanum*	Native Myrtle	6	
SOLANACEAE	*Nicotiana velutina*	Velvet Tobacco		4
AMARANTHACEAE	*Osteocarpum dipterocarpum*	Two-wing Bonefruit		5
POACEAE	*Panicum decompositum* var. *decompositum*	Native Millet		2
POACEAE	*Paractaenum novae-hollandiae* ssp. *reversum*	Barbed-wire Grass		1
THYMELAEACEAE	*Pimelea microcephala* ssp. *microcephala*	Shrubby Riceflower	2	
THYMELAEACEAE	*Pimelea simplex*	Desert Riceflower		1
PLANTAGINACEAE	*Plantago drummondii*	Dark Plantain		4
ASTERACEAE	*Pluchea rubelliflora*	Winged Plains-bush		3
ASTERACEAE	*Podolepis davisiana*	Button Podolepis		3
ASTERACEAE	*Podolepis* sp.	Copper-wire Daisy		1
ASTERACEAE	*Polycalymma stuartii*	Poached-egg Daisy		2
PORTULACACEAE	*Portulaca oleracea*	Common Purslane		2
ASTERACEAE	*Pterocaulon sphacelatum*	Apple-bush		3
AMARANTHACEAE	*Ptilotus nobilis*	Yellow-tails		1
AMARANTHACEAE	*Ptilotus obovatus*	Silver Mulla Mulla	7	
AMARANTHACEAE	*Rhagodia spinescens*	Spiny Saltbush	6	
ASTERACEAE	*Rhodanthe floribunda*	White Everlasting		2
ASTERACEAE	*Rhodanthe* sp.	Everlasting		1
ASTERACEAE	*Rhodanthe stricta*	Slender Everlasting		8
ZYGOPHYLLACEAE	*Roepera eremaea*	Climbing Twinleaf		1
ZYGOPHYLLACEAE	*Roepera howittii*	Clasping Twinleaf		2
ZYGOPHYLLACEAE	*Roepera* sp.	Twinleaf		1
ACANTHACEAE	*Rostellularia adscendens* ssp.	Pink Tongues		5
AMARANTHACEAE	*Salsola australis*	Buckbush		6
SANTALACEAE	*Santalum lanceolatum*	Plumbush	5	
GOODENIACEAE	*Scaevola spinescens*	Spiny Fanflower	4	
AMARANTHACEAE	*Sclerolaena brachyptera*	Short-wing Bindyi		10
AMARANTHACEAE	*Sclerolaena diacantha*	Grey Bindyi		2

Family	Scientific Name	Common Name	Number of Records	
			Long-lived	Short-lived
AMARANTHACEAE	*Sclerolaena divaricata*	Tangled Bindyi		15
AMARANTHACEAE	*Sclerolaena intricata*	Tangled Bindyi		11
AMARANTHACEAE	*Sclerolaena patenticuspis*	Spear-fruit Bindyi		3
AMARANTHACEAE	*Sclerolaena* sp.	Bindyi		1
AMARANTHACEAE	*Sclerolaena ventricosa*	Salt Bindyi		6
FABACEAE	*Senna artemisioides ssp. helmsii*	Blunt-leaf Senna	5	
FABACEAE	*Senna artemisioides ssp. oligophylla*	Limestone Senna	1	
FABACEAE	*Senna artemisioides* ssp. *X artemisioides*	Silver Senna	5	
FABACEAE	*Senna artemisioides* ssp. *X sturtii*	Grey Senna	3	
POACEAE	*Setaria constricata*	Knotty-butt Paspalidium	1	
MALVACEAE	*Sida ammophila*	Sand Sida		2
MALVACEAE	*Sida corrugata* var.	Corrugated Sida		5
MALVACEAE	*Sida fibulifera*	Pin Sida		8
MALVACEAE	*Sida intricata*	Twiggy Sida	10	
MALVACEAE	*Sida petrophila*	Rock Sida	6	
BRASSICACEAE	*Sisymbrium erysimoides**	Smooth Mustard		3
SOLANACEAE	*Solanum lithophilum*	Velvet Potato-bush		3
SOLANACEAE	*Solanum quadriloculatum*	Plains Nightshade		5
ASTERACEAE	*Sonchus oleraceus**	Common Sow-thistle		2
POACEAE	*Sporobolus actinocladus*	Ray Grass		14
CELASTRACEAE	*Stackhousia* sp.	Candles		2
FABACEAE	*Swainsona* sp.	Swainson-pea		1
AMARANTHACEAE	*Tecticornia medullosa*	Samphire	13	
AMARANTHACEAE	*Tecticornia pergranulata* ssp. *divaricata*	Black-seed Samphire	2	
AMARANTHACEAE	*Tecticornia tenuis*	Slender Samphire	4	
LAMIACEAE	*Teucrium racemosum*	Grey Germander		2
POACEAE	*Themeda triandra*	Kangaroo Grass	2	
ASPARAGACEAE	*Thysanotus baueri*	Mallee Fringe-lily		1
ASPARAGACEAE	*Thysanotus* sp.	Fringe-lily		1
AIZOACEAE	*Trianthema triquetrum*	Red Spinach		2
BORAGINACEAE	*Trichodesma zeylanicum* var. *zeylanicum*	Camel Bush		2
ASTERACEAE	*Vittadinia gracilis*	Woolly New Holland Daisy		1
CAMPANULACEAE	*Wahlenbergia* sp.	Native Bluebell		3
COLCHICACEAE	*Wurmbea australis*	Inland Nancy		1
POACEAE	*Zygochloa paradoxa*	Sandhill Cane-grass	2	

[1]*Acacia sp. Blyth Range* is a poorly known entity, formerly known as *Acacia affin. papyrocarpa*. It is most common in the vicinity of Lake Torrens, NW edge of Flinders Ranges and near Bltyh Range in WA. Factsheet - Acacia sp. Blyth Range (W.V.Fitzgerald s.n. 1898) [affin. papyrocarpa] "Further field and laboratory studies are needed to determine the status of this taxon. It is clearly related to *A. papyrocarpa,* but differs most obviously in having rather rigid, often subterete, ±pungent phyllodes and minutely appressed hairy pods." In the Carrapateena operational area, the taxon of the trees is still under review.

Appendix B2. Site specific descriptive statistics, grazing impact

Table B2.1: Plant diversity, life span, grazing impact, life stages and cover/abundance per RAM Site

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
Flora Site 1 / CAR001	*Abutilon halophilum*	Plains Lantern-bush	Y	4	Mixed	>50	<50	0
	Astrebla pectinata	Barley Mitchell-grass	Y	4	Mixed	<50	>50	0
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	<50	0
	Bulbine semibarbata	Small Leek-lily	N	1				
	Dissocarpus paradoxus	Ball Bindyi	N	3				
	Eragrostis setifolia	Bristly Love-grass	Y	2	Mixed	<50	>50	0
	Euphorbia tannensis ssp. *eremophila*	Desert Spurge	N	1				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	1	Adult	>50	0	0
	Goodenia fascicularis	Silky Goodenia	N	1				
	Maireana aphylla	Cotton-bush	Y	1	Adult	>50	0	0
	Maireana appressa	Pale-fruit Bluebush	Y	1	Adult	>50	<50	0
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	2	Adult	<50	>50	0
	Malvastrum americanum var.	Malvastrum	N	1				
	Minuria cunninghamii	Bush Minuria	Y	2	Adult	0	>50	<50
	Nicotiana velutina	Velvet Tobacco	N	1				
	Portulaca oleracea	Common Purslane	N	1				
	Rhodanthe floribunda	White Everlasting	N	1				
	Roepera howittii	Clasping Twinleaf	N	1				
	Sclerolaena brachyptera	Short-wing Bindyi	N	4				
	Sclerolaena divaricata	Tangled Bindyi	N	4				
	Sclerolaena intricata	Tangled Bindyi	N	3				
	Sida intricata	Twiggy Sida	Y	2	Adult	0	0	0
	Sporobolus actinocladus	Ray Grass	N	4				
	Tecticornia medullosa	Samphire	Y	3	Mixed	>50	0	0
	Site 1 Totals: 24 (long-lived = 11, short-lived = 13)							
Flora Site 2 / CAR002	*Abutilon halophilum*	Plains Lantern-bush	Y	3	Adult	>50	0	0
	Anacampseros australiana	Australian Anacampseros	N	1				
	Astrebla pectinata	Barley Mitchell-grass	Y	2	Adult	<50	>50	<50
	Atriplex holocarpa	Pop Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	4	Mixed	>50	<50	0
	Brachyscome ciliaris var.	Variable Daisy	N	1				
	Calotis hispidula	Hairy Burr-daisy	N	1				
	Cullen cinereum	Annual Scurf-pea	N	2				
	Daucus glochidiatus	Native Carrot	N	1				
	Dissocarpus paradoxus	Ball Bindyi	N	2				
	Eragrostis setifolia	Bristly Love-grass	Y	3	Adult	0	0	>50
	Euphorbia tannensis ssp. *eremophila*	Desert Spurge	N	1				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Adult	>50	0	0
	Lepidium phlebopetalum	Veined Peppercress	N	1				
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	3	Adult	>50	0	0
	Plantago drummondii	Dark Plantain	N	1				
	Ptilotus nobilis	Yellow-tails	N	1				
	Rhodanthe sp.	Everlasting	N	1				
	Salsola australis	Buckbush	N	3				
	Sclerolaena brachyptera	Short-wing Bindyi	N	4/5				
	Sclerolaena divaricata	Tangled Bindyi	N	4				
	Sclerolaena intricata	Tangled Bindyi	N	4				
	Sclerolaena ventricosa	Salt Bindyi	N	3				
	Sporobolus actinocladus	Ray Grass	N	3				
	Tecticornia medullosa	Samphire	Y	3	Adult	>50	0	0
	Thysanotus baueri	Mallee Fringe-lily	N	1				
	Trianthema triquetrum	Red Spinach	N	2				
	Wahlenbergia sp.	Native Bluebell	N	1				
	Site 2 Totals: 28 (long-lived = 7, short-lived = 21)							

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
Flora Site 3 / CAR003	*Abutilon halophilum*	Plains Lantern-bush	Y	3	Adult	>50	0	0
	Anacampseros australiana	Australian Anacampseros	N	3				
	Arthropodium fimbriatum	Nodding Vanilla-lily	N	1				
	Astrebla pectinata	Barley Mitchell-grass	Y	2	Adult	>50	<50	0
	Atriplex fissivalvis	Gibber Saltbush	N	2				
	Atriplex holocarpa	Pop Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	4	Mixed	>50	<50	0
	Brachyscome ciliaris var.	Variable Daisy	N	1				
	Bulbine semibarbata	Small Leek-lily	N	3				
	Calotis hispidula	Hairy Burr-daisy	N	1				
	Centipeda crateriformis		N	1				
	Cullen cinereum	Annual Scurf-pea	N	1				
	Daucus glochidiatus	Native Carrot	N	3				
	Dissocarpus paradoxus	Ball Bindyi	N	3				
	Eragrostis setifolia	Bristly Love-grass	Y	2	Adult	0	>50	0
	Euphorbia stevenii	Bottletree Spurge	N	1				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	2	Mixed	>50	0	0
	Lepidium phlebopetalum	Veined Peppercress	N	1				
	Lotus cruentus	Red-flower Lotus	N	1				
	Maireana appressa	Pale-fruit Bluebush	Y	3	Adult	<50	>50	0
	Maireana eriantha	Woolly Bluebush	Y	1	Mixed	0	>50	0
	Minuria cunninghamii	Bush Minuria	Y	2/4	Mixed	>50	0	0
	Plantago drummondii	Dark Plantain	N	3				
	Podolepis davisiana	Button Podolepis	N	1				
	Portulaca oleracea	Common Purslane	N	3				
	Rhodanthe stricta	Slender Everlasting	N	3				
	Salsola australis	Buckbush	N	3				
	Sclerolaena brachyptera	Short-wing Bindyi	N	2				
	Sclerolaena divaricata	Tangled Bindyi	N	3				
	Sclerolaena intricata	Tangled Bindyi	N	2/4				
	Sclerolaena ventricosa	Salt Bindyi	N	2				
	Sida fibulifera	Pin Sida	N	2				
	Sida intricata	Twiggy Sida	Y	2	Adult	0	>50	0
	Sporobolus actinocladus	Ray Grass	N	2/3				
	Tecticornia medullosa	Samphire	Y	5	Mixed	>50	0	0
	Tecticornia tenuis	Slender Samphire	Y	1	Mixed	>50	0	0
	Wahlenbergia sp.	Native Bluebell	N	1				
	Site 3 Totals: 37 (long-lived = 11, short-lived = 26)							
Flora Site 4 / CAR004	*Abutilon halophilum*	Plains Lantern-bush	Y	1	Adult	>50	>50	0
	Atriplex holocarpa	Pop Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	0	0
	Brachyscome ciliaris var.	Variable Daisy	N	3				
	Bulbine semibarbata	Small Leek-lily	N	2				
	Calotis hispidula	Hairy Burr-daisy	N	1				
	Convolvulus remotus	Grassy Bindweed	N	1				
	Daucus glochidiatus	Native Carrot	N	3				
	Dissocarpus biflorus var.	Two-horn Saltbush	N	1				
	Dissocarpus paradoxus	Ball Bindyi	N	1				
	Eragrostis setifolia	Bristly Love-grass	Y	3	Adult	<50	>50	<50
	Euphorbia stevenii	Bottletree Spurge	N	1				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Adult	>50	0	0
	Lepdiium phlebopetalum	Phebalium	N	3				
	Maireana appressa	Pale-fruit Bluebush	Y	3	Adult	<50	>50	0
	Minuria cunninghamii	Bush Minuria	Y	1	Adult	0	>50	0
	Osteocarpum dipterocarpum	Two-wing Bonefruit	N	3				
	Rhodanthe stricta	Slender Everlasting	N	3				
	Sclerolaena brachyptera	Short-wing Bindyi	N	2				
	Sclerolaena divaricata	Tangled Bindyi	N	2/4				
	Sclerolaena ventricosa	Salt Bindyi	N	4				
	Sida fibulifera	Pin Sida	N	3				
	Sida intricata	Twiggy Sida	Y	3	Adult	0	>50	<50

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Sporobolus actinocladus	Ray Grass	N	2/4				
	Tecticornia medullosa	Samphire	Y	2	Mixed	>50	0	0
	Tecticornia tenuis	Slender Samphire	Y	2	Mixed	>50	0	0
	Site 4 Totals: 26 (long-lived = 9, short-lived = 17)							
Flora Site 5 / CAR005	*Abutilon halophilum*	Plains Lantern-bush	Y	4	Mixed	>50	<50	0
	Anacampseros australiana	Australian Anacampseros	N	2				
	Atriplex holocarpa	Pop Saltbush	N	3				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	<50	0
	Bulbine semibarbata	Small Leek-lily	N	2				
	Dissocarpus paradoxus	Ball Bindyi	N	1				
	Enneapogon avenaceus	Common Bottle-washers	N	2				
	Eragrostis setifolia	Bristly Love-grass	Y	2	Adult	>50	<50	0
	Frankenia serpyllifolia	Thyme Sea-heath	Y	4	Adult	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N	3				
	Lepidium phlebopetalum	Veined Peppercress	N	3				
	Maireana aphylla	Cotton-bush	Y	3	Adult	>50	<50	0
	Maireana appressa	Pale-fruit Bluebush	Y	2	Adult	<50	>50	0
	Maireana turbinata	Top-fruit Bluebush	Y	2	Adult	0	>50	0
	Minuria cunninghamii	Bush Minuria	Y	2	Adult	<50	>50	<50
	Osteocarpum dipterocarpum	Two-wing Bonefruit	N	3				
	Roepera sp.	Twinleaf	N	1				
	Sclerolaena brachyptera	Short-wing Bindyi	N	2				
	Sclerolaena divaricata	Tangled Bindyi	N	3				
	Sclerolaena intricata	Tangled Bindyi	N	1				
	Sclerolaena ventricosa	Salt Bindyi	N	2				
	Sida fibulifera	Pin Sida	N	2				
	Sporobolus actinocladus	Ray Grass	N	4				
	Tecticornia medullosa	Samphire	Y	4	Mixed	>50	0	0
	Site 5 Totals: 24 (long-lived = 9, short-lived = 15)							
Flora Site 6 / CAR006	*Astrebla pectinata*	Barley Mitchell-grass	Y	1	Adult	0	>50	0
	Atriplex holocarpa	Pop Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	<50	0
	Bulbine semibarbata	Small Leek-lily	N	3				
	Cullen cinereum	Annual Scurf-pea	N	1				
	Eragrostis setifolia	Bristly Love-grass	Y	2/4	Adult	<50	>50	0
	Euphorbia stevenii	Bottletree Spurge	N	2/4				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	2	Adult	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N	3				
	Maireana aphylla	Cotton-bush	Y	1	Adult	>50	0	0
	Maireana appressa	Pale-fruit Bluebush	Y	1	Adult	0	>50	>50
	Minuria cunninghamii	Bush Minuria	Y	4	Adult	<50	>50	<50
	Osteocarpum dipterocarpum	Two-wing Bonefruit	N	1				
	Podolepis davisiana	Button Podolepis	N	3				
	Rhodanthe stricta	Slender Everlasting	N	1				
	Sclerolaena brachyptera	Short-wing Bindyi	N	2				
	Sclerolaena divaricata	Tangled Bindyi	N	2				
	Sclerolaena intricata	Tangled Bindyi	N	2				
	Sclerolaena ventricosa	Salt Bindyi	N	2/4				
	Sida fibulifera	Pin Sida	N	3				
	Sida intricata	Twiggy Sida	Y	1	Adult	0	>50	0
	Sporobolus actinocladus	Ray Grass	N	3/4				
	Tecticornia medullosa	Samphire	Y	2/4	Mixed	>50	0	0
	Wahlenbergia sp.	Native Bluebell	N	1				
	Site 6 Totals: 24 (long-lived = 9, short-lived =15)							
Flora Site 7 / CAR007	*Abutilon halophilum*	Plains Lantern-bush	Y	1	Mixed	>50	0	0
	Aristida contorta	Curly Wire-grass	N	2				
	Astrebla pectinata	Barley Mitchell-grass	Y	1	Adult	0	<50	>50
	Atriplex holocarpa	Pop Saltbush	N	3				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	<50	0
	Calotis hispidula	Hairy Burr-daisy	N	2				

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Dodonaea viscosa ssp. *angustissima*	Narrow-leaf Hop-bush	Y	1	Adult	>50	0	0
	Enneapogon avenaceus	Common Bottle-washers	N	4				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Mixed	>50	0	0
	Frankenia subteres		Y	1	Mixed	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N	4				
	Gunniopsis quadrifida	Sturt's Pigface	N	1				
	Lotus cruentus	Red-flower Lotus	N	1				
	Maireana appressa	Pale-fruit Bluebush	Y	2	Mixed	>50	0	0
	Maireana astrotricha	Low Bluebush	Y	1	Mixed	>50	<50	<50
	Maireana georgei	Satiny Bluebush	Y	2	Mixed	0	>50	<50
	Maireana pyramidata	Black Bluebush	Y	2	Adult	>50	<50	0
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	2	Mixed	0	>50	0
	Malvastrum americanum var.	Malvastrum	N	1				
	Minuria cunninghamii	Bush Minuria	Y	4	Adult	0	>50	<50
	Myoporum montanum	Native Myrtle	Y	1	Adult	>50	0	0
	Osteocarpum dipterocarpum	Two-wing Bonefruit	N	4				
	Pimelea simplex	Pimelea	N	3				
	Pterocaulon sphacelatum	Apple-bush	N	1				
	Ptilotus obovatus	Silver Mulla Mulla	Y	2	Mixed	>50	<50	0
	Sclerolaena intricata	Tangled Bindyi	N	4				
	Sclerolaena patenticuspis	Spear-fruit Bindyi	N	2				
	Sida intricata	Twiggy Sida	Y	2	Mixed	>50	<50	<50
	Sida petrophila	Rock Sida	Y	1	Mixed	<50	>50	0
	Solanum quadriloculatum	Plains Nightshade	N	1				
	Sporobolus actinocladus	Ray Grass	N	3				
	Stackhousia sp.	Candles	N	2				
	Tecticornia pergranulata ssp. divaricata	Black-seed Samphire	Y	5	Mixed	>50	0	0
	Tecticornia tenuis	Slender Samphire	Y	3	Mixed	>50	0	0
	Thysanotus sp.	Fringe-lily	N	1				
	Site 7 Totals: 35 (long-lived = 18, short-lived = 17)							
Flora Site 9 / CAR009	*Abutilon halophilum*	Plains Lantern-bush	Y	3	Mixed	>50	<50	0
	Acacia papyrocarpa	Western Myall	Y	6	Mixed	>50	0	0
	Astrebla pectinata	Barley Mitchell-grass	Y	2	Mixed	0	<50	>50
	Atriplex fissivalvis	Gibber Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	4	Mixed	>50	<50	0
	Calotis hispidula	Hairy Burr-daisy	N	2				
	Centipeda sp.	Sneezeweed	N	1				
	Cullen cinereum	Annual Scurf-pea	N	1				
	Dactyloctenium radulans	Button-grass	N	1				
	Dissocarpus paradoxus	Ball Bindyi	N	3				
	Enchylaena tomentosa	Ruby Saltbush	Y	2	Mixed	>50	<50	0
	Enneapogon avenaceus	Common Bottle-washers	N	2				
	Eremophila glabra ssp.	Tar Bush	Y	1	Adult	>50	0	0
	Eremophila oppositifolia ssp.	Opposite-leaved Emubush	Y	1	Adult	0	0	>50
	Euphorbia tannensis ssp. eremophila	Desert Spurge	N	1				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Mixed	<50	>50	0
	Gnephosis arachnoidea	Spidery Button-flower	N	2				
	Lotus cruentus	Red-flower Lotus	N	1				
	Maireana aphylla	Cotton-bush	Y	1	Adult	<50	>50	0
	Maireana appressa	Pale-fruit Bluebush	Y	2	Mixed	>50	0	0
	Maireana eriantha	Woolly Bluebush	Y	2	Mixed	>50	<50	0
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	2	Adult	>50	<50	0
	Minuria cunninghamii	Bush Minuria	Y	2	Mixed	0	>50	<50
	Myoporum montanum	Native Myrtle	Y	2	Young	>50	0	0
	Panicum decompositum var. *decompositum*	Native Millet	N	1				
	Ptilotus obovatus	Silver Mulla Mulla	Y	2	Mixed	>50	<50	0
	Rhodanthe stricta	Slender Everlasting	N	3				
	Rostellularia adscendens	Pink Tongues	N	2				

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Salsola australis	Buckbush	N	1				
	Sclerolaena brachyptera	Short-wing Bindyi	N	4				
	Sclerolaena divaricata	Tangled Bindyi	N	4				
	Sclerolaena intricata	Tangled Bindyi	N	4				
	Sida corrugata	Corrugated Sida	N	1				
	Sida intricata	Twiggy Sida	Y	2	Adult	0	0	0
	Solanum quadriloculatum	Plains Nightshade	N	2				
	Sporobolus actinocladus	Ray Grass	N	4				
	Swainsona sp.	Swainson-pea	N	1				
	Tecticornia medullosa	Samphire	Y	3	Mixed	>50	0	0
	Tecticornia pergranulata ssp. *divaricata*	Black-seed Samphire	Y	5	Mixed	>50	<50	0
	Tecticornia tenuis	Slender Samphire	Y	3	Mixed	>50	0	0
	Vittadinia gracilis	Woolly New Holland Daisy	N	1				
	Site 9 Totals: 41 (long-lived = 19, short-lived = 22)							
Flora Site 10 / CAR010	*Abutilon otocarpum*	Desert Lantern-bush	Y	3	Mixed	>50	0	0
	Acacia papyrocarpa	Western Myall	Y	3	Mixed	>50	0	0
	Acacia tetragonophylla	Dead Finish	Y	3	Mixed	>50	0	0
	Alternanthera denticulata	Lesser Joyweed	N	1				
	Chenopodium desertorum ssp.	Desert Goosefoot	Y	1	Adult	>50	<50	0
	Chrysocephalum pterochaetum	Shrub Everlasting	N	3				
	Daucus glochidiatus	Native Carrot	N	3				
	Digitaria brownii	Cotton Panic-grass	Y	2	Adult	0	>50	0
	Dodonaea lobulata	Lobed-leaf Hop-bush	Y	3	Mixed	>50	0	0
	Duma florulenta	Lignum	Y	2	Mixed	>50	0	0
	Einadia nutans ssp.	Climbing Saltbush	Y	1	Adult	>50	<50	0
	Enchylaena tomentosa	Ruby Saltbush	Y	4	Mixed	>50	<50	0
	Enteropogon acicularis	Umbrella Grass	N	2				
	Eragrostis setifolia	Bristly Love-grass	Y	1	Adult	<50	<50	>50
	Eremophila serrulata	Green Emubush	Y	1	Mixed	>50	0	0
	Eucalyptus camaldulensis ssp. *arida*	Northern River Red Gum	Y	2/4	Mixed	>50	0	0
	Exocarpos aphyllus	Leafless Cherry	Y	1	Adult	>50	0	0
	Iseilema membranaceum	Small Flinders-grass	N	2				
	Lepidium phlebopetalum	Veined Peppercress	N	3				
	Maireana aphylla	Cotton-bush	Y	1	Adult	0	>50	0
	Malvastrum americanum var.	Malvastrum	N	1				
	Marsilea drummondii	Common Nardoo	N	1				
	Myoporum montanum	Native Myrtle	Y	3	Mixed	>50	0	0
	Pluchea rubelliflora		N	3				
	Pterocaulon sphacelatum	Apple-bush	N	3				
	Ptilotus obovatus	Silver Mulla Mulla	Y	4	Mixed	>50	<50	0
	Rhagodia spinescens	Spiny Saltbush	Y	2	Mixed	>50	0	0
	Rhodanthe stricta	Slender Everlasting	N	1				
	Rostellularia adscendens ssp.	Pink Tongues	N	3				
	Santalum lanceolatum	Plumbush	Y	3	Mixed	>50	0	0
	Scaevola spinescens	Spiny Fanflower	Y	3	Mixed	>50	<50	0
	Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	Y	4	Mixed	>50	0	0
	Senna artemisioides ssp. *X artemisioides*	Silver Senna	Y	3	Adult	>50	0	0
	Sida petrophila	Rock Sida	Y	4	Mixed	0	>50	0
	Stackhousia sp.	Candles	N	1				
	Themeda triandra	Kangaroo Grass	Y	2/4	Mixed	0	>50	0
	Site 10 Totals: 36 (long-lived = 23, short-lived = 13)							
Flora Site / CAR011	*Abutilon halophilum*	Plains Lantern-bush	Y	5	Mixed	>50	0	0
	Acacia papyrocarpa	Western Myall	Y	4	Mixed	>50	<50	0
	Anacampseros australiana	Australian Anacampseros	N	3				
	Arthropodium fimbriatum	Nodding Vanilla-lily	N	1				
	Astrebla pectinata	Barley Mitchell-grass	Y	4	Mixed	>50	<50	0
	Atriplex holocarpa	Pop Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	>50	<50

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Bulbine semibarbata	Small Leek-lily	N	3				
	Enchylaena tomentosa	Ruby Saltbush	Y	2	Mixed	>50	<50	0
	Eragrostis australasica	Cane-grass	Y	1	Mixed	0	0	>50
	Eragrostis setifolia	Bristly Love-grass	Y	3	Mixed	0	>50	0
	Eremophila serrulata	Green Emubush	Y	1	Adult	>50	0	0
	Euphorbia tannensis ssp. *eremophila*	Desert Spurge	N	1				
	Exocarpos aphyllus	Leafless Cherry	Y	1	Adult	>50	<50	0
	Frankenia serpyllifolia	Thyme Sea-heath	Y	2	Mixed	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N	2				
	Lepidium phlebopetalum	Veined Peppercress	N	1				
	Maireana aphylla	Cotton-bush	Y	2	Adult	0	>50	0
	Maireana appressa	Pale-fruit Bluebush	Y	3	Mixed	>50	<50	0
	Maireana eriantha	Woolly Bluebush	Y	3	Mixed	>50	<50	0
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	3	Mixed	0	>50	0
	Minuria cunninghamii	Bush Minuria	Y	4	Mixed	0	<50	>50
	Podolepis sp.	Copper-wire Daisy	N	1				
	Rhagodia spinescens	Spiny Saltbush	Y	2	Mixed	>50	<50	0
	Rhodanthe stricta	Slender Everlasting	N	3				
	Sclerolaena diacantha	Grey Bindyi	N	5				
	Sclerolaena divaricata	Tangled Bindyi	N	5				
	Sclerolaena intricata	Tangled Bindyi	N	5				
	Sclerolaena patenticuspis	Spear-fruit Bindyi	N	4				
	Sida corrugata	Rock Sida	N	1				
	Sida intricata	Twiggy Sida	Y	1	Adult	>50	0	0
	Sporobolus actinocladus	Ray Grass	N	5				
	Tecticornia medullosa	Samphire	Y	5	Mixed	>50	0	0
	Site 11 Totals: 33 (long-lived = 18, short-lived = 15)							
Flora Site 12/ CAR012	*Atriplex holocarpa*	Pop Saltbush	N	4				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	<50	>50	<50
	Bulbine semibarbata	Small Leek-lily	N	3				
	Calotis hispidula	Hairy Burr-daisy	N	3				
	Dissocarpus biflorus var.	Two-horn Saltbush	N	3				
	Dissocarpus paradoxus	Ball Bindyi	N	3				
	Eragrostis setifolia	Bristly Love-grass	Y	2/4	Mixed	0	>50	<50
	Euphorbia stevenii	Bottletree Spurge	N	3				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Adult	>50	<50	0
	Lepidium phlebopetalum	Veined Peppercress	N	3				
	Maireana appressa	Pale-fruit Bluebush	Y	1	Adult	>50	0	0
	Minuria cunninghamii	Bush Minuria	Y	2/4	Adult	0	>50	<50
	Plantago drummondii	Dark Plantain	N	1				
	Sclerolaena divaricata	Tangled Bindyi	N	5				
	Sclerolaena intricata	Tangled Bindyi	N	4				
	Sclerolaena patenticuspis	Spear-fruit Bindyi	N	4				
	Sida fibulifera	Pin Sida	N	3				
	Sida intricata	Twiggy Sida	Y	4	Mixed	0	>50	<50
	Sporobolus actinocladus	Ray Grass	N	4				
	Tecticornia medullosa	Samphire	Y	4	Mixed	>50	0	0
	Site 12 Totals: 20 (long-lived = 7, short-lived = 13)							
Flora Site 13 / CAR013	*Abutilon halophilum*	Plains Lantern-bush	Y	4	Adult	<50	>50	0
	Atriplex holocarpa	Pop Saltbush	N	5				
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	<50	0
	Dissocarpus biflorus var.	Two-horn Saltbush	N	3				
	Dissocarpus paradoxus	Ball Bindyi	N	3				
	Eragrostis setifolia	Bristly Love-grass	Y	3	Mixed	0	<50	>50
	Euphorbia stevenii	Bottletree Spurge	N	3				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Mixed	>50	0	0
	Maireana aphylla	Cotton-bush	Y	1	Adult	0	>0	0
	Maireana appressa	Pale-fruit Bluebush	Y	3	Adult	>50	>50	0
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	3	Adult	0	<50	>50
	Minuria cunninghamii	Bush Minuria	Y	3	Adult	0	>50	<50

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Nicotiana velutina	Velvet Tobacco	N	1				
	Rhodanthe floribunda	White Everlasting	N	1				
	Rhodanthe stricta	Slender Everlasting	N	1				
	Sclerolaena brachyptera	Short-wing Bindyi	N	3				
	Sclerolaena diacantha	Grey Bindyi	N	4				
	Sclerolaena divaricata	Tangled Bindyi	N	4				
	Sclerolaena intricata	Tangled Bindyi	N	4				
	Sida fibulifera	Pin Sida	N	3				
	Sida intricata	Twiggy Sida	Y	3	Mixed	0	>50	<50
	Solanum quadriloculatum	Plains Nightshade	N	1				
	Sporobolus actinocladus	Ray Grass	N	3				
	Tecticornia medullosa	Samphire	Y	4	Mixed	>50	0	0
	Site 13 Totals: 24 (long-lived = 10, short-lived = 14)							
Site 15 / CAR015	*Atriplex holocarpa*	Pop Saltbush	N	2				
	Atriplex vesicaria	Bladder Saltbush	Y	4	Mixed	>50	0	0
	Bulbine semibarbata	Small Leek-lily	N	3				
	Calotis hispidula	Hairy Burr-daisy	N	1				
	Dissocarpus biflorus var.	Two-horn Saltbush	N	3				
	Enneapogon avenaceus	Common Bottle-washers	N	3				
	Euphorbia tannensis ssp. *eremophila*	Desert Spurge	N	1				
	Frankenia serpyllifolia	Thyme Sea-heath	Y	2	Adult	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N	3				
	Lepidium phlebopetalum	Veined Peppercress	N	3				
	Lotus cruentus	Red-flower Lotus	N	1				
	Maireana aphylla	Cotton-bush	Y	2	Adult	>50	0	0
	Maireana appressa	Pale-fruit Bluebush	Y	1	Adult	0	>50	0
	Maireana turbinata	Top-fruit Bluebush	Y	1	Adult	0	0	>50
	Minuria cunninghamii	Bush Minuria	Y	1	Mixed	0	>50	0
	Plantago drummondii	Dark Plantain	N	1				
	Rhodanthe stricta	Slender Everlasting	N	1				
	Salsola australis	Buckbush	N	3				
	Sclerolaena brachyptera	Short-wing Bindyi	N	2				
	Sclerolaena divaricata	Tangled Bindyi	N	5				
	Sclerolaena ventricosa	Salt Bindyi	N	4				
	Sida fibulifera	Pin Sida	N	3				
	Sida intricata	Twiggy Sida	Y	2	Adult	0	>50	<50
	Sporobolus actinocladus	Ray Grass	N	1				
	Tecticornia medullosa	Samphire	Y	2	Adult	>50	0	0
	Site 15 Totals: 25 (long-lived = 8, short-lived = 17)							
Flora Site 16 / CAR016	*Abutilon halophilum*	Plains Lantern-bush	Y	4	Mixed	<50	>50	0
	Astrebla pectinata	Barley Mitchell-grass	Y	3	Mixed	>50	>50	<50
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed			
	Bulbine semibarbata	Small Leek-lily	N	1				
	Cullen cinereum	Annual Scurf-pea	N	2				
	Enneapogon avenaceus	Common Bottle-washers	N	1		0	>50	<50
	Eragrostis setifolia	Bristly Love-grass	Y	3	Adult			
	Euphorbia stevenii	Bottletree Spurge	N	1		>50	0	0
	Frankenia serpyllifolia	Thyme Sea-heath	Y	3	Adult			
	Goodenia fascicularis	Silky Goodenia	N	1				
	Lepidium phlebopetalum	Veined Peppercress	N	1				
	Lotus cruentus	Red-flower Lotus	N	1		>50	<50	0
	Maireana appressa	Pale-fruit Bluebush	Y	1	Adult	>50	0	0
	Maireana eriantha	Woolly Bluebush	Y	2	Adult	<50	0	>50
	Minuria cunninghamii	Bush Minuria	Y	3	Adult	<50	>50	0
	Osteocarpum dipterocarpum	Two-wing Bonefruit	N	1				
	Panicum decompositum var. *decompositum*	Native Millet	N	1				
	Podolepis davisiana	Button Podolepis	N	1				
	Sclerolaena brachyptera	Short-wing Bindyi	N	4				
	Sclerolaena divaricata	Tangled Bindyi	N	3				

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Sclerolaena intricata	Tangled Bindyi	N	2				
	Sida fibulifera	Pin Sida	N	2				
	Sporobolus actinocladus	Ray Grass	N	4				
	Tecticornia medullosa	Samphire	Y	3	Adult	>50	0	0
	Site 16 Totals: 24 (long-lived = 9, short-lived =15)							
Flora Site 17 / CAR017	*Abutilon halophilum*	Plains Lantern-bush	Y	3	Adult	>50	0	0
	Acacia papyrocarpa	Western Myall	Y	6	Mixed	>50	0	0
	Acacia tetragonophylla	Dead Finish	Y	3	Mixed	>50	0	0
	Anacampseros australiana	Australian Anacampseros	N					
	Atriplex vesicaria	Bladder Saltbush	Y	5	Mixed	>50	<50	0
	Chenopodium desertorum ssp.	Desert Goosefoot	Y	1	Adult	>50	0	0
	Crinum flaccidum	Murray Lily	N					
	Dodonaea lobulata	Lobed-leaf Hop-bush	Y	5	Mixed	>50	<50	0
	Einadia nutans ssp.	Climbing Saltbush	Y	3	Adult	>50	>50	0
	Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush	Y	4	Mixed	>50	<50	0
	Eremophila latrobei ssp. *glabra*	Crimson Emubush	Y	4	Adult	>50	0	0
	Eremophila serrulata	Green Emubush	Y	3	Adult	>50	0	0
	Eulalia aurea	Silky Brown-top	Y			>50	>50	<50
	Exocarpos aphyllus	Leafless Cherry	Y	1	Adult	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N					
	Lepidium phlebopetalum	Veined Peppercress	N					
	Maireana aphylla	Cotton-bush	Y	3	Mixed	0	>50	<50
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	3	Adult	0	>50	<50
	Ptilotus obovatus	Silver Mulla Mulla	Y	5	Mixed	>50	0	0
	Rhagodia spinescens	Spiny Saltbush	Y	1	Adult	>50	<50	0
	Rostellularia adscendens	Pink Tongues	N					
	Santalum lanceolatum	Plumbush	Y	3	Mixed	>50	0	0
	Scaevola spinescens	Spiny Fanflower	Y	3	Mixed	<50	>50	0
	Sclerolaena divaricata	Tangled Bindyi	N					
	Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	Y	3	Adult	>50	0	0
	Senna artemisioides ssp. *oligophylla*	Limestone Senna	Y	3	Adult	>50	0	0
	Senna artemisioides ssp. *X artemisioides*	Silver Senna	Y	3	Mixed	>50	0	0
	Sida petrophila	Rock Sida	Y	3	Mixed	0	>50	0
	Solanum quadriloculatum	Plains Nightshade	N					
	Tecticornia medullosa	Samphire	Y	2	Adult	>50	0	0
	Site 17 Totals: 30 (long-lived = 23 / short-lived = 7)							
Flora Site 18 / CAR018	*Abutilon otocarpum*	Desert Lantern-bush	Y	2	Adult	>50	0	0
	Acacia aneura	Mulga	Y	1	Adult	<50	>50	0
	Acacia papyrocarpa	Western Myall	Y	5	Mixed	>50	<50	0
	Atriplex vesicaria	Bladder Saltbush	Y	4	Mixed	>50	<50	0
	Boerhavia sp.	Tar-vine	N	3				
	Cheilanthes lasiophylla	Woolly Cloak-fern	N	1				
	Chenopodium curvispicatum	Cottony Goosefoot	Y	3	Adult	>50	0	0
	Chenopodium desertorum ssp.	Desert Goosefoot	Y	2	Adult	>50	<50	0
	Crinum flaccidum	Murray Lily	N	1				
	Digitaria brownii	Cotton Panic-grass	Y	4	Adult	0	>50	0
	Dodonaea lobulata	Lobed-leaf Hop-bush	Y	4	Mixed	>50	0	0
	Enchylaena tomentosa	Ruby Saltbush	Y	4	Mixed	>50	0	0
	Eremophila latrobei ssp. *glabra*	Crimson Emubush	Y	4	Mixed	>50	0	0
	Eremophila oppositifolia ssp.	Opposite-leaved Emubush	Y	1	Adult	0	0	>50
	Eulalia aurea	Silky Brown-top	Y	4	Adult	>50	<50	<50
	Exocarpos aphyllus	Leafless Cherry	Y	1	Adult	>50	0	0
	Gnephosis arachnoidea	Spidery Button-flower	N	3				
	Lepidium phlebopetalum	Veined Peppercress	N	2				
	Maireana aphylla	Cotton-bush	Y	1	Adult	>50	<50	0
	Maireana spongiocarpa	Spongy-fruit Bluebush	Y	2/4	Mixed	>50	<50	0
	Myoporum montanum	Native Myrtle	Y	2	Mixed	>50	0	0
	Ptilotus obovatus	Silver Mulla Mulla	Y	4	Mixed	>50	0	0

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Rhagodia spinescens	Spiny Saltbush	Y	2	Adult	>50	0	0
	Rostellularia adscendens ssp.	Pink Tongues	N	1				
	Santalum lanceolatum	Plumbush	Y	2	Mixed	>50	0	0
	Scaevola spinescens	Spiny Fanflower	Y	2	Mixed	>50	0	0
	Sclerolaena divaricata	Tangled Bindyi	N	1				
	Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	Y	2	Mixed	>50	0	0
	Senna artemisioides ssp. *X artemisioides*	Silver Senna	Y	3	Adult	>50	0	0
	Senna artemisioides ssp. *X sturtii*	Grey Senna	Y	2	Mixed	>50	0	0
	Sida corrugata	Corrugated Sida	N	3				
	Sida petrophila	Rock Sida	Y	3	Adult	>50	0	0
	Solanum lithophilum	Velvet Potato-bush	N	3				
	*Sonchus oleraceus**	Common Sow-thistle	N	1				
	Sporobolus actinocladus	Ray Grass	N	2/4				
	Teucrium racemosum	Grey Germander	Y	2	Adult	>50	0	0
	Wurmbea australis	Inland Nancy	N	1				
	Site 18 Totals: 36 (long-lived =24, short-lived = 12)							
Flora Site 19 / CAR019	*Abutilon otocarpum*	Desert Lantern-bush	Y	2	Adult	>50	0	0
	Acacia papyrocarpa	Western Myall	Y	4	Mixed	>50	0	0
	Acacia tetragonophylla	Dead Finish	Y	4	Adult	>50	0	0
	Atriplex vesicaria	Bladder Saltbush	Y	2	Mixed	>50	0	0
	Chenopodium curvispicatum	Cottony Goosefoot	Y	1	Adult	>50	0	0
	Crinum flaccidum	Murray Lily	N	1				
	Digitaria brownii	Cotton Panic-grass	Y	1	Adult	0	0	0
	Dodonaea lobulata	Lobed-leaf Hop-bush	Y	4/5	Mixed	>50	0	0
	Duma florulenta	Lignum	Y	2	Adult	>50	0	0
	Einadia nutans ssp.	Climbing Saltbush	Y	2/4	Mixed	>50	0	0
	Enchylaena tomentosa	Ruby Saltbush	Y	4	Mixed	>50	0	0
	Enneapogon avenaceus	Common Bottle-washers	N	3				
	Eragrostis setifolia	Bristly Love-grass	Y	2/4	Adult	0	>50	<50
	Eremophila serrulata	Green Emubush	Y	1	Adult	>50	0	0
	Eucalyptus camaldulensis ssp. *arida*	Northern River Red Gum	Y	2/4	Mixed	>50	0	0
	Eulalia aurea	Silky Brown-top	Y	2/4		>50	>50	<50
	Maireana aphylla	Cotton-bush	Y	3	Adult	>50	<50	0
	Malvastrum americanum var.	Malvastrum	N	3				
	Marsilea drummondii	Common Nardoo	N	3				
	Myoporum montanum	Native Myrtle	Y	2/4	Mixed	>50	0	0
	Pluchea rubelliflora		N	2/4				
	Pterocaulon sphacelatum	Apple-bush	N	3				
	Ptilotus obovatus	Silver Mulla Mulla	Y	4	Adult	>50	0	0
	Santalum lanceolatum	Plumbush	Y	2/4	Mixed	>50	0	0
	Scaevola spinescens	Spiny Fanflower	Y	2	Mixed	>50	<50	0
	Sclerolaena divaricata	Tangled Bindyi	N	1				
	Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	Y	2/4	Mixed	>50	0	0
	Senna artemisioides ssp. *X artemisioides*	Silver Senna	Y	2	Adult	>50	0	0
	Senna artemisioides ssp. *X sturtii*	Grey Senna	Y	2	Mixed	>50	0	0
	Sida corrugata var.	Corrugated Sida	N	2				
	Sida petrophila	Rock Sida	Y	2	Adult	>50	0	0
	Solanum lithophilum	Velvet Potato-bush	N	2				
	*Sonchus oleraceus**	Common Sow-thistle	N	1				
	Teucrium racemosum	Grey Germander	N	1				
	Trianthema triquetrum	Red Spinach	N	1				
	Site 19 Totals: 36 (long-lived = 23, short-lived = 13)							

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
Flora Site 20 / CAR020	*Abutilon otocarpum*	Desert Lantern-bush	Y	2	Adult	>50	0	0
	Acacia papyrocarpa	Western Myall	Y	3	Adult	>50	<50	0
	Acacia tetragonophylla	Dead Finish	Y	4	Mixed	>50	0	0
	*Centaurea melitensis**	Malta Thistle	N	2				
	Chenopodium curvispicatum	Cottony Goosefoot	Y	1	Adult	>50	0	0
	Crinum flaccidum	Murray Lily	N	1				
	Daucus glochidiatus	Native Carrot	N	2				
	Digitaria brownii	Cotton Panic-grass	Y	4	Adult	<50	<50	0
	Dodonaea lobulata	Lobed-leaf Hop-bush	Y	4	Mixed	>50	>50	<50
	Duma florulenta	Lignum	Y	4	Mixed	>50	0	0
	Einadia nutans ssp.	Climbing Saltbush	Y	2	Mixed	>50	0	0
	Enchylaena tomentosa	Ruby Saltbush	Y	2/4	Adult	>50	0	0
	Enneapogon avenaceus	Common Bottle-washers	N	1				
	Eragrostis setifolia	Bristly Love-grass	Y	1	Adult	>50	>50	0
	Eremophila latrobei ssp. *glabra*	Crimson Emubush	Y	1	Mixed	>50	0	0
	Eremophila serrulata	Green Emubush	Y	2	Adult	>50	0	0
	Eucalyptus camaldulensis ssp. *arida*	Northern River Red Gum	Y	4	Mixed	>50	0	0
	Eulalia aurea	Silky Brown-top	Y	4	Adult	<50	>50	0
	Euphorbia tannensis ssp. *eremophila*	Desert Spurge	N	1				
	Glossocardia bidens	Native Cobbler's-pegs	N	1				
	Lepidium phlebopetalum	Veined Peppercress	N	3				
	Malvastrum americanum var.	Malvastrum	N	3				
	Marsilea drummondii	Common Nardoo	N	1				
	Minuria cunninghamii	Bush Minuria	Y	1	Adult	0	>50	0
	Myoporum montanum	Native Myrtle	Y	2/4	Mixed	>50	0	0
	Pluchea rubelliflora		N	4				
	Ptilotus obovatus	Silver Mulla Mulla	Y	2/4	Mixed	>50	0	0
	Rhagodia spinescens	Spiny Saltbush	Y	1	Adult	>50	>50	0
	Rostellularia adscendens ssp.	Pink Tongues	N	3				
	Santalum lanceolatum	Plumbush	Y	2	Mixed	>50	<50	0
	Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	Y	3	Mixed	>50	0	0
	Senna artemisioides ssp. *X artemisioides*	Silver Senna	Y	1	Adult	>50	0	0
	Senna artemisioides ssp. *X sturtii*	Grey Senna	Y	1	Adult	>50	0	0
	Setaria constricta	Knotty-butt Paspalidium	Y	2	Adult	< 50	> 50	0
	Sida corrugata var.	Corrugated Sida	N	1				
	Sida petrophila	Rock Sida	Y	4	Mixed	>50	0	0
	*Sisymbrium erysimoides**	Smooth Mustard	N	1				
	Solanum lithophilum	Velvet Potato-bush	N	1				
	Teucrium racemosum	Grey Germander	N	2				
	Themeda triandra	Kangaroo Grass	Y	1	Adult	0	>50	0
	Trichodesma zeylanicum var.	Camel Bush	N	1				
	Site 20 Totals: 41 (long-lived = 25, short-lived = 16)							
Flora Site / CAR021	*Acacia ligulata*	Umbrella Bush	Y	4	Mixed	>50	0	0
	Acacia oswaldii	Umbrella Wattle	Y	1	Adult	0	>50	0
	Alectryon oleifolius ssp. *canescens*	Bullock Bush	Y	1	Adult	0	>50	0
	Aristida holathera var.	#N/A	N					
	Atriplex velutinella	Sandhill Saltbush	N					
	Cullen pallidum	White Scurf-pea	N					
	Dodonaea viscosa ssp. *angustissima*	Narrow-leaf Hop-bush	Y	1	Mixed	<50	>50	0
	Einadia nutans ssp.	Climbing Saltbush	Y	1	Adult	>50	0	0
	Enchylaena tomentosa	Ruby Saltbush	Y	3	Adult	>50	<50	0
	Enneapogon avenaceus	Common Bottle-washers	N					
	Euphorbia drummondii group	Spurge	N					
	Lycium australe	Australian Boxthorn	Y	1	Adult	>50	0	0
	Maireana pyramidata	Black Bluebush	Y	1	Adult	0	>50	0
	Nicotiana velutina	Velvet Tobacco	N					

RAM Site	Scientific Name	Common Name	Long-lived[1]	CSR[2]	Age Class[3]	Grazing Level % of Total Population		
						Intact	Modified	Over-utilised
	Lysiandra fuernrohrii	Sand Spurge	Y	3/4	Mixed	>50	0	0
	Pimelea microcephala ssp. *microcephala*	Shrubby Riceflower	Y	1	Adult	>50	0	0
	Polycalymma stuartii	Poached-egg Daisy	N					
	Roepera eremaea	Climbing Twinleaf	N					
	Salsola australis	Buckbush	N					
	Sida ammophila	Sand Sida	N					
	*Sisymbrium erysimoides**	Smooth Mustard	N	2/4				
	Zygochloa paradoxa	Sandhill Cane-grass	Y	2	Mixed	>50	0	0
	Site 21 Totals: 21 (long-lived = 11, short-lived = 11)							
Site 22 / CAR022	*Acacia ligulata*	Umbrella Bush	Y	4/5	Mixed	0	>50	0
	Acacia ramulosa var.	Horse Mulga	Y	1	Adult			
	Aristida holathera var. *holathera*	Tall Kerosene Grass	N					
	Atriplex velutinella	Sandhill Saltbush	N					
	Crotalaria eremaea ssp.	Loose-flowered Rattle-pod	N					
	Cullen pallidum	White Scurf-pea	N			>50	<50	0
	Dodonaea viscosa ssp. *angustissima*	Narrow-leaf Hop-bush	Y	1	Adult	>50	0	0
	Einadia nutans ssp.	Climbing Saltbush	Y	1	Adult	>50	<50	0
	Enchylaena tomentosa	Ruby Saltbush	Y	3	Adult			
	Euphorbia drummondii group	Spurge	N					
	Hibiscus krichauffianus	Velvet-leaf Hibiscus	N			>50	<50	0
	Maireana pyramidata	Black Bluebush	Y	1	Adult			
	Nicotiana velutina	Velvet Tobacco	N					
	Paractaenum novae-hollandiae ssp. *reversum*	Barbed-wire Grass	N			>50	0	0
	Pimelea microcephala ssp. *microcephala*	Shrubby Riceflower	Y	1	Adult			
	Polycalymma stuartii	Poached-egg Daisy	N			>50	0	0
	Rhagodia spinescens	Spiny Saltbush	Y	1	Adult			
	Roepera howittii	Clasping Twinleaf	N					
	Salsola australis	Buckbush	N					
	Sida ammophila	Sand Sida	N					
	*Sisymbrium erysimoides**	Smooth Mustard	N	4/5				
	Trichodesma zeylanicum var.	Camel Bush	N			>50	0	0
	Zygochloa paradoxa	Sandhill Cane-grass	Y	4	Adult	0	>50	0
	Site 22 Totals: 23 (long-lived = 9, short-lived = 14)							

* Non-native

[1] Long lived woody perennials – refer Appendix C

[2] CSR ratio (Source = DENR (2011). Pastoral Lease Assessment Manual. Pastoral Land Management Group

CLASS	TERM	CSR	FIELD CRITERIA
1	Present	< 12 plants	< 12 plants within 200 m radius
2	Isolated Clumps	>20 spaces	Isolated clumps of two to five woody plants 200 m further apart
3	Isolated Plants	>20 spaces	Isolated plants
4	Very Sparse	6-20 spaces	Well spaced, crowns well separated
5	Sparse	1-5 spaces	Clearly spaced, crowns clearly separated
6	Mid dense	0-0.9 spaces	Crowns touching to slight separation
7	Closed or dense	0	Crowns touching to overlapping

[3] Age Classes: Recorded for Long-lived perennials only; M = Adults and Juveniles present; A = Adults only present; J = Juveniles only present

Appendix C. Flora life span classification

Table B2.1: Long-lived Woody Species Perennial Classification

Family	Scientific Name	Common Name	Long-lived woody? Yes (Y) No (N)
MALVACEAE	*Abutilon halophilum*	Plains Lantern-bush	Y
MALVACEAE	*Abutilon leucopetalum*	Desert Lantern-bush	Y
MALVACEAE	*Abutilon otocarpum*	Desert Lantern	Y
MALVACEAE	*Abutilon* sp.	Lantern-bush	Y
FABACEAE	*Acacia aneura* var.	Mulga	Y
FABACEAE	*Acacia papyrocarpa*	Western Myall	Y
FABACEAE	*Acacia tetragonophylla*	Dead Finish	Y
FABACEAE	*Acacia victoriae* ssp.	Elegant Wattle	Y
SAPINDACEAE	*Alectryon oleifolius* ssp. *canescens*	Bullock Bush	Y
AMARANTHACEAE	*Alternanthera denticulata*	Lesser Joyweed	N
AMARANTHACEAE	*Alternanthera nodiflora*	Common Joyweed	N
LORANTHACEAE	*Amyema maidenii* ssp. *maidenii*	Pale-leaf Mistletoe	Y
LORANTHACEAE	*Amyema quandang* var. *quandang*	Grey Mistletoe	Y
ANACAMPSEROTACEAE	*Anacampseros australiana*	Australian Anacampseros	N
ASTERACEAE	*Anemocarpa podolepidium*	Rock Everlasting	N
ASTERACEAE	*Angianthus* sp.	Cup-flower	N
BRASSICACEAE	*Arabidella glaucescens*	Bluish Cress	N
BRASSICACEAE	*Arabidella* sp.	Native Cress	N
POACEAE	*Aristida anthoxanthoides*	Yellow Three-awn	N
POACEAE	*Aristida contorta*	Curly Wire-grass	N
POACEAE	*Aristida holathera* var. *holathera*	Tall Kerosene Grass	N
POACEAE	*Aristida nitidula*	Brush Three-awn	N
POACEAE	*Aristida* sp.	Three-awn/Wire-grass	N
POACEAE	*Astrebla pectinata*	Barley Mitchell-grass	Y
POACEAE	*Astrebla* sp.	Mitchell-grass	Y
AMARANTHACEAE	*Atriplex fissivalvis*	Gibber Saltbush	N
AMARANTHACEAE	*Atriplex holocarpa*	Pop Saltbush	N
AMARANTHACEAE	*Atriplex lindleyi* ssp.	Baldoo	N
AMARANTHACEAE	*Atriplex lindleyi* ssp. *conduplicata*	Baldoo	N
AMARANTHACEAE	*Atriplex lindleyi* ssp. *inflata*	Corky Saltbush	N
AMARANTHACEAE	*Atriplex lindleyi* ssp. *lindleyi*	Baldoo	N
AMARANTHACEAE	*Atriplex* sp.	Saltbush	N
AMARANTHACEAE	*Atriplex spongiosa*	Pop Saltbush	N
AMARANTHACEAE	*Atriplex turbinata*	A Saltbush	N
AMARANTHACEAE	*Atriplex velutinella*	Sandhill Saltbush	N
AMARANTHACEAE	*Atriplex vesicaria*	Bladder Saltbush	Y
POACEAE	*Austrostipa nitida*	Balcarra Spear-grass	N
POACEAE	*Austrostipa scabra* ssp.	Rough Spear-grass	N
POACEAE	*Austrostipa* sp.	Spear-grass	N
POACEAE	*Austrostipa trichophylla*	Spear-grass	N
ASTERACEAE	*Bidens pilosa*	Cobblers Pegs	N
ASTERACEAE	*Blennospora drummondii*	Dwarf Button-flower	N
NYCTAGINACEAE	*Boerhavia dominii*	Tar-vine	N
NYCTAGINACEAE	*Boerhavia* sp.	Tar-vine	N
ASTERACEAE	*Brachyscome ciliaris* var.	Variable Daisy	N
ASTERACEAE	*Brachyscome ciliaris* var. *lanuginosa*	Woolly Variable Daisy	N
ASTERACEAE	*Brachyscome* sp.	Native Daisy	N
ASPHODELACEAE	*Bulbine semibarbata*	Small Leek-lily	N
ASPHODELACEAE	*Bulbine* sp.	Bulbine-lily	N
MONTIACEAE	*Calandrinia* sp.	Purslane/Parakeelya	N
MONTIACEAE	*Calandrinia volubilis*	Twining Purslane	N
ASTERACEAE	*Calotis hispidula*	Hairy Burr-daisy	N
ASTERACEAE	*Calotis* sp.	Burr-daisy	N
AIZOACEAE	*Carpobrotus rossii*	Native Pigface	Y
ASTERACEAE	*Centipeda cunninghamii*	Common Sneezeweed	N
ASTERACEAE	*Centipeda thespidioides*	Desert Sneezeweed	N
AMARANTHACEAE	*Chenopodium desertorum* ssp.	Desert Goosefoot	Y

Family	Scientific Name	Common Name	Long-lived woody? Yes (Y) No (N)
AMARANTHACEAE	*Chenopodium* sp.	Goosefoot	N
POACEAE	*Chloris pectinata*	Comb Windmill Grass	N
POACEAE	*Chloris* sp.	Windmill Grass/Chloris	N
ASTERACEAE	*Chrysocephalum pterochaetum*	Shrub Everlasting	N
ASTERACEAE	*Chrysocephalum* sp.	Everlasting	N
COMPOSITAE	*Compositae* sp.	Daisy Family	N
CONVOLVULACEAE	*Convolvulaceae* sp.	Bindweed Family	N
CONVOLVULACEAE	*Convolvulus angustissimus* ssp.	Narrow-leaf Bindweed	N
CONVOLVULACEAE	*Convolvulus erubescens complex*	Bindweed	N
CONVOLVULACEAE	*Convolvulus remotus*	Grassy Bindweed	N
CONVOLVULACEAE	*Convolvulus* sp.	Bindweed	N
ASTERACEAE	*Craspedia* sp.	Buttons	N
CRASSULACEAE	*Crassula* sp.	Crassula/Stonecrop	N
AMARYLLIDACEAE	*Crinum flaccidum*	Murray Lily	N
FABACEAE	*Crotalaria eremaea* ssp.	Loose-flowered Rattle-pod	N
FABACEAE	*Cullen australasicum*	Tall Scurf-pea	N
FABACEAE	*Cullen cinereum*	Annual Scurf-pea	N
FABACEAE	*Cullen graveolens*	Native Lucerne	N
FABACEAE	*Cullen pallidum*	Woolly Scurf-pea	N
FABACEAE	*Cullen* sp.	Scurf-pea	N
CONVOLVULACEAE	*Cuscuta* sp.	Dodder	N
POACEAE	*Cymbopogon ambiguus*	Lemon-grass	Y
APOCYNACEAE	*Cynanchum viminale* ssp. *australe*	Caustic Bush	Y
CYPERACEAE	*Cyperus rigidellus*	Dwarf Flat-sedge	N
CYPERACEAE	*Cyperus* sp.	Flat-sedge	N
POACEAE	*Dactyloctenium radulans*	Button-grass	N
APIACEAE	*Daucus glochidiatus*	Native Carrot	N
POACEAE	*Dichanthium sericeum* ssp.	Silky Blue-grass	Y
POACEAE	*Digitaria brownii*	Cotton Panic-grass	Y
POACEAE	*Digitaria divaricatissima* var. *divaricatissima*	Finger Panic-grass	Y
POACEAE	*Digitaria* sp.	Summer-grass	Y
AMARANTHACEAE	*Dissocarpus biflorus* var.	Two-horn Saltbush	N
AMARANTHACEAE	*Dissocarpus paradoxus*	Ball Bindii	N
SAPINDACEAE	*Dodonaea lobulata*	Lobed-leaf Hop-bush	Y
SAPINDACEAE	*Dodonaea viscosa* ssp. *angustissima*	Narrow-leaf Hop-bush	Y
POLYGONACEAE	*Duma florulenta*	Lignum	Y
AMARANTHACEAE	*Dysphania cristata*	Crested Goosefoot	N
AMARANTHACEAE	*Dysphania pumilio*	Clammy Goosefoot	N
POLYGONACEAE	*Duma florulenta*	Lignum	Y
AMARANTHACEAE	*Einadia nutans* ssp. *nutans*	Climbing Saltbush	Y
CYPERACEAE	*Eleocharis pallens*	Pale Spike-rush	N
AMARANTHACEAE	*Enchylaena tomentosa* var.	Ruby Saltbush	Y
POACEAE	*Enneapogon avenaceus*	Common Bottle-washers	N
POACEAE	*Enneapogon cylindricus*	Jointed Bottle-washers	N
POACEAE	*Enneapogon polyphyllus*	Leafy Bottle-washers	N
POACEAE	*Enneapogon* sp.	Bottle-washers / Nineawn	N
POACEAE	*Enteropogon acicularis*	Umbrella Grass	N
POACEAE	*Enteropogon ramosus*	Umbrella Grass	N
POACEAE	*Enteropogon* sp.	Umbrella Grass	N
POACEAE	*Eragrostis australasica*	Cane-grass	Y
POACEAE	*Eragrostis dielsii*	Mulka	N
POACEAE	*Eragrostis eriopoda*	Woollybutt	N
POACEAE	*Eragrostis parviflora*	Soft Love-grass	N
POACEAE	*Eragrostis setifolia*	Bristly Love-grass	Y
POACEAE	*Eragrostis* sp.	Love-grass	Y
POACEAE	*Eragrostis xerophila*	Knotty-butt Neverfail	Y
SCROPHULARIACEAE	*Eremophila duttonii*	Harlequin Emubush	Y
SCROPHULARIACEAE	*Eremophila glabra* ssp.	Tar Bush	Y
SCROPHULARIACEAE	*Eremophila latrobei* ssp.	Crimson Emubush	Y
SCROPHULARIACEAE	*Eremophila maculata* ssp.	Spotted Emubush	Y
SCROPHULARIACEAE	*Eremophila oppositifolia* ssp.	Opposite-leaved Emubush	Y

Family	Scientific Name	Common Name	Long-lived woody? Yes (Y) No (N)
SCROPHULARIACEAE	*Eremophila serrulata*	Green Emubush	Y
GERANIACEAE	*Erodium crinitum*	Blue Heron's-bill	N
GERANIACEAE	*Erodium* sp.	Heron's-bill/Crowfoot	N
MYRTACEAE	*Eucalyptus camaldulensis* ssp.	River Red Gum	Y
POACEAE	*Eulalia aurea*	Silky Brown-top	Y
EUPHORBIACEAE	*Euphorbia drummondii group*	Spurge	N
EUPHORBIACEAE	*Euphorbia* sp.	Spurge	N
EUPHORBIACEAE	*Euphorbia stevenii*	Bottletree Spurge	N
EUPHORBIACEAE	*Euphorbia tannensis* ssp. *eremophila*	Desert Spurge	N
SANTALACEAE	*Exocarpos aphyllus*	Leafless Cherry	Y
ASTERACEAE	*Flaveria trinervia*	Clustered Yellow-tops	N
FRANKENIACEAE	*Frankenia serpyllifolia*	Thyme Sea-heath	Y
FRANKENIACEAE	*Frankenia* sp.	Sea-heath	Y
FRANKENIACEAE	*Frankenia subteres*	Round Sea-heath	Y
MALVACEAE	*Gilesia biniflora*	Western Tar-vine	N
ASTERACEAE	*Glossocardia bidens*	Native Cobbler's-pegs	N
FABACEAE	*Glycine* sp.	Glycine	N
ASTERACEAE	*Gnephosis arachnoidea*	Spidery Button-flower	N
ASTERACEAE	*Gnephosis* sp.	Cup-flower	N
GOODENIACEAE	*Goodenia fascicularis*	Silky Goodenia	N
GOODENIACEAE	*Goodenia lunata*	Stiff Goodenia	N
GOODENIACEAE	*Goodenia pinnatifida*	Cut-leaf Goodenia	N
GOODENIACEAE	*Goodenia* sp.	Goodenia	N
GRAMINEAE	*Gramineae* sp.	Grass Family	N
AIZOACEAE	*Gunniopsis quadrifida*	Sturt's Pigface	Y
BORAGINACEAE	*Heliotropium* sp.	Heliotrope	N
MALVACEAE	*Hibiscus krichauffianus*	Velvet-leaf Hibiscus	N
POACEAE	*Iseilema membranaceum*	Small Flinders-grass	N
ASTERACEAE	*Ixiochlamys cuneifolia*	Silverton Daisy	N
ASTERACEAE	*Ixiochlamys nana*	Small Fuzzweed	N
ASTERACEAE	*Leiocarpa leptolepis*	Pale Plover-daisy	N
BRASSICACEAE	*Lepidium phlebopetalum*	Veined Peppercress	N
BRASSICACEAE	*Lepidium* sp.	Peppercress	N
LILIACEAE	*Liliaceae* sp.	Lily Family	N
ASPARAGACEAE	*Lomandra* sp.	Mat-rush	Y
FABACEAE	*Lotus cruentus*	Red-flower Lotus	N
SOLANACEAE	*Lycium australe*	Australian Boxthorn	Y
AMARANTHACEAE	*Maireana aphylla*	Cotton-bush	Y
AMARANTHACEAE	*Maireana appressa*	Pale-fruit Bluebush	Y
AMARANTHACEAE	*Maireana astrotricha*	Low Bluebush	Y
AMARANTHACEAE	*Maireana coronata*	Crown Fissure-plant	Y
AMARANTHACEAE	*Maireana eriantha*	Woolly Bluebush	Y
AMARANTHACEAE	*Maireana georgei*	Satiny Bluebush	Y
AMARANTHACEAE	*Maireana integra*	Entire-wing Bluebush	Y
AMARANTHACEAE	*Maireana pyramidata*	Black Bluebush	Y
AMARANTHACEAE	*Maireana sedifolia*	Bluebush	Y
AMARANTHACEAE	*Maireana* sp.	Bluebush/Fissure-plant	Y
AMARANTHACEAE	*Maireana spongiocarpa*	Spongy-fruit Bluebush	Y
AMARANTHACEAE	*Maireana turbinata*	Top-fruit Bluebush	Y
AMARANTHACEAE	*Malacocera tricornis*	Goat-head Soft-horns	N
MALVACEAE	*Malvastrum americanum* var.	Malvastrum	N
MARSILEACEAE	*Marsilea drummondii*	Common Nardoo	N
ASTERACEAE	*Minuria cunninghamii*	Bush Minuria	Y
ASTERACEAE	*Minuria denticulata*	Woolly Minuria	N
ASTERACEAE	*Minuria integerrima*	Smooth Minuria	N
ASTERACEAE	*Minuria leptophylla*	Minnie Daisy	N
LOGANIACEAE	*Mitrasacme* sp.	Mitrewort	N
SCROPHULARIACEAE	*Myoporum montanum*	Native Myrtle	Y
AMARANTHACEAE	*Neobassia proceriflora*	Desert Glasswort	N
SOLANACEAE	*Nicotiana velutina*	Velvet Tobacco	N
AMARANTHACEAE	*Osteocarpum acropterum* var.	Bonefruit	N

Family	Scientific Name	Common Name	Long-lived woody? Yes (Y) No (N)
AMARANTHACEAE	*Osteocarpum dipterocarpum*	Two-wing Bonefruit	N
AMARANTHACEAE	*Osteocarpum* sp.	Bonefruit	N
POACEAE	*Panicum decompositum* var.	Native Millet	N
POACEAE	*Panicum* sp.	Panic/Millet	N
POACEAE	*Paractaenum novae-hollandiae* ssp. *reversum*	Barbed-wire Grass	N
PHYLLANTHACEAE	*Lysiandra fuernrohrii*	Sand Spurge	N
THYMELAEACEAE	*Pimelea simplex* ssp. *simplex*	Desert Riceflower	N
PLANTAGINACEAE	*Plantago drummondii*	Dark Plantain	N
ASTERACEAE	*Pluchea rubelliflora*	Plains-bush	N
ASTERACEAE	*Podolepis capillaris*	Wiry Podolepis	N
ASTERACEAE	*Polycalymma stuartii*	Poached-egg Daisy	N
PORTULACACEAE	*Portulaca oleracea*	Common Purslane	N
PORTULACACEAE	*Portulaca* sp.	Purslane	N
ASTERACEAE	*Pterocaulon sphacelatum*	Apple-bush	N
AMARANTHACEAE	*Ptilotus incanus/obovatus*	Mulla	Y
AMARANTHACEAE	*Ptilotus nobilis* ssp.	Yellow-tails	N
AMARANTHACEAE	*Ptilotus obovatus*	Silver Mulla	Y
ASTERACEAE	*Pycnosorus pleiocephalus*	Soft Billy-buttons	N
ASTERACEAE	*Pycnosorus* sp.	Billy-buttons	N
AMARANTHACEAE	*Rhagodia* sp.	Saltbush	Y
AMARANTHACEAE	*Rhagodia spinescens*	Spiny Saltbush	Y
ASTERACEAE	*Rhodanthe corymbiflora*	Paper Everlasting	N
ASTERACEAE	*Rhodanthe floribunda*	White Everlasting	N
ASTERACEAE	*Rhodanthe microglossa*	Clustered Everlasting	N
ASTERACEAE	*Rhodanthe stricta*	Slender Everlasting	N
ASTERACEAE	*Rhodanthe uniflora*	Woolly Daisy	N
FABACEAE	*Rhynchosia australis*	Rhynchosia	N
ZYGOPHYLLACEAE	*Roepera ammophila*	Sand Twinleaf	N
ZYGOPHYLLACEAE	*Roepera aurantiaca* ssp. *aurantiaca*	Shrubby Twinleaf	Y
ZYGOPHYLLACEAE	*Roepera billardierei*	Coast Twinleaf	N
ZYGOPHYLLACEAE	*Roepera crenata*	Notched Twinleaf	N
ZYGOPHYLLACEAE	*Roepera eremaea*	Climbing Twinleaf	N
ZYGOPHYLLACEAE	*Roepera iodocarpa*	Violet Twinleaf	N
ZYGOPHYLLACEAE	*Roepera ovata*	Dwarf Twinleaf	N
ZYGOPHYLLACEAE	*Roepera prismatotheca*	Square-fruit Twinleaf	N
ZYGOPHYLLACEAE	*Roepera* sp.	Twinleaf	N
ACANTHACEAE	*Rostellularia adscendens* var. *pogonanthera*	Pink Tongues	N
POACEAE	*Rytidosperma caespitosum*	Common Wallaby-grass	Y
POACEAE	*Rytidosperma* sp.	Wallaby-grass	Y
AMARANTHACEAE	*Salsola australis*	Buckbush	N
SANTALACEAE	*Santalum lanceolatum*	Plumbush	Y
SANTALACEAE	*Santalum* sp.	Plumbush	Y
AIZOACEAE	*Sarcozona praecox*	Sarcozona	N
GOODENIACEAE	*Scaevola spinescens*	Spiny Fanflower	Y
AMARANTHACEAE	*Sclerolaena anisacanthoides*		N
AMARANTHACEAE	*Sclerolaena bicornis* var. *bicornis*	Goat-head Bindyi	N
AMARANTHACEAE	*Sclerolaena brachyptera*	Short-wing Bindyi	N
AMARANTHACEAE	*Sclerolaena cuneata*	Tangled Bindyi	N
AMARANTHACEAE	*Sclerolaena decurrens*	Green Bindyi	N
AMARANTHACEAE	*Sclerolaena diacantha*	Horned Bindyi	N
AMARANTHACEAE	*Sclerolaena divaricata*	Tangled Bindyi	N
AMARANTHACEAE	*Sclerolaena intricata*	Poverty Bush	N
AMARANTHACEAE	*Sclerolaena parallelicuspis*	Western Copperburr	N
AMARANTHACEAE	*Sclerolaena patenticuspis*	Spear-fruit Copperburr	N
AMARANTHACEAE	*Sclerolaena* sp.	Copperburr	N
#N/A	*Sclerolaena* sp. *Pernatty Station*		N
AMARANTHACEAE	*Sclerolaena tricuspis*	Giant Redburr	N
AMARANTHACEAE	*Sclerolaena ventricosa*	Salt Copperbush	N
ASTERACEAE	*Senecio magnificus*	Showy Groundsel	Y
FABACEAE	*Senna artemisioides* ssp.	Desert Senna	Y
FABACEAE	*Senna artemisioides* ssp. *alicia x ssp. coriacea*	Desert Senna	Y

Family	Scientific Name	Common Name	Long-lived woody? Yes (Y) No (N)
FABACEAE	*Senna artemisioides* ssp. *artemisioides x* ssp. *coriacea*	Desert Senna	Y
FABACEAE	*Senna artemisioides* ssp. *helmsii*	Blunt-leaf Senna	Y
FABACEAE	*Senna artemisioides* ssp. *oligophylla*	Limestone Senna	Y
FABACEAE	*Senna artemisioides* ssp. *X artemisioides*	Silver Senna	Y
FABACEAE	*Senna artemisioides* ssp. *X coriacea*	Broad-leaf Desert Senna	Y
FABACEAE	*Senna artemisioides* ssp. *X sturtii*	Grey Senna	Y
POACEAE	*Setaria constricta*	Knotty-butt Paspalidium	Y
POACEAE	*Setaria* sp.	Pigeon-grass	Y
MALVACEAE	*Sida ammophila*	Sand Sida	N
MALVACEAE	*Sida corrugata* var.	Variable Sida	N
MALVACEAE	*Sida fibulifera*	Pin Sida	N
MALVACEAE	*Sida intricata*	Twiggy Sida	Y
MALVACEAE	*Sida petrophila*	Rock Sida	Y
MALVACEAE	*Sida trichopoda*	Narrow-leaf Sida	N
SOLANACEAE	*Solanum esuriale*	Potato-bush	N
SOLANACEAE	*Solanum quadriloculatum*	Tomato Bush	N
SOLANACEAE	*Solanum sturtianum*	Sturt's Nightshade	Y
POACEAE	*Sporobolus actinocladus*	Ray Grass	N
POACEAE	*Sporobolus caroli*	Yakka Grass	N
CELASTRACEAE	*Stackhousia muricata ssp. Perennial (W.R.Barker 3641)*		N
BRASSICACEAE	*Stenopetalum lineare*	Narrow Thread-petal	N
FABACEAE	*Swainsona* sp.	Swainson-pea	N
ASTERACEAE	*Taraxacum cygnorum*	Dandelion	N
AMARANTHACEAE	*Tecticornia indica* ssp.	Samphire	Y
AMARANTHACEAE	*Tecticornia medullosa*	Samphire	Y
AMARANTHACEAE	*Tecticornia pergranulata* ssp.	Black-seed Samphire	Y
AMARANTHACEAE	*Tecticornia* sp.	Samphire	Y
AMARANTHACEAE	*Tecticornia tenuis*	Slender Samphire	Y
AIZOACEAE	*Tetragonia eremaea*	Annual Spinach	N
AIZOACEAE	*Tetragonia tetragonoides*	Warragul cabbage	N
LAMIACEAE	*Teucrium racemosum*	Grey Germander	N
POACEAE	*Themeda triandra*	Kangaroo Grass	Y
ASPARAGACEAE	*Thysanotus baueri*	Mallee Fringe-lily	N
ASPARAGACEAE	*Thysanotus patersonii*	Twining Fringe-lily	N
ASPARAGACEAE	*Thysanotus* sp.	Fringe-lily	N
ARALIACEAE	*Trachymene glaucifolia*	Blue Parsnip	N
POACEAE	*Tragus australianus*	Red Spinach	N
AIZOACEAE	*Trianthema triquetrum*	Small Hogweed	N
BORAGINACEAE	*Trichodesma zeylanicum* var. *zeylanicum*	Camel Bush	N
POACEAE	*Tripogonella loliiformis*	Purple Plume Grass	N
POACEAE	*Triraphis mollis*	Purple Needle-grass	N
ASTERACEAE	*Vittadinia cuneata* var.	Fuzzy New Holland Daisy	N
ASTERACEAE	*Vittadinia* sp.	New Holland Daisy	N
CAMPANULACEAE	*Wahlenbergia communis*	Tufted Bluebell	N
CAMPANULACEAE	*Wahlenbergia luteola*	Yellow-wash Bluebell	N
CAMPANULACEAE	*Wahlenbergia* sp.	Native Bluebell	N
CAMPANULACEAE	*Wahlenbergia stricta* ssp. *stricta*	Tall Bluebell	N
COLCHICACEAE	*Wurmbea latifolia* ssp. *latifolia*	Early Nancy	N

Appendix D. Jessup Sites raw data

Appendix D1. Jessup raw data – total number of long-lived woody perennial adults and juveniles, spring 2024

Species	Life Stage	Flora Site																		Total
		1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	18	19	20	
Abutilon halophilum	Adult	19	13	4		73			1		176			1	28					315
	Juvenile	2	4			23		1	2		23				25					80
Abutilon otocarpum	Adult									10							4	1	3	18
	Juvenile									3										3
Acacia papyrocarpa	Adult		18						1	1							334	10	1	365
	Juvenile															9		1		10
Acacia tetragonophylla	Adult									25								27	9	61
Atriplex vesicaria	Adult	86	112	143	173	314	152	51	104	1	498	228	180	93	324	142	160	11		2772
	Juvenile	3	9	19	30	77	5	10	39		80	15	42	9	15	17		4		374
Chenopodium curvispicatum	Adult									2						13	5	2		22
Dodonaea lobulta	Adult									29						19	15	112	13	188
	Juvenile																			
Duma florulenta	Adult									7								4	26	37
	Juvenile																		1	1
Einadia nutans	Adult									1						1		11	1	14
Enchylaena tomentosa	Adult									14						58	55	34	6	167
	Juvenile															46	21	6		73
Eremophila latrobei	Adult									2							9		1	12
	Juvenile															1				1
Eremophila oppositifolia	Adult																1			1
Eremophila serrulata	Adult									1	1					2				4
Eremopila oppositifolia	Adult								1											1
Eucalyptus camaldulensis ssp. *arida*	Adult									6								6	7	19
	Juvenile																		2	2
Exocarpos aphyllus	Adult									2										2
Frankenia serpyllifolia	Adult		1	27	3	65	5	9	11		2	1	14	8						146
	Juvenile			1					1											2
Maireana aphylla	Adult										2			21			1			24
Maireana appressa	Adult			5		1	1	11	1				2		2					23
	Juvenile							1												1
Maireana astrotricha	Adult							3												3

Species	Life Stage	Flora Site																		Total
		1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	18	19	20	
Maireana eriantha	Adult					3														3
Maireana spongiocarpa	Adult							4			37					18	19			78
	Juvenile															1				1
Maireana turbinata	Adult					7														7
Maireana turbinata/georgii	Adult							2												2
Minuria cunninghamii	Adult	3		12	1	5	24	1			43	8	3		2					102
	Juvenile			1										4	2					7
Myoporum montanum	Adult									7								25	10	42
	Juvenile									7							1	11	14	33
Ptilotus obovatus	Adult									129						48	97	13	5	292
	Juvenile									4						34	7			45
Rhagodia spinescens	Adult									1						3	7			11
Santalum lanceolatum	Adult									3								2	1	6
	Juvenile									1								2	12	15
Scaevola spinescens	Adult									26						1	2	22	7	58
	Juvenile									2						1		2	2	7
Senna artemisiodes artemisioides	Adult									2										2
Senna artemisiodes helmsii	Adult									1										1
Senna artemisioides ssp. *artemisioides*	Adult															1		1		2
	Juvenile																3			3
Senna artemisioides ssp. *helmsii*	Adult																		1	1
Senna artemisioides ssp. *oligophylla*	Adult															5				5
Senna artemisioides ssp. *sturtii*	Adult																	1		1
	Juvenile																	1		1
Sida intricata	Adult	3			4			1			2			14						24
Sida intricata/fibulifera	Adult											71								71
Sida petrophila	Adult							3		50						3		4	2	62
	Juvenile							15		6									1	22
Tecticornia medullosa	Adult	1	1	59	2	112	20				3	8	73	2	8					289
	Juvenile			1	0	3							5		8					17
Tecticornia pergranulata	Adult							31	32											63
Tecticornia tenuis	Adult			1	5			6	9											21
	Juvenile				2				8											10
Teucrium racemosum	Adult																	1		1

Appendix D2. Eliza Creek species abundance trends

Acacia tetragonophylla	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	39	28	22	43	37	34	25	25
17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	1	0
19	31	27	26	19	26	32	26	27
20	9	6	7	11	14	11	11	9
***A. tetragonophylla* All Sites**	**79**	**61**	**55**	**73**	**77**	**77**	**63**	**61**
Acacia papyrocarpa	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	0	1	0	2	3	0	0	1
17	33	28	30	29	33	37	21	27
18	42	53	15	49	45	63	56	54
19	8	20	11	10	15	13	13	11
20	2	1	1	0	1	1	1	1
***A. papyrocarpa* Totals All Sites**	**85**	**103**	**57**	**90**	**97**	**114**	**91**	**94**
Dodonaea lobulata	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	25	37	25	31	33	25	38	30
17	17	21	24	20	21	22	18	19
18	11	11	13	15	15	14	13	15
19	106	122	116	118	150	128	106	112
20	13	6	12	16	12	20	11	13
***Dodonaea* Totals All Sites**	**172**	**197**	**190**	**200**	**231**	**209**	**186**	**189**
Duma florulenta	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	6	6	8	7	5	8	7	7
17	0	7	0	0	0	0	0	0
18	0	7	0	0	0	0	0	0
19	0	2	5	2	7	7	5	4
20	27	31	24	26	26	24	24	27
***Duma* Totals All Sites**	**33**	**53**	**37**	**35**	**38**	**39**	**36**	**38**
Eremophila latrobei	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	1	1	1	1	0	1	1	2
17	0	0	1	1	1	2	0	1
18	3	7	9	5	11	9	10	9
20	0	0	1	0	1	1	1	1
***E. latrobei* Totals All Sites**	**4**	**8**	**12**	**7**	**13**	**13**	**12**	**13**
Eremophila serrulata	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	2	2	2	0	1	0	1	1
17	1	1	0	1	1	3	2	2
18	2	1	0	4	0	0	0	0
19	1	2	1	2	0	1	0	0
20	0	0	0	0	0	0	0	0
***E. serrulata* Totals All Sites**	**6**	**6**	**3**	**7**	**2**	**4**	**3**	**3**
Maireana spongiocarpa	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
17	nr	14	10	24	12	27	18	19
18	nr	19	11	29	16	33	29	19
***Maireana* Totals All Sites**		**33**	**21**	**53**	**28**	**60**	**47**	**38**
Myoporum montanum	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	23	7	19	23	10	27	5	14
19	27	17	18	15	17	19	36	1
20	16	14	19	16	16	27	20	36
***Myoporum* Totals All Sites**	**66**	**38**	**56**	**54**	**43**	**73**	**61**	**24**
Ptilotus obovatus	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	25	66	31	65	71	105	115	133
17	30	30	31	46	52	95	84	82
18	100	73	48	46	23	97	80	104
19	9	1	5	6	12	18	17	13
20	0	0	3	1	1	2	3	5
***Ptilotus* Totals All Sites**	**164**	**170**	**118**	**164**	**159**	**317**	**299**	**337**

Scaevola spinescens	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	12	21	6	11	22	13	23	28
17	4	4	5	2	3	4	5	2
18	4	3	3	2	1	2	2	2
19	11	9	11	12	15	18	16	24
20	2	1	9	10	6	5	5	9
Scaevola Totals All Sites	**33**	**38**	**34**	**37**	**47**	**42**	**51**	**65**
Senna (all species combined)	2018 Autumn	2018 Spring	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
10	4	2	3	4	5	4	5	3
17	7	4	4	3	6	7	6	6
18	4	6	3	4	2	5	3	3
19	1	3	1	2	0	2	2	3
20	0	0	0	0	0	1	1	1
Senna Totals All Sites	**16**	**15**	**11**	**13**	**13**	**19**	**17**	**16**

Appendix E. Canopy cover visual estimates

Western Myall Transects

Species / Transect	Tree No.	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 Spring
Western Myall / 17A	1	98	100	100	100	100	90
	2	98	100	100	95	100	95
	2b				76	75	65
	2c*						100
	3	100	100	100	100	100	100
	4	40	32	45	41	40	20
	5	95	90	98	95	100	80
	5b			95	90	100	90
	6	86	100	100	100	100	80
	7	86	86	100	98	100	100
	7b			100	100	100	100
	7c			100	100	100	100
	Mean	**86**	**87**	**94**	**90**	**92**	**85**
	SD	**21**	**25**	**17**	**18**	**19**	**23**
Western Myall / 17B	1	100	98	100	98	95	95
	2	95	95	95	90	100	80
	3	95	76	76	78	100	70
	4	76	95	90	86	90	90
	5	100	100	100	100	100	100
	5b			100	95	100	90
	6	72	86	86	77	90	70
	7	90	95	100	100	100	95
	Mean	**90**	**92**	**93**	**91**	**97**	**86**
	SD	**11.3**	**8.4**	**8.8**	**9.4**	**4.6**	**11.6**
Western Myall / 18A	1	86	nr	81	81	100	95
	1b						95
	2	86	nr	81	90	90	80
	3	9	nr	1	5	5	5
	3b					100	100
	4	98	nr	81	100	100	90
	5	98	nr	85.5	100	100	80
	6	98	nr	98	100	100	80
	7	100	nr	85.5	86	100	90
	7a					100	90
	7b					100	90
Western Myall / 18A	7c					100	90
	8	10	nr	0 (died)	0	0	0
	8a				90	100	90
	8c		nr	85.5	86	100	Not intercepted
	8d					100	Not intercepted
	9	95	nr	76.5	77	100	60
	10	95	nr	76.5	100	100	100
	11	100	nr	90.25	100	100	100
	12	100	nr	90.25	100	100	90
	Mean	**81**		**72**	**80**	**89**	**80**
	SD	**34**		**32**	**34**	**31**	**19**
Western Myall / 18B	1	57	nr	8	1	0	5
	1b						60
	2	56	nr	25	40	72	50
	3	29	nr	6	23	12	10
	4	67	nr	49	76	90	70
	5	2	nr	0 (died)	0	0	0
	Mean	**42**	**nr**	**22**	**28**	**35**	**33**
	SD	**27**	**nr**	**20**	**32**	**43**	**31**

*Shaded cells represent trees recorded for first time in 2024

River Red Gum

Species / Transect	Tree No.	2019 Autumn	2019 Spring	2020 Spring	2021 Spring	2022 Spring	2023 Autumn	2024 spring
River Red gum 19A	1	93	88	90	86	81	90	85
	5	40	27	27	27	29	29	30
	7	72	77	90	75	80	100	70
	8	57	72	56	57	63	100	50
	9	26	68	45	63	75	100	70
	10	64	90	72	54	76	100	60
	Mean	**59**	**70**	**63**	**60**	**67**	**87**	**61**
	SD	**24**	**23**	**25**	**20**	**20**	**29**	**19**
Western Myall 19A	2	100	100	100	100	100	100	100
	4b				72	100	100	100
	4c				100	100	100	90
	6	93	100	100	100	100	100	90
	6b				100	100	100	90
	6c				100	90	100	90
	10b				100	100	100	100
	Mean	**97**	**100**	**100**	**96**	**99**	**100**	**95**
	SD	**4**	**0**	**0**	**10**	**4**	**0**	**5**
River Red Gum 19B	1	8	5	9	5	5	4	5
	2	46	86	81	90	96	100	80
	4	51	15	3	0	0	0	0
	5	33	81	56	43	81	100	35
	5A					10	100	20
	6	67	90	86	77	60	100	70
	Mean	**4**	**55**	**47**	**43**	**42**	**67**	**47**
	SD	**22**	**42**	**39**	**41**	**42**	**51**	**31**
Western Myall 19B	6A	100	100	100	100	nr	nr	nr
	7	10	8	5	3	5	15	5
	7B				81	86	100	95
	7C						100	95
	8	100	100	98	93	95	100	90
	5AA					100	100	100
	5B				100	100	100	100
	Mean	**70**	**69**	**68**	**75**	**77**	**86**	**79**
	SD	**52**	**53**	**54**	**41**	**41**	**35**	**37**
River Red Gum 20A	1	55	80	46	68	90	100	80
	2	2	3	2	23	90	90	10
	3	6	11	30	Not recorded	96	100	90
	4	42	72	53	60	63	80	40
	5	34	45	35	18	67	90	60
	6	55	48	53	64	90	100	70
	7	86	88	56	81	98	100	80
	8	18	42	33	18	38	70	35
	10	54	49	49	46	90	90	80
	Mean	**39**	**49**	**40**	**47**	**80**	**91**	**61**
	SD	**27**	**29**	**17**	**25**	**20**	**11**	**27**
River Red Gum 20B	1	24	45	35	28	48	70	70
	2	81	86	68	77	98	100	95
	3	20	36	33	23	67	90	65
	4	81	86	49	56	86	80	80
	Mean	**52**	**63**	**46**	**46**	**75**	**85**	**78**
	SD	**34**	**27**	**16**	**25**	**22**	**13**	**13**
Western Myall 20A (one tree only)	**9**	**100**	**100**	**90**	**77**	**100**	**100**	**70**

Appendix F. Fauna

Table F1: Bird species detected at formal bird survey sites and opportunistic sites at Carrapateena during the spring 2024 survey

Family	*Species Name*	Common Name	Site																Opportunistic[1]
			1	2	3	4	5	6	7	9	10	11	15	16	17	18	19	20	21	22	
Podicipedidae	*Tachybaptus novaehollandiae novaehollandiae*	Australasian Grebe								1											DD, NED, SED, AD
Artamidae	*Gymnorhina tibicen*	Australian Magpie	1	1[2]		1		1	1		1			1					1	1	NED, SED
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar					1		1		1										
Motacillidae	*Anthus australis australis*	Australian Pipit		1[2]		1[2]	1	1[2]	1		1	1	1[2]	1[2]							DD, EV, NED, SED, Admin, AD
Glareolinae	*Stiltia isabella*	Australian Pratincole	1	1		1		1[2]	1				1	1							SED, AD
Corvidae	*Corvus coronoides*	Australian Raven	1[2]	1[2]	1	1	1[2]	1[2]	1		1		1	1[2]			1				DD, SED, WAR,
Psittacidae	*Barnardius zonarius zonarius*	Australian Ringneck							1		1							1			YC
Rallidae	*Porzana fluminea*	Australian Spotted Crake																			SED
Anatidae	*Chenonetta jubata*	Australian Wood Duck																			SED
Charadriidae	*Vanellus tricolor*	Banded Lapwing																			DD, SED
Anatidae	*Cygnus atratus*	Black Swan																			SED
Artamidae	*Artamus cinereus*	Black-faced Woodswallow	1	1	1		1		1	1	1	1		1		1	1	1	1		SED, WAR
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel																			DD, NED, SED, AD
Rallidae	*Tribonyx ventralis*	Black-tailed Nativehen								1											SED
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt																			SED
Falconidae	*Falco berigora*	Brown Falcon				1							1								
Locustellidae	*Cincloramphus cruralis*	Brown Songlark				1		1						1							
Psittacidae	*Melopsittacus undulatus*	Budgerigar	1				1		1	1	1			1[2]				1			SED
Acanthizidae	*Acanthiza uropygialis*	Chestnut-rumped Thornbill							1		1							1			
Cinclosomatidae	*Cinclosoma cinnamomeum*	Cinnamon Quailthrush	1	1					1												CWM02
Cacatudiae	*Nymphicus hollandicus*	Cockatiel	1																		SED
Columbidae	*Phaps chalcoptera*	Common Bronzewing							1												
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper																			
Columbidae	*Ocyphaps lophotes*	Crested Pigeon	1						1	1	1				1	1		1	1		NED, SED, AD
Meliphagidae	*Epthianura tricolor*	Crimson Chat	1	1			1	1	1				1	1					1		
Psittacidae	*Northiella haematogaster haematogaster*	Eastern Bluebonnet																			

Family	*Species Name*	Common Name	Site																Opportunistic[1]
			1	2	3	4	5	6	7	9	10	11	15	16	17	18	19	20	21	22	
Casuariidae	*Dromaius novaehollandiae*	Emu		1					1		1						1			1	DD, SED, WAR
Rallidae	*Fulica atra*	Eurasian Coot																			NED, SED
Hirundinidae	*Petrochelidon ariel*	Fairy Martin							1												NED, SED
Cacatudiae	*Eolophus roseicapillus*	Galah	1				1		1		1		1	1[2]			1	1	1		
Artamidae	*Cracticus torquatus*	Grey Butcherbird	1	1							1				1		1				
Anatidae	*Anas gracilis*	Grey Teal							1	1											
Anatidae	*Aythya australis*	Hardhead																			
Podicipedidae	*Poliocephalus poliocephalus*	Hoary-headed Grebe																			SED
Petroicidae	*Melanodryas cucullata westralensis*	Hooded Robin								1											
Passeridae	*Passer domesticus*	House Sparrow																			EV, Admin
Charadriidae	*Passer domesticus*	Inland Dotterel	1																		CMW02
Cacatudiae	*Cacatua sanguinea sanguinea*	Little Corella	1								1										NED, SED, CWM05
Monarchidae	*Grallina cyanoleuca*	Magpie-lark							1												SED
Charadriidae	*Vanellus miles*	Masked Lapwing																			SED
Artamidae	*Artamus personatus*	Masked Woodswallow	1						1		1	1		1							
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoe Bird									1										
Psittacidae	*Psephotus varius*	Mulga Parrot									1				1	1		1			SED
Falconidae	*Falco cenchroides*	Nankeen Kestrel			1	1	1		1	1				1				1			SED, WAR
Meliphagidae	*Epthianura aurifrons*	Orange Chat				1		1		1			1								SED, AD
Anatidae	*Anas superciliosa*	Pacific Black Duck								1											SED
Pelecanidae	*Pelecanus conspicillatus*	Pelican				1															
Anatidae	*Malacorhynchus membranaceus*	Pink-eared Duck																			SED
Maluridae	*Malurus assimilis*	Purple-backed Fairywren							1	1	1							1		1	
Meropidae	*Merops ornatus*	Rainbow Bee-eater							1		1	1									
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher	1	1																	
Petroicidae	*Petroica goodenovii*	Red-capped Robin																			SED
Charadriidae	*Erythrogonys cinctus*	Red-kneed Dotterel																			SED
Recurvirostridae	*Recurvirostra novaehollandiae*	Red-necked Avocet																			SED
Acanthizidae	*Calamanthus campestris*	Rufous Fieldwren	1	1		1[2]	1[2]	1[2]	1			1	1[2]	1[2]							LFA Aero, LFA Tju
Locustellidae	*Cincloramphus mathewsi*	Rufous Songlark																			SED
Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper																			SED
Laridae	*Larus novaehollandiae*	Silver Gull			1																

Family	*Species Name*	Common Name	Site																Opportunistic[1]
			1	2	3	4	5	6	7	9	10	11	15	16	17	18	19	20	21	22	
Meliphagidae	*Gavicalis virescens*	Singing Honeyeater	1	1				1	1	1	1		1	1[2]	1	1		1	1	1	NED, SED
Meliphagidae	*Acanthogenys rufogularis*	Spiny-cheeked Honeyeater	1	1					1		1		1		1		1	1			DD, SED
Pardalotidae	*Pardalotus striatus*	Striated Pardalote							1		1										
Hirundinidae	*Petrochelidon nigricans*	Tree Martin							1		1							1			NED, SED, AD
Accipitridae	*Aquila audax*	Wedge-tailed Eagle						1				1						1			AD
Hirundinidae	*Hirundo neoxena*	Welcome Swallow				1		1	1		1		1	1[2]							DD, NED, SED, EV, AD
Hirundinidae	*Cheramoeca leucosterna*	White-backed Swallow				1		1	1[2]				1								
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler							1	1	1			1					1		
Ardeidae	*Egretta novaehollandiae*	White-faced Heron																			SED
Meliphagidae	*Epthianura albifrons*	White-fronted Chat							1				1								SED
Meliphagidae	*Lichenostomus penicillatus*	White-plumed honeyeater																			SED
Maluridae	*Malurus leucopterus*	White-winged Fairywren		1	1		1		1	1	1	1	1	1[2]	1			1		1	DD, SED, LFA Tju
Campephagidae	*Lalage tricolor*	White-winged Triller							1[2]		1										
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail							1		1						1				NED, SED, DD, EV
Meliphagidae	*Manorina flavigula*	Yellow-throated Miner									1										
Estrildidae	*Taeniopygia guttata*	Zebra Finch	1		1	1			1	1	1	1		1				1		1	
		Grand Total	19	14	6	13	10	12	35	15	29	8	14	17	6	4	7	15	7	6	

[1]Opportunistic observation locations: South Eliza Dam (SED), North Eliza Dam (NED), Dawson Dam (DD), Exploration Village (EV), Western Access Road (WAR), Exploration Village (EV), CWM02/5 (weed monitoring sites), YC (Yeltacowie Creek), [2]Observed plus Song meter detection.; Note '1' denotes present, not counts of individuals; Grey cells = EPBC Status. No bird surveys were undertaken at Site 12 and 13 due to unsuitable conditions and limited time available.

Specialised Zoological

Acoustic analysis and bat call identification from Carrapateena, South Australia

Prepared for **Lathwida Environmental Pty Ltd**

Version **29 January 2025**

SZ project reference **SZ754**

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Date	Note
2025-01-29	Final version

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Summary

Bat identifications from bat detector sound files are provided from recordings made in the Carrapateena study area, c. 65 km east of Woomera, near the Carrapateena Arm of Lake Torrens, South Australia.

The dataset submitted for analysis included a total of 539 WAV format bat detector sound files from three recording sites over 8 recording nights (nights of 2024-10-16 – 2024-10-21).

Five species of bat were detected in the recordings (**Tables 1** and **2**; **Figure 1**). All species were identified unambiguously.

Methods

The ultrasonic recordings provided were recorded in WAV sound format from Wildlife Acoustics Song Meter Mini Bat bat detectors. All sound files were inspected in Anabat Insight version 2.1.3 software and Adobe Audition version 23.1.

Species identifications were made based on measurements of characteristic frequency and observation of pulse shape, and with reference to information in Armstrong et al. (2021). Nomenclature follows Jackson and Groves (2015). Distribution information for all bat species considered here was checked against the BatMap resource hosted by the Australasian Bat Society, Inc (https://www.ausbats.org.au/batmap.html) (Milne et al. 2023).

References

Armstrong K.N., Clarke S., Linke A., Scanlon A., Roetman P., Hitch, A.T. and Donnellan S.C. (2021b). Citizen science implements the first intensive acoustics-based survey of insectivorous bat species across the Murray-Darling Basin of South Australia. *Australian Journal of Zoology* 68: 364–381. https://doi.org/10.1071/ZO20051

Jackson, S.M. and Groves, C.P. (2015). *Taxonomy of Australian mammals*. CSIRO Publishing, Victoria.

Milne D.J., Reardon T.B. and Ford G. (2023) BatMap – authoritative distribution maps for Australian bats. *Australian Mammalogy*. 45: 350–355. https://doi.org/10.1071/AM23005

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).

2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further extended comment on these species and the possible impacts of a planned project on bat species were not part of the scope.

3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.

4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.

5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.

6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.

7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be requested.

8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.

9. This version of the document supersedes any previous version. Previous drafts are not authorised by us for submission to the regulator or the public domain.

Table 1. Species identified from all sites combined.

VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Lesser Long-eared Bat	*Nyctophilus geoffroyi*
Inland Forest Bat	*Vespadelus baverstocki*
MOLOSSIDAE	
White-striped Free-tailed Bat	*Austronomus australis*
Inland Free-tailed Bat	*Ozimops petersi*

Table 2. Species identifications summarised for all nights across each recording site (see *Table 1* for full species names).

Site	Unit serial	Night	Coordinates	*A. australis*	*C. gouldii*	*O. petersi*	*N. geoffroyi*	*V. baverstocki*
Carra CAR007	SMU13599	16/10/2024	-31.17247, 137.44265	.	.	X	X	X
Carra CAR007	SMU13599	17/10/2024	-31.17247, 137.44265	.	.	X	X	.
Carra CAR007	SMU13599	18/10/2024	-31.17247, 137.44265	.	.	.	X	X
Eliza Creek CAR010	SMU13599	21/10/2024	-31.23181, 137.52590	.	X	.	X	X
South Eliza Dam	SMU13725	18/10/2024	-31.34085, 137.50383	.	X	.	.	X
South Eliza Dam	SMU13725	19/10/2024	-31.34085, 137.50383	.	X	X	X	X
South Eliza Dam	SMU13725	20/10/2024	-31.34085, 137.50383	.	X	X	X	X
South Eliza Dam	SMU13725	21/10/2024	-31.34085, 137.50383	X	X	X	X	X

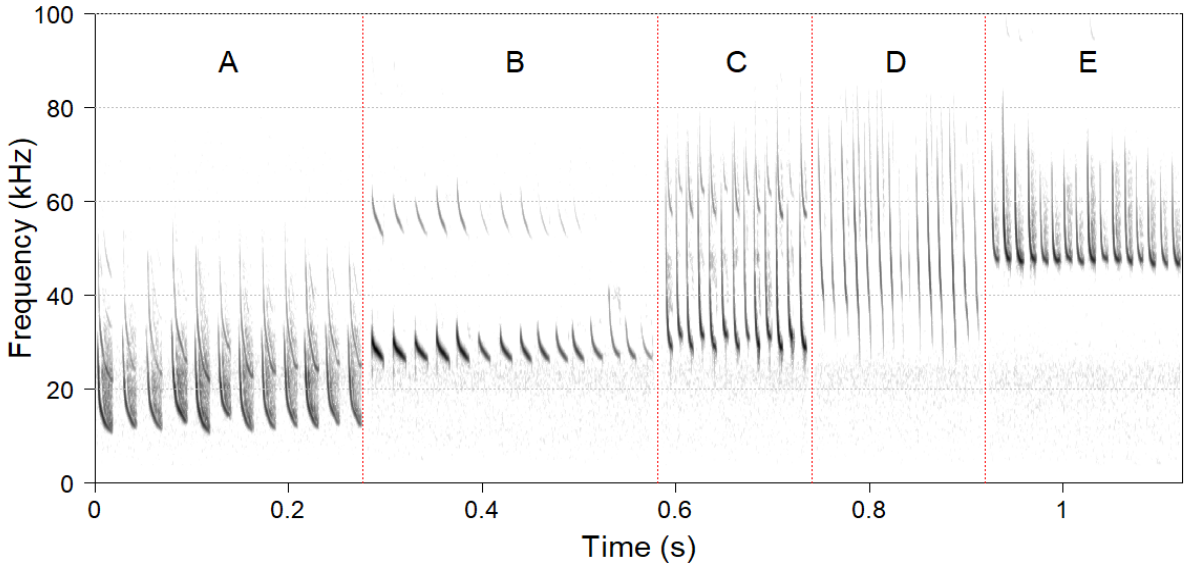

Figure 1. Representative echolocation call sequence portions of the species identified (**A**: *Austronomus australis*; **B**: *Ozimops petersi*; **C**: *Chalinolobus gouldii*; **D**: *Nyctophilus geoffroyi*; **E**: *Vespadelus baverstocki*; time between pulses has been compressed).

Appendix G. Weeds

Appendix G1. Weed summary

Table G1: Weeds recorded at various locations across the Carrapateena Site during baseline (2012-2016) and compliance (autumn 2018 to spring 2024)

Scientific name	Common Name	Location	EBS 2012 – 2016	Years recorded between 2018 and 2023 and (CSR)*	Spring 2024 CSR*
Asphodelus fistulosus	Onion Weed	Dawson Dam	NR	2020 (2)	NR
Brassica tournefortii	Mustard	CWM01	Present	NR	NR
Carrichtera annua	Wards Weed	CWM01	NR	2021 (isolated CSR 4)	
		CWM05	NS	NR	1
Carthamus lanatus	Saffron Thistle	CWM01	Present	2018, 2021, 2023 (1,2)	
		CAR007	Present	NR	
		South Eliza Dam	NS	2021 (2)	2
		Whittata Creek	NS	NS	
Centaurea calcitrapa	Star Thistle	CWM02	Present	NR	
Centaurea melitensis	Malta Thistle	CAR010	Present	2021 (1)	
		CAR018	NS	2021, 2023 (1)	
		CAR020	NS	2021, 2023 (2)	2/4
		CWM01	NS	NR	1/5
		Dawson Dam	NS	2021, 2022 (2)	1/3
Centarium erythraea / tenuiflorum	Centaury	CAR010	Present	NR	
		EV EIA	NS	2018 (1), 2023 (4)	
		Dawson Dam	NS	2020 (4), 2023 (1)	
		Anzac Dam	NS	2022 (1)	
		South Eliza Dam	NS	2022 (2)	
		North Eliza Dam	NS	NR	
		Dawson	NS	2023 (2/4)	
Chenopodium album/murale	Goosefoot	Expo Village EIA	NS	2018, 2019, 2021, 2023 (2/4)	2/4
		Anzac Dam	NS	2018, 2020 - 2023 (1/2/4)	
		Whittata Creek	NS	2021 (1)	
		Dawson Dam	NR	2020 - 2023 (2/3/4)	
Citrullus species, inc. C. colocynthis	Bitter Melon	Anzac Dam	NS	2019 – 2023 (2/3/4)	
		South Eliza Dam	NS	2019, 2020 (2/4)	
		Dawson Dam	NS	2018 – 2020, 2023 (1/2/4)	2
		CWM01	NR	2020, 2022 (1/3)	
		CWM02	NR	2022 (1)	
		CWM05	NS	2020, 2022, 2023 (2/3/4/5)	3

Scientific name	Common Name	Location	EBS 2012 – 2016	Years recorded between 2018 and 2023 and (CSR)*	Spring 2024 CSR*
		CWM06	NR	2020, 2022, 2023 (1/2/3)	
		CWM021	NS	2020, 2022, 2023 (1/2)	
		CWM022	NS	2020, 2022, 2023 (1/2)	
		Tjungu EIA	NS	2023 (1/3)	
Cucumis myriocarpus	Paddy Melon	EV EIA	NS	2020, 2023 (3)	
		CWM01	NR	2020 (3)	
		Dawson Dam	NR	2020, 2023 (2/3/5)	
		South Eliza Dak	NR	2020, 2023 (2/3/5)	
Cynodon dactylon	Couch	Whittata Creek	NS	2021 (2)	2
Erodium sp. including E. cicutarium	Cut-leaf Stork's-bill	CWM02	NR	2020 (1)	
		Dawson Dam	NR	2020 (1)	
		Whittata Creek	NS	2021 (1)	
		Anzac Dam	NR	2020, 2021 (1/2)	
Heliotropium curassavicum	Smooth Heliotrope	North Eliza	NS	2018 – 2023 (2/3/4/5)	2/3
		South Eliza	NS	2018 – 2023 (2/3/4/5)	2/4/5
		Anzac Dam	NS	2018 – 2023 (2/4/5/6)	
		Dawson Dam	NS	2018 – 2023 (2/4/5/6)	2/4/5/6
		CWM02	Present	2019 – 2023 (1/2/3/4/)	3
		Whittata Creek	NS	2021 (2)	
		CWM01	NR	2023 (1)	2
		CWM02	Present	2019 – 2021, 2023 (1/2)	
		CWM06	NR	2023 (1)	
Heliotropium europeum and/or supinum	Spreading Heliotrope	CWM01	Present	2018, 2021 (1/2)	
		CWM02	NR?	NR	
		Anzac Dam	NS	2019 (1)	
		North Eliza Dam	NS	2019 – 2023 (2/3/4)	2
		South Eliza Dam	NS	2021 – 2023 (1/2/4)	2
		Dawson Dam	NS	2018 – 2021 (2/3/4)	2
		Whittata Creek	NS	2021 (2)	
Lepidium africanum	Peppercress	CWM02	Present	NR	
Lysimachia arvensis	Scarlet Pimpernel	Expo Village EIA	NS	2018 – 2022 (2/4)	2/6
		CWM001	NR	2022 (1)	
		CWM006	NR	2020 (1)	
		North Eliza Dam	NS	NR	1
Malva parviflora	Mallow	Anzac Dam	NS	2019 (1)	
		North Eliza Dam	NS	NR	1
		South Eliza Dam	NS	2023 (3)	

Scientific name	Common Name	Location	EBS 2012 – 2016	Years recorded between 2018 and 2023 and (CSR)*	Spring 2024 CSR*
		CWM01	NR	2020, 2022 (1)	
		CWM02	NR	2020, 2023 (2/3)	
Medicago sp. *(including M. minima)*	Medic	CWM01	NR	2022 (1)	
		CWM02	NR	2022 (1)	3
		North Eliza Dam	NS	NR	3
		South Eliza Dam	NS	NE	3
Mesembryanthemum crystallinum	Iceplant	CWM01	NR	2020 (3)	
		South Eliza Dam, EV	NR	2020 (1)	
Mesembryanthemum nodiflorum	Slender Iceplant	CAR001, CAR008, CAR009, CAR010	Present	NR	
Nicotiana glauca	Tree Tobacco	CAR013	Present	2022 (1)	
		Dawson Dam	NS	2023 (1)	
		South Eliza Dam	NS	2018 – 2023 (2/4/5)	2/4
Opuntia sp. [1]	Prickly Pear	Yeltacowie homestead	NS	2018 – 2023 (1)	1
Polygonum aviculare	Wire Weed	Anzac Dam	NS	2019 (1)	
Rostraria pumila	Tiny Bristle Grass	CAR003-CAR005, CAR007, CAR008, CAR012-CAR015, CAR022	CAR003- CAR005, CAR007, CAR008, CAR012-CAR015	CAR004, CAR012 (1) Recorded in 2019 an 2020	
		South Eliza Dam	NS	2019 (3)	
		Expo Villlage	NS	2019 – 2022 (1/2/4)	2
Rumex vesicarius	Rosy Dock	CAR004, CAR013	Present	NR	
Rumex vesicarius	Rosy Dock	CAR007	Present	2020 (1)	
Schinus molle	Pepper Tree	Whittata Creek	NS	2021 (1) Not surveyed other years	
Schismus barbatus	Arabian Grass	CAR003, CAR006, CAR012, CAR014	Present	NR	
Sisymbrium erysimoides	Smooth Mustard	Anzac Dam	NS	2019 (1)	
		Dawson Dam			2/4
		CAR001, CAR009, CAR011, CAR013, CAR014, CAR016	Present	NR	
		CAR010	NS	2021 (1)	
		CAR012, CAR017		2019 (1)	
		CAR020		NR	1
		CAR021		2020, 2022, 2023 (1/2/3/4)	2/4
		CAR022		2019 – 2023 (1/2/3/4)	4/5
		CWM01	NR	2019, 2020, 2022, 2023 (1/2/3/4)	3
		CWM03	Present	NR	
		CWM05	NS	2020, 2021 (1/3)	1/4
		CWM06	NR	2019 – 2023 (1/3)	1/5
		South Eliza Dam	NS	2019, 2020 (3)	3
		Norh Eliza Dam		NR	1/3

Scientific name	Common Name	Location	EBS 2012 – 2016	Years recorded between 2018 and 2023 and (CSR)*	Spring 2024 CSR*
		Expo Village		2020 (2)	2/4
Solanum nigrum	Black Nightshade	Anzac Dam	NS	2019 – 2023 (1)	
		Dawson Dam		2019 – 2020, 2023 (2)	2
		South Eliza Dam		2020, 2023 (1)	1
		Expo Village		2018 – 2021, 2023 (1/2)	1
		Expo Village EIA		2018 – 2021, 2023 (1/2/3/4)	2/3
		Whittata Creek		2021 (1) Not surveyed other years	
		CWM01	Present	2021, 2022 (1)	1
		CWM02		NR	
Sonchus oleraceus	Sow Thistle	Expo Village	NS	2018 (1)	2
		CWM02	NR	NR	3
		Expo Village EIA	NS	2018, 2019, 2021, 2023 (1/3/4)	3/4
		TV EIA	NS	2018 – 2023 (4)	
		CAR006-CAR010, CAR014	Present	NR	
		CAR012		2023 (1)	
		CAR003, CAR011, CAR015		2019 (1)	
		CAR013		2019, 2023 (1)	
		CAR016	NR	2019 (1)	
		CAR018		2023 (1)	1
		CAR019	NS	2020 (1)	1
Tamarix aphylla[1,2]	Athel Pine	Yeltacowie homestead	NS	2018, 2019, 2021 – 2023 (1)	1
Tribulus terrestris	Caltrop	CAR002, CAR005, CAR008-CAR010, CAR013, CAR014	Present	NR	
		CAR020	NS	2020 (1)	
Urtica urens	Stinging Nettle	Exploration Village EIA	NS	2023 (2)	
Verbena supina	Trailing Verbena	Anzac Dam	NS	2022 (2)	
		North Eliza Dam		NR	1
Xanthium spinosum[1]	Bathurst Burr	CWM01	NR	2018, 2019, 2021, 2023 (1/3)	2
		CWM02		2019. 2021, 2023 (2//3/4)	3
		Dawson Dam	NS	2019 – 2023 (4/5)	4/5
		South Eliza Dam		2019, 2021, 2023 (2/3/4/5)	3
		Whittata Creek		2021 (2/5) Not surveyed other years	1

*CSR = Crown Separation Ratio: Abundance recorded using the CSR scale 1 = < 12 individuals; 2 = isolated clumps, 3 = isolated individuals, 4 = plants separated by 6-20 crown widths, 5 = plants separated by 1-5 crown widths

[1] Declared in SA under the Landscapes South Australia 2019 Act. Declared plant species are regulated as to their movement, sale, notification and/or control.

[2] WoNS - Weed of National Significance. Must be controlled within 100 m of a watercourse

[3] EV = Exploration Village, EV EIA = Exploration Village Effluent Irrigation Area. TV EIA = Tjungu Village Effluent Irrigation Area, NR = Not Recorded, site was surveyed, but weed species was not observed; NA = Not applicable, site was discontinued in spring 2018, NS = Not surveyed.

Appendix G2. Weed transect species (baseline and compliance)

Table G2: Weed species recorded along weed transects, baseline and compliance/operational monitoring

Transect*	Species	2012-2016[1]	Years recorded between 2018 and 2023 and (CSR)*	Spring 2024 notes and/or CSR**
CWM01	*Brassica tournefortii* (Mustard)	Present	NR#	NR
CWM01	*Carrichtera annua* (Wards Weed)	NR	2021	NR
CWM01	*Carthamus lanatus* (Saffron Thistle)	Present	2018, 2023 (1)	NR
CWM01	*Centaurea melitensis* (Malta Thistle)	NR	NR	1 plant recorded at small creek
	Cucumis sp. (Paddy Melon)	NR	2020	NR
	Cynodon dactylon (Couch)	NR	2021 (2)	Localised at Whittata creek
	Heliotropium curassavicum (Smooth Heliotrope)	NR	2022 (1), 2023 (1)	Localised at culvert where CSR = 4
	Heliotropium supinum (Spreading Heltiotrope)	Present	2018, 2019, 2021	NR
	Lysimachia arvensis (Scarlet Pimpernel)	NR	2022 (1)	NR
	Malva parviflora (Mallow)	NR	2020, 2022 (1)	NR
	Medicago minima (Medic)	NR	2022 (3)	NR
	Mesembryanthemum crystallinum (Iceplant)	NR	2020	NR
	Sisymbrium erysimoides (Smooth Mustard)	NR	2020, 2022 (1), 2023 (2/4)	NR
	Sonchus oleraceus (Sow Thistle)	Present	2021, 2022 (1), 2023 (1)	NR
	Solanum nigrum (Black Nightshade)	NR	2022 (1)	NR
	Xanthium spinosum (Bathurst Burr)	NR	2018, 2019, 2021, 2023 (3)	Localised, 30+ seedlings at culvert
CWM02	*Centaurea calcitrapa* (Star Thistle)	Present	NR	
	Citrullus Cucumis (Bitter Melon)	NR	2022 (1)	
	Erodium cicutarium (Cut-leaf Stork's-bill)	NR	2020	
	Heliotropium curassavicum (Smooth Heliotrope)	Present	2019, 2020, 2021, 2022 (3), 2023 (2)	Culvert and water's edge CSR =b3
	Lepidium africanum (Peppercress)	Present	NR	
	Malva parviflorus (Mallow)	NR	2020, 2023 (2)	
	Medicago minima (Medic)	NR	2022 (1)	Culvert and water's edge CSR = 4
	Solanum nigrum (Black Nightshade)	NR	2022 (1)	
	Sonchus oleraceus (Sow Thistle)	NR	2022 (1)	Culvert + water's edge CSR = 4
	Xanthium spinosum (Bathurst Burr)	Present	2019, 2021, 2023 (2/4)	Culvert + water's edge CSR = 3
CWM03	*Sisymbrium erysimoides* (Smooth Mustard)	Present	NR	NR
CWM04	*Sonchus oleraceus* (Sow Thistle)	Present	NR	NR
CWM05	*Carrichtera annua* (Wards Weed)	NR	NR	Two dead stalks midway CSR = 1
	Citrullus sp. (Bitter Melon)	NS	2020, 2022 (4/5), 2023 (4/5)	Localised, sparse CSR = 3
	Sisymbrium erysimoides (Smooth Mustard)	NS##	2020	Widespread CSR 1 to 4
CWM06	*Citrullus* sp. (Bitter Melon)	NR	2020, 2022 (1), 2023 (2/3)	
	Lysimachia arvensis (Scarlet Pimpernel)	NR	2020	
	Sisymbrium erysimoides (Smooth Mustard)	NS	2018, 2019, 2020, 2022 (1), 2023 (1)	Widespread CSR 1 to 5
CWM07	No weeds present			
NWM01	*Tribulus terrestris* (Caltrop)	NS	2019	NR

Transect*	Species	2012-2016[1]	Years recorded between 2018 and 2023 and (CSR)*	Spring 2024 notes and/or CSR**
NWM02	*Citrullus* sp. (Bitter Melon)	NS	2019	NR
NWM02	*Cucumis* sp. (Paddy Melon)	NS	2019	NR
NWM03	No weeds present	NS	Nil	Nil

BHP

Appendix D
Native Vegetation Management Plan

Carrapateena Operation

Native Vegetation Management Plan

May 2025

Executive Summary

BHP submit this Native Vegetation Management Plan (NVMP) to support the Program for Environment Protection and Rehabilitation (PEPR) for the Carrapateena Mineral Lease (ML 6471), and associated Miscellaneous Purposes Licences (MPL 149, MPL 152, MPL 153, MPL 154 and MPL 156), Extractive Minerals Lease (EML 6488), regional Exploration Licences (Els) and other works on land authorised under other legislative requirements or third-party agreements.

BHP is operating an underground mining operation, minerals processing plant and supporting infrastructure at Carrapateena (the Project), approximately 160 km north of Port Augusta in South Australia.

At the completion of operations, all surface infrastructure will be removed, and land disturbances rehabilitated to a land condition equivalent to surrounding analogues, with the exception of the tailings storage facility (TSF) and the surface expression of the sub-level cave (SLC) subsidence zone, which will remain as permanent landscape features.

This NVMP has been developed to formalise BHP's approach to the management of the interaction between its activities at Carrapateena and the native vegetation environment within which it operates. It provides a framework for managing and mitigating the potential effects, impacts and risks associated with Project-related land disturbance.

The NVMP details the regulatory framework within which land disturbance associated with Project activities is managed, and provides a description of the baseline vegetation and land system environment, including discussion of conservation significant flora and weeds and pest plants. Currently approved and potential future land disturbance are described in the context of the areas of disturbance and the vegetation associations. The management and mitigation measures to be applied to eliminate and/or minimise land disturbance are presented, together with Outcome Measurement Criteria and monitoring commitments developed to ensure Outcomes are achieved.

The characterisation of land disturbance and calculation and approach to significant environmental benefit (SEB) have been presented separately for Carrapateena and the Northern Wellfield (collectively referred to as the Operation in this document).

The following tenement documents were submitted for regulatory approval prior to 1 July 2017, and have therefore been assessed using the historical vegetation assessment and offsetting policy (i.e. Native Vegetation Regulations 2003 (SA) and SEB policy:

- Airstrip and Workers' Accommodation Village (Tjungu Village) MPL Management Plan, which was submitted on 2 December 2016, for tenement MPL 149
- Carrapateena Mining Lease Proposal and MPL Management Plans (MLP), which was submitted on 26 May 2017, inclusive of:
    - ML 6471
    - MPL 152, MPL 153 and MPL 154
    - EML 6488.

All disturbance considered after 1 July 2017 has been assessed using the revised assessment and offsetting policy as current at the time of submission (Native Vegetation Regulations 2017 (SA) and SEB policy).

The Northern Wellfield MPL Management Plan for tenement MPL 156 was submitted on 25 June 2018, after 1 July 2017, and has therefore been also be assessed using the revised assessment and offsetting policy as current at the time of submission.

This NVMP contemplates minor realignments to the Carrapateena footprint and disturbance undertaken since MPEPR 2024/009, which will result in no net change to total area of Project footprint being proposed.

Acknowledgements

Kokatha Aboriginal Corporation

The Kokatha People have a direct, unbroken and unique relationship with the land on which the Carrapateena operation is located.

BHP recognises the sense of place and belonging of the Kokatha People is linked to their identity, creation stories, travel, trade, ceremonies, family and places held sacred. We recognise the deep and ongoing feelings of relationship and attachment they hold for their lands.

BHP acknowledges the Kokatha People's connection to 'country', the contribution of the Kokatha People to their region and the enduring importance to the Kokatha People of values, cultural authority, cultural norms and customary laws.

BHP places great value on our relationship with the Kokatha People. BHP and the Kokatha Aboriginal Corporation seek to work in partnership, as equals, to further develop the Partnering Agreement *Nganampa palyanku kanyintjaku 'Keeping the future good for all of us'*. This collaborative agreement encapsulates, recognises and values the ongoing contribution of both partners, and will inform the relationship between the Kokatha People and BHP throughout and beyond the development of the Carrapateena operation.

Document history

Document title	Date	Reference citation
Native Vegetation Management Plan published as Appendix D to 2020 PEPR	October 2019	OZ Minerals 2020
Native Vegetation Management Plan published as Appendix D to 2024 PEPR	March 2024	BHP 2024
Native Vegetation Management Plan published as Appendix D to 2025 PEPR	May 2025	BHP 2025

Currency

Where possible, the contents of the Native Vegetation Management Plan (Document) are up to date as at May 2025. This was not possible where parts of the Document were prepared from information provided by third parties (as discussed below) prior to the third-party documents being finalised.

Disclaimer

The Native Vegetation Management Plan (Document) has been prepared as an appendix to the approvals document for submission to the South Australian Minister for Energy and Mining under the *Mining Act 1971* (SA), and no one other than the Minister should rely on the information contained in the Document to make, or refrain from making, any decision.

In preparing the Document, BHP have relied, in part, on information provided by specialist consultants, government agencies and other third parties. BHP have not fully verified the accuracy or completeness of that information, except where expressly acknowledged in the Document.

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1. Introduction

This Native Vegetation Management Plan (NVMP) has been developed to formalise BHP's approach to the management of the interaction between Carrapateena operation and the native vegetation environment within which it operates. It provides a framework for managing and mitigating the potential effects, impacts and risks associated with Project-related land disturbance and outlines the basis for the establishment of a significant environmental benefit (SEB) to offset native vegetation disturbance.

For the purpose of the NVMP the following terminology has been defined:

- Carrapateena or Carrapateena Project Area: the area defined by the extent of Mineral Lease (ML) 6471, Miscellaneous Purposes Licences (MPL) MPL 149, MPL 152, MPL 153, MPL 154, EML 6488
- Northern Wellfield or Northern Wellfield Area: the area as defined by the extent of MPL 156
- Carrapateena Project: activities related to Carrapateena
- Northern Wellfield Project: activities related to the Northern Wellfield
- Operation: activities related to Carrapateena and the Northern Wellfield combined.

The objectives of this NVMP are to:

- Ensure compliance with relevant regulatory requirements related to native vegetation.
- Describe relevant BHP policies and standards.
- Describe the baseline native vegetation environment within the Carrapateena Project Area (ML 6471, MPL 149, MPL 152, MPL 153, MPL 154, EML 6488) and Northern Wellfield (MPL 156) (collectively referred to as the Operation).
- Provide details on the extent of expected impacts to native vegetation as a result of Project activities.
- Detail the design and management controls proposed to minimise the impacts to native vegetation.
- Detail the mitigation measures proposed to minimise the risk of unauthorised land disturbance.
- Calculate an SEB provision for the offset of proposed native vegetation disturbance.
- Briefly describe the studies that informed the methodology by which an SEB will calculated and achieved.

1.1 Project ownership

On 2 May 2023, BHP Group Limited (Company) announced the completion of the acquisition of OZ Minerals Limited and the implementation of a scheme of arrangement for BHP Lonsdale Investments Pty Ltd, a wholly owned subsidiary of BHP Group Limited, to acquire 100% of the shares in OZ Minerals Limited. As a result of the acquisition, BHP Group Limited is now the ultimate parent company of OZ Minerals Limited.

The Carrapateena Operation has been developed and operated by OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd, wholly owned by OZ Minerals Limited. The Carrapateena site has been integrated into the BHP Copper SA asset, also incorporating BHP's Prominent Hill mine, Olympic

Dam mine and Oak Dam exploration sites. Copper SA falls under the BHP Minerals Australia business portfolio which also incorporates Western Australia Iron Ore, Nickel West, Coal, Mt Arthur Coal and Operations Services.

References to BHP in this NVMP are context sensitive however, in the main, refer collectively to OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd unless otherwise stated.

1.2 Tenement history

OZ Minerals undertook advanced exploration activities under Retention Lease 127 (RL 127) from 12 April 2013 (OZ Minerals 2015) for the purpose of undertaking further geotechnical investigations to inform the selection of an appropriate and cost-effective mining methodology for the resource. The RL 127 activities were supported by an airstrip and accommodation village approved under MPL 149; granted 5 July 2017 (OZ Minerals 2017b).

OZ Minerals submitted a Mining Lease Proposal and Miscellaneous Purposes Licence Management Plans (collectively referred to as the MLP) on 26 May 2017 to support applications for a Mining Lease and associated Miscellaneous Purposes Licences (MPL 152, MPL 153 and MPL 154) (OZ Minerals 2017a). OZ Minerals received formal notification of the granting of ML 6471 and MPL 152, MPL 153 and MPL 154 on 3 January 2018 (OZ Minerals 2018a).

These tenements are for the purposes of constructing and operating the key Project elements described by Section 1.3, with tenements shown in Figure 1.2.

1.3 Project Overview

BHP is operating an underground mining operation and minerals processing plant at Carrapateena to create copper concentrate for export to international and domestic customers. Mining primarily occurs via sub-level caving (SLC) methods, with areas of nearby satellite mineralisation mined via sub-level open stoping (SLOS) methods. Ore is crushed underground prior to being conveyed to surface stockpiles.

The minerals processing plant consists of a standard grinding, flotation and filtration processing circuit, reclaiming crushed ore for surface stockpiles prior to treatment. Produced concentrate is containerised prior to transport. Waste material generated during minerals processing operations is pumped as a slurry to a valley-fill tailings storage facility (TSF) for permanent disposal.

Supporting the mining and processing operations is surface infrastructure, including:

- electricity supply infrastructure, including an electricity transmission line, local renewable generation and local electricity distribution lines and infrastructure
- water supply and distribution infrastructure, including groundwater wellfields, staging complexes, water distribution pipelines, water desalination (reverse osmosis) plants and wastewater treatment plants; associated with these are a number of water holding and treatment ponds
- an airstrip and associated workforce accommodation village
- site access roads and minor infrastructure access tracks
- miscellaneous surface offices, workshops, explosives magazines, chemical and hydrocarbon storage facilities, car parks, security gatehouse and other similar infrastructure
- resource explorations, groundwater exploration and geotechnical investigations.

At the completion of operations, all surface infrastructure will be removed, and land disturbances rehabilitated to a land condition equivalent to surrounding analogues, with the exception of the TSF and the surface expression of the SLC subsidence zone that will remain as permanent landscape features. The focus of this NVMP is for the overall Operation including Carrapateena Project and Northern Wellfield Project (Figure 1.1), the key features of which are described in Table 1.1 and Table 1.2.

Table 1.1 | Tenements and key project elements

Tenement	Key project elements
Mineral Lease	
Carrapateena ML 6471	Mining, processing, tailings storage facility, onsite water supply and ancillary infrastructure
Miscellaneous Purposes Licences	
Airstrip, Workers' Accommodation Village and Ancillary Infrastructure MPL 149	Airstrip, Workers' Accommodation Village, access road and ancillary infrastructure
Western Infrastructure Corridor MPL 152(1)	Transmission line, access road and common services, EML 6488 (Midway borrow pit)
Eastern Radial Wellfield MPL 153(2)	Water supply (east)
Southern Access Road and Radial Wellfield MPL 154	Access road and water supply (south)
Northern Wellfield MPL 156	Water supply (north)

(1) EMLs (EML 6480, 6481, 6482, 6483, 6484, 6485, 6486 and 6487) have also been approved separately within MPL 152, but to date have not been used. If developed, these would be subject to an updated NVMP assessment and offset calculation and subject to separate approval. EMLs 6480, 6481, 6482, 6483, 6484, 6485, 6486 and 6487 have been removed from the footprint and are not considered further in this document.

(2) A number of activities on these tenements are approved or existing because of the activities of the previous RL 127 and have transferred over to the respective tenement (refer Chapter 4 for further information).

Table 1.2 | Carrapateena Exploration Licences

Tenement	Key project elements
Multiple regional exploration tenements Exploration Licences (EL 5863, 5919, 6035, 6452, 6518, 6528, 6675, 6684, 6685, 6686), and Petroleum Exploration Licence Applications (PELA 601, 748) (see Figure 1.2)	Resource exploration, groundwater explorations and geotechnical investigations

KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- Waterbodies

0 50 100 km

GDA 1994 MGA Zone 53

Figure 1.1 | Project location

Carrapateena BHP

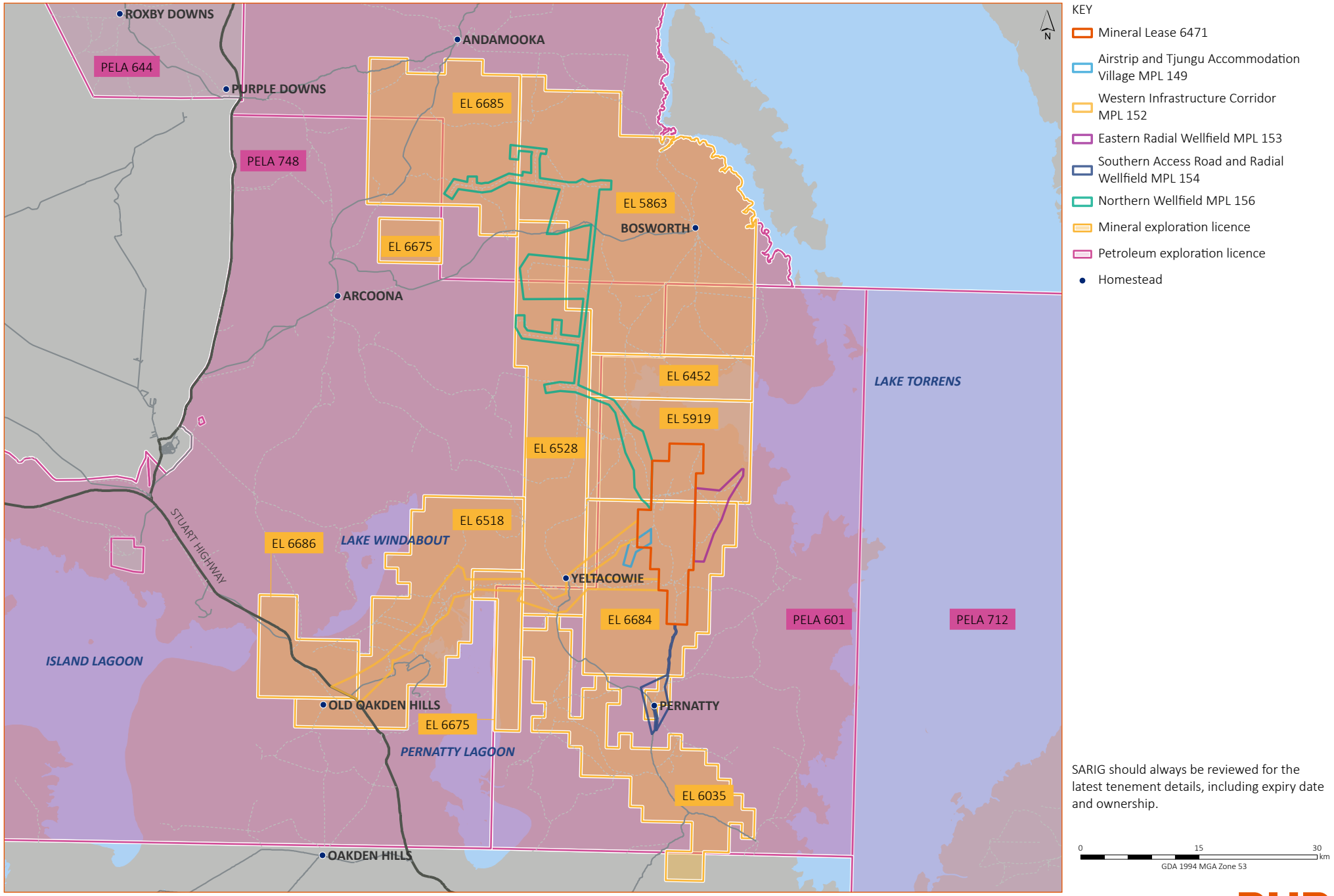


Figure 1.2 | BHP tenements and underlying Exploration Licences

Carrapateena BHP

1.4 Proponent details

Proponent details are summarised in Table 1.3.

Table 1.3 | Proponent details

Mine name	Carrapateena		
Tenements	• ML 6471 • MPL 149 Airstrip, workers' accommodation village, access road and ancillary infrastructure • MPL 152 Western Infrastructure Corridor • MPL 153 Eastern Radial Wellfield • MPL 154 Southern Access and Radial Wellfield (together, the Tenements) • MPL 156 Northern Wellfield including borefields, pipelines and access roads and associated infrastructure		
Site location	Located approximately 160 km north of Port Augusta, 65 km east of Woomera and 90 km south-east of Roxby Downs. Refer to Figure 1.1		
Applicant (Licence Holder and Operator)	OZM Carrapateena Pty Ltd (58%) and OZ Minerals Carrapateena Pty Ltd (42%)		
Site Contact	Elton Peebles	**Position**	Carrapateena General Manager
Address	2 Hamra Road	**City (Postcode)**	Adelaide Airport (5950)
Email	elton.peebles@bhp.com	**Telephone**	+61 8 8422 3713

1.5 Landowners and land use

BHP maintains tenements underlying or adjacent to the tenements detailed in Table 1.2 and Figure 1.2. To satisfy Section 80(2) of *Mining Act 1971* (SA) (Mining Act), Overlapping Tenement Agreements have been signed with OZ Minerals Carrapateena Pty Ltd and OZM Carrapateena Pty Ltd or OZ Exploration Pty Ltd as the holder of EL 6452, EL 6528, EL 6684, EL 6685, EL 5863, EL 5919 and EL 6686. The Overlapping Tenement Agreements enable the granting of simultaneous tenements and provide rights and obligations for the respective tenement holders. These licence numbers (also shown in Table 1.2) remain subject to change with the grant of subsequent licences, and the South Australian Resources Information Gateway (SARIG) should always be reviewed to ensure the latest tenement details, including expiry date and ownership.

The area of the tenements is subject to the Kokatha People (Part A) Native Title Determination (Federal Court Reference SAD 90/2009). The Kokatha Aboriginal Corporation (KAC) is the Registered Native Title Body Corporate who acts as an agent for the Kokatha People in relation to their native title rights and interests.

OZ Minerals and KAC had a Native Title Mining Agreement in place for RL 127, which was registered on 5 March 2013. BHP and KAC entered into a Partnering Agreement called *Nganampa palyanku kanyintjaku 'Keeping the future good for all of us'* to inform the relationship throughout and beyond the development of Carrapateena. Subsequent to negotiation of the Partnering Agreement, the parties

negotiated an NTMA pursuant to Part 9B of the Mining Act in relation to the tenements. The NTMA was executed on 31 July 2017 and registered in the Mining Register on 28 August 2017.

All of the tenements, except for the Western Infrastructure Corridor MPL 152 and Northern Wellfield MPL 156, are situated within the Pernatty Pastoral Lease, which shares boundaries with Bosworth, Arcoona, South Gap and Oakden Hills Pastoral Leases. The Western Infrastructure Corridor MPL 152 is located within Pernatty Pastoral Lease and the neighbouring Oakden Hills Pastoral Lease. The Northern Wellfield MPL 156 lies primarily within the Arcoona Pastoral Lease and also within the Bosworth and Pernatty Pastoral Leases. These pastoral leases are predominantly used for sheep grazing, however limited water resources in the area necessitate low stocking rates and some areas are only grazed when surface water is present in dams, creeks and waterholes.

The Arcoona Plateau has had a long history of grazing by native, domestic and feral herbivores, as well as being subject to the operations and infrastructure of sheep and cattle stations, and the construction and operation of the Woomera Rocket Range. The Project is located outside the Woomera Prohibited Area (situated to the west).

For further information about the third-party land ownership interests refer to Table 2.2 and Figure 2.2 of the Carrapateena Operation Program for Environment Protection and Rehabilitation (PEPR), to which this NVMP is appended (BHP 2024).

The exempt land, as defined in Section 9 of the Mining Act, within the boundary of the Project tenements, is summarised in Section 2.2.2 of the Carrapateena Operation PEPR (BHP 2024; Table 2.3 to Table 2.7 and Figure 2.3). Waivers of the benefit of the exemption from mining operations have been negotiated with the owners of the land in accordance with Section 9AA of the Mining Act.

2. Regulatory framework

The *Native Vegetation Act 1991* (SA) (NV Act) is the key piece of legislation protecting native vegetation in South Australia. Changes to the Native Vegetation Regulations are described below with the implications for the Operation and the environmental offsets presented in this NVMP.

Additional legislation that is relevant to the value, management and protection of native vegetation, and therefore the approval to clear, is summarised below. Further information regarding legislation and descriptions of relevance to the Operation are described in the related PEPR; Chapter 3, Section 3.4 (BHP 2024). The legislative framework for the Operation takes into consideration the value that native vegetation provides as habitat for conservation significant flora and fauna, as well as secondary permitting that will be required at various phases of the Operation including approval to clear native vegetation.

2.1 Native Vegetation Act 1991 (SA)

The NV Act controls the clearance of native vegetation. BHP is required to provide an SEB for any vegetation clearance under the NV Act. An SEB must provide an environmental gain over and above the impacts of an approved clearance (DEWNR 2020a; DEWNR 2020b). The SEB may be established via four different options, including monetary payment, management of native vegetation for conservation purposes, direct revegetation and/or on-ground works.

On 1 July 2017, the Native Vegetation Regulations 2003 (SA) were replaced with the Native Vegetation Regulations 2017 (SA). Accompanying this change, revised assessment methodologies relating to proposed clearance of native vegetation and revised guidance regarding the calculation of SEB offset requirements were implemented by the Native Vegetation Council (NVC). For projects seeking approval for activities under the Mining Act during this period, transitional arrangements were agreed with the then Government of South Australia's Department of the Premier and Cabinet (DPC) (now known as the Department for Energy and Mining (DEM)). Applications for activities received on or before 30 June 2017 were to be assessed under the historical arrangements, i.e. those outlined within the Guidelines for a Native Vegetation Significant Environmental Benefit Policy for the Clearance of Native Vegetation Associated with the Minerals and Petroleum Industry, MG16 (DWLBC 2005) (former Native Vegetation Policy). Mining Lease Applications submitted on or after 1 July 2017, were to be considered under the Native Vegetation Regulations 2017 (SA) and by the revised SEB policy and guidance (current Native Vegetation Policy).

The MPL Management Plan for tenement MPL 149 was submitted on 2 December 2016. The Carrapateena MLP for tenements ML 6471 and MPL 152, MPL 153 and MPL 154, and EML 6480, EML 6481, EML 6482, EML 6483, EML 6484, EML 6485, EML 6486, EML 6487 and EML 6488, was submitted on 26 May 2017 (noting that only EML 6488 has been developed). As both documents were submitted prior to 1 July 2017 the Carrapateena Project has been assessed using the historical vegetation assessment and offsetting policy. The Northern Wellfield MPL Management Plan was submitted on 25 June 2018, after 1 July 2017, and has therefore been assessed using the revised assessment and offsetting policy. The discussion of SEB is therefore discussed in two parts within Chapter 6; the Carrapateena Project and the Northern Wellfield Project, together referred to as the Operation. Furthermore, new land disturbing activities not contemplated in previous NVMPs has been assessed using the revised assessment and offsetting policy and are presented separately for clarity (refer Section 6.1.6).

Exploration land disturbance within and outside the Operation's tenements, which does not overlap with project infrastructure, will be rehabilitated in accordance with various approved Exploration PEPRs (EPEPRs). Exploration land disturbance that does overlap is captured and assessed by this NVMP and included in associated SEB calculations.

2.2 *Environment Protection and Biodiversity Conservation Act 1999* (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) is the primary Commonwealth legislation established to protect and manage Matters of National Environmental Significance (MNES), including nationally and internationally important flora, fauna, ecological communities and heritage places.

Part of the Carrapateena Project (ML 6471, MPL 152, MPL 153 and MPL 154) was referred under the EPBC Act for two reasons; the trigger of the nuclear action definition as a result of disposal of naturally-occurring radioactive material in the TSF, and the identification of listed threatened and migratory species that have been observed onsite or have the potential to occur within the Project. OZ Minerals received notification on 21 April 2017 that the proposed action (the Carrapateena Project) is considered a controlled action and will therefore require assessment and approval under the EPBC Act before it can proceed. It was determined that the Project would be assessed under the Assessment Bilateral Agreement, with the Government of South Australia, with some additional information requested to enable the assessment of potential impacts to MNES. Approval to proceed, subject to conditions, was granted for the ML 6471 and MPL 152, MPL 153 and MPL 154 on 29 March 2018.

Upon assessment of supporting information for the Northern Wellfield Project, OZ Minerals decided not to refer with the proposed action assessed as having no significant impacts on MNES.

The interaction of the EPBC Act and associated approval conditions for the Carrapateena Project are managed separately to SEB liability under the NV Act (the subject of this plan).

2.3 *National Parks and Wildlife Act 1972* (SA)

The *National Parks and Wildlife Act 1972* (SA) (NPW Act) allows for the protection of habitat and wildlife through the establishment of parks and reserves (both on land and in State waters) and provides for the use of wildlife through a system of permits allowing certain actions, i.e. keeping, selling, trading, harvesting, farming, hunting and the destruction of native species. The NPW Act assigns species to state conservation categories; Endangered (as listed under Schedule 7), Vulnerable (Schedule 8), and Rare (Schedule 9). Habitats which support conservation listed species represent elevated value and should be managed as such.

2.4 *Mining Act 1971* (SA)

Approval under the Mining Act was the primary statutory approval required for RL, ML and associated MPLs. The Mining Act regulates and controls mining operations in South Australia and is regulated by the DEM on behalf of the Minister for Energy and Mining. The Mining Act provides a two-stage assessment and approval process to enable mining operations to commence. The first is the assessment of a mining lease application and mining proposal, which results in the granting or refusal of a mineral lease. If a mineral lease is granted, the tenement holder must have an approved PEPR in place to enable operations to commence. A requirement of a PEPR, where a project requires the clearance of native vegetation, is the development of an NVMP that outlines a commensurate SEB offset.

This process is the same for EMLs and MPLs, with the only exception being the proposal for the latter is in the form of a management plan.

2.5 Other legislative requirements

Other specific legislative requirements that have been considered in relation to the Operation are described in Chapter 3, Section 3.1 of the MLP (OZ Minerals 2017a). These include:

- *Aboriginal Heritage Act 1988* (SA)
- *Civil Aviation Act 1988* (Cth)
- *Climate Change and Greenhouse Emissions Reduction Act 2007* (SA)
- *Dangerous Substances Act 1979* (SA)
- *Electricity Act 1996* (SA)
- *Environment Protection Act 1993* (SA)
- *Fire and Emergency Services Act 2005* (SA)
- *Landscape South Australia Act 2019* (SA)
- *National Greenhouse and Energy Reporting Act 2007* (Cth)
- *Native Title Act 1993* (Cth)
- *Petroleum Production Act 2000* (SA)
- *Radiation Protection and Control Act 2021* (SA)
- *Road Traffic Act 1961* (SA)
- *Safe Drinking Water Act 2011* (SA)
- *South Australian Public Health Act 2011* (SA)
- *Work Health and Safety Act 2012* (SA).

3. Land

This chapter provides a summary of the existing environment for the Operation including the ML 6471, and MPL 149 (Airstrip and Tjungu Accommodation Village), MPL 152 (Western Infrastructure Corridor, which encompasses EML 6488 (Midway)), MPL 153 (Eastern Radial Wellfield), MPL 154 (Southern Access Road and Radial Wellfield) and MPL 156 (Northern Wellfield). High-level descriptions of the pathways and receptors are provided that were considered in the assessment of impacts that supported the Carrapateena MLP (OZ Minerals 2017a) and Response Document (OZ Minerals 2017c) and the Northern Wellfield MPL MP (OZ Minerals 2018b) and Response Document (OZ Minerals 2018c), and are addressed by the PEPR document to which this NVMP is appended (BHP 2024). Information has been drawn from:

- extensive regional surveys undertaken since 2008 (e.g. OZ Minerals 2018a; Appendix C6)
- online databases:
    - Biological Database of South Australia (BDBSA)
    - EPBC Act Protected Matters database accessed via the online Protected Matters Search Tool (PMST)
- targeted threatened species and floristic surveys across the Operation:
    - Carrapateena Project Ecological Baseline Assessment (OZ Minerals 2019b; Appendix C4.1)
    - Northern Wellfield Vegetation Assessment and associated Rangelands Assessment Method (RAM) data sheets (Jacobs 2018; Appendix C)
    - Northern Wellfield Ecological Report (OZ Minerals 2019b; Appendix C4.2).

3.1 Pre-existing site contamination and previous disturbance

The Operation lies primarily within the Pernatty Pastoral lease, with the Northern Wellfield Area also extending further north into the Arcoona Pastoral Lease and Bosworth Pastoral Lease. The Operational Area has previously been used for pastoral activities, with some mining exploration activities undertaken in more recent times. Baseline ecology surveys have described the land within the ML as having vegetation in good condition with little disturbance, low weed cover but with some existing grazing pressure. There was good native vegetation cover and flora and fauna diversity typical of a semi-arid system.

Prior to the granting of RL 127, existing disturbance within the Operational Area was limited to early exploration, and disturbance associated with pastoral activities including grazing impacts and grazing-related infrastructure, such as tracks and fences. There are no identified potential sources of pre-existing contamination and, given the historical land uses, there is very low potential for pre-existing soil or groundwater contamination in the area.

Native vegetation disturbance associated with advanced exploration activities under RL 127 and the construction and operation of the airstrip and accommodation village under MPL 149 was described within their respective Retention Lease Proposal (OZ Minerals 2012) and MPL PEPR (OZ Minerals 2017b). An SEB was calculated for the combined disturbance of 476.15 ha at a land condition ratio of 8:1. The SEB was realised through a payment to the Native Vegetation Fund (NVF).

3.2 Topography and landscape

The Operation is situated in the Gawler Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion, the Arcoona Plateau Sub-region and the Andamooka IBRA Environmental Association. Additionally, the Western Infrastructure Corridor (MPL 152) linking ML 6471 to the Stuart Highway passes through the Gawler Lakes IBRA Sub-region, and the Northern Wellfield (MPL 156) crosses through a small area of the Roxby Sub-region. The Gawler Bioregion is located between Woomera and the edge of Lake Torrens, and comprises one quarter of South Australia's Pastoral Rangelands encompassing an area of 123,070 km^2.

Lake Torrens, the largest inland salt lake in the region, is also a National Park proclaimed under the *National Parks and Wildlife Act 1972* (SA).

A summary of the topography and landscape within which the Project is situated is provided in Table 3.1.

Table 3.1 | Topography and landscape summary

Region	Landscape summary	% of tenement[1]	Area (ha)[1]
Topography	The northern and eastern parts of the region consist of an extensive tableland that forms the Arcoona Plateau. The principal areas of drainage consist of numerous salt lakes (playas) in the southern and western parts, as well as Lake Torrens to the east. The Arcoona Plateau has a dendritic drainage pattern of short channels radiating from the main tablelands, with wide shallow drainage channels in the upper parts of the tablelands and incised creeks in the lower parts (Waterhouse et al. 2002).	100	43,872
Gawler Bioregion	Characterised by semi-arid to arid, flat topped to broadly rounded hills of the Gawler Range Volcanics and Proterozoic sediments, low plateaux on sandstone and quartzite with an undulating surface of aeolian sand or gibbers and rocky quartzite hills with colluvial footslopes, erosional and depositional plains and salt encrusted lake beds, with black oak (belah) and myall low open woodlands, open mallee scrub, bluebush/saltbush open chenopod shrublands and tall mulga shrublands on shallow loams, calcareous earths and hard red duplex soils.	100	43,872
Arcoona Plateau Sub-region	A series of low plateaux on sandstone and quartzite with an undulating surface of aeolian sand or gibbers over red duplex soils, and rocky quartzite hills with colluvial footslopes. There is a cover of low chenopod shrubland, *Acacia victoriae* tall shrubland with a chenopod shrub understorey and fringing *Acacia papyrocarpa* woodland. Approximately 97% (1,153,042 ha) of the sub-region is mapped as remnant vegetation, of which 0.1% (1,143 ha) is formally conserved. Sub-region consists of a dissected sandstone plateau with a bold eastern escarpment. Surface is undulating to hilly and often gibber-covered, particularly in the east, and consists of crusty red duplex soils and red calcareous loams. Vegetation is generally Chenopod shrublands.	84	37,031
Gawler Lakes Sub-region	An undulating upland plain underlain by quartzite and sandstone, with shallow loamy soils. Encompasses the Woomera plateau, which is characterised by the absence of trees and tall shrubs, except on floodplains, where mulga (*Acacia aneura*), bullock bush (*Alectryon oleifolius* ssp. *canescens*), occasional red gums (*Eucalyptus camaldulensis*) and other species may be found. The gibber-covered areas are either bare or carry a scattered growth of samphire (*Tecticornia* sp., formerly *Halosarcia* sp.) and bindyi (*Sclerolaena* spp.). The depositional plains to the south and south-west of the plateau are covered with deep calcareous earths characteristically carrying an open myall (*Acacia papyrocarpa*) woodland with a bluebush (*Maireana sedifolia*) understorey, on red aeolian sand sheets and dunes with open mulga shrubland or a low woodland *of Casuarina pauper* or *Callitris glaucophylla*. Approximately 62% (1,271,089 ha) of the subregion is mapped as remnant native vegetation, of which 2% (30,615 ha) is formally conserved. Undulating plains overlain with sand sheets and dunes, with occasional silcrete-capped rises with brown calcareous earths, crusty loamy soils with red clayey subsoils, sand soils, brown and red, shallow dense loams.	15	6,581
Roxby Sub-region	Undulating terrain with mesas and buttes, some saline seasonally swampy areas with gypseous lunettes. Landforms include dune formations in the east. The whole region is mapped as remnant vegetation, 12,300 ha of which is formally conserved through the Arid Recovery Project. A significant proportion of the Roxby Sub-region lies within the Woomera Prohibited Area (WPA); Commonwealth land. Geology consists of variable stone and gravel mantle, with some low silcrete capped hills, evaporite deposits (gypsum, halite). Sand, silt, clay deposits in lowlands. Soils are primarily brown calcareous earths. There is arid and semi-arid acacia low open woodlands and shrublands with tussock grass.	0.6	260

1 Total tenement area includes ML 6471, MPL 149, MPL 152, MPL 153, MPL 154, MPL 156 and EML 6488 (within MPL 152), with all overlap removed

3.3 Soil characterisation

Soil investigations have been undertaken across the Operation's region with a focus on the area of ML 6471, including:

- soil samples taken from five sampling sites in 2012 and eight sampling sites in 2014
- heavy metal soil samples from 12 locations in 2012
- clay content investigations at 41 locations
- soil profiles determined from 44 test pits.

Detailed soil mapping has not been completed for the Operation, however the desktop studies for the area and the investigations describe above are considered sufficient for the purposes of establishing the baseline environment (OZ Minerals 2017a; Appendix B1). Soil characterisation information is presented in Table 3.2.

Table 3.2 | Soil characterisation

Subject	Summary
Land system	**Alluvial Flat** – comprising broad, clay-floored flats fringing several of the larger watercourses with a braided architecture of channels that are extensively scoured. Undissected Plateau – including the high, gibber plains and contain generally shallow, first order watercourses and drainage depressions. The plateau dips gently to the northwest from the Andamooka Ranges, and merges with a more subdued sand-covered plateau west of Woomera. In contrast, the eastern plateau scarp plunges steeply to the shoreline of Lake Torrens. Elevations range from 30 mAHD (metres above Australian Height Datum) on Lake Torrens to over 150 mAHD along the western and southern parts of the plateau. The hilly to gently undulating plateau maintains a sparse chenopod shrubland and is largely devoid of trees, restricted in the main to fringing woodlands. Ground surfaces are formed on dense gibber, red duplex soils or more isolated dunes, the latter covered in native pine and Acacia scrub. **Dissected Plateau** – comprising areas that are invariably mantled by dense gibber and include the deeply incised foot slopes and escarpments of the plateau. Most of the major waterholes are contained in this land system. An additional area of plateau and low hills, bounded by long foot slopes, rises above the marginal plains along the western shoreline of Pernatty Lagoon (incorporating the Mount Gunson Ranges). The hills are formed on Precambrian metasedimentary units (quartzite, sandstone, shale), and discontinuous outcrops of ironstone, and maintain a mixed cover of low chenopod shrubland and isolated woodland thickets. **Sand Sheet** – including the broad source-bordering sands extending east from the shorelines of the major playa lakes and creek lines. The eastern margins of the larger playas are typically bounded by high, gypseous lunettes, with a more subdued sand sheet or dune field continuing beyond these features. The sand sheets extend to the rocky foot slopes of the Arcoona Plateau and are interspersed with a variety of seasonal swamps and pans contained within interdunal corridors. Isolated patches of silcrete capped bedrock emerge above the sand plains. The sand sheets maintain a dense cover of black oak and myall, mulga, and other Acacia spp. scrub together with spinifex (*Triodia* spp.) grasslands. **Water Body** – including the beds of the major water bodies found throughout the Project Area and the major playa lakes. These continue between Lake Dutton and Lake Younghusband and outline the course of a major palaeo-drainage system. Gypseous, source-bordering dunes flank their eastern margins while small residual outcrops can often be seen standing above the salt encrusted beds. Lake Torrens itself occupies an extensive tectonic basin and is fringed along the eastern shoreline by gypsum dunes, and along the western shore, by steep marginal cliffs of the Arcoona Plateau. The beds of these lakes lie below the water table, and discharge through springs and soaks around the base of the marginal cliffs, is likely to occur in parts.
Soil profile	Soil profiles are typically observed to comprise a thin quaternary deposit that overlies 0.5 to 2.0 m of brown-red firm clay (residual). Underlying the firm clay layer is typically a bleached milky white, soft clay generally 0.5 m thick. The profile transitions into extremely to moderately weathered quartzite of the Stuart Shelf. The topsoils (0 to 150 mm) and subsoils (150 to 300 mm) are of very poor quality due to low organic matter, poor fertility and high salinity and sodicity. The soils are fine-textured, are likely to be highly dispersive and susceptible to erosion during heavy rainfall. Soil maps for the northern pastoral districts are very broad in scale, with mapping units based mainly on the surficial geology. The Atlas of Australian Soils lists two soil types occurring in the regional area: • Sodosols (heavy red sodic sandy clays) occur on the Arcoona Plateau where the Tent Hill Formation outcrops. Sodosols are characterised as having a strong texture contrast between topsoils and sodic subsoils. In arid regions, these soils generally consist of a surface pavement of gravels partly embedded in loamy brown surface soils, with an abrupt boundary to the red clay subsoil. The term sodic refers to soils that contain a high proportion of sodium ions relative to other cations. • Calcarosols occur in the sand plains in the south-west of the regional Operational Area where quaternary sediments outcrop. Calcarosols are characterised as having gradational texture profiles and being calcareous throughout the profile and often highly so. Analysis of the soil structure within the Operational Area indicates: • all samples were classed as sodosols and alkaline to strongly alkaline • sulphur is generally low in topsoil samples but much higher in the subsoils

Subject	Summary
	• phosphorus is low in all samples • potassium levels range from being acceptable to high in all samples • calcium is low in most samples, magnesium is high and sodium is very high • salts and chlorides are high in most topsoils and all subsoils • boron levels are very high and indicate poorly drained soils • trace elements are deficient in all samples • organic matter is very low and is attributed to poor vegetation cover and root growth within these soils.
Soil characterisation	**Metals** – Sediment sampling data was assessed against the commercial/industrial environments criteria of the NEPC (2013) guidelines. It was found that all sediment samples from within the Project Area are naturally below the NEPC (2013) guideline values. **Soil Water Potentials** – Soil samples taken during drilling showed that the range of soil water potentials with depth is spatially variable through different creek lines. The soil water potentials at locations in Salt Creek and Yeltacowie Creek initially become rapidly less negative with depth before stabilising between -5 and -8 MPa at 1.2 mbgl and 1.6 mbgl respectively. The soil water potentials in Eliza Creek are more variable with a trend of soil water potential becoming more negative. Salinity – Salts and chlorides are high in most topsoils and all subsoils. The natural environment is high in salt concentrations as a result of low rainfall and high evaporation rates, which is typical for arid zones. **Acid Sulphate Soils** – Analysis of acid sulphate soil databases for the region indicate that across both the ML and the associated MPLs there is an extremely low probability (with high confidence) that acid sulphate soils exist in the Project Area. Isolated areas in the immediate vicinity of water bodies may have a greater likelihood. **Radionuclides** – Baseline radiation was assessed through an environmental radiation monitoring program commencing in April 2012 and summarised in the Geochemical Rock Classification Baseline Assessment of the MLP (OZ Minerals 2017a; Appendix B2), which also covers radiation in soil. Soils naturally contain radionuclides in varying concentrations, which primarily depends on the geology of the area, geography and land use history. These concentrations also vary with burial depth. Soil radionuclide concentrations are consistent with naturally occurring Australian concentrations. Baseline radiation surveys were undertaken to characterise the naturally occurring radiation in the region. This included soil sampling at 12 Environmental Radiation Monitoring Locations (ERMLs) at depths of 0 to 2 cm and 13 to 30 cm. The results of the survey indicated that the soils in the region of the Project Area are radiologically similar to that in most of outback Australia and are consistent with worldwide average values.

3.4 Conservation areas

The proximity of the Operation to areas of conservation significance is detailed in Table 3.3.

Table 3.3 | Proximity to conservation areas

Subject	Summary
World heritage properties	There are no world heritage properties within 500 km of the Operation.
National heritage places	The closest national heritage place is the Ediacara Fossil Site situated at Nilpena, approximately 70 km east of the Operation.
Ramsar wetlands	There are no wetlands of international importance in proximity to the Operation, including downstream.
Marine parks	The Operation is located approximately 165 km north-north-west of the nearest marine environment, and there are no Commonwealth marine areas identified in the Operational Area.
Lake Torrens National Park	MPL 153 (Eastern Radial Wellfield) is the closest tenement boundary, located approximately 1.0 km from the western boundary of Lake Torrens National Park, with the nearest wellfield infrastructure located approximately 1.6 km from the Lake Torrens National Park boundary.

3.5 Landforms and vegetation

The Operation is located on stony hills and plains-dominated formations that cover over 90% of the area. This is accentuated by ephemeral drainage lines that fall away to saline creeks and depressions. Tableland soils are typically heavy self-mulching clays that are highly sodic and dispersive. Without a surface strew of flat stones in place that act as the mulch, the soil is subject to high levels of erosion.

The landscape is dominated by a low layer of open Chenopod shrubland including a mixture of common bluebush (*Maireana* spp.) and saltbush (*Atriplex* spp.) species. Chenopod shrubland may be present either without or with emergent overstorey species depending on its position within the landscape (i.e. plains, drainage, stony rises, clay flats).

Chenopod shrubland, usually less than 1 m in height, highly homogenous and devoid of emergent overstorey, is common across much of the Operation and the region more broadly. Ephemeral drainage lines are typically dominated by small shrubs and trees that persist through higher water flows and flushing of the soil profile. These often have a higher diversity of flora species than the surrounding stony hills with more homogenous cover and structure. Major drainage lines support an even wider range of species including large trees, particularly River Red Gum (*Eucalyptus camaldulensis* ssp. *arida*), which are believed to persist through sourcing water from the soil profile, recharged by rainfall and surface water runoff, as well as from the accumulation of infiltrated surface water at the base of the alluvium sediments on low permeability residual clay/rocks.

The landforms and vegetation present result in watercourse zones of high habitat potential in an otherwise sparse environment. Trees, where present, provide hollows and other habitat resources for fauna species. The lowest-lying creeks with highly saline branches and flood out zones are dominated by samphire and other halophytes (salt tolerant plants) commonly recorded in arid regions.

A detailed description of vegetation and land disturbance associated with the Operation is provided in Chapter 4.

3.6 Management issues

3.6.1 Weeds and pest plant species

In general, the semi-arid zone supports few pest flora species. Dispersal mechanisms for these species include rainfall events and fauna transportation (native, introduced and stock). However, these species are also distributed by vehicle movements along access tracks and by earthwork construction. Arid area weed species are also typically annual species that respond to heavy rainfall events and are widespread throughout the arid region.

Since 2012, 25 exotic flora species have been recorded during monitoring surveys of the Carrapateena Project Area (i.e. ML 6471, MPL 149, MPL 152 (including EML 6488), MPL 153 and MPL 154), including opportunistic sightings outside the transect areas. No weeds have been identified during assessments of the Northern Wellfield (MPL 156) to date. A number of species such as Common Sow-thistle (*Sonchus oleraceus*), Bathurst Burr (*Xanthium spinosum*), Saffron Thistle (*Carthamus lanatus*) and Smooth Mustard (*Sisymbrium erysimoides*) are considered naturalised across their range and are well established in the rangelands of South Australia. Bathurst Burr, Prickly Pear (*Opuntia* sp.) and Patterson's Curse (*Echium plantagineum*) are listed as declared species under the *Landscape South Australia Act 2019* (LSA Act) and are also target Priority Weeds for the South Australian Arid Lands (SAAL) Region.

Under the LSA Act, landowners have the legal responsibility to control declared plants. The Government of South Australia has established a Declared Plant Policy for Bathurst Burr (SAG 2021a), Prickly Pear (SAG 2021b) and Patterson's Curse (salvation Jane) (SAG 2021c), which detail the feasibility of containment and control costs associated with its management. All three species are highly visible when growing, and control in pasture is readily achieved by commonly used selective herbicides, or spot spraying of small infestations with non-selective herbicides.

Weed species recorded for the Operation are detailed in Table 3.4. For easy identification, Priority Weeds (for immediate identification and action) are further illustrated in Chapter 5 by Plate 5.1.

Table 3.4 | Pest plant and weed species

Species name	Common name	Significance			Records within 50 km of the Operation
		National[1]	State[2]	Landscape region[3]	
Acetosa vesicaria	Rosy Dock	N	N	N	N
Bidens pilosa	Cobbler's Pegs	N	N	N	N
Brassica tournefortii	Wild Turnip	N	N	N	**Y**
Carrichtera annua	Wards Weed	N	N	N	**Y**
Carthamus lanatus	Malta Thistle	N	N	N	N
Centaurea calcitrapa	Golden Starthistle	N	N	N	N
Centaurium erythraea	Common Centaury	N	N	N	N
Centaurium melitensis	Cockspur thistle	N	N	N	**Y**
Citrullus colocynthis	Camel Melon	N	N	N	**Y**
Citrullus lanatus	Bitter Lemon	N	N	N	N
Echium plantagineum	Patterson's Curse	N	**Y**	N	**Y**
Flaveria trinervia	Clustered Yellowtops	N	N	N	N
Heliotropium sp.	Blue Heliotrope	N	N	N	**Y**
Lepidium africanum	Common Pepper-cress	N	N	N	**Y**
Malva parvifolium	Mallow	N	N	N	**Y**
Mesembryanthemum nodiflorum	Slenderleaf Iceplant	N	N	N	N
Nicotiana glauca	Tree tobacco	N	N	N	**Y**
Opuntia sp.	Prickly Pear	Y	Y	Y	**Y**
Physalis sp.	Nightshade	N	N	N	N
Rostraria pumila	Tiny Bristle Grass	N	N	N	**Y**
Schismus barbatus	Arabian Grass	N	N	N	**Y**
Sisymbrium erysimoides	Smooth Mustard	N	N	N	**Y**
Solanum linnaeanum	Apple of Sodom	N	N	N	N
Sonchus oleraceus	Common Sowthistle	N	N	N	**Y**
Tribulus terrestris	Caltrop	N	N	N	**Y**
Xanthium spinosum	Bathurst Burr	N	**Y**	N	**Y**

1 National: Australia (Weeds of National Significance)
2 State: South Australia (Declared pest plants Landscape South Australia Act 2019 (SA))
3 Landscape region: SAAL (Priority Weeds of the SAAL Landscape Board)

3.6.2 Stock and other management issues

Table 3.5 presents other potential management issues for the Operation, and some commentary around the likely applicability and significance of each issue to this location.

Table 3.5 | Summary of other potential management issues

Potential management issue	Comment
Stock access	Stock have access to the Operational Area (with the exception of a few sections of fenced mining infrastructure). There are a number of stock water points (wells) across the Project which are protected where appropriate by Exempt Land zoning. Refer to the MLP (Carrapateena Project; OZ Minerals 2017a) and MPL MP (Northern Wellfield; OZ Minerals 2018b) for the number that are operational. The stations across the site have predominantly grazed sheep for some time, however limited water resources in the area have necessitated low stocking rates.
Lack of native vegetation/ regeneration	Regeneration after disturbance is considered reliable for the semi-arid location and occurs as a transitional phase with annual species initially dominating cover. Regeneration events are driven by rainfall events.
Phytopthora	Phytophthora is unlikely to occur within the Operational Area, given the preference of this fungus for high rainfall areas. No records within the wider region or the Operation (NatureMapsSA 2019).
Rubbish dumping	The site is not subject to illegal rubbish dumping given its remote location away from the Stuart Highway. Waste is managed as part of the site's Environmental Management System.
Salinity, acidity, water logging, erosion	Potential impacts have been considered as part of the source-pathway-receptor process undertaken to inform approval and environmental management assessments. Salinity, acidity and water logging are not considered to cause impact to the Operation. Erosion is considered as part of the erosion and sedimentation impact ID; refer to the Carrapateena MLP Consolidated Assessment (OZ Minerals 2017a; Appendix D6), and Northern Wellfield MPL MP Consolidated Assessment (OZ Minerals 2018b; Appendix E).
Grazing by native mammals	Present. The region of the Arcoona Plateau has had a long history of grazing by native, domestic and feral herbivores (e.g. goats). Kangaroos in large numbers have been observed grazing near the banks of Lake Torrens.
Public access, off-road vehicles	The Operation is accessed through existing access roads and pastoral tracks that service the local pastoral stations. An access route was constructed in 2020 for access and haulage of product between the ML 6471 and Stuart Highway (via MPL 152 Western Infrastructure Corridor). Existing access tracks were widened where required. Access is controlled at all times through a gatehouse, which limits public access to the site. Off-road vehicles include local pastoralists and BHP personnel.
Other	Declared and Noxious Weed Branched Broomrape (*Orobanche ramulosa* and *O. minor*) has not been recorded for the Operation.

4. Vegetation and land disturbance

4.1 Carrapateena

This section presents the Carrapateena Project Area vegetation and land disturbance associated with the construction and operation of key project elements (Table 1.1) within the ML 6471, MPL 149, MPL 152, MPL 153 and MPL 154, and EML 6488 (Midway) located within the Western Infrastructure Corridor MPL 152. As these tenements were assessed and approved under the former methodology under the Native Vegetation Regulations 2003 (SA), it is discussed separately to that associated with the Northern Wellfield MPL 156 (Section 4.2; approved under the revised Native Vegetation Regulations 2017 (SA)).

Together, Section 4.1.4 for the Carrapateena Project and Section 4.2.5 for the Northern Wellfield Project, describe the pre-existing land disturbance and proposed land disturbance in order to understand the distribution of disturbance in a native vegetation context. Updated estimates are provided with a higher level of confidence with the completion of the construction phase of the Operation. Land disturbance information has been used to calculate SEB requirements under the respective methodologies in Chapter 6.

4.1.1 Vegetation structure and associations

The results of vegetation association mapping for the Project Area are presented in Figure 4.1 and described in Table 4.1. Vegetation Associations 1 and 6 (see Table 4.1) are examples of Chenopod shrubland without an emergent overstorey layer, which are dominant in the Carrapateena area and the region more broadly. Vegetation Associations 3, 4, 5 and 12 are examples of Chenopod shrubland with dominant emergents and, as a result, taller vegetation cover and a more complex overall structural diversity.

Table 4.1 | Carrapateena vegetation associations

Vegetation association	Description	Representation in the Ecological Study Area	
		ha	%
1	*Atriplex vesicaria* (Bladder Salt Bush) +/- *Tecticornia medullosa* (Samphire) Low Open Shrubland	64,831.24	77.97
2	*Acacia ligulata* (Umbrella Bush) / *Dodonaea viscosa* var. *angustissimus* (Narrow-leaf Hop Bush) Low Open Shrubland +/- *Zygochloa paradoxa* (Sandhill Canegrass)	4,785.65	5.76
3	*Acacia aneura* (Mulga) Open Woodland over *Maireana sedifolia* / *Maireana pyramidata* / *Maireana astrotricha* / *Atriplex vesicaria*	1,421.33	1.71
4	*Acacia papyrocarpa* (Western Myall) Woodland over *Maireana astrotricha* (Low Bluebush)	1,271.42	1.53
5	*Acacia aneura* (Mulga) +/- *Dodonaea viscosa* ssp. *angustissimus* (Narrow-leaf Hop Bush) Shrubland over *Maireana pyramidata* (Black Bluebush), *Maireana astrotricha* (Low Bluebush)	1,137.97	1.37
6	*Atriplex vesicaria* (Bladder Saltbush) / *Maireana astrotricha* (Low Bluebush) Low Open Shrubland	2,090.28	2.51
7	*Acacia papyrocarpa* (Western Myall ssp.) Vey Low Woodland over *Atriplex vesicaria* (Bladder Saltbush) +/- *Ptilotus obovatus* (Silver Mulla Mulla), *Dodonaea lobulata* (Lobe-leafed Hop Bush), *Acacia tetragonophylla* (Dead Finish) and *Eremophila* spp. (Emu Bush) in drainage depressions	4363.22	5.25
8	*Eucalyptus camaldulensis* ssp. *arida* (River Red Gum) +/- *Acacia papyrocarpa* (Western Myall ssp.) Low Woodland	855.97	1.03
9	*Zygochloa paradoxa* (Sandhill Canegrass) Grassland	145.00	0.17
10	*Casuarina pauper* (Black Oak) Open Woodland on calcrete outcrops and sand dune rises	136.80	0.16
11	*Atriplex vesicaria* (Bladder Saltbush) Shrubland +/- *Dodonaea viscosa* var. *angustissimus* (Narrow-leaf Hop Bush) Open Shrubland	132.96	0.16
12	*Acacia papyrocarpa* (Western Myall) Woodland over *Maireana pyramidata* (Black Bluebush) / *Callitris gracilis* (Native Pine)	81.19	0.10
13	*Tecticornia pergranulata* (Black Seed Samphire) +/- *Melaleuca xerophila* (Boree) Low Shrubland	65.79	0.08
14	*Eragrostis australasica* (Swamp Canegrass) Tussock Grassland	61.62	0.07
15	*Duma florulenta* (Lignum) *Tecticornia pergranulata* (Black Seed Samphire) *Maireana pyramidata* (Black Bluebush) Shrubland in flood out zones and alluvial fans	51.13	0.06
16	*Dodonaea viscosa* ssp. *angustissimus* (Narrow-leaf Hop Bush) / *Acacia ligulata* (Umbrella Bush) Low Shrubland in drainage channels	32.65	0.04
17	*Callitris glaucophylla* (Native Pine) Woodland	28.21	0.03
18	*Acacia papyrocarpa* (Western Myall ssp.) / *Eucalyptus camaldulensis* ssp. *arida* (River Red Gum) Low Woodland	1.40	0.00
19	*Melaleuca xerophila* (Boree) Shrubland	65.73	0.08
20	*Tecticornia medullosa* (Samphire) Low Open Shrubland	213.91	0.26
21	Claypan	1,335.94	1.61
	No data	42.39	0.05
	TOTAL	**83,151.83**	**100.00**

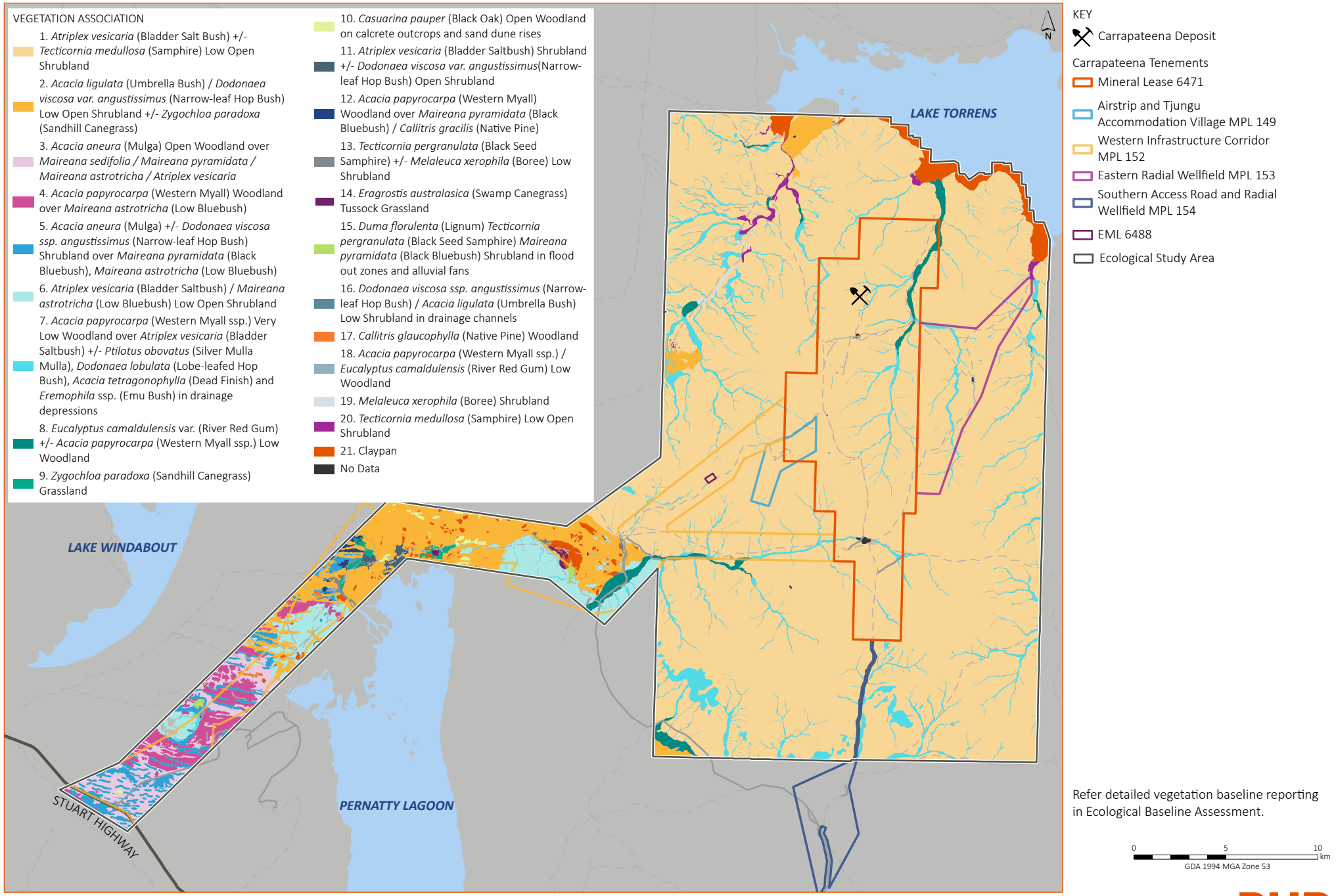


Figure 4.1 | Carrapateena Project Area native vegetation associations

Carrapateena BHP

4.1.2 Native vegetation habitats and species

Review of the BDBSA records from all surveys (baseline and compliance) conducted in the Carrapateena Project Area indicate that a total of 462 flora species (consisting of 419 native species and 43 exotic species) have been recorded on, or around, the Carrapateena Project Area (including a 30 km buffer).

Over the combined baseline survey periods (2012 to 2016), 215 flora species represented by 37 families were observed in vegetation monitoring plots. Of these, 14 were exotic species. Species were largely represented by individuals from the *Chenopodiaceae* family with other dominant representation provided by *Gramineae* (Grass) species, *Compositae* (Daisies), *Leguminosae* (Peas, Wattles) and *Malvaceae* (Abutilon, Sida etc.).

Species diversity, species abundance, species cover and threatened species are summarised in Table 4.2.

Table 4.2 | Carrapateena flora species diversity, abundance, cover and threatened species

Subject	Comment
Species Richness	Species diversity was recorded across 16 quadrats measuring 100 m x 100 m from 2012 to 2016 in the region. Flora species richness from 2012 to 2016 shows significant changes between survey periods. This is largely driven by the fluctuation in short-term seasonal conditions. Annual species vary considerably with presence and absence of some species changing from one survey period to the next. Average diversity is shown in Figure 4.2.
Species Abundance	Species abundance was recorded across 16 transects from 2012 to 2016 in the region. Mean long-lived perennial species abundance over the survey period show very consistent values with a mean abundance of approximately 300 individuals per plot. This equates to a mean individual shrub value of 7,500 per hectare. There has been no significant survey-to-survey change in this value since the start of the survey period. The total number of established perennial individuals over time is described in Figure 4.3.
Species Cover	Species cover was recorded across 10 quadrats measuring 1 m^2 from 2012 to spring 2015 in the region. The average total coverage over time closely follows the trends in richness, which suggests that higher cover values are driven by the presence of annual species. Over time, a consistent cover of perennial species would be expected, although many arid region flora species have adapted to defoliate during dry periods as a means of persisting. Cover values are shown in Figure 4.3.

4.1.3 Conservation significant flora species

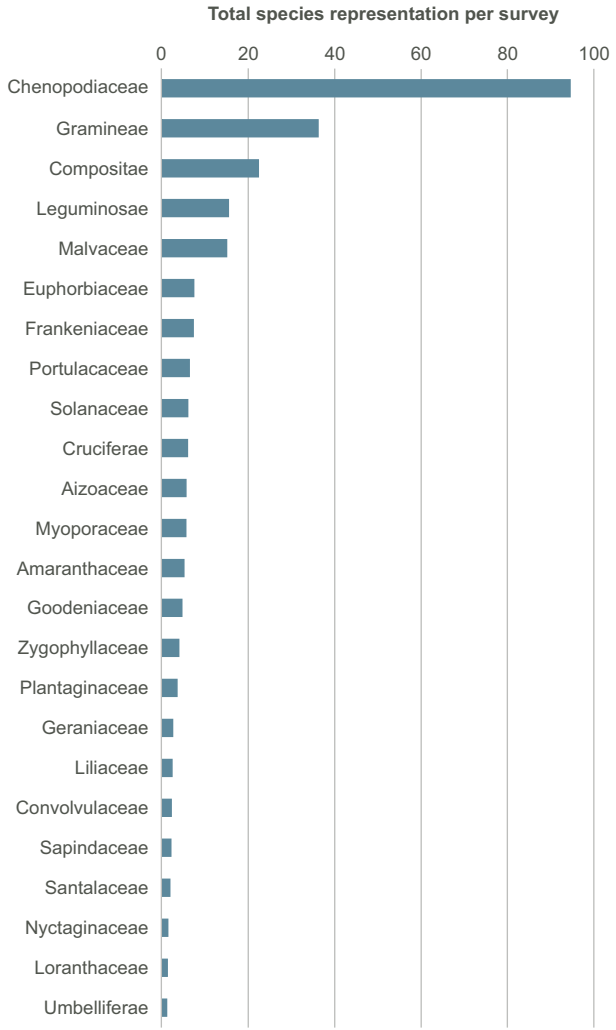
There have been 10 flora species of local and state conservation significance recorded on or around the Carrapateena Project tenements during the course of vegetation survey activities, as described in Table 4.3 and Figure 4.4. Four of these species are known to occur in the Project Area. A single EPBC-listed flora species was also identified in the PMST at the time of the Project approval, noted as potentially occurring within the Project Area; Sea-heath, *Frankenia plicata*. This species has not been recorded or observed in the Project Area to date, despite extensive ecology surveys conducted in autumn and spring over multiple seasons, and a targeted search effort of suitable habitat and landscapes (Appendix B).

Table 4.3 | Carrapateena conservation significant flora species

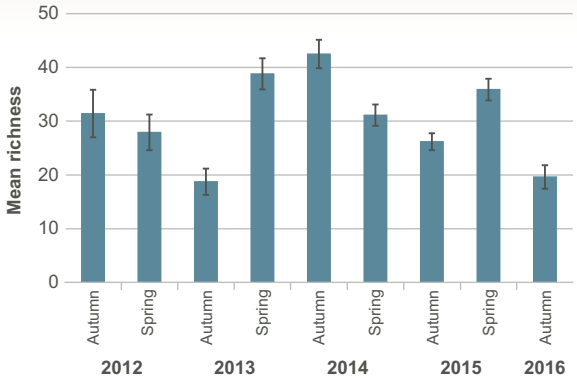
Species name and common name	Conservation status		Likelihood within leases from surveys[3]	Habitat
	National (EPBC)[1]	State (NPW)[2]		
Sea-heath *Frankenia plicata*	EN	V	Unlikely	Sea-heath, listed as endangered under the EPBC Act, was identified within the BDBSA search records 45 km north of the Project Area. The species is a low, mat-forming perennial shrub on lower slopes of hills and in small run-off channels. Most confirmed records of this species are from the Breakaways. Additionally, the majority of state listed species for Frankenia genus are ephemeral species. This species has not been identified within the Project Area during the surveys undertaken to date.
Western Tar-vine *Gilesia biniflora*		R	Present (ML 6471)	Typically found on saline clay habitat and its distribution is the central regions of Australia, in the interiors of New South Wales, Western Australia, South Australia and Northern Territory.
Sandalwood *Santalum spicatum*		V	Present (ML 6471)	Sandalwood grows in loam soils and amongst rocks in woodland and scrubland areas. It is primarily found in the southern half of Western Australian and South Australia. Often occurs sporadically as individuals in a variety of habitats throughout the semi-arid rangelands of SA.
Annual Buttercup *Ranunculus sessiliflorus* var. *pilulifer*		V[4]	Present (ML 6471)	Known to occur in semi-arid rangelands in the Flinders Ranges.
Koch's Saltbush *Atriplex kochiana*		V	Possible	Occurs on gibber slopes with other chenopod shrubs. It is known to occur in northern regions of South Australia, around Andamooka and north of Olympic Dam.
Desert Lime *Citrus glauca*		V	Possible	Known to occur within the semi-arid lands of South Australia usually on heavy clay soils.
Gratwickia monochaeta		R	Possible	Little information is available on the habitat of this species, however, it has been located within the Gawler IBRA bioregion and is known to occur within Acacia woodlands and inland salt lakes and lagoons.
Large Adder's-tongue *Ophioglossum polyphyllum*		R	Possible	The species is known to inhabit moist places on sand hills and sandplains and can often form large colonies on open clay loams. It is frequently encountered in ranges where it occurs in shallow soil pockets subject to flooding or amongst rocks or along stream banks.
Australian Broomrape *Orobanche cernua* var. *australiana*		R	Possible	The species is most abundant on sandy soils and especially along drainage lines.

1 National: Australia (*Environment Protection and Biodiversity Conservation Act 1999*) (Cth.). Conservation Codes: EN: Endangered. V: Vulnerable.
2 State: South Australia (*National Parks and Wildlife Act 1972* (SA)). Conservation Codes: V: Vulnerable. R: Rare.
3 Likelihood Codes:
Unlikely: Carrapateena Area does not contain habitat and/or is outside of the species' current known distribution and the species has not been recorded within the Carrapateena Area to date.
Possible: Carrapateena Area contains preferred habitat that may support a population of the species, however the species has not been recorded within the Carrapateena Area to date.
Present: Carrapateena Area contains preferred habitat that may support a population of the species, and the species has been observed within the Carrapateena Area during ecological surveys.
4 Also listed as threatened within the SAAL region (DEH 2007)

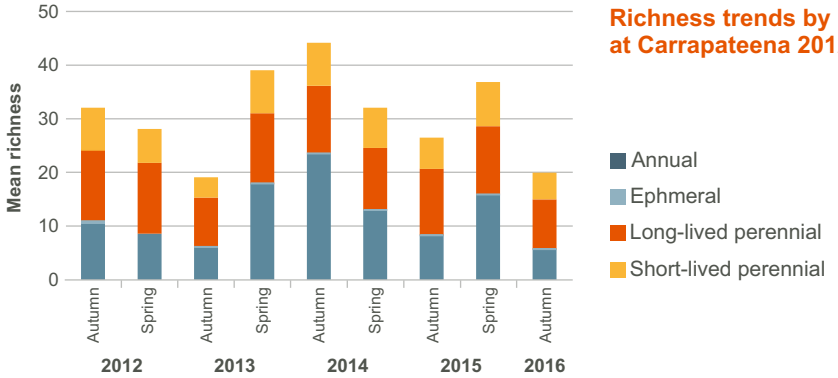
Floristic family richness over the 2012–2016 survey periods



Mean species richness at Carrapateena monitoring sites 2012–2016



Richness trends by lifeform at Carrapateena 2012–2016



Mean richness by landform at Carrapateena 2012–2016

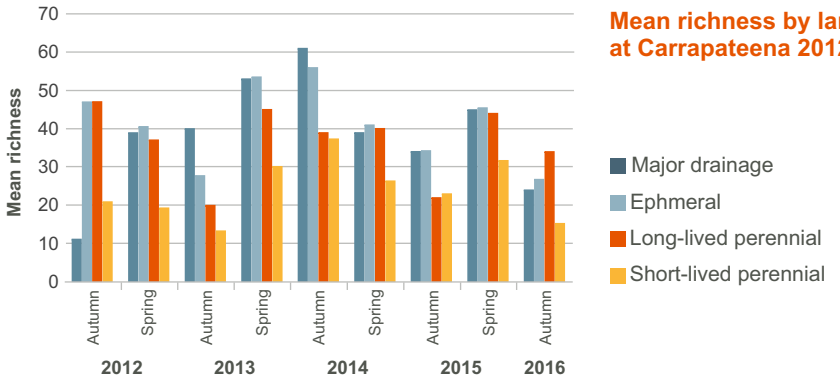
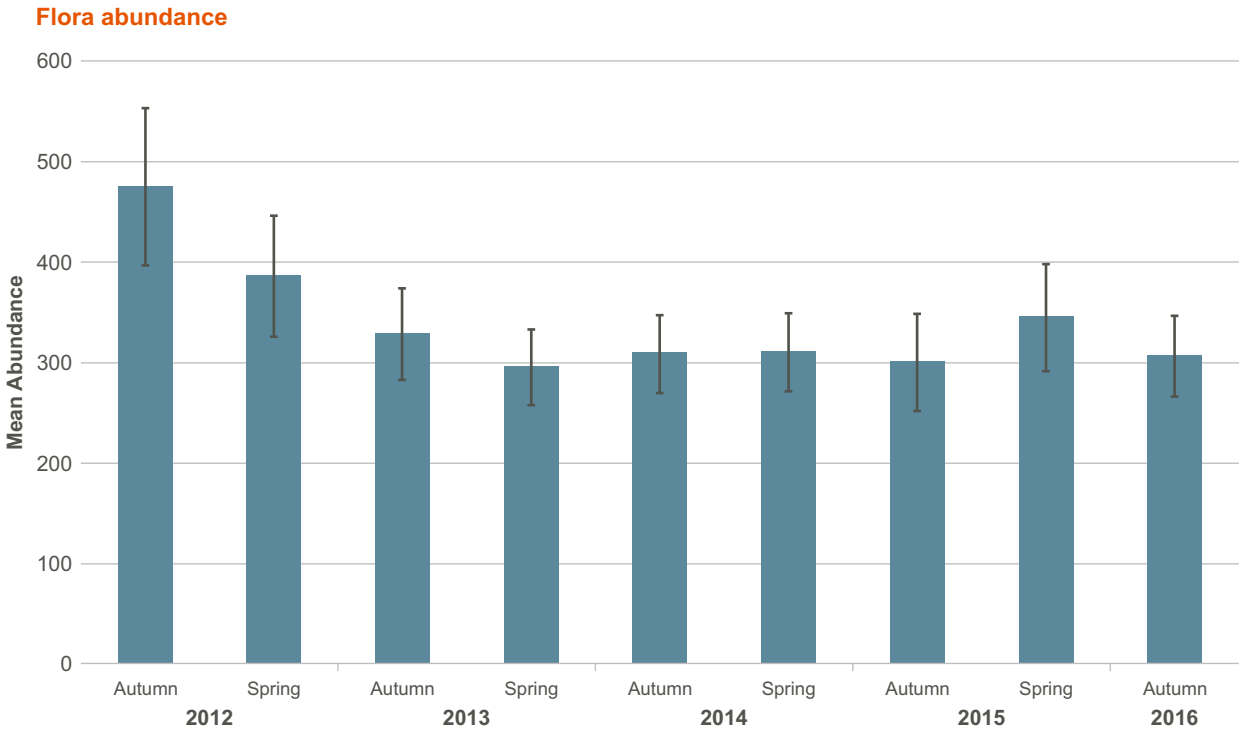


Figure 4.2 | Flora richness at Carrapateena 2012 to 2016



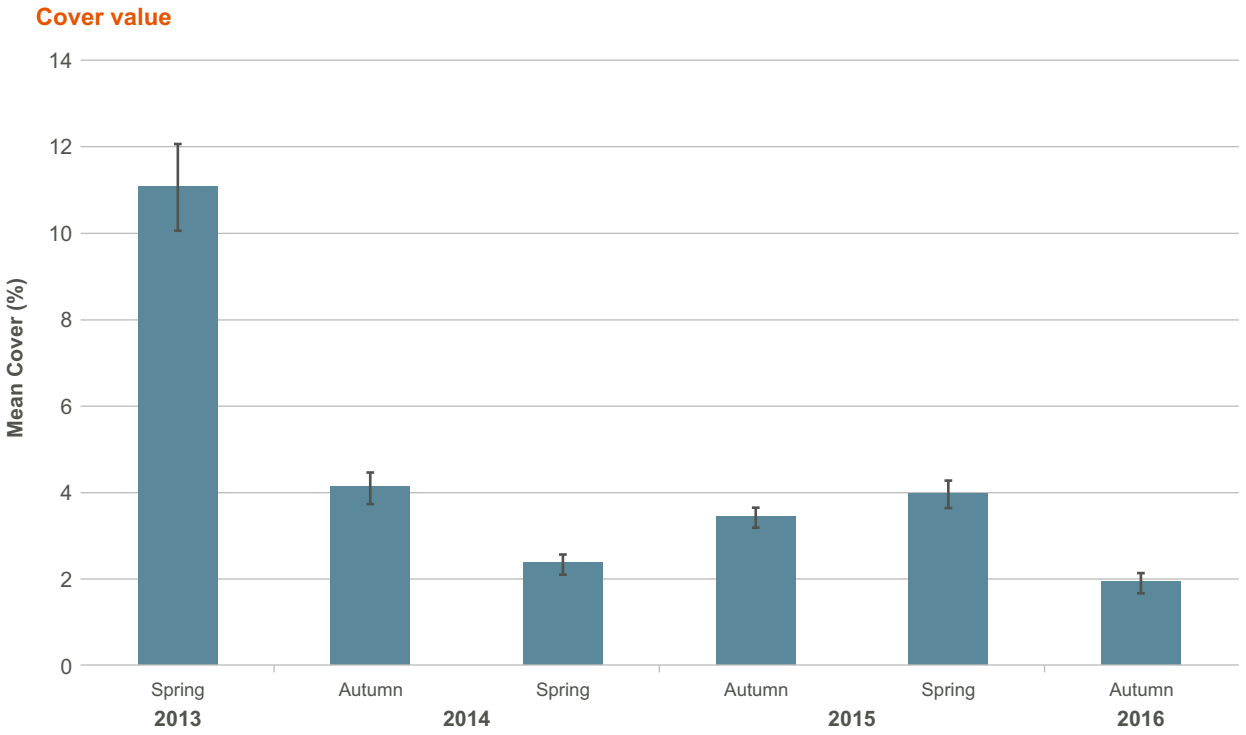


Figure 4.3 | Flora abundance and cover values observed Spring 2013 to Autumn 2016

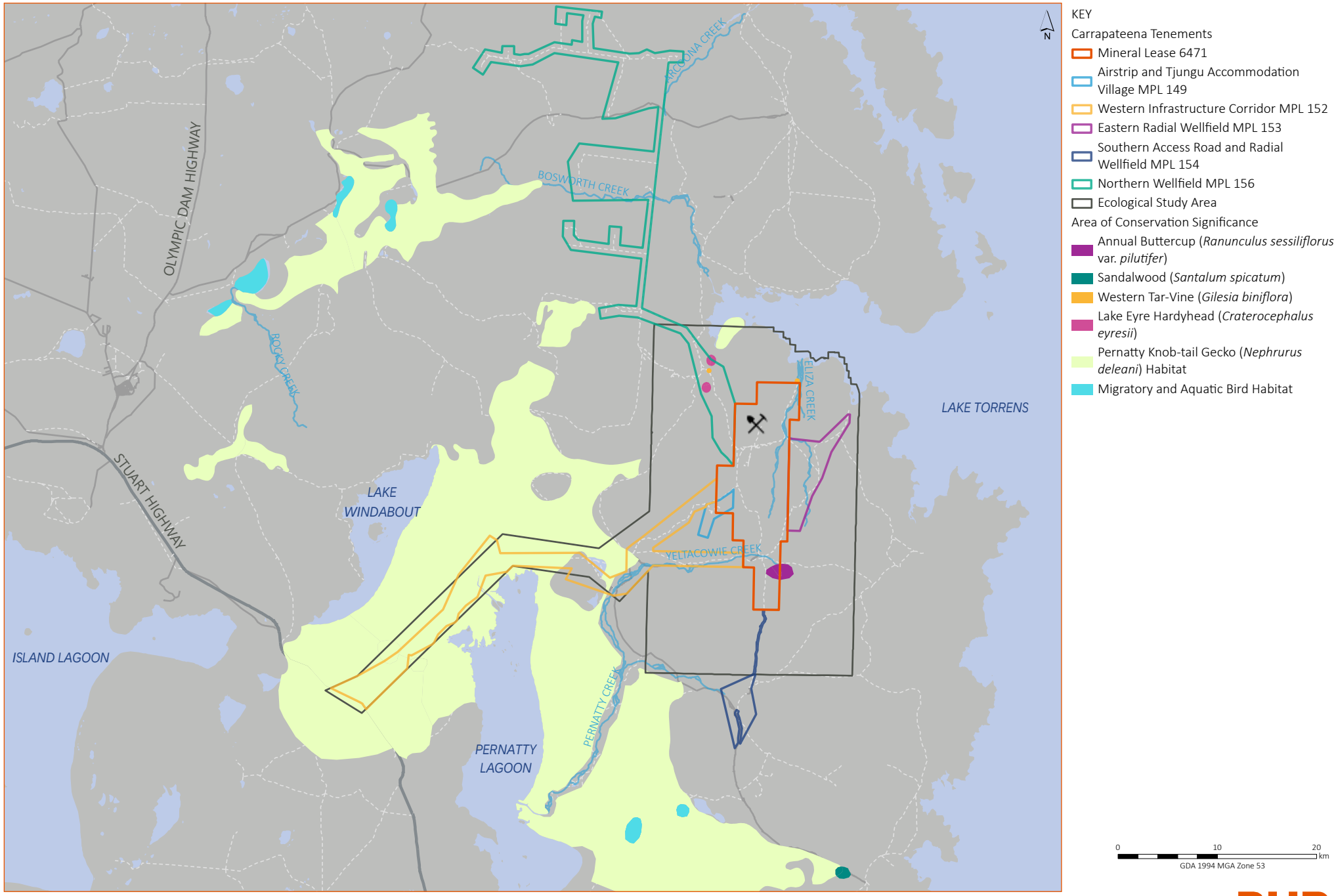


Figure 4.4 | Distribution of local and state significant species

Carrapateena BHP

4.1.4 Pre-existing native vegetation disturbance

Prior to the granting of RL 127 in 2013 and MPL 149 in 2017, pastoral and exploration activities had resulted in 85.1 ha of disturbance that overlapped the Project footprint. An estimate of this disturbance includes:

- 2.2 ha associated with the pastoral track that would become the Southern Access Road (MPL 154)
- 32.5 ha associated with the pastoral track that would become the Western Access Road (MPL 152) and Airstrip and Accommodation Village (MPL 149)
- 51.4 ha associated with pre-Retention Lease mineral exploration and associated access track development that would become the Retention Lease (RL 127).

In 2012, an EPBC Referral was submitted for the Retention Lease contemplating a clearance of 198.37 ha of mainly chenopod shrubland (see Figure 4.7).

Upon granting of RL 127 in 2013, OZ Minerals made the commitment to lift the disturbance of any exploration activities and any off-lease activities, such as the already developed access roads, drill pads and further exploration into the total amount of disturbance for the Retention Lease. This enabled the Project to provide an SEB for all existing activities, Retention Lease activities, regional exploration activities, and other works on land authorised under other legislative requirements or third-party agreements; totalling 476.15 ha (see Section 6.1.3).

4.1.5 Approved land disturbance

Table 4.4 describes the land disturbance estimate (i.e. land disturbance footprint) including buffers for the Carrapateena Project Area for all existing tenements (excluding MPL 156 Northern Wellfield which is considered separately by Section 4.2). The current land disturbance footprint is less than 2,432.1 ha which is the area originally estimated and approved in the Carrapateena MLP (OZ Minerals 2017a; Section 4.2.3). Differences between actual and estimated land disturbance will be reconciled in a post-construction land disturbance audit.

Table 4.4 | Carrapateena approved land disturbance footprint by tenement

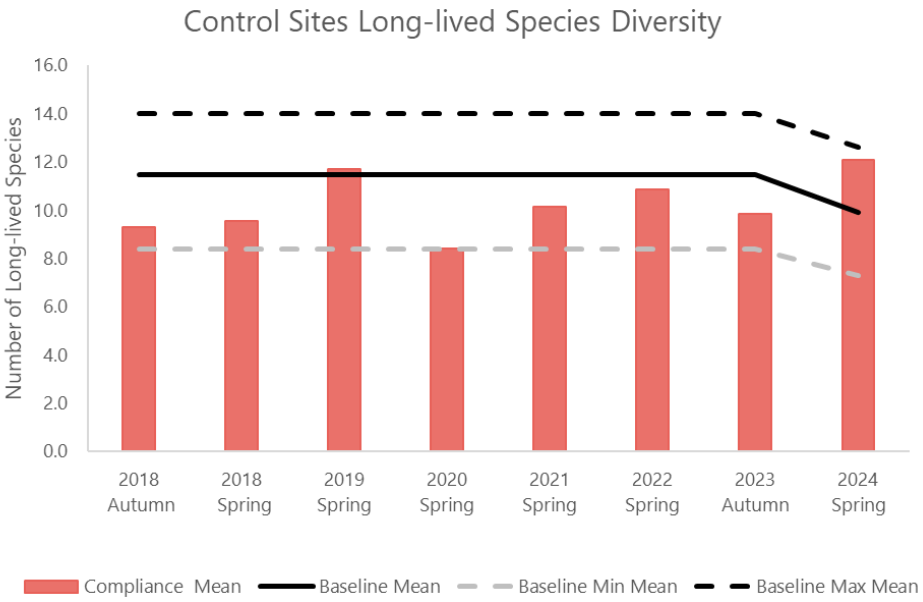
Tenement	Land Disturbance Footprint (ha)
ML 6471 Mineral Lease	1,322.84
MPL 149 Airstrip, Workers' Accommodation Village, Access Road and Ancillary Infrastructure	107.43
MPL 152 Western Infrastructure Corridor, including associated EML 6488 (Midway)	509.58
MPL 153 Eastern Radial Wellfield	17.74
MPL 154 Southern Access Road and Radial Wellfield	28.90
TOTAL	**1,986.49**

The total Carrapateena Project land disturbance footprint (including buffers) associated with the construction, operation and closure of authorised activities on ML 6471, MPL 149, MPL 152 and EML 6488 (Midway), MPL 153 and MPL 154 (see Table 4.4) will be up to 1,986.49 ha. Figure 4.7 shows the existing approved land disturbance associated with Actions authorised under EPBC Referral 2012/6494 (198.37 ha) and hence excluded from EPBC Referral 2017/7895 and the current land disturbance assessed under ML 6471, MPL 152 and EML 6488 (Midway), and MPL 153 and MPL 154, noting there is some overlap between approved land disturbances resulting in a total consistent with that shown on Table 4.4.

4.1.6 Realignment of approved footprint and Rangelands Assessment Metrics

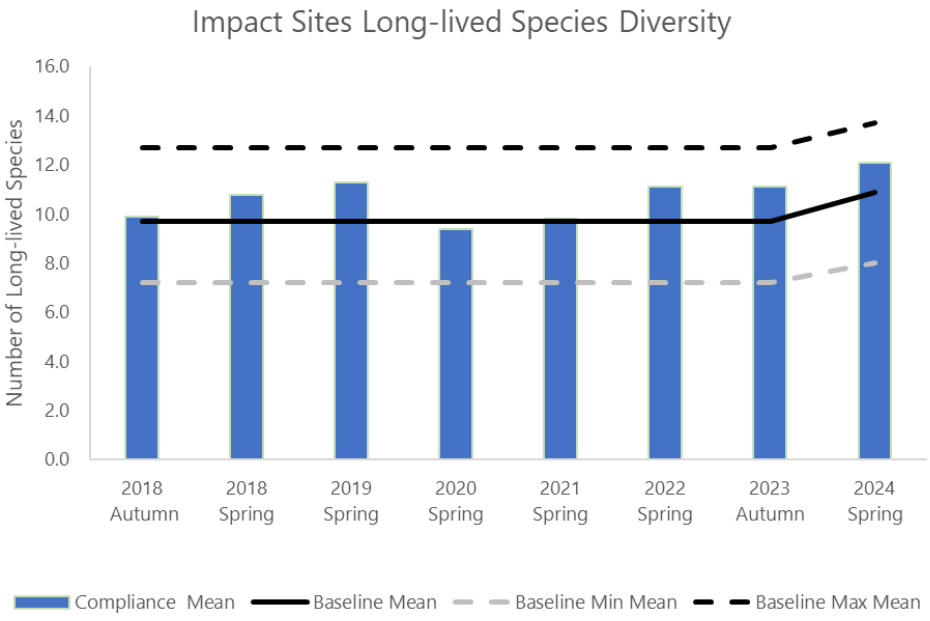
This NVMP recognises a minor realignment of 68.8 ha of disturbance related to Carrapateena TSF activities in immediate proximity to the TSF, which has previously been contemplated, assessed and approved as part of Gateway 3 (Section 6.1.5). The realignment will result in no net change to the total area of the Project footprint being proposed. Further, the realigned disturbance will impact only stony tablelands and stony tablelands watercourse habitats, also as previously proposed. Hence this change is not considered material.

Annual ecological assessments, which include collection of RAM data, continue to demonstrate the consistency of the tablelands environments since baseline characterisation of the area prior to 2017. The most recent 2024 ecological compliance monitoring summarises a robust ecological dataset, including for the diversity of long-lived perennial species across multiple years (2018, 2019, 2020, 2021, 2022, 2023 and 2024) as compared to baseline (2012-2016), and an assessment of grazing impact, both of which are key inputs that determine the Unit Biodiversity Score (UBS) and Vegetation Condition of a site (Lathwida 2024). The data demonstrates that mean long-lived (perennial) species diversity at both control (Figure 4.5) and impact (Figure 4.6) sites located across the Carrapateena Project area (Figure 5.2), consistently fall within the minimum and maximum values established during baseline monitoring (Lathwida 2024). Annual data varies about the baseline mean condition, as influenced predominantly by climatic conditions, noting that low stocking rates have been consistently maintained throughout. RAM results as such show no meaningful change since collection began in 2017 (and also to baseline prior, collected with equivalent methods), and remain relevant to and suitable for use by the Carrapateena project.



Footnotes: 1,2,3

Figure 4.5 | Mean diversity of long-lived flora species at control sites during compliance monitoring (compared with baseline mean, min, max)



Footnotes: 1,3,4

Figure 4.6 | Mean diversity of long-lived flora species at impact sites during compliance monitoring (compared with baseline mean, min, max)

[1] Two established impact sites (CAR006 and CAR004) were converted from impact to control in 2024, causing variance in data 2023-24, with categorisation as determine from site proximity to development.
[2] Control sites (2024): Site 1, Site 2, Site 4, Site 6, Site 7, Site 9, Site 13, refer Figure 5.2
[3] Source: Figure 3.4 and Figure 3.5, Lathwida (2024)
[4] Impact sites (2024): Site 3, Site 5, Site 10, Site 11, Site 12, Site 15, Site 16, refer Figure 5.2

4.1.7 Land disturbance (as originally approved and subsequent to original approval)

The current disturbance footprint described in Table 4.4 has been overlaid on the existing vegetation association mapping undertaken within the Ecological Study Area in order to understand the distribution of land disturbance in a native vegetation context. The land disturbance footprint is presented in Figure 4.9 and described in Table 4.5 by tenement, and includes EML 6488 (Midway).

A further eight EMLs potentially situated within MPL 152 (i.e. EML 6480, EML 6481, EML 6482, EML 6483, EML 6484, EML 6485, EML 6486 and EML 6487) have not been developed and are not part of the current land disturbance footprint. If required, these additional tenements will be addressed by future separate approvals, and hence are not considered further by this NVMP or associated PEPR.

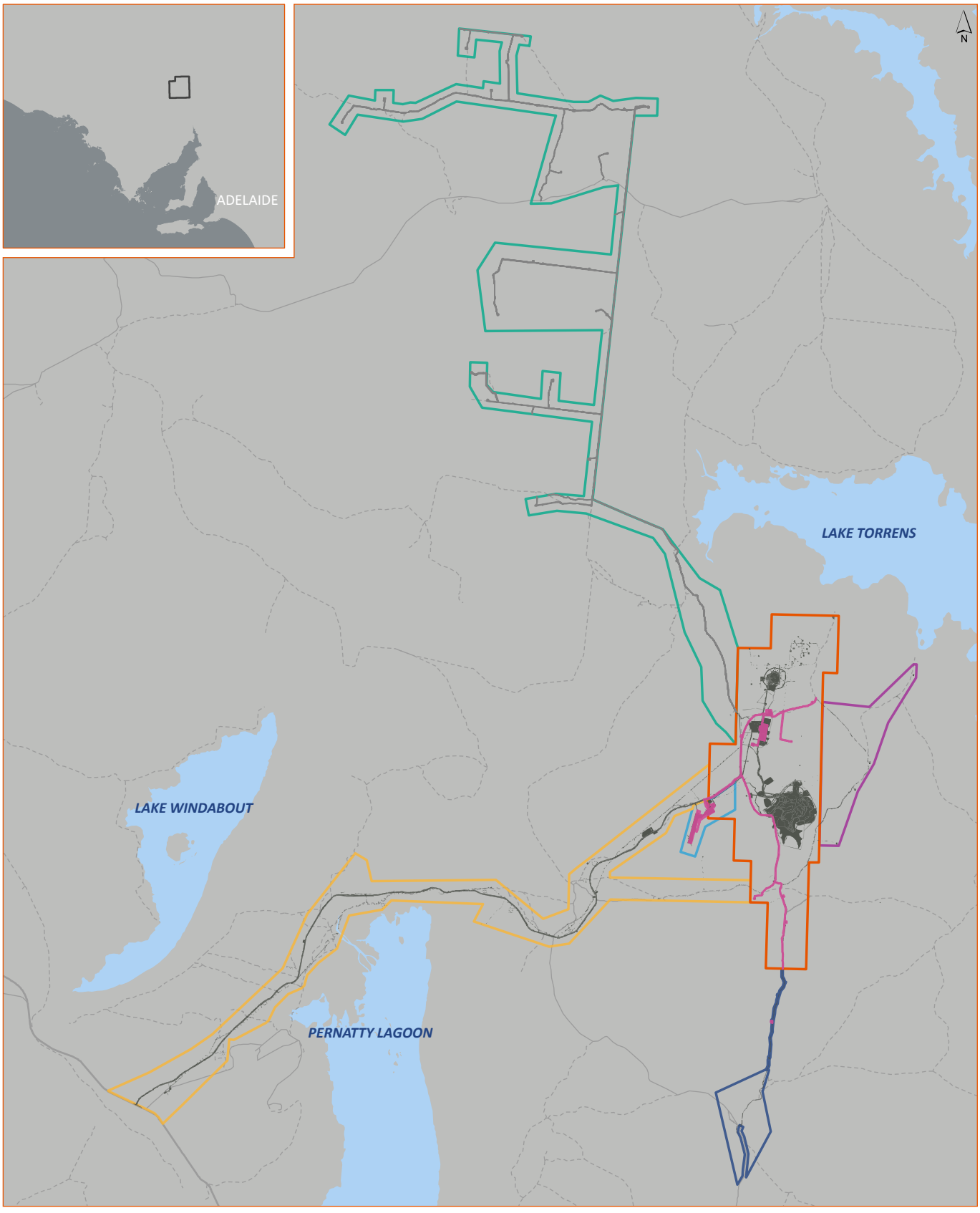
In addition to the land disturbance estimate presented in Table 4.4, BHP have also previously sought approval for new proposed disturbance not contemplated prior to July 2017 (e.g. for the TSF tailings pipeline duplication and haul road).

The SEB associated with all land disturbance (submitted for assessment prior to 1 July 2017) (i.e. as in Appendix D, OZ Minerals 2018a) has been calculated under the former Native Vegetation Regulations and calculation methodology, and the SEB for all land disturbance submitted for assessment after 1 July 2017 has been calculated under the current Native Vegetation Regulations (refer Section 6.1). The Northern Wellfield, submitted after 1 July 2017 and assessed under revised Native Vegetation Regulations and calculation methodology, is presented separately to the Carrapateena component (submitted prior to 1 July 2017) for this reason.

Table 4.5 | Approved Carrapateena Project native vegetation disturbance by vegetation association and tenement (including buffers)

Vegetation association	Description	Representation in Ecological Study Area		Area cleared (ha)						Total reduction within study area (ha)	Association cover loss in ecological study area (%)
		ha	%	ML 6471	MPL 149	MPL 152	EML 6488	MPL153	MPL 154		
1	*Atriplex vesicaria* (Bladder Salt Bush) +/- *Tecticornia medullosa* (Samphire) Low Open Shrubland	64,831.24	77.88	1,233.82	107.37	138.12	22.85	17.33	15.23	1,521.38	0.24%
2	*Acacia ligulata* (Umbrella Bush) / *Dodonaea viscosa* var. *angustissimus* (Narrow-leaf Hop Bush) Low Open Shrubland +/- *Zygochloa paradoxa* (Sandhill Canegrass)	4,785.65	5.75	0	0	73.16	0	0	0	73.16	1.53%
3	*Acacia aneura* (Mulga) Open Woodland over *Maireana sedifolia* / *Maireana pyramidata* / *Maireana astrotricha* / *Atriplex vesicaria*	1,421.33	1.71	0	0	41.47	0	0	0	41.47	2.92%
4	*Acacia papyrocarpa* (Western Myall) Woodland over *Maireana astrotricha* (Low Bluebush)	1,271.42	1.53	0	0	53.53	0	0	0	53.53	4.21%
5	*Acacia aneura* (Mulga) +/- *Dodonaea viscosa* ssp. *angustissimus* (Narrow-leaf Hop Bush) Shrubland over *Maireana pyramidata* (Black Bluebush), *Maireana astrotricha* (Low Bluebush)	1,137.97	1.37	0	0	25.42	0	0	0	25.42	2.23%
6	*Atriplex vesicaria* (Bladder Saltbush) / *Maireana astrotricha* (Low Bluebush) Low Open Shrubland	2,090.28	2.51	0	0	123.39	0	0	0	123.39	5.90%
7	*Acacia papyrocarpa* (Western Myall ssp.) Vey Low Woodland over *Atriplex vesicaria* (Bladder Saltbush) +/- *Ptilotus obovatus* (Silver Mulla Mulla), *Dodonaea lobulata* (Lobe-leafed Hop Bush), *Acacia tetragonophylla* (Dead Finish) and *Eremophila* spp. (Emu Bush) in drainage depressions	4363.22	5.24	71.50	0.06	5.73	0	0.41	2.79	80.47	1.84%
8	*Eucalyptus camaldulensis* var. (River Red Gum) +/- *Acacia papyrocarpa* (Western Myall ssp.) Low Woodland	855.97	1.03	0.13	0	9.57	0	0	0	9.7	1.13%
9	*Zygochloa paradoxa* (Sandhill Canegrass) Grassland	145.00	0.17	0	0	15.01	0	0	0	15.01	10.35%
10	*Casuarina pauper* (Black Oak) Open Woodland on calcrete outcrops and sand dune rises	136.80	0.16	0	0	3.55	0	0	0	3.55	2.60%
11	*Atriplex vesicaria* (Bladder Saltbush) Shrubland +/- *Dodonaea viscosa* var. *angustissimus* (Narrow-leaf Hop Bush) Open Shrubland	132.96	0.16	0	0	8.10	0	0	0	8.1	6.09%
12	*Acacia papyrocarpa* (Western Myall) Woodland over *Maireana pyramidata* (Black Bluebush) / *Callitris gracilis* (Native Pine)	81.19	0.10	0	0	5.25	0	0	0	5.25	6.47%
13	*Tecticornia pergranulata* (Black Seed Samphire) +/- *Melaleuca xerophila* (Boree) Low Shrubland	65.79	0.08	0	0	0.55	0	0	0	0.55	0.84%
14	*Eragrostis australasica* (Swamp Canegrass) Tussock Grassland	61.62	0.07	0	0	0.68	0	0	0	0.68	1.10%
15	*Duma florulenta* (Lignum) *Tecticornia pergranulata* (Black Seed Samphire) *Maireana pyramidata* (Black Bluebush) Shrubland in flood out zones and alluvial fans	51.13	0.06	0	0	0.13	0	0	0	0.13	0.25%
16	*Dodonaea viscosa* ssp. *angustissimus* (Narrow-leaf Hop Bush) / *Acacia ligulata* (Umbrella Bush) Low Shrubland in drainage channels	32.65	0.04	0	0	0	0	0	0	0	0.00%
17	*Callitris glaucophylla* (Native Pine) Woodland	28.21	0.03	0	0	1.23	0	0	0	1.23	4.63%
18	*Acacia papyrocarpa* (Western Myall ssp.) / *Eucalyptus camaldulensis* (River Red Gum ssp.) Low Woodland	1.40	0.00	0	0	0	0	0	0	0	0.00%
19	*Melaleuca xerophila* (Boree) Shrubland	65.73	0.08	0	0	0	0	0	0	0	0.00%
20	*Tecticornia medullosa* (Samphire) Low Open Shrubland	213.91	0.26	0	0	0	0	0	0	0	0.00%
21	Claypan	1,335.94	1.60	0	0	3.63	0	0	0	3.63	0.27%
	No data	-	-	17.37	0	0	0	0	0	17.37	-

1 Area cleared column for MPL 152 does not include EML 6488 (Midway) which is listed separately in an adjacent column.



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156

TSF Stage 3 PEPR footprint

- Carrapateena
- Northern Wellfield
- Disturbance excluded from EPBC Referral 2017-7895

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 4.7 | Carrapateena disturbance footprint and areas excluded from EPBC referral 2017-7895

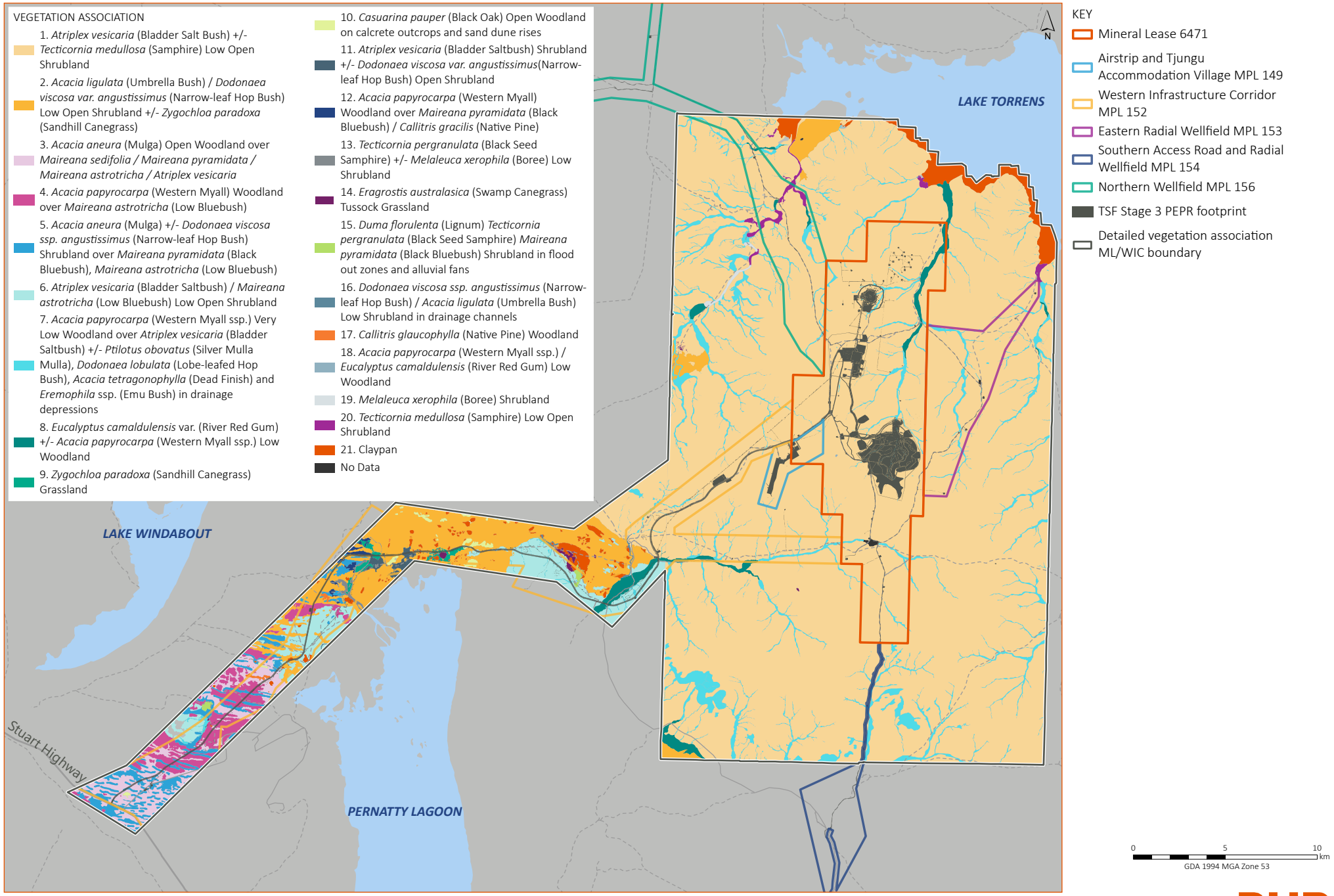
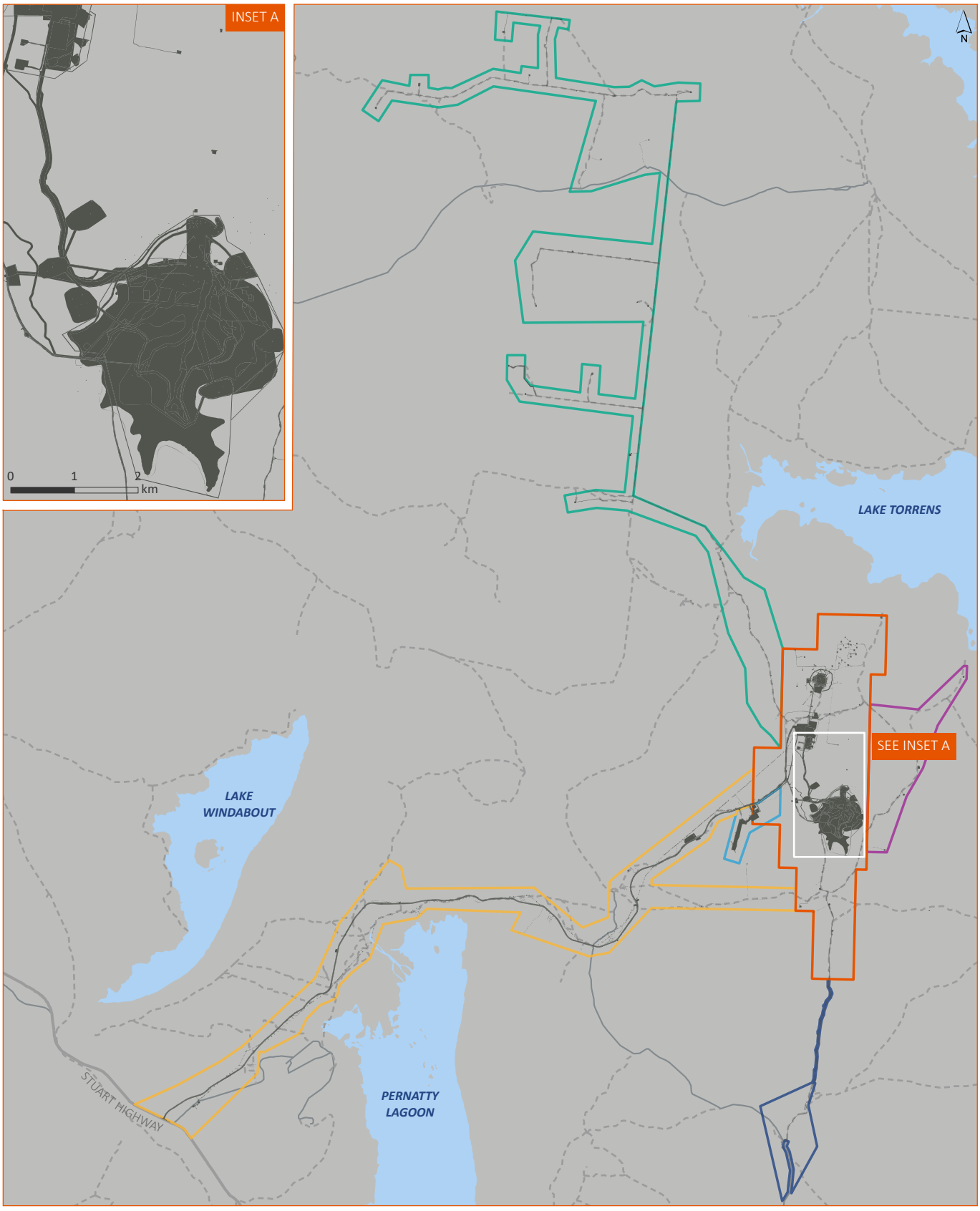


Figure 4.8 | Carrapateena native vegetation disturbance by vegetation association

Carrapateena BHP



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- Land disturbance footprint

0 7.5 15 km

GDA 1994 MGA Zone 53

Figure 4.9 | As-built and proposed land disturbance footprint

Carrapateena BHP

4.2 Northern Wellfield

This section presents the Northern Wellfield Area vegetation and land disturbance associated with the construction and operation of the Northern Wellfield Project, as represented by the extent of MPL 156. The Northern Wellfield Project is presented separately to that associated with Carrapateena Project (Section 4.1) as it was assessed and approved under the RAM and the Native Vegetation Regulations 2017 (SA).

4.2.1 Native vegetation habitats

The Northern Wellfield Area (MPL 156) has been described with reference to overlying landscapes (see Chapter 3) and observed key terrestrial habitats. Key habitats within the region are those that supply specific resources for living organisms (e.g. food and shelter). Largely, these habitats are driven by landforms and climate that have continually changed over millions of years. There are six distinct natural landform types identified within the region. Two of these are also dominant within the Carrapateena Project Area and provide the major habitat structures; the Arcoona Land System and Roxby Land System. The remaining habitats form a minor part of the Northern Wellfield Area, however, are important due to their limited size geographically and lack of connectivity to each other. These are summarised in Table 4.6, in order from the most to least dominant in terms of geographical size and distribution.

The Northern Wellfield Project footprint is dominated by relatively homogenous Low Open Shrubland vegetation associations (Chenopod Shrublands) as described in Section 4.2.2. The Chenopod Shrublands are extensive and relatively intact across the Northern Wellfield Area, making them highly resilient to semi-arid climate conditions and the existing impacts of grazing.

Table 4.6 | Northern Wellfield Area habitat summary

Subject	Summary
Dominant habitats	**Stony Tablelands** – Stony tableland comprises the principal habitat structure across the Operation including the Northern Wellfield MPL. The dominant vegetation community in this habitat is chenopod shrublands, which are influenced by soil salinity, soil structure and water availability. The Stony Tablelands habitat provides limited niche width in terms of fauna habitat and resource availability. Faunal diversity is subsequently restricted and would most commonly include small rodents and marsupials and small reptiles that can live in the cracks in soil and rocks. Avian diversity is also restricted primarily to small birds that can roost in low shrubs and gain food resources from insects, associated invertebrates and seeds. **Minor Drainage** – Minor drainage lines form a visually distinct habitat type, usually by Western Myall and present in most valleys across the Northern Wellfield Area. In most instances, other shrubs and perennial grasses grow as other stratums within the drainage lines giving a variety of niche layers and structures for fauna species. Various sized rocks, as well as erosional zones within meanders of drainage line, provide refuge habitat. There are very few surface water retention points along the minor drainage lines due to moderate declines in topography. There are suitable nesting and roosting sites for birds as well as insect resources, which may attract bats and other insectivores. These channels provide refuge for larger macropods (e.g. kangaroos) as shelter and shade during periods of high temperatures.

Subject	Summary
Minor habitats	**Consolidated Dunefield** – The dominant flora species in the consolidated dunefields landform were Umbrella Bush, Hopbush, Sandhill Cane-grass and Northern Cypress-pine. This landform offers vegetative cover at a range of height classes, and therefore, would support a high diversity of birds. It would be expected this landform would support favourable habitat for an array of bird species, including Splendid Fairywrens, Variegated Fairywrens, White-browed Babblers and Singing Honeyeaters. The dunes within this region are also known to support the Pernatty Knob-tailed Gecko, which is State listed as Rare. The soft sand would also provide a suitable substrate for constructing burrows, used by an array of small mammals and reptiles. Stony rises – Stony rise habitats provide a disparate level of flora species richness to that found in other, more widespread and common, habitats. Flora species specific to this habitat type exist such as Rock Isotome. There were large numbers of refuge sites available due to extensive weathering of rocks, which has created fissures and cracks. As such, these habitats are important in the landscape. **Gilgais** – Gilgais are micro habitats within the tableland where water pools following periods of high rainfall. Due to extended periods of wet soils, these slowly accumulate airborne silts and fine materials and as a result have extremely fine clay soils which expand and contract when exposed to wetting and drying. These cracks can extend deep down into the soil which provide habitat for species such as the nationally threatened Plains Mouse. Typically, these habitats are dominated by Swamp Cane-grass as well as several herbaceous ephemeral annual species which respond to rain events. **Sand Plain** – The dominant habitats within the Sand Plains landform are Mulga and Myall open woodland. The mid-storey vegetative cover over this landform consisted of chenopods, Hopbush, Dead-finish and Emu bushes, while herbaceous annuals are abundant in the understorey under suitable conditions. Overstorey vegetation is favourable for the presence of a diverse assemblage of birds, including the Mulga Parrot, Bluebonnet, Red-capped Robin and Jacky Winter. Numerous reptile species also preferentially occur within Myall and Mulga habitats. **Clay pans** – Clay pans occurred sporadically within areas of low-relief in the western sector of the Northern Wellfield Area. The clay pans would predominantly be dry, only filling after substantial rainfall events. When wet, macro-invertebrates and micro-invertebrates boom; as well as Shield Shrimp. The clay pans may also support breeding for the Sudell's Frog and provide foraging habitat for shorebird species.

4.2.2 Vegetation structure and associations

Four broad landforms types occur within the Northern Wellfield Area; sourced from DEWNR (2017c). This was supported by ecological surveys undertaken within the Northern Wellfield Project footprint (see Section 4.2.2). However, whilst the broad landforms for these areas aligned with the DEWNR data, there were differences in the type of vegetation associations present; for example, *Eucalyptus coolabah* was not present. Chenopod shrubland were mapped as the dominant vegetation type (87%), with minor presence of Acacia Woodlands (9.3%) and Acacia shrubland (2.8%) and very minor coverage of hummock grassland (1%). The landforms and corresponding DEWNR vegetation associations, aligned with Jacobs (2018) field-verified vegetation associations, are detailed in Table 4.7.

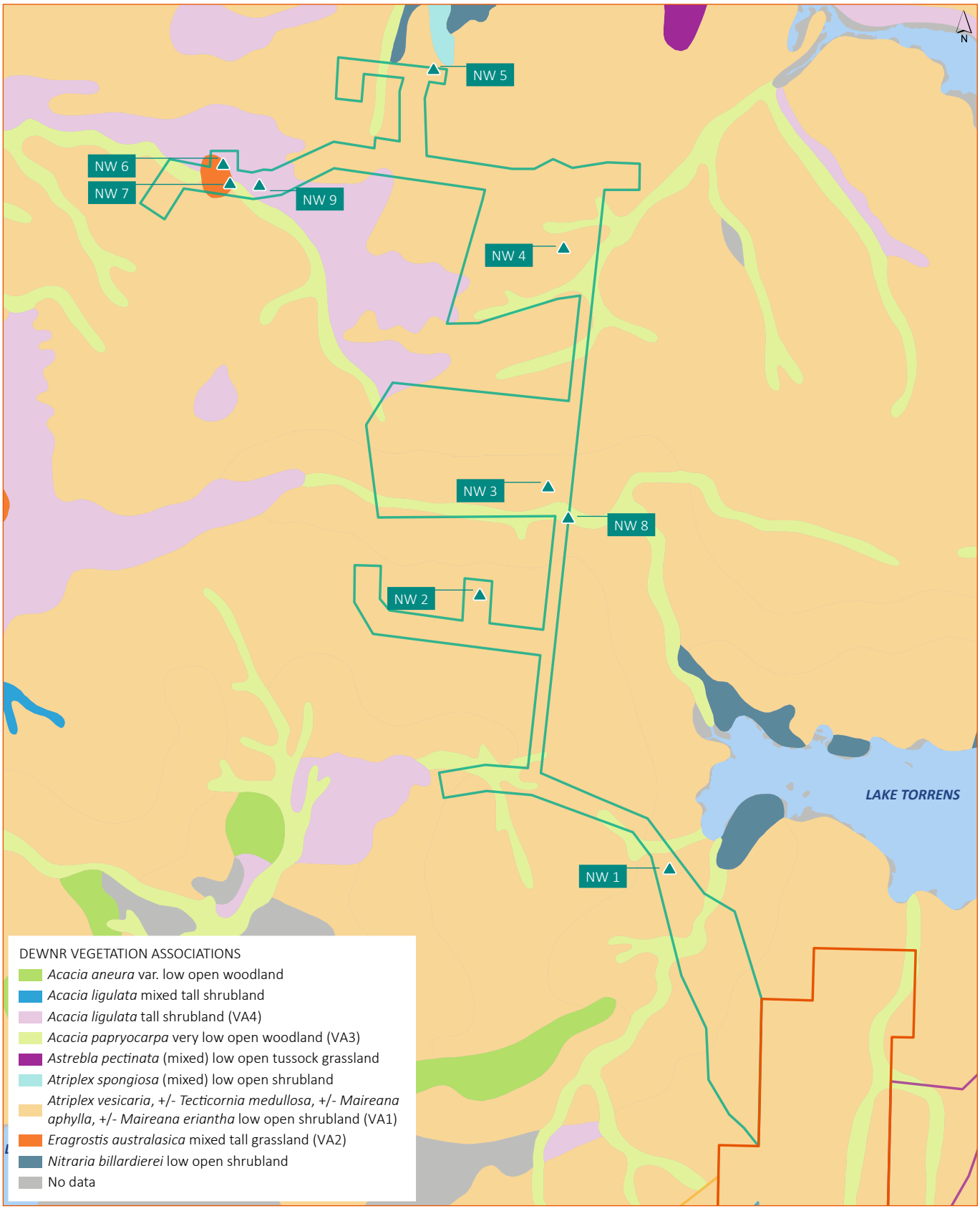
The Northern Wellfield Area is dominated by stony plains and tablelands landform that cover nearly 90% of the area. This is accentuated by ephemeral drainage lines that fall away to saline creeks and depressions. Tableland soils are typically heavy self-mulching clays that are highly sodic and dispersive. Without the flat stones that act as the mulch in place, the soil is subject to high levels of erosion.

The ephemeral drainage lines are typically dominated by small shrubs and trees that persist through higher water flows and flushing of the soil profile. These often have a higher diversity of flora species than the surrounding stony hills.

The results of vegetation association mapping for the Northern Wellfield Area are presented in Figure 4.10 and summarised in Table 4.7.

Table 4.7 | Northern Wellfield Area broad vegetation associations

Vegetation association	Landform	Description	DEWNR Short descriptor	Representation in Northern Wellfield	
				ha	%
1	Gently undulating stony tableland	*Atriplex vesicaria* +/- *Tecticornia medullosa*, +/- *Maireana aphylla*, +/- *Maireana eriantha* low open shrubland	*Atriplex vesicaria* ssp. (mixed) shrubland less than 1 m	14,254	86.8
2	Run-on depression	*Maireana aphylla* / *Eragrostis australasica* low open shrubland	*Eragrostis australasica* (mixed) grassland	170	1.0
3	Stony drainage line	*Acacia papyrocarpa* very low open woodland	Eucalypt forest and woodland. *E. coolabah* – not present	1,530	9.3
4	Low sand dune	*Acacia ligulata* tall shrubland (over *Zygochloa paradoxa*)	Hummock Grassland. *Zygochloa paradoxa* (mixed grassland)	459	2.8
			Total	**16,413**	**100.0**



KEY

- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156
- ▲ RAM vegetation survey site

0 5 10 km

GDA 1994 MGA Zone 53

Figure 4.10 | Northern Wellfield native vegetation associations

Carrapateena BHP

4.2.3 Northern Wellfield land disturbance footprint vegetation associations

Four key vegetation associations occur across the Northern Wellfield Area. Further detail from nine recent Rangelands Assessments of the Northern Wellfield Project disturbance footprint is presented here (Jacobs 2018), with Rangeland Assessment scoresheets attached for reference (Appendix C). Rangeland Assessments were completed by Jacobs' accredited consultants (endorsed by the NVC). The vegetation associations impacted by the land disturbance footprint are summarised below, with an overview provided by Figure 4.11.

4.2.3.1 Vegetation Association 1: Atriplex vesicaria +/- Tecticornia medullosa, +/- Maireana aphylla, +/- Maireana eriantha low open shrubland

This Chenopod low open shrubland occurs on gently undulating stony tablelands and is one of the dominant vegetation associations within the Northern Wellfield Project footprint. The sites encountered varied based on combination of Chenopod species and condition. *Atriplex vesicaria* (Bladder Saltbush) is always the dominant species in this association. Subdominant species included a mix of *Maireana appressa* (Pale-fruit Bluebush) and *Tecticornia medullosa* (a Samphire), or *Maireana appressa* (Cotton-bush), or *Maireana eriantha* (Woolly Bluebush).

Threatened fauna species that have been recorded in these communities (records within 20 years, within 50 km, with <1 km reliability (as required for Rangeland Assessment criteria; NVC 2017b) include *Ardeotis australis* (Australian Bustard, SA Vulnerable), *Phaps histrionica* (Flock Bronzewing, SA Rare), *Falco peregrinus* (Peregrine Falcon, SA Rare) and *Pseudomys australis* (Plains Mouse, Au / SA Vulnerable).

No threatened flora or fauna were observed during the site assessment. No declared weeds present, but existing impacts from grazing and tracks were present. Summary Rangeland Assessment statistics about this association represented by five rangeland sites are summarised in Table 4.8. Representative photos are provided in Plate 4.1, Plate 4.2 and Plate 4.3. It is estimated that 179.25 ha of this Vegetation Association has been disturbed, with an additional 27.27 ha likely to be disturbed with associated access, expansion and exploration phases, bringing the total predicted footprint within Vegetation Association 1 to 206.62 ha. This minor increase (from the 205.72 ha approved and offset) represents likely realignments to reduce erosive capacity, and would represent a 0.32% reduction in the existing vegetation association present across the Northern Wellfield Area (see Figure 4.11).

Table 4.8 | VA1 *Atriplex vesicaria +/- Tecticornia medullosa, +/- Maireana aphylla, +/- Maireana eriantha* low open shrubland

Site	Dominant species	Threatened Flora Score	Threatened Fauna Score	UBS	TBS	Site (ha)	SEB points required
NW 1	*Atriplex vesicaria / Tecticornia medullosa*	0	1.08	59.79	12,353.93	206.62	12,971.63
NW 2	*A. vesicaria / T. medullosa*	0	1.08	64.20	13,264.57	206.62	13,927.80
NW 3	*A. vesicaria / Maireana aphylla*	0	1.08	64.76	13,379.77	206.62	14,048.76
NW 4	*A. vesicaria / M. eriantha*	0	1.08	69.45	14,350.75	206.62	15,068.29
NW 5	*A. vesicaria / M. eriantha*	0	1.08	60.53	12,507.54	206.62	13,132.91
			Average	**63.75**	**13,171.31**	**206.62**	**13,829.88**

Plate 4.1 | VA1 variant 1 *Atriplex vesicaria / Tecticornia medullosa* low open shrubland

Plate 4.2 | VA1 variant 2 *Atriplex vesicaria* / *Maireana aphylla* low open shrubland

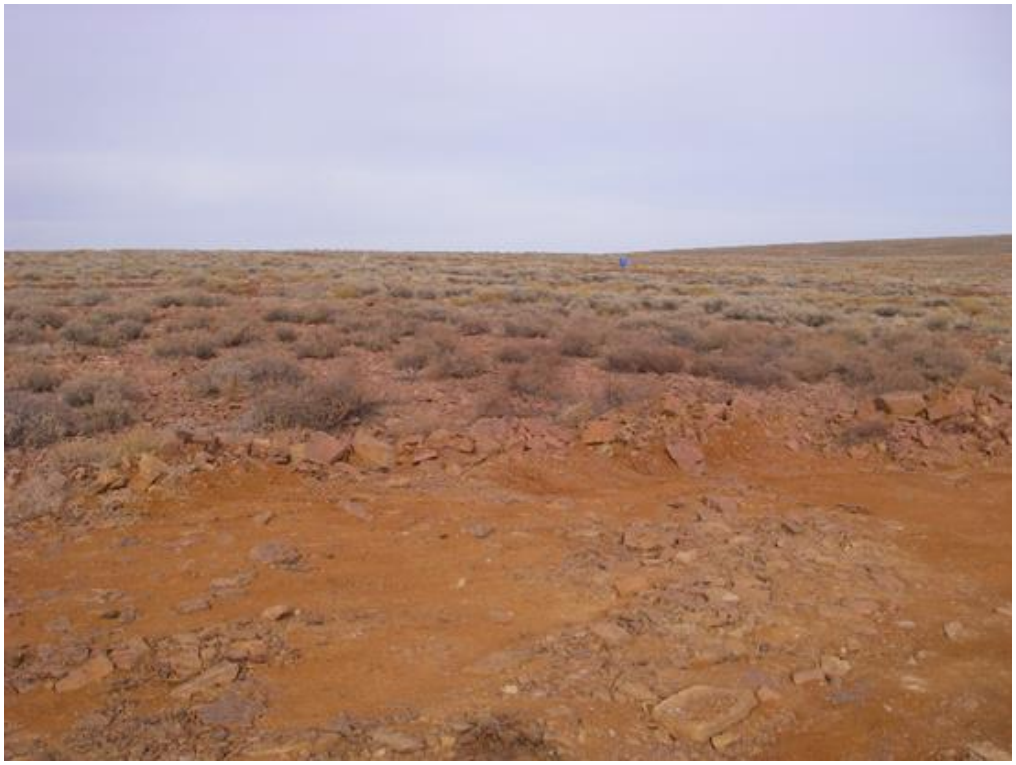


Plate 4.3 | VA1 variant 3 *Atriplex vesicaria* / *Maireana eriantha* low open shrubland

4.2.3.2 Vegetation Association 2: *Maireana aphylla* / *Eragrostis australasica* low open shrubland

This vegetation occurs on landforms defined as run-on depression. Dominant species included *Maireana aphylla* (Cotton-bush) and *Eragrostis australasica* (Cane-grass). Understorey species included *Eragrostis setifolia* (Narrow-leaved Neverfail) and *Sclerolaena intricata* (Tangled Poverty Bush), *Dissocarpus paradoxus* (Cannon-ball).

Threatened fauna species that have been recorded in these communities (records within 20 years, within 50 km, with <1 km reliability (as required for Rangeland Assessment criteria; NVC 2017b)) include *Ardeotis australis* (Australian Bustard, SA Vulnerable), *Phaps histrionica* (Flock Bronzewing, SA Rare), *Falco peregrinus* (Peregrine Falcon, SA Rare) and *Pseudomys australis* (Plains Mouse, Au / SA Vulnerable).

No threatened flora or fauna were observed during the site assessment. No declared weeds present, but existing impacts from grazing and tracks were present.

Summary Rangeland Assessment statistics about this vegetation association represented by two rangeland sites are summarised in Table 4.9. Representative photos are provided in Plate 4.4. It is estimated that 5.36 ha of Vegetation Association 2 will be disturbed, representing a 8.7% reduction in the existing vegetation association present across the Northern Wellfield Area (see Figure 4.11) The Northern Wellfield Project originally included the approval and offset of 4.73 ha of Vegetation Association 2; OZ Minerals 2018b) (see Figure 4.11). This minor increase is a result of realignments to reduce erosive capacity, with Vegetation Association 2 growing in close association with Vegetation Association 1 (and collectively representing the majority of habitat within the Northern Wellfield Area).

Table 4.9 | VA2 *Maireana aphylla* / *Eragrostis australasica* low open shrubland

Site	Landform	Threatened Flora Score	Threatened Fauna Score	UBS	TBS	Site (ha)	SEB points required
NW 6	Run-on depressions	0	0.08	57.83	309.95	5.36	325.44
NW 7	Run-on depressions	0	0.08	63.24	338.98	5.36	355.93
			Average	**60.54**	**324.47**	**5.36**	**340.69**

Plate 4.4 | VA2 *Maireana aphylla* / *Eragrostis australasica* low open shrubland

4.2.3.3 Vegetation Association 3: *Acacia papyrocarpa* low very open woodland

This open woodland community occurs on stony drainage lines within the Northern Wellfield Project disturbance footprint. Dominant overstory species included *Acacia papyrocarpa* (Western Myall), as well as taller shrubs such as *Acacia tetragonophylla* (Dead Finish) and *Acacia aneura* (includes *brachystachya*, *clelandii*) (Mulga). Shrubs in the midstorey included *Rhagodia spinescens* (Spiny Saltbush), *Santalum lanceolatum* (Plumbush), *Senna artemisioides* ssp. *helmsii* (Blunt-leaf Senna) and *Atriplex vesicaria* (Bladder Saltbush). Lower storey species that were present included *Maireana astrotricha* (Low Bluebush), *Maireana aphylla* (Cotton-bush) and *Ptilotus obovatus* (Silver Mulla Mulla).

Threatened fauna species that have been recorded in these communities (records within 20 years, within 50 km, with <1 km reliability (as required for Rangeland Assessment criteria; NVC 2017b) include *Ardeotis australis* (Australian Bustard, SA Vulnerable), *Phaps histrionica* (Flock Bronzewing, SA Rare) and *Falco peregrinus* (Peregrine Falcon, SA Rare).

No threatened flora or fauna were observed during the site assessment. No declared weeds were present, but existing impacts from grazing and tracks were present.

Summary Rangeland Assessment statistics about this vegetation association are summarised in Table 4.10. A representative photo is provided in Plate 4.5. It is estimated that 22.16 ha of Vegetation Association 3 will be disturbed, representing a 0.51% reduction in the existing vegetation association present across the Northern Wellfield (see Figure 4.11). The originally approved and offset land disturbance of Vegetation Association 3 was 22.38 ha (OZ Minerals 2018b).

Table 4.10 | VA3 *Acacia papyrocarpa* low very open woodland

Site	Landform	Threatened Flora Score	Threatened Fauna Score	UBS	TBS	Site (ha)	SEB points required
NW 8	Stony drainage line	0	0.04	76.29	1,690.63	22.16	1,775.16

Plate 4.5 | VA3 *Acacia papyrocarpa* low very open woodland

4.2.3.4 Vegetation Association 4: *Acacia ligulata* tall open shrubland

This woodland community occurs on low sand dunes within the Northern Wellfield Project disturbance footprint. Dominant species included *Acacia ligulata* (Umbrella Bush) over *Rhagodia spinescens* (Spiny Saltbush) and *Enchylaena tomentosa* (Ruby Saltbush).

Threatened fauna species that have been recorded in these communities (records within 20 years, within 50 km, with <1 km reliability (as required for Rangeland Assessment criteria, NVC 2017b) include *Ardeotis australis* (Australian Bustard, SA Vulnerable), *Phaps histrionica* (Flock Bronzewing, SA Rare), *Falco peregrinus* (Peregrine Falcon, SA Rare) and *Nephrurus deleani* (Pernatty Knob-tailed Gecko, SA Rare).

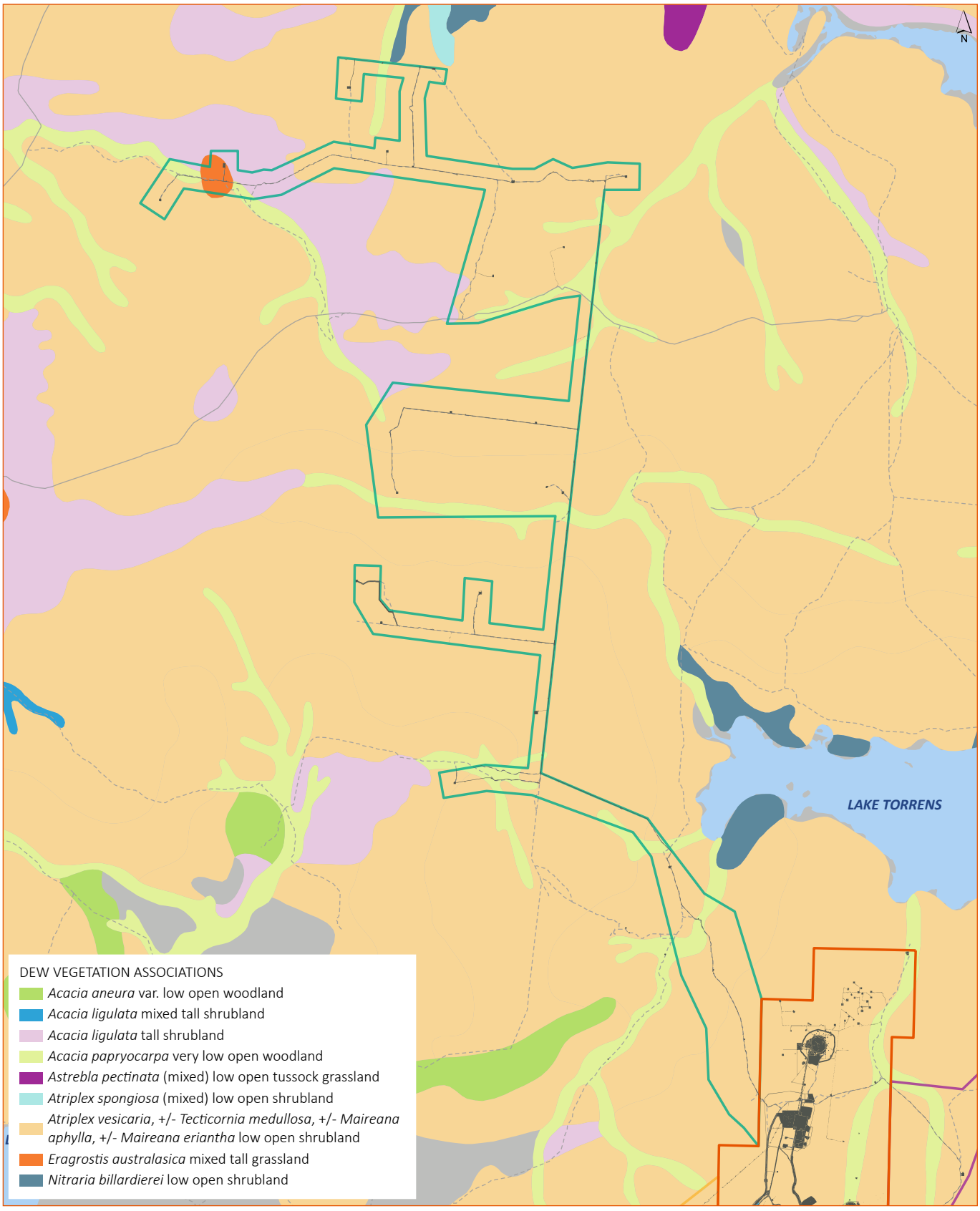
No threatened flora or fauna were observed during the site assessment. No declared weeds present, but existing impacts from grazing and tracks were present.

Summary Rangelands Assessment statistics about this association are summarised in Table 4.11. A representative photo is provided in Plate 4.6. It is estimated that 3.37 ha of Vegetation Association 4 will be disturbed, representing a 0.07% reduction in the existing vegetation association present across the Northern Wellfield (see Figure 4.11). The originally approved disturbance area estimate was 4.68 ha (OZ Minerals 2018b) (see Figure 4.11).

Table 4.11 | VA4 *Acacia ligulata* tall open shrubland

Site	Landform	Threatened Flora Score	Threatened Fauna Score	UBS	TBS	Site (ha)	SEB points required
NW 9	Low sand dune	0	0.06	70.46	237.46	3.37	249.33

Plate 4.6 | VA4 *Acacia ligulata* tall open shrubland



KEY

- TSF Stage 3 PEPR footprint
- Mineral Lease 6471
- Airstrip and Tjungu Accommodation Village MPL 149
- Western Infrastructure Corridor MPL 152
- Eastern Radial Wellfield MPL 153
- Southern Access Road and Radial Wellfield MPL 154
- Northern Wellfield MPL 156

0 5 10 km
GDA 1994 MGA Zone 53

Figure 4.11 | Northern Wellfield native vegetation disturbance by vegetation association

Carrapateena BHP

4.2.4 Conservation significant species

A single EPBC-listed flora species (*Frankenia plicata*) was identified in the PMST report as potentially occurring within the wider Northern Wellfield Area, however this species has not been recorded or observed in the Carrapateena Project Area to date, and has not been observed in targeted surveys (Appendix A) or surveys of the Northern Wellfield Area footprint. Liaison with the SA Herbarium has indicated that specimens obtained from the same locations as historic records were not *Frankenia plicata* and that museum vouchers relating to the historic records were not *Frankenia plicata* (Helen Vonow, Collections Manager, State Herbarium of SA, pers. comm. 02/12/2019), therefore it is very unlikely to occur within the Northern Wellfield Area or Northern Wellfield Project land disturbance footprint.

There are seven flora species of local and state conservation significance recorded within 50 km of the Northern Wellfield footprint by vegetation survey activities within the wider regional area. The species and the likelihood of their occurrence within the Northern Wellfield, are summarised in Table 4.12. An additional species of interest is *Sclerolaena* sp. Yeltacowie. This species is under taxonomic revision and has been recorded in the wider regional area. It has not been recorded within the Northern Wellfield Area footprint.

It is noted that the Carrapateena PEPR (OZ Minerals 2019b; Section 5.9.1) referred to nine state-listed species having been recorded within the BDBSA search area, however the number has been reduced here as this plan has only included species with records in the last 20 years, within 50 km of the MPL boundary and with a reliability of <1 km as per the Rangelands Assessment Manual (NVC 2017b). Species that had historical records for the site included *Santalum spicatum* (Sandalwood), *Gratwickia monochaeta*, *Calocephalus sonderi* (Pale Beauty Heads), *Embadium stagnense* (Arcoona Slipper-plant) and *Malacocera gracilis* (Slender Soft-horns). However, Sandalwood has been included in Table 4.12 below as it has been recorded more recently during ecological surveys of the Carrapateena Project site.

Similar to flora, there are records for EPBC and State-listed fauna within the Operation, including the Northern Wellfield Area. Rangelands Assessment of vegetation requires inclusion of relevant threatened fauna records and observations within 50 km of the MPL boundary, that are less than 20 years old and have a reliability of less than 1 km. Fauna species that meet these criteria are listed in Table 4.13. It should be noted that only species that were likely to occur within the vegetation associations of the Northern Wellfield Area footprint were included in the RAM scoresheets (Appendix C), thus contributing to the UBS of those vegetation associations, i.e. species with preferences for water or shoreline habitats were not included in RAM scoresheets; Plains Mouse, Pernatty Knob-tailed Gecko and Thick-billed Grasswren were only included for relevant habitats known to support the species. The Night Parrot has not been included here given lack of suitable records within 20 years, targeted Significant Impact Assessment results (Appendix A) and lack of preferred breeding habitat, but it is noted that the PEPR includes design controls around this species (OZ Minerals 2019b; Table 4.9 and Section 6.2.5).

Table 4.12 | Conservation significant flora recorded within 50 km of Northern Wellfield Area (<20 years, <1 km reliability)

Species name and common name	Conservation status		Likelihood within MPL from surveys[3]	Habitat
	National (EPBC)[1]	State (NPW)[2]		
Southern Sea-heath *Frankenia plicata*	EN	V	Unlikely	Nine historical BDBSA records (1996), 8 km SSW of Pintara Pile Summit (20 km from the Northern Wellfield). The species is a low, mat-forming perennial shrub on lower slopes of hills and in small run-off channels. Most confirmed records of this species are from the Breakaways. Additionally, the majority of state listed species for *Frankenia* genus are ephemeral species. This species has not been identified within the wider regional area during the surveys undertaken to date, including recent targeted surveys for *Frankenia plicata* (Appendix B). In addition, the SA herbarium has recently verified that specimens from the Northern Wellfield, as well as historical vouchers from the region were not *Frankenia plicata*. Previous surveys for the Carrapateena Project have located a common Sea-heath, *Frankenia serpyllifolia* (Bristly Sea-heath) and this species was observed throughout the site during the targeted survey. Another species not previously recorded was also observed, namely *F. subteres*, however *F. plicata* was not observed. It was noted that most areas considered to be preferred habitat for *F. plicata* within the wider Operation were located near to stock dams and have been heavily impacted from livestock grazing which may contribute to the absence of the species in the area surveyed. This species was not observed during surveys of the Northern Wellfield Project land disturbance footprint.
Sclerolaena sp. Yeltacowie (A.Sinel & R.Kelman CAR037)	-	-	Present (ML 6471)	Species is under taxonomic revision. The known distribution is restricted to an area of approximately 25 ha and consists of approximately 1,000 individuals, which appear to be a true perennial lifeform, living for more than three years. Currently persisting in a stony tableland habitat type, which makes up the large majority of the available habitat.
Western Tar-vine *Gilesia biniflora*	-	R	Present (ML 6471)	Possible. Located in the region south of the Carrapateena Project (OZ Minerals 2019b; Appendix C4.1). Typically found on saline clay habitat and its distribution is the central regions of Australia, in the interiors of New South Wales, Western Australia, South Australia and Northern Territory. Five recent BDBSA records (2016), 5.4 km SSE of Hatch Hill Summit (~20 km south of the Northern Wellfield).
Koch's Saltbush *Atriplex kochiana*		V	Possible	Occurs on gibber slopes with other chenopod shrubs. It is known to occur in northern regions of South Australia, around Andamooka and north of Olympic Dam. There are 24 recent BDBSA records within 20 years (2005 to 2013), 1 – 6 km NNE/ENE Andamooka (~25 km NE of the Northern Wellfield).
Desert Lime *Citrus glauca*		V	Unlikely	Conspicuous species, known to occur within the semi-arid lands of SA on heavy clay soils. Three records (2002, 2007, 2009), 15.7 km SSW Pernatty (~30 km SW of the Northern Wellfield). Suitable habitat may occur within the Northern Wellfield Area, but given conspicuous nature and cultural significance it is likely to have been detected if it occurred within the Northern Wellfield Area.
Australian Broomrape *Orobanche cernua* var. *australiana*		R	Possible	The species is most abundant on sandy soils and especially along drainage lines. One BDBSA record (2004), 8 km NNE of Andamooka (~25 km NE of the Northern Wellfield). Possible in minor drainage lines, but unlikely.
Finger Flat-sedge *Cyperus dactylotes*		V	Unlikely	Tussock-forming perennial sedge, grows in seasonally wet areas such as stream banks and roadside drains (NSW FloraOnline). One BDBSA record (2004), 9.7 km ENE Andamooka (~25 km NE of the Northern Wellfield). This record is at the southern extent of records in South Australia with the majority of records in NT QLD (ALA 2019). Possible in minor drainage lines, but unlikely given range and limited records.
Gibber Daisy *Brachyscome eriogona*		R	Possible	Occurs in north-eastern South Australia, growing in sand on gibber plains and along watercourses. One BDBSA record (2004), 2.6 km NNW of Andamooka (~20 km NW of the Northern Wellfield). Historical records concentrated in central and northern South Australia. Suitable habitat may occur along minor drainage lines within the Northern Wellfield Area.
Sandalwood *Santalum spicatum*	-	V	Possible	Two historical records within 50 km of MPL, however recorded within Carrapateena during 2007 flora and fauna survey. Occurs sporadically as individuals in a variety of habitats throughout the semi-arid rangelands of South Australia (OZ Minerals 2019b; Appendix C4.2).

1 National: Australia (*Environment Protection and Biodiversity Conservation Act 1999*) (Cth.). Conservation Codes: EN: Endangered.
2 State: South Australia (*National Parks and Wildlife Act 1972* (SA)). Conservation Codes: V: Vulnerable. R: Rare.
3 Likelihood Codes:
Unlikely: Northern Wellfield Area does not contain habitat and/or is outside of the species' current known distribution and the species has not been recorded within the Northern Wellfield Area to date.
Possible: Northern Wellfield Area contains preferred habitat that may support a population of the species, however the species has not been recorded within the Northern Wellfield Area to date.
Present: Northern Wellfield Area contains preferred habitat that may support a population of the species, and the species has been observed within the Northern Wellfield Area during ecological surveys.

Table 4.13 | Conservation significant fauna recorded within 50 km of Northern Wellfield Area (<20 years, <1 km reliability)

Species name and common name	Conservation status		Likelihood within MPL from surveys[3]	Habitat
	National (EPBC)[1]	State (NPW)[2]		
Common Sandpiper *Actitis hypoleucos*	Migratory	R	Unlikely	Two records from wider region (Lake Coorlay, dams). Prefers beach or lake shorelines, preferred habitat not present within footprint.
Thick-billed Grasswren / Thick-billed Grasswren (NW) *Amytornis modestus* / *Amytornis modestus indulkanna*	VU	-	Unlikely	One record 7.8 km WSW of Pintara Pile summit. Northern Wellfield Area lies south of current known distribution (Lake Eyre Sub-species). Not recorded during repeated surveys in wider Operation since 2008. Whilst drainage line habitat within the Northern Wellfield Area is considered to provide sub-optimal habitat, this will not be cleared or disturbed during construction.
Australasian Shoveler *Anas rhynchotis rhynchotis*	-	R	Unlikely	There are 20 records from lakes within wider region (Coorlay, Arcoona, Mary, Purple, Richardson). Prefers water habitats, preferred habitat not present within Northern Wellfield Area.
Australasian Darter *Anhinga novaehollandiae*	-	R	Unlikely	Six records from the wider region's lakes (Coorlay, Richardson). Prefers water habitats, preferred habitat not present within the Northern Wellfield Area.
Australian Bustard *Ardeotis australis*	-	V	Possible	One record within the Northern Wellfield Area. Regularly observed within the wider Operation. Vast area of suitable habitat available. Habitat within the Northern Wellfield Area is not distinct or specifically preferred by this species.
Musk Duck *Biziura lobata*	-	R	Unlikely	There are 25 records within wide region from lakes (Purple, Coorlay, Richardson, Arcoona, Mary, Bessie). Prefers water habitats, preferred habitat not present within the Northern Wellfield Area.
Pectoral Sandpiper *Calidris melanotos*	Migratory	R	Unlikely	No record within Northern Wellfield Area. Prefers beach or lake shorelines, preferred habitat not present within the Northern Wellfield Area.
Banded Stilt *Cladorhynchus leucocephalus*	-	V	Unlikely	Over 50 regional records, primarily from the region's lakes (Coorlay, Richardson, Arcoona, Mary, Torrens) and Andamooka Island. Prefers beach or lake shorelines, preferred habitat not present within the Northern Wellfield Area.
Peregrine Falcon *Falco peregrinus*	-	R	Possible	Two records within the Northern Wellfield. Has been observed within the wider Operation (nesting 9.4 km ENE of Hunter Hill Summit). Vast area of suitable habitat available. Habitat within the Northern Wellfield Area is not distinct or specifically preferred by this species.
Latham's Snipe *Gallinago hardwickii*	Migratory	R	Unlikely	No records within wider Operation. Prefers water habitats, preferred habitat not present within Northern Wellfield Area.
Yellow-throated Miner (Black-eared Subspecies *Manorina flavigula melanotis*	EN	E	Unlikely	No records within Northern Wellfield Area for the nationally threatened subspecies. Seven records within wider Operation for *Manorina flavigula*. Northern Wellfield Area outside known distribution of this threatened subspecies (Menkhorst et al. 2017).
Hooded Robin South East *Melanodryas cucullata cucullata*	-	Ssp, R	Unlikely	One record for Hooded Robin likely to be *Melanodryas cucullata westralensis* given distribution (Menkhorst et al. 2017). Northern Wellfield Area outside known distribution of this threatened subspecies.
Blue Bonnet (WA subspecies) *Northiella haematogaster narethae*	-	Ssp, R	Unlikely	There are 19 records for Blue Bonnet likely to be *Northiella haematogaster haematogaster* given distribution (Menkhorst et al. 2017). Northern Wellfield Area well outside known distribution of this threatened subspecies.
Blue-winged Parrot *Neophema chrysostoma*	-	V	Possible	One record from within Northern Wellfield Area. Vast area of suitable habitat available. Habitat within the Northern Wellfield Area is not distinct or specifically preferred by this species.
Pernatty Knob-tailed Gecko *Nephrurus deleani*	-	R	Likely	There are 17 records from within and around the Northern Wellfield Area in sand dune habitat (Elizabeth Creek, Arcoona Station, Pernatty Station). Species has restricted range, where distribution is patchy (Cogger 2014; OZ Minerals 2019b, Appendix C4). It occupies vegetated sand dune habitat where it digs burrows and backfills from within for refuge during the day (Cogger 2014, OZ Minerals 2019b, Appendix C4). Suitable habitat occurs within the Northern Wellfield Area within the *Acacia ligulata* vegetation association. Threats include increased soil compaction during works leading to loss of burrow habitat and introduction of weeds on habitat.
Blue-billed Duck *Oxyura australis*	-	R	Unlikely	Nine records from lakes within the wider region (Arcoona, Coorlay, Mary). Also observed in dams within Carrapateena ML. Prefers water habitats, preferred habitat not present within the Northern Wellfield Area.
Flock Bronzewing *Phaps histrionica*	-	R	Possible	Eight records from within the Operation in Canegrass Dam near Pernatty Lagoon and near Lake Torrens shoreline. The site is at the southern-most extent of the species range (Menkhorst et al. 2017). Extensive habitat occurs north of the Northern Wellfield Area. Prefers Mitchell Grass Downs, savanna, saltbush shrubland and Triodia flats. The Northern Wellfield Area does not contain distinct or specifically preferred habitat.
Glossy Ibis *Plegadis falcinellus*	Migratory	R	Unlikely	Eight records from within wider region's lakes (Purple, Coorlay, Arcoona). Prefers water habitats, preferred habitat not present within Northern Wellfield Area.

Species name and common name	Conservation status		Likelihood within MPL from surveys[3]	Habitat
	National (EPBC)[1]	State (NPW)[2]		
Plains mouse *Pseudomys australis*	VU	V	Present	Only one record from the Northern Wellfield Area and known to have been occasionally caught in regular fauna surveys at Carrapateena ML. Habitat is widespread within the tableland country that dominates the Northern Wellfield Area and more broadly in the region. Whilst Plains Mouse may be present during irruptive periods of its life cycle, the Northern Wellfield Area infrastructure is not expected to disturb the important refuge habitat in low lying run-on areas, deeper gilgais or drainage lines where cracking clays are present.
Freckled Duck *Stictonetta naevosa*	-	V	Unlikely	There are 45 records in lakes of the region (Coorlay, Arcoona, Richardson, Mary, Purple, Bessie). Prefers water habitats, preferred habitat not present within the Northern Wellfield Area.
Wood Sandpiper *Tringa glareola*	Migratory	R	Unlikely	Five records in lakes within wider region (Aroona, Coorlay, Purple). Prefers water habitats, water habitat not present within Northern Wellfield Area.

1 National: Australia (*Environment Protection and Biodiversity Conservation Act 1999*) (Cth.). Conservation Codes: EN: Endangered. VU: Vulnerable. Migratory: listed as migratory with no conservation rating ascribed unless otherwise indicated.
2 State: South Australia (*National Parks and Wildlife Act 1972* (SA)). Conservation Codes: E: Endangered. V: Vulnerable. R: Rare. Ssp. indicates listing only applicable to a particular subspecies of the listed species.
3 Likelihood Codes:
Unlikely: Northern Wellfield Area does not contain habitat and/or is outside of the species' current known distribution and the species has not been recorded within the Northern Wellfield Area to date.
Possible: Northern Wellfield Area contains preferred habitat that may support a population of the species, however the species has not been recorded within the Northern Wellfiled Area to date.
Present: Northern Wellfield Area contains preferred habitat that may support a population of the species, and the species has been observed within the Northern Wellfileld Area during ecological surveys.

4.2.5 Pre-operational disturbance

The Northern Wellfield Area is located on pastoral leases and the area has therefore been subjected to some existing/historic land disturbance activities to enable vehicle access to stock paddocks and the establishment of stock watering infrastructure. Further, groundwater and mineral exploration activities have been undertaken since 2013 (BHP 2024; Section 4.12.2), which have involved the construction of drill pads and associated access track development under existing approved EPEPRs associated with exploration tenements EL 5504, EL 5797 and EL 5863 (EPEPR 2017_1359) and EL 5729 (EPEPR 2018_1386).

Total existing land disturbance within the Northern Wellfield MPL 156 boundary is 81.28 ha, of which 39.54 ha is related to approved regional exploration (i.e. non-pastoral) activities. Existing regional exploration land disturbance that overlaps with Northern Wellfield Project infrastructure within the MPL 156 boundary has been moved from the respective EPEPRs to the MPL PEPR (BHP 2024) and is considered by this NVMP (see Section 4.2.6). Regional exploration disturbance outside the Northern Wellfield Project land disturbance footprint (totalling approximately 10.59 ha) was rehabilitated in accordance with the commitments of the respective EPEPR.

4.2.6 Approved land disturbance

Northern Wellfield Project construction activities have included earthworks and drainage for the construction and/or modification of access tracks, and land disturbance associated with wellhead and water distribution infrastructure. Fencing, flagging or pegging of construction areas, stripping and stockpiling of topsoils and subsoils plus grading and ground consolidation works have been required.

To enable the calculation of future SEB offset options and the calculation of the cumulative effect to the land system, vegetation associations and habitat, buffering has included (where appropriate) and potential future activities to ensure a conservative assessment is undertaken (Figure 4.11, Table 4.14).

The built Northern Wellfield land disturbance footprint is 210.14 ha, reserving 27.37 ha of approved footprint for future access, expansion and exploration phases (OZ Minerals 2018b). This includes the overlapping existing exploration land disturbance within the MPL (25.87 ha) plus 10.59 ha of overlapping existing pastoral land disturbance (see Table 4.14), which was accounted for in the Unit Biodiversity Scores of the vegetation associations.

Selection of the infrastructure locations was undertaken using a multi-criteria analysis, with locations selected based on available areas, site topography, earthwork requirements, and environmental and social constraints. BHP has spent time in the field with both the Kokatha People and the pastoralists, considering the location of infrastructure to ensure that where possible, it follows existing pastoral tracks and fence disturbance lines.

Table 4.14 | Northern Wellfield Project land disturbance footprint (including buffers)

Area description	Existing exploration disturbance (ha)	Existing pastoral disturbance (ha)	NW infrastructure footprint (ha)[1]
Well pads and wellhead infrastructure	5.70	0.00	9.84
Pipeline, access tracks, truck turnaround, laydown	20.11	10.59	198.93
Scour and pitting pits	0.06	0.00	1.36
Telemetry tower	0.00	0.00	0.01
Access, expansion, exploration works	(TBC prior to development)	(TBC prior to development)	27.37
Total Northern Wellfield Project land disturbance footprint[1]	(25.87)	(10.59)	237.51

1 Includes existing pastoral and regional exploration land disturbance within the Northern Wellfield Area

4.2.7 Land disturbance by vegetation associations

The land disturbance footprint as described in Table 4.14 has been overlaid on the existing vegetation association mapping undertaken within MPL 156 in order to understand the distribution of land disturbance by native vegetation association. This is summarised in Table 4.15.

Table 4.15 | Native vegetation disturbance by vegetation association for the Northern Wellfield

Carrapateena equivalent VA	NW VA Code	Description	Representation in broader ecological study area		Area within NW MPL (ha)	Area proposed to be cleared within NW MPL (ha)	Total reduction within MPL area (%)	UBS	TBS
			ha	%					
1, 6	VA1	*Atriplex vesicaria* (Bladder Saltbush), +/- *Tecticornia medullosa*, +/- *Maireana aphylla* (Leafless Bluebush), +/- *Maireana eriantha* (Woolly Bluebush) Low Open Shrubland	64,831.24	77.88	14,254	206.62	0.32%	63.75	13,171.31
14	VA2	*Maireana aphylla* (Leafless Bluebush), *Eragrostis australasica* (Swamp Canegrass) Low Open Shrubland	61.62	0.07	170	5.36	8.70%	60.52	324.47
7	VA3	*Acacia papyrocarpa* (Western Myall ssp.) Vey Low Woodland	4363.22	5.24	1,530	22.16	0.51%	76.29	1,690.63
2	VA4	*Acacia ligulata* (Umbrella Bush) +/- *Zygochloa paradoxa* (Sandhill Canegrass)	4,785.65	5.75	459	3.37	0.07%	70.46	237.46
				Total	**16,413**	**237.51**	**-**	**-**	**15,423.87**

5. Management and mitigation measures

BHP manages the environmental aspects of the Carrapateena Project and Northern Wellfield Project through the implementation of the site Environment Management System (EMS, OZ Minerals 2024). The EMS combine the requirements of the OZ Minerals performance standards, the statutory requirements, permitting conditions and the recommended outcomes associated with the tenements, and identifies the operational management procedures and controls that must be followed by BHP's employees or contractors operating under associated leases and licences.

The EMS defines the mechanisms for the successful management of environment related risks at Carrapateena in accordance with South Australian legislation and other obligations such as the Native Title Mining Agreement (NTMA). The EMS also demonstrates how the Environmental Outcomes associated with specific lease and licence conditions as outlined in the PEPR (BHP 2024) under the various Carrapateena tenements, are achieved at the operational level.

Verification of compliance with the Environmental Outcomes is undertaken through monitoring, assessment and reporting as outlined in the monitoring plans and is the responsibility of the site-based Environment Department. The EMS and supporting management plans are not regulatory documents.

For overarching environmental management Corporate Governance and Performance Standards, please refer to Chapter 3 of the Carrapateena PEPR (BHP 2024). In addition to overarching environmental management, the Environmental Performance Standards have specific requirements related to:

- water
- land and biodiversity
- air emissions
- emissions and resource efficiency
- waste rock and ore
- waste and waste water
- tailings
- rehabilitation and closure.

The requirements of the Environmental Performance Standards are further described in Section 3.1 Management Capability of the PEPR (2024).

5.1 Approach to native vegetation management

The Mitigation Hierarchy as described within the State Government Policy for a Significant Environmental Benefit under the NV Act and the associated Native Vegetation Regulations 2017 (SA) has been applied. This hierarchy is as follows:

- Avoid impacts on native vegetation. This must always be the first step and includes careful spatial or temporal placement of a development, to completely avoid impacts to biodiversity.
- Minimise as far as practicable the duration, intensity and/or extent of impacts on native vegetation (including direct, indirect and cumulative impacts) that cannot be avoided completely.
- Rehabilitate/restore the degraded ecosystem at the site of clearance if adverse impacts cannot be minimised or avoided completely.
- Offset to compensate for any residual adverse impacts that cannot be otherwise avoided, minimised and/or rehabilitated or restored, so that there is no net loss of biodiversity. Offsets take the form of positive management interventions such as restoring already degraded habitat or preventing any further degradation. Offsets will only be considered once residual impacts have been minimised.

5.1.1 Design and management strategies

The achievement of nominated Environmental Outcomes, Outcome Measurement Criteria and Leading Indicators are discussed in Section 5.2, and the corresponding reduction of risks and impacts associated with the disturbance of native vegetation, is achieved through the initial and ongoing application of design and management controls. These are detailed in Table 5.1, with cross-reference to relevant operational documentation to support implementation of the nominated control.

Table 5.1 | Project design and management strategies

Control measure	Documentation reference
Design controls	
Avoidance of critical habitat during site selection	Carrapateena MLP Chapter 6 (OZ Minerals 2017a), Northern Wellfield MPL MP Chapter 6 (OZ Minerals 2018b)
Minimise width of Western Access Road in the location of 'Pernatty Station' *Sclerolaena*	Carrapateena MLP Chapter 6 (OZ Minerals 2017a), Northern Wellfield MPL MP Chapter 6 (OZ Minerals 2018b)
Buffer applied to disturbance footprint to account for edge effects on native vegetation and habitat	Carrapateena MLP Chapter 6 (OZ Minerals 2017a), Northern Wellfield MPL MP Chapter 6 (OZ Minerals 2018b)
Progressive rehabilitation of disturbed areas (primary, secondary rehabilitation and/or revegetation)	Carrapateena MLP Chapter 6 (OZ Minerals 2017a), Northern Wellfield MPL MP Chapter 6 (OZ Minerals 2018b)

Control measure	Documentation reference
Management controls	
Land disturbance approval process	Carrapateena Land Disturbance Permit Form (CA-0000-ENV-FRM-0001) Carrapateena Land Disturbance Procedure (CA-ENV-REP-1085)
Area-specific and site inductions and training	Carrapateena Induction Questionnaire (CA-OHS-FRM-1010) Carrapateena General Induction Presentation (CA-OHS-PRE-1000) Carrapateena Induction Register (CA-PRM-REG-1001)
Employment of suitably qualified people	Carrapateena Pre-Employment and Ongoing Personnel Requirements Procedure (CA-HRS-PRO-1001) Carrapateena Local Employment and Procurement Management Plan (CA-ER-PLN-0001)
Monthly (construction) or annual (operations) land disturbance reconciliation	Carrapateena Land Disturbance Procedure (CA-ENV-REP-1085)
Identifying location of 'Pernatty Station' *Sclerolaena* with flagging during construction.	Carrapateena MLP Chapter 6 (OZ Minerals 2017a), Northern Wellfield MPL MP Chapter 6 (OZ Minerals 2018b)
Land Disturbance Register and supporting GIS information (shapefiles) to record/identify clearance areas and status	Carrapateena Land Disturbance Procedure (CA-ENV-REP-1085) Carrapateena Land Disturbance Register
Destocking infrastructure areas	Carrapateena MLP Chapter 6 (OZ Minerals 2017a), Northern Wellfield MPL MP Chapter 6 (OZ Minerals 2018b)
Vehicle inspection and washdown procedures	Vehicle Weed Inspection Form (CA-ENV-FRM-1000)
Weed inspection program within disturbance footprint	Weed Management Plan (CA-ENV-REP-1085)
Priority weeds list for quick identification	Plate 5.1
Weed and pest eradication programs	Weed Management Plan (CA-ENV-REP-1085) Camp Weed Control Standard Operating Procedure (CA-OPS-SOP-1002)
Waste management plan and practices	Waste Oil and Coolant Disposal (CA-4530-PRO-PID-1008) Procurement Strategy Waste Management Services (CA-CPS-REP-1006) Carrapateena Project Site Waste Disposal (CA-ENV-SOW-1000) Waste Management Plan (CA-ENV-PLN-1009)
Daily cover of the landfill faces	Carrapateena MLP Chapter 6 (OZ Minerals 2017a)

5.2 Outcome Measurement Criteria and monitoring

Outcome Measurement Criteria (OMC) and Leading Indicators allow the demonstration that the Environmental Outcomes specified in each tenement document are being, or will be, achieved. The OMCs have been developed using key elements including measurement methods, monitoring locations, achievement values, monitoring frequency and relevant control or baseline data. Approved OMCs and monitoring commitments related to native vegetation, weeds and pests, native fauna, land and soil for the Carrapateena Operation's tenements are described in Table 5.2 to Table 5.5 below as presented in Chapter 7 of the Carrapateena PEPR (BHP 2024). The location of specific monitoring sites are shown in Figure 5.1, Figure 5.2 and Figure 5.3.

BHP is committed to accurate monitoring and measurement of land disturbance and accurate calculation of required offsets. The Land Disturbance Procedure (CA-ENV-REP-1085) and the associated data record template (CA-ENV-FRM-0001) is used to obtain internal approval of land disturbance activities and once approved, accurately record the area of disturbance and type of disturbance. These areas of disturbance are then used to allocate the required offsets under either the EPBC Act (e.g. for disturbance of Nationally Threatened Species habitat, for the Carrapateena Project) or the NV Act. The procedure also includes the type of vegetation assessment that is required and whether the offset relates to the former or current Native Vegetation Policy and SEB Policy as a means of reconciling all of the Operation's disturbance against legislative commitments.

Table 5.2 | Outcome Measurement Criteria and monitoring: native vegetation

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Outcome Measurement Criteria						
L10 ID018 ID021	Land clearing associated with the construction of project infrastructure results in a loss of abundance and/or diversity of common native vegetation and fauna.	Design Strategies • Avoidance of critical habitat during site selection • Completing pre-construction 'clearance' surveys to identify any critical and preferred habitat of plains mouse (e.g. cracking clays on run-ons, drainage channels or gilgais), thick billed grasswrens (e.g. patches of taller and dense shrubland habitat, often associated with drainage channels) and night parrots (e.g. spinifex hummock grasslands) by a suitably qualified and experienced ecologist • Flag off any populations or preferred habitat identified in close proximity to the disturbance footprint identified during the pre-construction 'clearance' surveys • Access track upgrade or construction will include flow disruptors and diversion drains to minimise erosion Management Strategies • Land disturbance approval process* • Area-specific and site inductions and training • Monthly (construction) or annual (operations) audits of the land disturbance register (which captures all land disturbance permits) for infrastructure locations* • Land Disturbance Register and supporting GIS information (shapefiles) to record/identify clearance areas and status* • Identifying location of *Slcerolaena* sp. Yeltacowie with flagging during construction • Inspections (via ground survey, drone flyover or suitable alternative method) of the Northern Wellfield during construction to ensure that land clearing does not occur outside of approved areas defined in the land disturbance permits • Including awareness training regarding the conservation significance of flora and fauna species in the area as part of the induction process	Land Disturbance Land disturbance associated with project infrastructure has been determined and assessed against the known vegetation associations in the Project Area. Baseline Ecology Baseline ecology is well understood with extensive survey efforts undertaken in Autumn and Spring from 2012 to 2017 following an intensive survey in 2007. New sites to assess the potential impacts from air quality and surface water will have surveys undertaken prior to the commencement of construction activities. SEB Management It is recognised that reconciliation of actual land disturbance is retrospective, and thus land disturbances beyond the significant environmental benefit provision may occur prior to reconciliation if both the significant environmental benefit provision and the land disturbance is not managed appropriately. OMC have been applied to require reconciliation to ensure adequate offsetting provisions are available** MNES Baseline information supported by a comprehensive understanding of the ecological environment which describes the likelihood of occurrence of each relevant EPBC Act listed species based on extensive baseline survey effort and assessment of key habitat and vegetation communities within the Project Area. Data collection methods relating to EPBC listed threated species included: • Bi-annual flora and fauna surveys utilising widely accepted State Government biological survey methods across a total of 16 sites, including habitat types suitable for potentially present EPBC listed species. • Dedicated habitat analysis and mapping for EPBC species: Plains Mouse (*Pseudomys australis*) and the Thick-billed Grasswren (*Amytornis modestus*). • Targeted threatened species survey in habitat considered suitable for Thick-billed Grasswren (*Amytornis modestus*). • Desktop reviews and assessment to assess the potential presence of threatened species and communities	ML 6471 MPL 152 to 154 Schedule 6 Condition 11 Tenement Holder must, during construction and operation, ensure that there is no permanent loss of abundance and/or diversity of native vegetation on or off the Land as a result of mining-related activities unless a significant environmental benefit has been approved in accordance with the relevant legislation MPL 149 Schedule 6 Condition 9 The Tenement Holder must during construction and operation ensure no loss of abundance or diversity of native vegetation on or off the Land unless a significant environmental benefit has been approved in accordance with the relevant legislation. MPL 156 Schedule 6 Condition 8 The Tenement Holder must during construction, operation and post Completion, ensure that there is no loss of abundance and/or diversity of native vegetation on or off the land unless a significant environmental benefit has been approved in accordance with the relevant legislation.	NV1	Audit (reconciliation) of land disturbance register	Infrastructure locations	Native vegetation clearance does not exceed the significant environmental benefit approved under the *Native Vegetation Act* 1991 (SA)	Annual	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
L11	Land clearing of fauna habitat associated with the construction of project infrastructure results in a loss of abundance and/or diversity of NPW Act listed flora and fauna.							Plains mouse habitat clearance does not exceed that approved under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth)			ML 6471 MPL 152 to 154
L12	Land clearing of fauna habitat associated with the construction of project infrastructure results in a loss of abundance and/or diversity of EPBC Act listed native flora and fauna.				EC01	Baseline ecological surveys	At water dependent ecosystems including, but not limited to SW-6 and SW-7	Completed # # Linked to Native Vegetation Strategy (Schedule 6 Condition 9.1)	Prior to the impact of mining operations or mining-related activities on the existing environment	Not applicable	MPL 156
					Leading Indicator						
					NV2	Inspection (ground survey, drone flyover or suitable alternative method)	Infrastructure locations	Demonstrates land clearing has not been undertaken outside of areas defined in the associated land disturbance permit	Following completion of land clearance	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

Table 5.3 | Outcome Measurement Criteria and monitoring: weeds and pests

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Outcome Measurement Criteria						
L16 L20 ID013	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing or new weeds (overabundance) reducing the quality of grazing land and impacting the income and business viability of surrounding pastoral stations.	Management Strategies • Vehicle inspections and wash-down procedures* • Weed inspection program within disturbance footprint* • Priority Weed list for quick identification (Plate 5.1) • Weed and pest eradication programmes* • Waste Management Plan and practices • Landfill Environment Management Plan • Pest eradication program • Waste Management Plan and practices • Daily cover of landfill face	**Overabundance** As arid area weed species are also typically annual species, which respond to heavy rainfall events and are widespread throughout the arid region, it is expected that the abundance of weeds will fluctuate naturally in response to the prevailing meteorology.	ML 6471 Schedule 6 Condition 6 Schedule 6 Condition 28.1 MPL 152 to MPL 154 Schedule 6 Condition 6 MPL 149 Schedule 6 Condition 10 MPL 156 Schedule 6 Condition 3 The Tenement holder must during construction and operation ensure no introduction of new species of Weeds declared or listed under relevant legislation, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing weed or pest species in the Land as a result of mining operations or mining-related activities	WP1	Flora and fauna surveys undertaken by independent and suitably qualified ecologists	Flora, fauna and weeds monitoring locations (Figure 5.1, Figure 5.2, Figure 5.3)	No introduction of: • new species of weeds declared or listed under relevant legislation • plant pathogens • pests (including feral animals) when compared to previously recorded weed species and introduced fauna	Annual (Spring)	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
L17 L21 ID024 ID027	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of common native vegetation and fauna										
L18 L22	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a reduction of habitat and a subsequent loss of abundance and/or diversity of NPW Act listed native flora and fauna.				WP2	Flora and fauna surveys undertaken by independent and suitably qualified ecologists	Flora, fauna and weeds monitoring locations (Figure 5.1, Figure 5.2, Figure 5.3)	No increase in the abundance of existing weeds or pest species in the land compared to previous survey records	Annual (Spring)	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
					Leading Indicator						
L19 L23	Land clearing associated with the construction of project infrastructure creates conditions favourable for an increase in density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a reduction of habitat and a subsequent loss of abundance and/or diversity of EPBC Act listed flora and fauna.				WP3	Inspection (including photographic evidence)	At selected infrastructure location. Alternative locations must be selected until all locations have been complete, or on a demonstrated risk-based approach	Identifies weeds listed as a Priority Weed (Plate 5.1) and triggers a review of the effectiveness of management strategies	Monthly	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
L24 L28	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds reducing the quality of grazing land and impacting the income and business viability of surrounding pastoral stations.				WP4	Audit of inspection records (including photographic evidence)	Maintained at the site by the waste contractor	Prior to collection food waste containers that service the accommodation village kitchen are closed to prevent feral animal scavenging	Quarterly	Construction and operation	ML 6471

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L25 L29	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of common native vegetation and fauna.				WP5	Audit of inspection records (including photographic evidence)	Maintained at the site by the waste contractor	The tip face has been covered at the end of each day to prevent feral animal scavenging	Quarterly	Construction and operation	ML 6471
L26 L30	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of NPW Act listed flora and fauna.				WP6	Audit of records	Maintained at the site by all contractors	Demonstrates that all incoming vehicle, plant and equipment have been subject to weed hygiene procedures	Quarterly	Construction and operation	ML 6471 MPL 152 to 154 MPL 156
L27 L31	Light and heavy vehicle movements to the site import weeds increasing the density of existing weeds (overabundance) and/or the introduction/recruitment of new weeds resulting in a loss of abundance and/or diversity of EPBC Act listed flora and fauna.										
L28 L32	Project activities attract predatory pest species to the Project Area that impact on the abundance and/or diversity of common native fauna species.										
L29 L33	Project activities attract predatory pest species to the Project Area that impact on the abundance and/or diversity of NPW Act listed fauna.										
L30 L34	Project activities attract predatory pest species to the Project Area that impact on the abundance and/or diversity of EPBC Act listed fauna.										

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed
** An uncertainty, sensitivity or assumption that requires further work through the application of an OMC

Table 5.4 | Outcome Measurement Criteria and monitoring: native fauna

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
					Outcome Measurement Criteria						
L31 L32 L33 ID040 L35 L36 L37	Project activities including the electricity line, vehicle movements or airstrip operations interact with native fauna species cause serious injury or death impacting on the abundance and/or diversity common, NPV Act listed and EPBC Act listed native fauna.	Design Strategies • 1.2–1.5 m high wildlife and stock control fence surrounding the airstrip • Airstrip clearance and foreign object inspections • Transmission line spacing between phase and ground conductors greater than 150 cm • Insulation of phase and/or ground conductors where necessary • Installation of perch discourages on transmission line. Management Strategies • Traffic Management Plan and speed limits. • Area-specific and site inductions and training. • Wherever possible, open excavations and drill holes will be covered as soon as practicable or managed to ensure no entrapment can occur through the use of ramps • Incident reporting procedures. • Airstrip operating procedures • Airstrip clearance and foreign object inspections • Wildlife and stock control fence maintenance program	MNES Baseline information supported by a comprehensive understanding of the ecological environment which describes the likelihood of occurrence of each relevant EPBC Act listed species based on extensive baseline survey effort and assessment of key habitat and vegetation communities within the Project Area. Data collection methods relating to EPBC listed threated species included: • Bi-annual flora and fauna surveys utilising widely accepted State Government biological survey methods across a total of 16 sites, including habitat types suitable for potentially present EPBC listed species. • Dedicated habitat analysis and mapping for EPBC species: Plains Mouse (Pseudomys australis) and the Thick-billed Grasswren (*Amytornis modestus*). • Targeted threatened species survey in habitat considered suitable for Thick-billed Grasswren (*Amytornis modestus*). • Desktop reviews and assessment to assess the potential presence of threatened species and communities.	ML 6471 Schedule 6 Condition 13 MPL 149 Schedule 6 Condition 8 MPL 152 to MPL 154 Schedule 6 Condition 12 The Tenement Holder must ensure during construction, operation and post completion that there are no native fauna injuries or deaths due to mining-related activities that could reasonably have been prevented. MPL 156 Schedule 6 Condition 10 The Tenement Holder must during construction, operation and post Completion ensure that there are no native fauna injuries or deaths due to mining operations or mining related activities that could have been reasonably prevented.	NF1	Investigation and review of incident report records	Infrastructure locations	• the incident could not have been reasonably prevented • animal welfare was handled in accordance with the *Animal Welfare Act 1985* (SA) • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or authorised officer).	Triggered as a result of serious harm or death of native fauna Serious harm is defined in the *Animal Welfare Act 1985* (SA)	Construction and operation	ML 6471 MPL 152 to 154 MPL 156
					NF4	Inspection (ground survey)	Wildlife and stock control fence surrounding the airstrip	The integrity of the fence is maintained	Monthly	Construction and operation	MPL 149
					Leading Indicator						
					NF2	Audit signed by construction manager	Transmission Line	Demonstrates infrastructure has been constructed in accordance with the transmission line design including: • Line spacing between phase and ground conductors greater than 150 cm • Insulation of phase and/or ground conductors where necessary • Installation of perch discourages	Completion of construction	Construction	MPL 152
					NF3	Audit signed by construction manager	Transmission Line	Demonstrates speed limit signage has been installed at entry points and at a minimum of 5 km intervals in accordance with the design plans	Completion of construction	Construction	MPL 152
					NF5	Airstrip clearance and foreign object inspections	Airstrip	Identify a rising trend in kangaroo, emu and stock assess to the internal permitter of the wildlife and stock control fence surrounding the airstrip	Prior to the landing and take-off of aircraft	Operations	MPL 149
L12	Land clearing of fauna habitat associated with the construction of	Design Strategies • Avoidance of critical habitat during site selection		ML 6471 Schedule 2 Condition 28.2 MPL 152	EPBC1	Flora and Fauna surveys or verified	Monitoring sites (Figure 5.1, Figure	Records of the Thick-billed Grasswren are provided to the Biological Database of South	Annual survey or	Operations	ML 6471 MPL 152 to 154

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
	project infrastructure results in a loss of abundance and/or diversity of EPBC Act listed native fauna.	Management Strategies • Land disturbance approval process* • Area-specific and site inductions and training • Monthly (construction) or annual (operations) land disturbance reconciliation* • Land Disturbance Register and supporting GIS information (shapefiles) to record/identify clearance areas and status*		Schedule 2 Condition 13.2 Provide data from any future sightings and records of the Thick-billed Grasswren to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. ML 6471 Schedule 2 Condition 28.3 MPL 152 Schedule 2 Condition 13.3 Provide data from any future sightings and records of the Plains Mouse to the Biological Database of South Australia (BDBSA) to enable effective monitoring and record keeping, as per the Recovery Plan Actions. ML 6471 Schedule 2 Condition 28.4 MPL 152 Schedule 2 Condition 13.4 Provide data from any future sightings and records of the Night Parrot to the Night Parrot Recovery Team.		opportunistic sighting	5.2, Figure 5.3)	Australia BDSA if observed # Linked to MNES Condition (Schedule 2 Condition 28.2)	opportunistic sighting		
					EPBC2	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 5.1, Figure 5.2, Figure 5.3)	Records of the Plains Mouse are provided to the Biological Database of South Australia BDSA if observed # Linked to MNES Condition (Schedule 2 Condition 28.4)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154
					EPBC3	Flora and Fauna surveys or verified opportunistic sighting	Monitoring sites (Figure 5.1, Figure 5.2, Figure 5.3)	Records of the Night Parrot are provided to the Night Parrot Recovery Team if observed # Linked to MNES Condition (Schedule 2 Condition 28.3)	Annual survey or opportunistic sighting	Operations	ML 6471 MPL 152 to 154

Table 5.5 | Outcome Measurement Criteria and monitoring: land and soil

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
L20 ID014 L24	The transport, storage and handling of hydrocarbons, chemicals and saline water contaminates land leading to a decrease in soil quality resulting in a loss of abundance and/or diversity of native vegetation.	Design Strategies • Hydrocarbon and chemical storage facilities designed in accordance with Australian Standards. • Storages bunded in accordance with EPA Bunding Guidelines and/or relevant Australian Standards* • Landfill is constructed and operated in accordance with EPA Guidelines and is appropriately licensed under the *Environment Protection Act 1993* (SA). Management Strategies • All commercial or industrial waste is disposed of in an EPA licensed facility which is closed in accordance with relevant EPA Guidelines* • Licenced chemical and waste transporters • Establishment of Chemical Database including copies of SDS and storage, handling and disposal requirements* • Contaminated land register • Contracts contain conditions relevant to the bringing of chemicals and hydrocarbons onto site • Induction contains process for bringing chemicals and hydrocarbons onsite including requirements for storage, handling and disposal • Contracts contain conditions relevant to design, management of the storage and handling of chemicals and hydrocarbons • Spill and emergency response procedures • Equipment maintenance to prevent spills • Incident reporting procedures • Regular inspection programs where bunding either temporary or permanent is installed to ensure appropriate use, placement of spill kits, clean up procedures and handling procedures • Decommissioning and Rehabilitation Plan • Establishment of a landscape function criteria and rehabilitation methodology	Effectiveness of Management Controls Spill and emergency response procedures that support the existing Operation have been developed and include remediation methods Operational performance has demonstrated that BHP can respond to any spills and implement corrective actions where required OMC have been applied to ensure storage areas are constructed and operated appropriately and waste records are maintained Rehabilitation The rehabilitation methodology has not been finalised. Historical rehabilitation of exploration sites has successfully achieved landscape functions equivalent to surrounding analogues, however a systematic methodology to achieve this has not been documented.	ML 6471 MPL 152 to MPL 154 Schedule 6 Condition 10.1 MPL 156 Schedule 6 Condition 7.1 The Tenement Holder must ensure that there is no contamination of land and soils either on or off the Land as a result of mining operations or mining-related activities MPL 149 Schedule 6 Condition 2.1 Schedule 2 Condition 9 The Tenement Holder must, ensure that there is no contamination of land and soils either on or off the Land as a result of mining related activities MPL 152 to MPL 154 Schedule 6 Condition 10.2 MPL 156 Schedule 6 Condition 7.2 The Tenement Holder must ensure that no contamination of land and soils either on or off the Land post Completion occurs as a result of mining operations or mining-related activities MPL 149 Schedule 6 Condition 2 Schedule 2 Condition 9 The Tenement Holder must, ensure that no contamination of land and soils either on or off the Land post completion occurs as a result of mining related activities. MPL 149 Schedule 6 Condition 1 Before mine completion, the Tenement Holder must satisfy the Director of Mines (or other authorised officer) that where practicable, the pre-mining land use can be recommenced post completion.	**Outcome Measurement Criteria**						
L21 L25	The transport, storage and handling of hydrocarbons, chemicals and saline water contaminate land leading to a decrease in soil quality resulting in a loss of habitat impacting on the abundance and/or diversity of native fauna				LS1	Accidental spill reporting, investigation and corrective actions	Infrastructure locations	• spill reported to the Director of Mines (or other authorised officer) as soon as reasonably practicable after becoming aware of the harm or threatened harm • all risks were minimised so far as is reasonably practicable • any corrective actions are closed out within 30 days or as agreed with the Director of Mines (or other authorised officer).	Triggered as a result of an accidental spill that results or threatens to result in material or serious environmental harm (as defined in Section 5(3) of the *Environment Protection Act 1993* (SA)) to native vegetation, native fauna and/or groundwater	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
L22 L26	The transport, storage and handling of hydrocarbons, chemicals and saline water contaminates land leading to a decrease in soil quality impacting on the income and business viability of pastoral stations.										
L39 ID049 L40	Waste generated during construction and operation activities is not managed correctly to ensure achievement of the post completion land use.				LS5	Internal audit of rehabilitation activities and waste disposal records	Infrastructure locations	• Commercial and/or industrial wastes have been disposed of to an EPA licenced facility	Prior to application of lease surrender	Closure	ML 6471 MPL 149 MPL 152 to 154 MPL 156
ID041	Rehabilitated areas where infrastructure items have been decommissioned are identified as having contaminated soil leading to impacts on the abundance and/or diversity of native vegetation.					Site contamination audit conducted by an independent and qualified auditor		No soil contamination (as defined in the National Environment Protection (Assessment of Site Contamination) Measure 2013) remains in areas used for the handling and storage of hazardous materials			
ID016	Rehabilitated areas where infrastructure items have been decommissioned are identified as having contaminated soil impacting the future income and business viability of Pernatty Station.				**Leading Indicator**						
ID042	Rehabilitated areas where infrastructure items have been decommissioned are not returned to a landscape function preventing the re-				LS2	Audit of waste disposal records	Maintained at the site	Commercial and/or industrial wastes have been disposed of to an EPA licenced facility	Annual	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
					LS3	Audit of chemical storages	Infrastructure locations	They have been constructed and are operating in accordance with the SA EPA Guideline	Monthly	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156

Impact ID	Impact Event	Design and management strategies	Uncertainties, sensitivities, and assumptions	Environmental Outcome	Outcome Measurement Criteria/Leading indicator						
					ID	Measurement method	Location	Achievement value	Frequency	Project phase	Relevant tenement
	establishment of native vegetation and results in the loss of abundance and/or diversity of native vegetation.	• Rehabilitation of land to achieve a landscape function equivalent to the surrounding landscape • Rehabilitation trials • Progressive rehabilitation • Stockpile management procedures to ensure quality and quantity is maintained • Landfill Environmental Management Plan • Waste Management Plan and practices, including daily covering of the landfill face						080/16 Bunding and Spill Management (2016)			
ID043	Rehabilitated areas where infrastructure items have been decommissioned are not returned to a landscape function that creates conditions favourable for an increase in density of existing weeds (overabundance) and/or introduced weeds and a loss of abundance and/or diversity of native vegetation.				LS4	Audit of chemical storages	Infrastructure locations	All chemicals are recorded (including volumes) in the chemical database.	Monthly	Construction and operation	ML 6471 MPL 149 MPL 152 to 154 MPL 156
ID017	Rehabilitated areas where infrastructure items have been decommissioned is not returned to a landscape function that allows grazing to be recommenced, impacting the income and business viability of Pernatty Station										

* If there is a high reliance on a control or management strategy to prevent or minimise an impact a leading indicator has been proposed

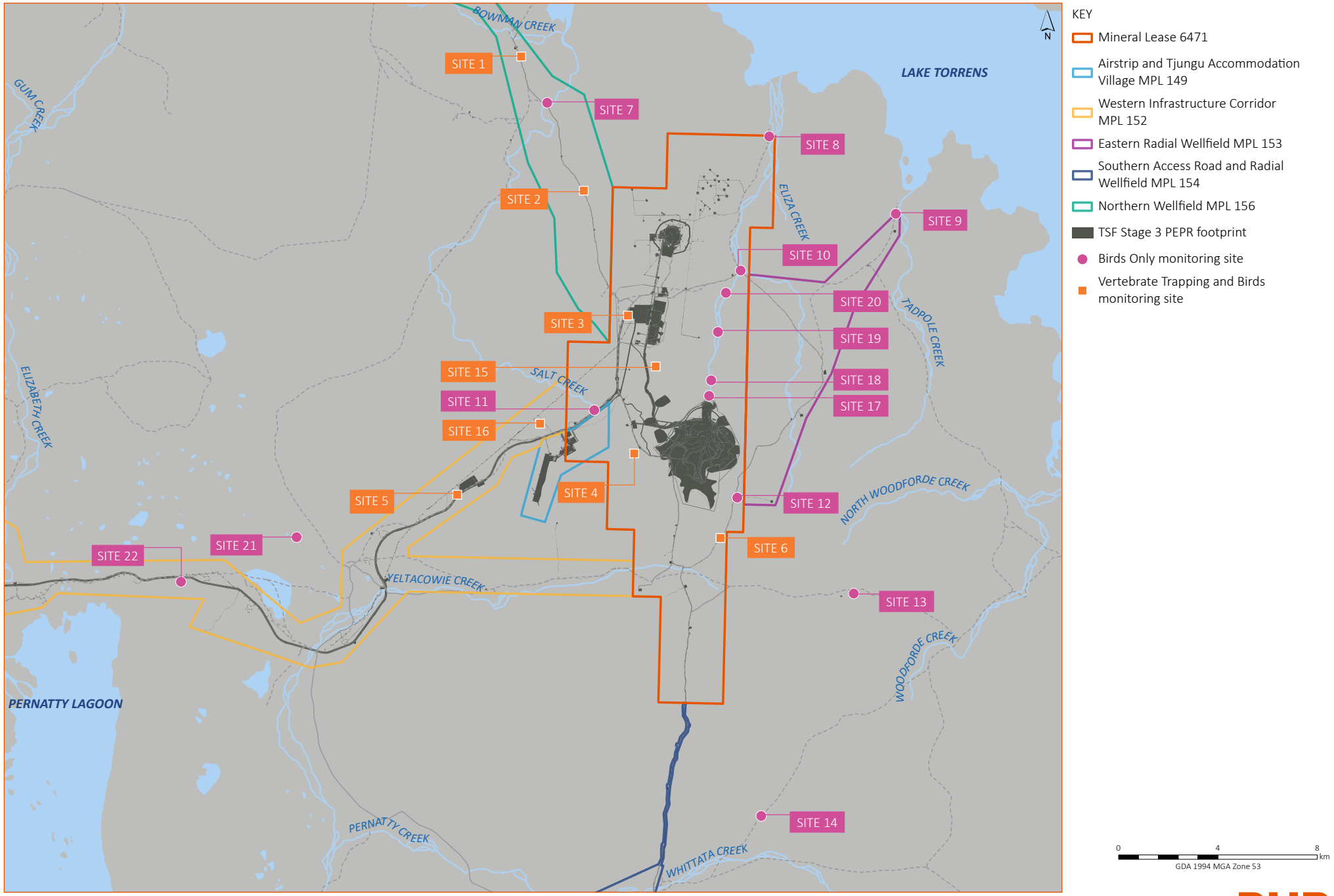


Figure 5.1 | Fauna monitoring locations

Carrapateena BHP

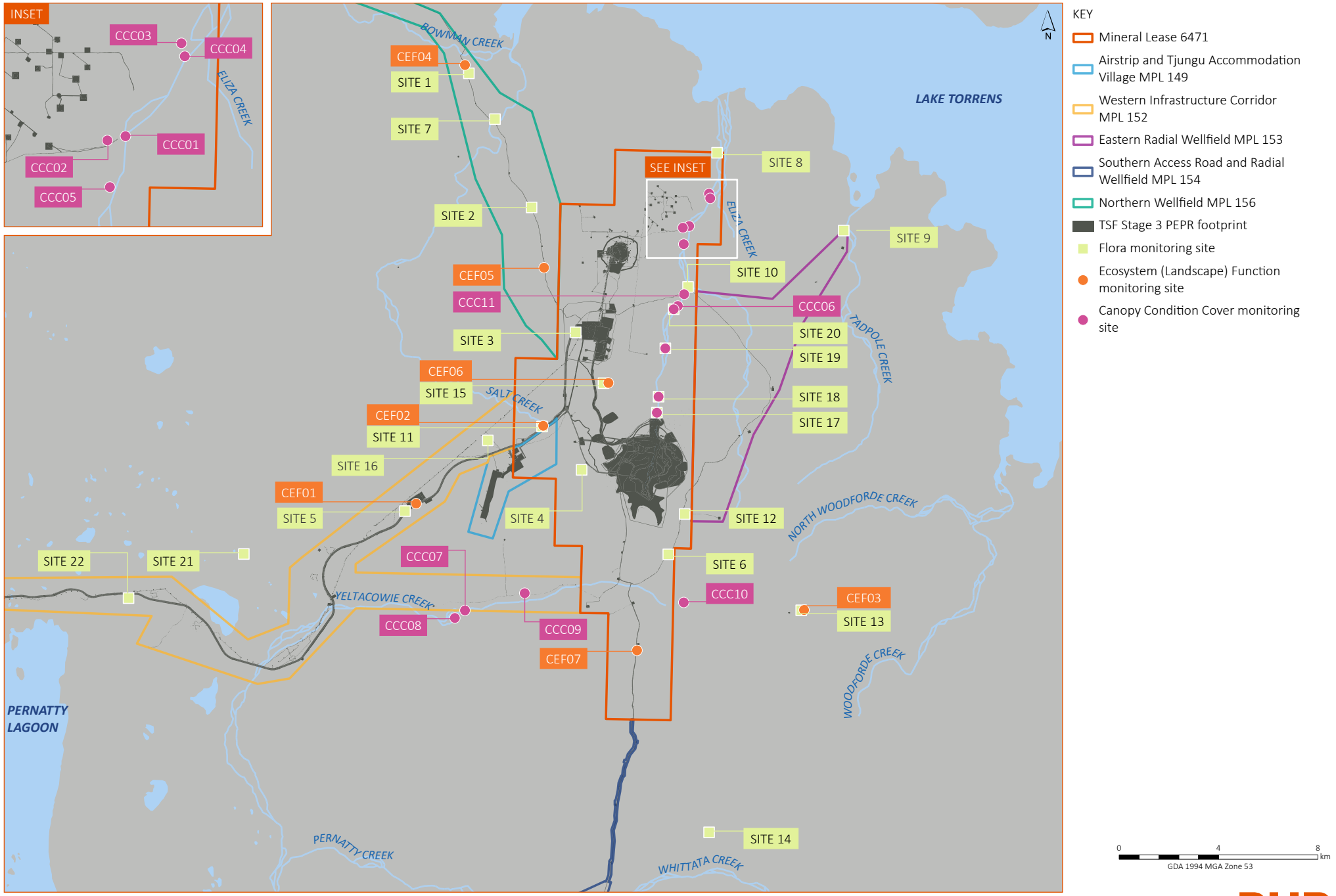


Figure 5.2 | Flora monitoring locations

Carrapateena BHP

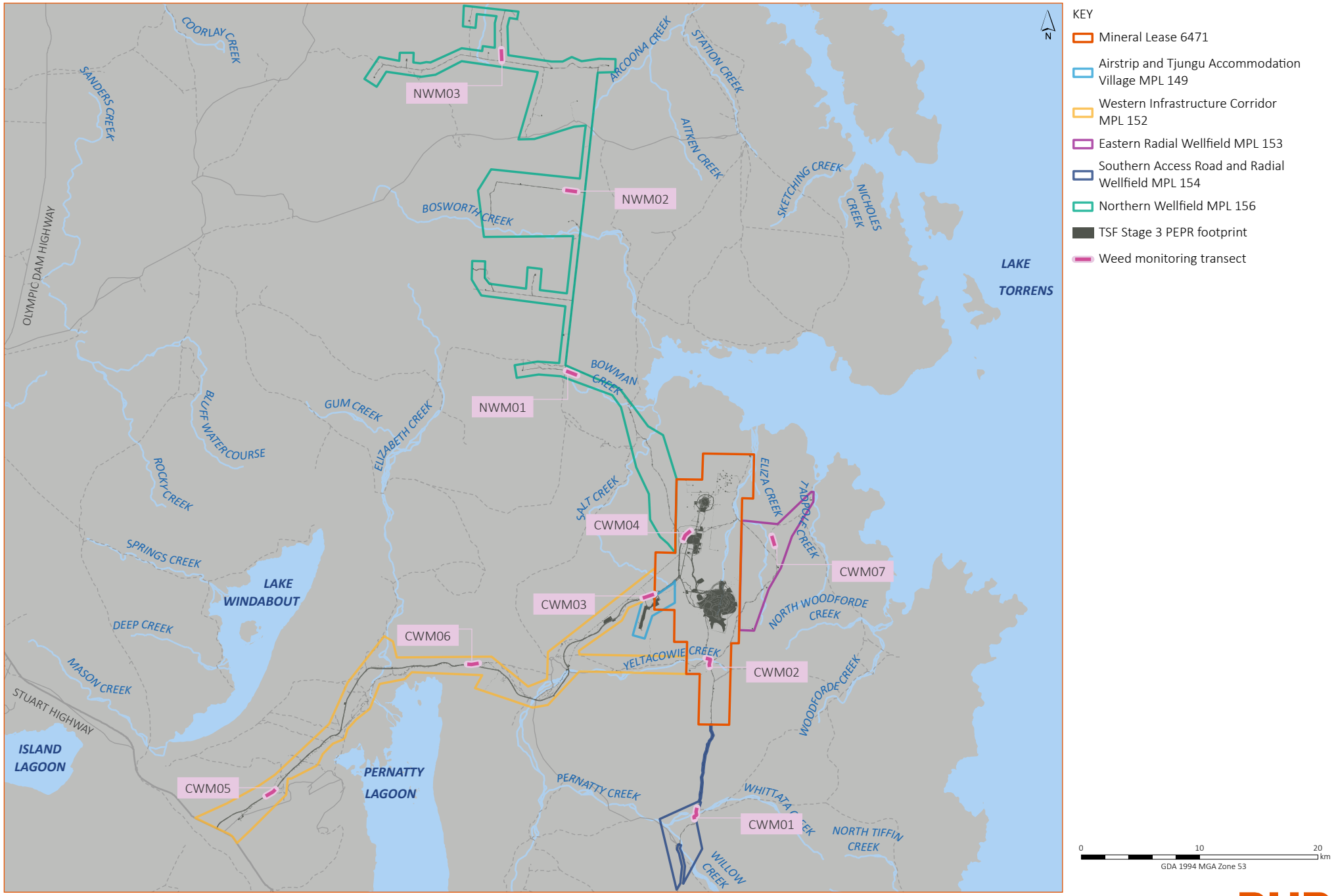


Figure 5.3 | Weed monitoring locations

Carrapateena BHP

AFRICAN RUE *(Peganum harmala)*

ATHEL PINE *(Tamarix aphylla)*

BUFFEL GRASS *(Cenchrus ciliaris)*

MESQUITE *(Prosopis juliflora)*

NEURADA *(Neurada procumbens)*

PARKINSONIA *(Parkinsonia aculeata)*

PRICKLY PEAR *(Opuntia sp.)*

PATTERSON'S CURSE *(Echium plantagineum)*

BATHURST BURR *(Xanthium spinosum)*

Imagery source:
African Rue – sourced online from weeds.nmsu.edu/photos/182.jpg, published by New Mexico State University (no date)
Athel Pine – sourced online from https://www.agric.wa.gov.au/sites/gateway/giles/styles/page_featured_image/public/Athel%20pine %20Tamarix%20aphylla%20flowers_Starr%20Environmental% 202003_0.jpg?itok=zPaBvKAx&c=f9351946d77a44477cabd195475100, published by the Government of Western Australia (no date)
Bathurst Burr – sourced online from https://en.wikipedia.org/wiki/Xanthium_spinosum, published by Wikipedia (2017)
Buffel Grass – sourced online from https://nt.gov.au/_data/assets/image/0004/229732/buffel-grass-habit.jpg (no date), published by the Northern Territory Government (no date)
Mesquite – sourced online from https://alchetron.com/Prosopis-juliflora-4103351-W, published by Alchetron (2017)
Neruada – sourced online from http://saseedbank.com.au/species_information.php?rid=3053, published by the SA Seedbank (2017)
Parkinsonia – sourced online from http://southwestdeserflora.com/WebsiteFolders/Images/Fabaceae/Parkinsonia%20aculeata,%20Jerusalem%20Thorn/9953Parkinsonia-aculeata650x407.jpg, published by South West Desert Flora (2015)
Prickly Pear – sourced online from https://www.greenoptimistic.com/wp-content/uploads/2010/04/prickly-pear-cactus-flowering.jpg, published by Green Optomistic (2017)
Patterson's Curse – sourced online from https://keyserver.lucidcentral.org/weds/data/media/Html/echium_plantagineum.htm, published by the Queensland Government (no date)

6. Significant Environmental Benefit

The NV Act provides for the management, enhancement and protection of native vegetation in South Australia. Native vegetation must not be cleared unless approval is granted by the NVC under the NV Act or it is permitted under the Native Vegetation Regulations 2017 (the Regulations). The Government of South Australia's Department for Energy and Mining (DEM) have delegated authority under the NV Act for the approval of the clearance of native vegetation associated with activities authorised under the Mining Act.

The NVC may give consent to the clearance of native vegetation under the NV Act if it is satisfied that actions will be taken that will result in an SEB. The achievement of an SEB is also a condition of approval for activities under Division 5 of the Regulations. An SEB is an action that results a positive impact on the environment that is over and above the negative impact of the clearance. An SEB can be achieved through the establishment (revegetation), management and/or protection of an area of native vegetation.

The NV Act provides four ways to achieve an SEB:

1. establishing and managing native vegetation on land (approved by the NVC)
2. protecting and managing existing areas of native vegetation on land (approved by the NVC)
3. entering into a Heritage Agreement which provides for ongoing protection of established native vegetation on land (approved by the NVC and Minister)
4. offset payment or engagement of an accredited third-party provider (through the purchasing of SEB credits) to achieve the SEB obligations on the behalf of the proponent.

Option 1, Option 2 and Option 3 are referred to as an 'on-ground SEB'. Option 4 is referred to as an 'SEB payment' principally into the NVF. The NVF is administered by the NVC and where funds paid in lieu of direct offsets to achieve an SEB are held. The NVC quarantines the funds collected in lieu of direct offsets and devolves these funds to accredited third parties who can demonstrate the capacity and skills to deliver the required offsets. Money paid into the NVF will be used by the NVC to establish, regenerate, preserve and maintain native vegetation on land in the same region of South Australia as the proposed clearance.

An on-ground offset may include the establishment of a new SEB area on land owned or controlled by the proponent, the use of existing SEB credit either previously established by the proponent or owned by another person or body, or delivered through the engagement of an accredited third-party provider to achieve the SEB obligation on behalf of the proponent.

Following the implementation of the mitigation hierarchy and the design and management controls to an Operation's activities, the approved activities associated within the Operation's tenements will result in the disturbance of native vegetation as described in Sections 4.1.5 and 4.2.6.

The originally approved Carrapateena Project SEB was assessed and calculated under historical arrangements, i.e. those outlined within the Guidelines for a Native Vegetation Significant Environmental Benefit Policy for the Clearance of Native Vegetation Associated with the Minerals and Petroleum Industry, MG16 (DWLBC 2005) (the Guidelines). The outcomes of the Carrapateena Project SEB assessment and the adopted approach to SEB offset are presented in Section 6.1. The new proposed clearance for the Operation, which was not considered by the original approval, was assessed and calculated in accordance with the current Native Vegetation Policy:

- Policy for a Significant Environmental Benefit under the *Native Vegetation Act 1991* and Native Vegetation Regulations 2017 (DEWNR 2020a)
- Guide for calculation a Significant Environmental Benefit (DEWNR 2020b)
- Guide for a Significant Environmental Benefit for the clearance of native vegetation associated with the Minerals and Petroleum Industry (NVC 2017a).

The Northern Wellfield Project SEB was assessed and calculated under current arrangements and based on guidance provided in the current Native Vegetation Policy at the time of the Northern Wellfield approval:

- Policy for a Significant Environmental Benefit under the *Native Vegetation Act 1991* and Native Vegetation Regulations 2017 (DEWNR 2016a)
- Guide for calculation a Significant Environmental Benefit (DEWNR 2016b)
- Guide for a Significant Environmental Benefit for the clearance of native vegetation associated with the Minerals and Petroleum Industry (NVC 2017a).

The outcomes of the Carrapateena SEB assessment are presented in Section 6.1, including the implication of new clearance (not previously contemplated by the PEPR), as presented in Section 6.1.6.

The outcomes of the Northern Wellfield Project SEB assessment and approach to SEB offset are presented in Section 6.2.

6.1 Carrapateena Project SEB

Section 6.1 presents the SEB calculations for the originally approved Project which is calculated under the former Native Vegetation Policy, and new proposed disturbance as introduced by Section 6.1.6, calculated under the current SEB methods (i.e. as presented later in Section 6.2.1 for Northern Wellfield).

6.1.1 SEB method

As per Guidelines for a Native Vegetation Significant Environmental Benefit Policy for the Clearance of Native Vegetation Associated with the Minerals and Petroleum Industry (DWLBC 2005), the approach to calculation of Carrapateena Project offset is as follows:

Payment ($) = (SEB Area x Land Value) + (Clearance Area x Land Management Cost)

Where:

- SEB Area = the SEB offset requirement based on a ratio of the condition of the land to be cleared and applied to the area of land to be cleared
- Land Value = average agreed land value of the land to be cleared
- Clearance Area = the area of land to be cleared
- Management Cost = $800/ha (regardless of the location of the land to be cleared).

Whilst assessed under the former Native Vegetation Policy, BHP's approach to SEB planning and delivery has adopted the principles of the current Native Vegetation Policy where possible.

6.1.1.1 SEB ratio

The land condition within the Carrapateena Project is described as having vegetation in good condition with little disturbance, low weed cover but with some existing grazing pressure. As a result, an SEB ratio of **8:1** was applied when calculating the required native vegetation offset. Under the former Native Vegetation Policy settings, if it can be demonstrated that ecological restoration activities will be achieved onsite after completion of mining and/or petroleum activities, then the initial SEB ratio may be reduced by 50%. The NVC would assess such requests on a case-by-case basis. This scenario as previously presented to and accepted by the NVC, would enable a reduced from 8:1 to 4:1. The revised land disturbance associated with the Carrapateena Project is 1,986.49 ha, of which all but the TSF and subsidence zone footprints (representing 736.97 ha) would be rehabilitated.

6.1.1.2 Land value

Advice from the Department of Environment and Water (DEW) indicated that a land value of $20/ha was appropriate for land disturbance outside of Council areas, and was considered to represent the costs associated with the purchase of small areas of land for offset purposes in the region. Note that the value of the total area associated with the Pernatty Pastoral Lease (including existing pastoral infrastructure – fencing, buildings, stock yards, water supply systems etc.) was assessed by OZ Minerals at around $14.70/ha.

6.1.1.3 Management costs

A management cost of $800/ha is specified within the Guidelines as being a flat rate representative of the work required to revegetate a disturbed area, taking into account variation associated with terrain, location, rainfall, preparation work required, soil types, etc. The management costs are only applied to the area to be cleared, not the SEB offset provision area.

6.1.2 SEB offset gateways

BHP proposes to reconcile SEB liability through a payment approach implemented via a series of gateways to ensure that appropriate SEB is in place prior to any native vegetation disturbance. The SEB offset gateways are summarised by Table 6.1 and discussed in Sections 6.1.3 to 6.1.8 below.

Native vegetation disturbance will not exceed the value of SEB credit established at any one time. If future tenements are granted that require additional land disturbance beyond the value of held SEB credit, further payments could be made as a component of the tenement-specific PEPR submission(s) (subject to separate approval).

Table 6.1 | SEB offset gateways and status

Gateway	Purpose	Approved disturbance limit	Native Vegetation Policy[1]	Current status
1	Offset existing land disturbance associated with RL activities, as per original RL approval	476 ha	Former	**Gateway 1 complete** (cleared and offset)
2	Offset for general land disturbance activities associated with Carrapateena Mine, as per original Carrapateena Project approval, and which will be subject to future rehabilitation (i.e. this clearance subject to offset discounting)	708.23 ha	Former	**Gateway 2 complete** (cleared and offset)
3	Offset for land disturbance activities associated with Carrapateena Mine, as per the original Carrapateena Project approval, the majority of which will form permanent features post-closure and will thus not be subject to future rehabilitation (i.e. this clearance is not subject to offset discounting)	1,012.38 ha	Former	**Gateway 3 in progress** (staged payment of clearance as required, primarily associated with developing subsidence zone and TSF footprints)
4	New land disturbance for Carrapateena Project not contemplated by original approval (as presented in Section 6.1.6)	1,187.87 SEB Points equivalent to 20.46 ha of on-ground disturbance (not yet approved)	Current	**Gateway 4 not yet commenced** (subject to approval of this NVMP)

1 Former Native Vegetation Policy refers to pre-July 2017 native vegetation offset calculation policy (NVC 2017a) which references offset ratios and hectares. Current Native Vegetation Policy refers to the current native vegetation offset calculation policy (DEWNR 2020a) which refers to SEB Points and approximate hectares (to be confirmed with selected offset area).

6.1.3 Gateway 1 – existing SEB

An initial SEB was established via payment in the NVF during the approvals associated with the granting of the RL 127 and the commencement of Advanced Exploration Activities. This offset covered the projected native vegetation disturbance of up to 476.15 ha as detailed in Table 6.2 and Table 6.3.

Table 6.2 | Retention Lease 127 SEB provision

Name	Area (m^2)	Land disturbance (ha)	Vegetation association	SEB ratio[1]	SEB offset area (ha)
Airstrip	586,688	59	Chenopod shrubland	8:1	469
Airstrip road	27913	3	Chenopod shrubland	8:1	22
Airstrip infrastructure	1,040,860	104	Chenopod shrubland	8:1	833
Access road	18,145	2	Eucalyptus Woodland[2]	8:1	15
Access road	74,816	7	Eucalyptus Woodland[2]	8:1	60
Camp	49,126	5	Chenopod shrubland	8:1	39
Future camp	198,374	20	Chenopod shrubland	8:1	159
Waste rock landform	698,181	70	Chenopod shrubland	8:1	559
Exploration activities	348,728	35	Chenopod shrubland	8:1	279
Decline corridor	1,186,067	119	Chenopod shrubland	8:1	949
Access road	417,376	42	Chenopod shrubland	8:1	334
Water well drill pads (18 pads nominally 80 x 80 m)	115,200	12	Chenopod shrubland	8:1	92

1 Based on good vegetation condition from surveys undertaken, little weed cover but some existing grazing pressure.
2 Note: Eucalyptus Woodland only associated with existing cleared roads where some widening and addition of buffers has occurred.

Table 6.3 | Retention Lease 127 SEB provision summary by vegetation association

Vegetation association	Area (m^2)	Land disturbance (ha)	SEB ratio[1]	SEB offset area (ha)
Chenopod shrubland	4,668,514	467	8:1	3,735
Eucalyptus Woodland[2]	92,961	9	8:1	74
SEB Total	**4,761,475**	**476**	**8:1**	**3,809**

1 Based on good vegetation condition from surveys undertaken, little weed cover but some existing grazing pressure.
2 Note: Eucalyptus Woodland only associated with existing cleared roads where some widening and addition of buffers has occurred.

A land value of $20/ha was agreed with the former DEWNR (now DEW) for the 476 ha of disturbance associated with the Retention Lease. Land management costs of $800/ha were based on an average known management cost as detailed in the DWLBC 2005 *'Guidelines for a Native Vegetation Significant Environmental Benefit Policy for the Clearance of Native Vegetation Associated with the Minerals and Petroleum Industry'*. The selected ratio for disturbance was 8:1. This was based on evidence of good vegetation condition, little weed cover and existing grazing pressure.

The payment made into the NVF for the RL SEB provisions was calculated as follows:

Land Value ($20/ha x SEB Area (3,809 ha @ 8:1 ratio) + [Management Costs ($800/ha) x Area to be cleared (476 ha)] = $457,101.55

The approved SEB provision included the consideration of native vegetation disturbance at a land condition ratio of 8:1. The calculation inputs described previously, relating to land value, disturbance ratio and management costs are still considered appropriate for the disturbance footprint.

As the vegetation association and conditions have not changed, the SEB calculation variables remain relevant. The total land disturbance associated with Gateway 1 did not exceeded 476.15 ha for which an SEB Area of 3,809 ha was approved. The existing SEB credit (associated with the Carrapateena Retention Lease Project; i.e. preliminary phase to the Carrapateena Project) has sufficient capacity to cover initial land disturbance through Gateway 1.

BHP has reached the limit of land disturbance and achieved Gateway 1 (refer Table 6.3).

Gateway 1 – SEB credit

Gateway 1 limit achieved and offset.

Native vegetation disturbance undertaken between Gateway 1 and Gateway 2 was only up to the total approved 476 ha, equivalent to an SEB Area 3,809 ha at average condition 8:1.

6.1.4 Gateway 2 – SEB

The SEB liability established in Chapter 4 was achieved partially through an offset payment and through purchase of third-party credits from Nature Foundation on Witchelina Station.

6.1.4.1 Calculation of Gateway 2 SEB

An SEB payment to the NVF and purchase of SEB credits from an accredited third-party provider has been made to offset native vegetation disturbance associated with Gateway 2.

At Gateway 2, BHP offset an additional 708.11 ha (approved for a maximum of 708.23 ha) of native vegetation disturbance at an average condition rating of 8:1. This value will be subject to rehabilitation (refer Section 6.1.1 SEB ratio above), and if approved, qualifies for a 50% discount (i.e. a reduction of initial SEB condition ratio from 8:1 to 4:1). An on-ground disturbance of 708.11 ha at 4:1 equates to an SEB Area of 2,832 ha.

Gateway 2 payment into the NVF to offset 708.11 ha of native vegetation disturbance is calculated as follows:

([SEB Area: 2,832] X [Land Value: 20]) + (708.11 x [Land Management Cost: 800]) = $623,137

The change to upper limit of approved SEB credit at Gateway 2 is summarised below.

Gateway 2 – SEB Offset

Following Gateway 2:

- Approved limit of native vegetation disturbance increases to 1,184 ha (476.15 ha + 708.11 ha).
- Limit of SEB Area liability increases to 6,642 ha (3,809.2 ha + 2,832.44 ha).

Gateway achieved when an SEB Area of 2,832 ha is offset by a payment(s) totalling $623,137 to the NVF and/or offset through the purchasing of SEB credits from an accredited third-party provider.

Native vegetation disturbance undertaken between Gateway 2 and Gateway 3 is up to a total of 1,184 ha.

Gateway 2 development has been completed and offset by purchase of credits from approved third-party offset provider; Nature Foundation (NF) (Witchelina Station).

6.1.5 Gateway 3 – SEB

For Gateway 3, BHP proposes to offset up to 986.06 ha of native vegetation at an average condition rating of 8:1, consisting primarily of native vegetation disturbance associated with the development of the Western Access Road, TSF, subsidence zone, and Mount Gunson Substation Figure 4.9). A land disturbance of 986.06 ha at 8:1 equates to an SEB Area of 7,888.48 ha.

To achieve Gateway 3, BHP will seek to offset the balance of SEB liability through the staged purchase of SEB credits. Credits will be purchased from Witchelina Station, a conservation property leased and operated by accredited third-party provider NF, at a cost determined by commercial agreement.

6.1.5.1 Gateway 3 staging

It is noted that the rate of progression of Gateway 3 will be closely linked to the rate of mining, and the progressive formation of the subsidence zone and TSF footprint. On 17 November 2018, NF (known then as Nature Foundation South Australia or NFSA) and BHP (OZ Minerals at the time of signing) signed a Deed for Purchase reserving sufficient SEB credit for an initial Gateway 3.1, which accommodated 250 ha of land disturbance at an average condition rating of 8:1, requiring an offset of 2,000 ha SEB Area.

The staging of further purchases under Gateway 3 will occur over the life of mine in accordance with the development of the Carrapateena Project (Table 6.4). With each staged purchase, NF will provide BHP with a letter of purchase signifying a change in ownership of the specified quantity of SEB credits from NF to BHP, and this will be forwarded on to DEM (as per Figure 6.1).

Table 6.4 | SEB offset staging to achieve Gateway 3

Stage	Demonstration of SEB	SEB area (ha)	Revised land disturbance limit(ha)	Revised SEB area liability limit (ha)
3.1	Credits to be purchased from accredited third-party provider	2,000	(1,184.26 + 250) = 1,434.26	(6,641.64 + 2,000) = 8,641.64
3.X[1]	Credits to be purchased from accredited third-party provider	5,888	(1,434.26 + 736.06) = 2,170.32	(8,641.64 + 5,888.48) = 14,530.12

1 Staging of future payment(s) under Gateway 3 to be determined and will occur over the remaining life of mine in alignment with the rate of mining.

The change to upper limit of approved SEB credit is summarised below.

Gateway 3 – Purchase of third-party SEB credits

Following Gateway 3:

- Approved limit of native vegetation disturbance increases to 2,170 ha (1,184.26 ha + 986.06 ha).
- Limit of SEB Area liability increases to approximately 14,530.12 ha (8,641.64 ha + 5,888.48 ha) at an average condition rating of 8:1.

Gateway achieved when SEB Liability is offset through staged purchase of existing SEB credits from NF's Witchelina Station.

Notification of each staged purchase of offset credits will be provided.

Native vegetation disturbance can be undertaken up to the land disturbance area used to calculate SEB Offset Liability.

6.1.6 Gateway 4 – SEB

Gateway 4 describes proposed native vegetation disturbance being undertaken in association with the Carrapateena Project. As described by the previous PEPR, 20.46 ha of disturbance for the following three items was not contemplated prior to 1 July 2017, and so was assessed and approved under revised Native Vegetation Policy and guidelines (as summarised below in Section 6.2.1):

- Western Access Road to Minerals Processing Plant access road expansion (11.63 ha)
- TSF tailings pipeline duplication adjacent the TSF haul road (8.02 ha)
- WAT-49 groundwater pad expansion (0.80 ha).

To date, BHP has offset 1,187.87 SEB points and cleared a total of 20.46 ha under Gateway 4 (Table 6.5).

Table 6.5 | SEB offset staging to achieve Gateway 4

Rep. Site	Vegetation Association	UBS	TBS	Site (ha)	SEB points required
CAR023	*#1 Atriplex vesicaria* (Bladder Salt Bush) +/- *Tecticornia medullosa* (Samphire) Low Open Shrubland	55.28	1,130.49	20.45	1,187.02
CAR024	*#7 Acacia papyrocarpa* (Western Myall ssp.) Vey Low Woodland over *Atriplex vesicaria* (Bladder Saltbush) +/- *Ptilotus obovatus* (Silver Mulla Mulla), *Dodonaea lobulata* (Lobe-leafed Hop Bush), *Acacia tetragonophylla* (Dead Finish) and *Eremophila* spp. (Emu Bush) in drainage depressions	80.98	[0.81]	[0.01]	[0.85]
CAR025	*#7 Acacia papyrocarpa* (Western Myall ssp.) Vey Low Woodland over *Atriplex vesicaria* (Bladder Saltbush) +/- *Ptilotus obovatus* (Silver Mulla Mulla), *Dodonaea lobulata* (Lobe-leafed Hop Bush), *Acacia tetragonophylla* (Dead Finish) and *Eremophila* spp. (Emu Bush) in drainage depressions	79.72	[0.80]	[0.01]	[0.84]
	Average (Vegetation Association #7)	**80.35**	**0.81**	**0.01**	**0.85**
	Total (Vegetation Association #1 and Avg. #7)	**-**	**1,131.20**	**20.46**	**1,187.87**

6.1.7 Gateway Summary

Table 6.6 summarises the estimated vegetation disturbance, SEB area liability and preferred method for offset by Gateway as presented in the sections above.

Table 6.6 | Estimated vegetation disturbance and SEB liability by Gateway

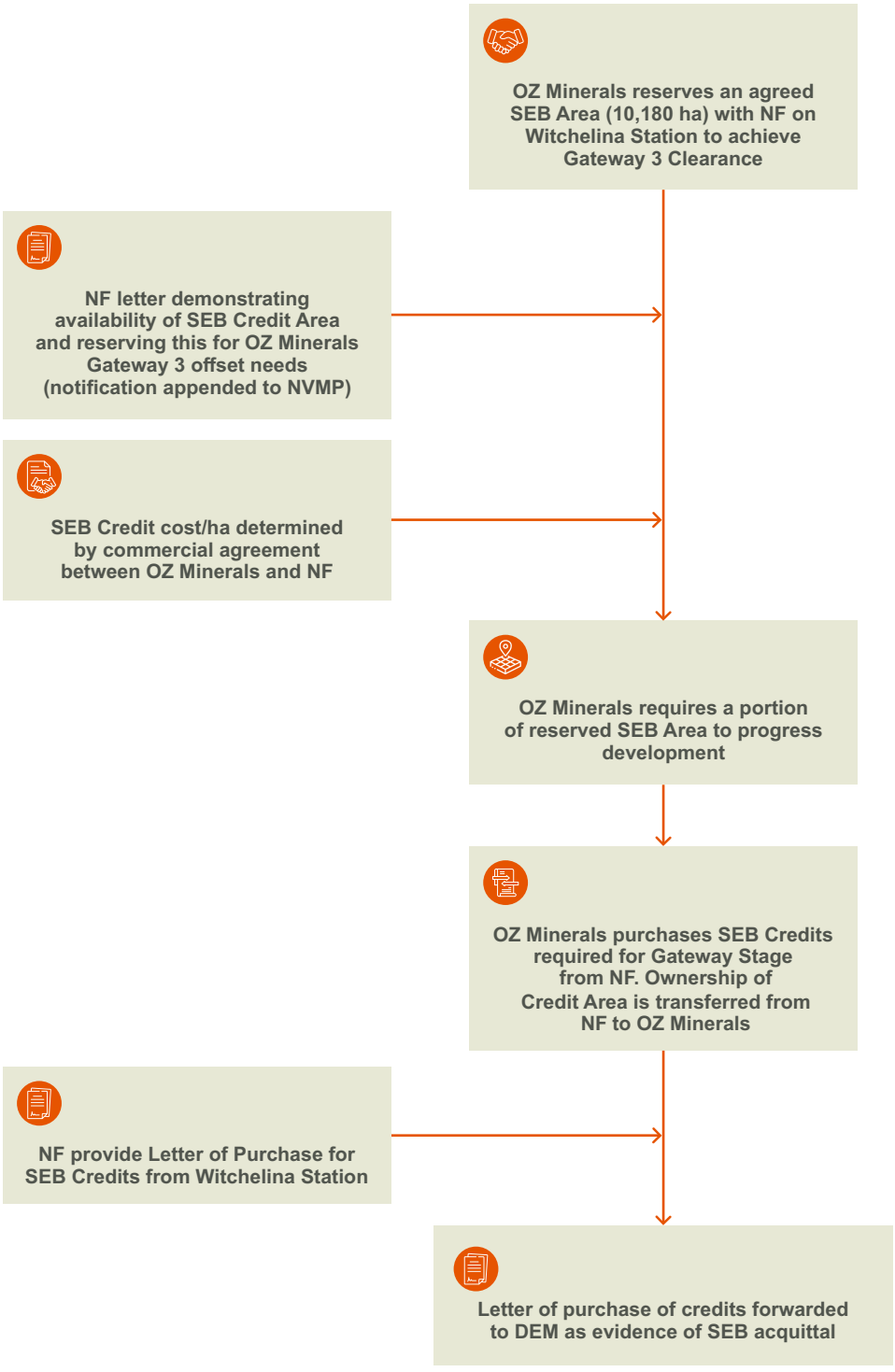
Gateway	Estimated disturbance (ha)	Applied ratio	SEB area (ha) / SEB points (pts)	Preferred SEB offset method
1	476.15	8:1	3,809.20 ha	Payment to NVF
2	708.11	4:1	2,832.92 ha	Payment to NVF / purchase of SEB credits from NF
3	986.06	8:1	7,919.44 ha	Staged purchase of SEB credits from NF
4	20.46	n/a	1,187.87 pts	Purchase of SEB credits from third party (NF)

6.1.8 Gateway 3 and Gateway 4 SEB offset pathway

To achieve Gateway 3 and Gateway 4, BHP will seek to offset the balance of SEB liability through purchasing SEB credits. Credits have or will be purchased from Witchelina Station, a conservation property leased and operated by accredited third-party provider NF, at a cost determined by commercial agreement. NF have provided a letter confirming that they have sufficient offset credit available, the total value of which will be reserved upfront by NF for staged purchase by BHP.

With each purchase of credits, the NF will provide BHP with a letter of purchase signifying a change in ownership of the specified quantity of SEB credits from NF to BHP, and this will be forwarded on to DEM. Land disturbance will not exceed the SEB credit established.

If appropriate third-party SEB credits cannot be purchased, BHP will seek to offset Gateway 3 and Gateway 4 SEB liability through staged payment into the NVF.



Note: formerly OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd, each wholly owned by BHP Lonsdale Investments Pty Ltd, and collectively referred to as BHP

Figure 6.1 | Carrapateena third-party SEB credit purchase and notification pathway

6.2 Northern Wellfield Project SEB

6.2.1 SEB method

The SEB required is calculated using Rangeland Assessment data of the proposed vegetation (noting the disturbance is occurring in the SAAL NRM region):

- SEB points required = Unit Biodiversity Score x area of clearance x 0.05%
- SEB payment = Hectares X management cost X rainfall factor X economies of scale
- Hectares = SEB points required divided by 8
- Management Cost = $20,000 (standard)
- Rainfall factor = annual rainfall (mm) for the region divided by 1,000
- Economies of scale = depends on NRM region e.g. SAAL is 0.125.

6.2.2 SEB points required

The SEB points required to offset the native vegetation disturbance by specific vegetation associations is summarised in Table 6.7

Table 6.7. This summary is based on information required per RAM site (as per Section 4.2.2) and calculated as per the NVC SEB Policy (DEWNR 2016b). For these estimates, the ‘block’ includes the total clearance area / footprint (237.51 ha), and each ‘site’ was the area of vegetation association within that footprint.

The approved Northern Wellfield MLP MP (OZ Minerals 2018b) originally estimated a land disturbance footprint of 237.51 ha, with 16,210 SEB points offset.

Native vegetation disturbance for the Northern Wellfield Area has not and will not exceed approved land disturbance and SEB points as described by the Northern Wellfield MPL MP (OZ Minerals 2018b).

Table 6.7 | SEB points required to offset native vegetation disturbance

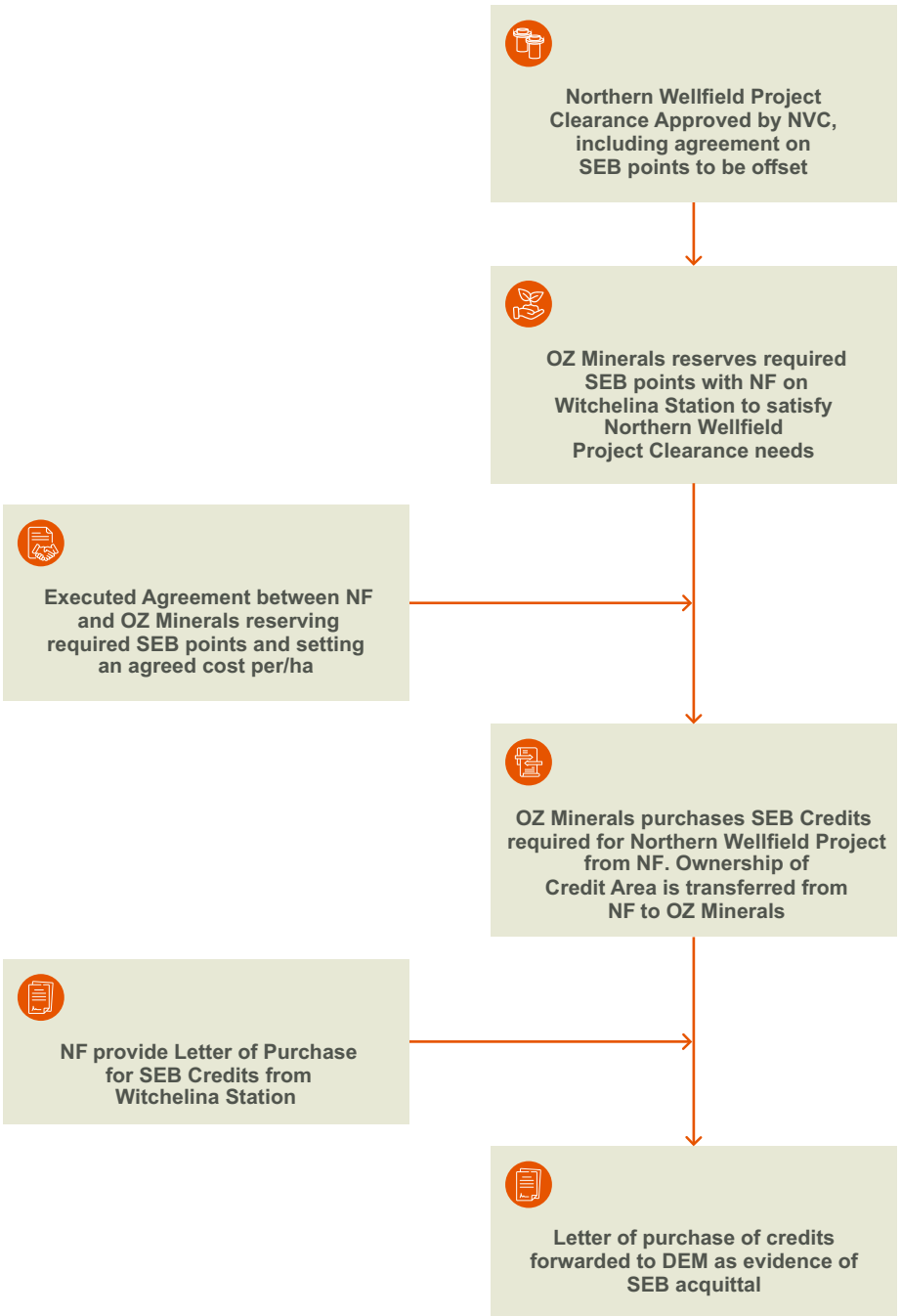
VA#	NW vegetation association	RAM sheet #[1]	Site / area proposed to be cleared (ha)	Average UBS	TBS	Loss Factor	SEB points required
1	Chenopod mixed shrubland	NW 1 – NW 5	206.62	63.75	13,171.31	1	13,829.88
2	Swamp Canegrass tussock grassland	NW 6 – NW 7	5.36	60.52	324.47	1	348.69
3	Western Myall low open woodland	NW 8	22.16	76.29	1,690.63	1	1,775.16
4	Umbrella Bush / Sandhill Canegrass	NW 9	3.37	70.46	237.46	1	249.33
		Total	**237.51**	**67.76**	**15,423.87**	**-**	**16,203.06**

1 SEB points required as per RAM scoresheet summaries, which automatically includes 5% gain to offset loss.

6.2.3 SEB offset pathway

BHP have offset SEB liability through purchasing SEB credits from Witchelina Station, a conservation property leased and operated by accredited third-party provider NF, at a cost determined by commercial agreement. On 17 November 2018, NF (known then as NFSA) and BHP (OZ Minerals at the time of signing) signed a Deed for Purchase, reserving sufficient SEB credits for OZ Minerals as required to satisfy the Northern Wellfield Project activities. SEB credits equivalent to 16,203 SEB Points (original SEB offset estimate as in OZ Minerals 2018b) were purchased in April 2019 from the approved Nilkidicana Paddock on Witchelina Station.

BHP has progressed the purchase of SEB credits in accordance with the pathway described by Figure 6.2. NF provided a letter of purchase signifying a change in ownership of the specified quantity of SEB credits from NFSA (now NF) to OZ Minerals (now BHP), and this letter was forwarded to DEM.



Note: formerly OZM Carrapateena Pty Ltd and OZ Minerals Carrapateena Pty Ltd, each wholly owned by BHP Lonsdale Investments Pty Ltd, and collectively referred to as BHP

Figure 6.2 | Northern Wellfield third-party SEB credit purchase and notification pathway

6.3 Plains Mouse offset – EPBC Act

Further to Carrapateena SEB offsetting (Section 6.1), an on-ground environmental offset as per Condition 2, Schedule 2 of ML 6471 is required by the EPBC Act to address residual impact of the mining operations on existing plains mouse (*Pseudomys australis*) habitat. BHP commit to delivering an on-ground offset of at least 1,740 ha of suitable plains mouse habitat, which will be described in detail by the offset management plan (under development).

An agreement to underlease has been executed reserving two suitable areas within 100 km of the mine site development and in excess of the required 1,740 ha, on South Gap Station. Survey works (i.e. land, cultural heritage and ecological) have been undertaken to satisfy conditions of the agreement to underlease, and it is intended to manage the Northern Offset to satisfy current approval conditions as per Condition 2, Schedule 2 of ML 6471, and the Southern Offset area as an advanced offset for Plains Mouse to support future regional works. The Northern Offset area is under active management by NF.

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7.2 Abbreviated terms

7.2.1 Abbreviations and acronyms

Table 7.1 | Definition of acronyms

Abbreviation	Description
AHD	Australian Height Datum
BDBSA	Biological Database of South Australia
DEM	Government of South Australia, Department for Energy and Mining
DEW	Government of South Australia, Department for Environment and Water
DEWNR	Government of South Australia, Department of Environment, Water and Natural Resources
DPC	Government of South Australia, the Department of the Premier and Cabinet
DWLBC	Department of Water, Land and Biodiversity Conservation (see DEWNR)
EL	Exploration Licence
EML	Extractive Minerals Lease
EMS	Environment Management System
EPEPR	Exploration Program for Environment Protection and Rehabilitation
ERML	Environmental Radiation Monitoring Location
IBRA	Interim Biogeographic Regionalisation for Australia
KAC	Kokatha Aboriginal Corporation
ML	Mineral Lease
MLP	Mining Lease Proposal
MNES	Matters of National Environmental Significance

Abbreviation	Description
MP	Management Plan
MPL	Miscellaneous Purposes Licence
NEPC	National Environment Protection Council
NF	Nature Foundation, formerly known also as Nature Foundation South Australia (NFSA)
NFSA	Nature Foundation South Australia
NRM	Natural Resource Management
NTMA	Native Title Mining Agreement
No.	Number
NVC	Native Vegetation Council
NVF	Native Vegetation Fund
NVMP	Native Vegetation Management Plan (this document)
OMC	Outcome Measurement Criteria
PELA	Petroleum Exploration Licences Applications
PEPR	Program for Environment Protection and Rehabilitation
PMST	Protected Matters Search Tool
RAM	Rangelands Assessment Method
RL	Retention Lease
SAAL	South Australian Arid Lands
SAG	South Australian Government, for the purpose of reference citation
SARIG	South Australian Resources Information Gateway
SEB	significant environmental benefit
SLC	sub-level cave
SLOS	sub-level open stoping
TBC	to be confirmed
TBS	Total Biodiversity Score
TSF	tailings storage facility
UBS	Unit Biodiversity Score
WPA	Woomera Prohibited Area

7.2.2 Units of measure

Table 7.2 | Units of measure

Unit	Description
%	per cent
$	Australian currency in dollars
ha	hectare
km	kilometre
km^2	kilometre squared
m	metre
m^2	metre squared

Unit	Description
mAHD	metres above Australian Height Datum
mm	Millimetre

BHP

APPENDICES

APPENDIX A EPBC ACT PROTECTED MATTERS SIGNIFICANCE ASSESSMENT, NORTHERN WELLFIELD, CARRAPATEENA

EPBC Act Protected Matters Significant Impact Assessment

Northern Wellfield Carrapateena

OZ Minerals

IW104000-0000-NE-RPT-001 | FINAL

28 May 2018

EPBC Act Protected Matters Significant Impact Assessment

Project No:	IW104000
Document Title:	Significant Impact Assessment, Northern Wellfield
Document No.:	IW104000-0000-NE-RPT-001
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Date:	28 May 2018
Client Name:	OZ Minerals
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Executive Summary

OZ Minerals propose to construct a project wellfield to support the mining operations (the Project) authorised under State Government Approval (ML6471) and EPBC Referral (2017/7895). The wellfield is to be located to the north of the Project and is referred to as the Northern Wellfield.

The proposed Northern Wellfield would include access roads, pipeline corridors, staging tanks and construction of well heads and pumps. Access will be achieved through the existing access road that connects to the existing mining operations, and any impacts to groundwater or resulting indirect impacts to ephemeral lake systems have already been assessed in EPBC Referral 2017/7895.

This report presents the findings of a detailed assessment of Protected Matters listed under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) which are relevant to the Carrapateena Northern Wellfield. The assessment involved a review of the likelihood of occurrence of Protected Matters in the area, followed by a detailed assessment of the potential for significant impacts upon those Protected Matters which were considered likely to be present within the study area, or as possible occurrences within the study area.

No Threatened Ecological Communities were identified within the study area.

One plant species was identified as potentially present based on a review of the Protected Matters database, *Frankenia plicata*. This species was considered possibly present, but only as scattered individuals rather than as part of an important population of the species. Recent scrutiny of the closest historic records of this species to the site, undertaken as part of the targeted EPBC protected matters habitat assessment at the site (Jacobs 2018a), has raised doubts about the validity of the records, and the State herbarium has now indicated that the voucher specimens were likely mis-identified and are not *F. plicata.* With the implementation of the proposed mitigation measures, including micro-placement of well pads, pipelines and track alignments to avoid any Protected Matters present, no significant impacts are anticipated to this plant species as a result of the project.

Four threatened fauna species, including three birds and a single mammal were identified as potentially present in the study area based upon a review of the Protected Matters database.

Three of these threatened species, the Thick-billed Grasswren (eastern species), Curlew Sandpiper and Night Parrot were considered to possibly be present at the site, despite these species not being detected during extensive baseline and targeted survey effort of the Carrapateena study area, including survey effort specifically targeting the Northern Well field area. The proposed activity is predicted to result in no significant impacts to any of these three fauna species as a result of the project, since the development does not significantly reduce the area of occupancy, fragment any populations, or substantially reduce the size of any population. Existing infrastructure in the area means that the introduction of new weed species or an increase in pest numbers as a result of the project is unlikely. Successful implementation of proposed mitigation measures, including targeted site walkovers prior to construction to identified locations of any preferred habitat, would result in a further reduction of impacts to any matters of national environmental significance which are possibly present.

The fourth threatened species, The Plains Mouse, was considered likely to be present within the project and study area based upon historic records within the Carrapateena project area, an irruptive life-cycle, and a broad distribution throughout arid South Australia. The proposed activity is predicted to result in no significant impacts to Plains Mouse since the development does not significantly reduce the area of occupancy, fragment the population, or substantially reduce the size of the population. Successful implementation of proposed mitigation measures, including targeted site walkovers prior to construction to identified locations of important refuge habitat, would result in a further reduction of impacts to Plains Mouse, and therefore no significant impacts are anticipated to this species as a result of the project.

Seventeen migratory species were assessed in the review (nine highlighted in the PMST, eight highlighted in the Biological Database of South Australia output). Avoidance of ground impacts to ephemeral lakes and wetland habitat, would reduce the probability of bird collisions or impacts to preferred habitat of migratory species, and therefore no significant impacts are expected to migratory species as a result of the project.

Important note about your report

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client; OZ Minerals, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and OZ Minerals. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

The sole purpose of this report and the associated services performed by Jacobs is to document results of desktop assessments of potential impacts upon EPBC listed species for the proposed Northern Wellfield at Carrapateena. The report is based on a desktop review of available data and documents. The scope of services, as described in this report, was developed with the Client, OZ Minerals.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs collected and reviewed data and information sourced from the OZ Minerals and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

1. Introduction

1.1 Background

OZ Minerals propose to construct a project wellfield to support the mining operations (the Project) authorised under State Government Approval (ML6471) and EPBC Referral (2017/7895). The project wellfield is to be located to the north of the Project and is referred to as the Northern Wellfield. The location of the Northern Wellfield is shown in Figure 1.

The proposed Northern Wellfield would include access roads, pipeline corridors, staging tanks and construction of well heads and pumps. Access will be achieved through the existing access roads that connect to the existing mining operations. Existing access tracks will be widened where required.

In order to develop the project, consideration of the requirements under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) is required, including a self-assessment of the potential for significant impacts to matters protected under the Act. This report presents desktop finding (including review of a recent survey report undertaken by EBS (2018)) for species and ecological communities which are protected under the EPBC Act (as Protected Matters) that are relevant to the project. Target Protected Matters are those which are considered to potentially occur at the site, or those which have previously been identified within close proximity to the site. An assessment of the likelihood of occurrence for each Protected Matter is made, and consideration of the potential for significant impacts is undertaken for those considered 'likely' to be present, or those whose presence is considered 'possible'.

The proposed action (i.e. the subject of the EPBC Referral consideration) will consist of:

- Establishing pumping infrastructure (e.g. diesel tanks, gensets, well metering) at each production groundwater well within the area previously cleared as a component of the groundwater exploration works. There is no additional land clearance associated with the installation of this infrastructure.
- Establishing water distribution infrastructure, including associated land disturbance, connecting each groundwater well to the mining operation raw water storages approved under EPBC Referral (2017/7895), specifically:
  - The installation of water pipelines
  - The installation of staging complexes along the pipeline corridors
  - The construction of access tracks or widening of existing access tracks where required
  - The construction of pipeline laydown areas

The groundwater production wells are equipped with submersible pumps, flow meters, telemetric controls, pole-mounted transformer, contactors and a motor starting panel.

It is noted that groundwater drawdown and other potential impacts to groundwater associated with the entire mining operation have been assessed separately under EPBC referral (2017/7895) and therefore any direct or indirect impacts associated with this are not considered in the assessment covered here.

This desktop study has focused on EPBC listed flora and fauna species and ecological communities and includes an assessment of the likelihood of their occurrence on or adjacent to the proposed Northern Wellfield. The assessment is supported by information derived from a targeted site assessment of relevant habitat types within the project footprint. This report describes potential impacts on listed species arising from the construction and operation of the Northern Wellfield and provides mitigation measures proposed to avoid or reduce potential impacts. An assessment of the potential residual impacts against the EPBC Significance Criteria has also been provided, assuming the mitigation measures outlined are implemented.

1.2 Objectives of Study

The purpose of this study was to:

- Identify species or ecological communities protected under the EPBC Act which may be present within the footprint of, or in close proximity to, the Northern Wellfield, Carrapateena.
- For each species or community identified as likely to be present, or as possibly present, to undertake as assessment of whether significant impacts are considered likely to result from the proposed action.

2. Desktop Study Methodology

The study area for this desktop assessment includes the proposed Northern Wellfield project area, plus search buffers as defined below. The Northern Wellfield project area is shown on Figure 1 below.

The desktop study reviewed information from a range of sources including:

- An EPBC Act Protected Matters database search covering the proposed wellfield and study area (i.e. a 10 km buffer to the project area). Protected Matters report presented in Appendix A.
- A Biological Database of South Australia (BDBSA) search extract covering a study area of 50 km radius from the project site, due to the highly limited number of ecological studies within 10 km of the project area.
- A review of relevant reports, reference materials and published papers from the project region, including:
    - The targeted assessment of habitats within the Northern Wellfield project footprint (Jacobs 2018a, attached here as Appendix B)
    - The Northern Wellfield Ecological Report Carrapateena (EBS 2018, version 1);
    - Baseline surveys and biannual monitoring reports at the southern Carrapateena survey sites (EBS 2008; EBS 2013 a,b,c; EBS 2014 a, b,c,d, e; EBS 2015 a,b; EBS 2016 a,b; EBS 2017 a,b)
    - Targeted Surveys at the Carrapateena site (Thick-billed Grasswren and identified *Sclerolaena,* EBS 2014a; Night Parrot and *Frankenia plicata*, Jacobs 2018b)
    - other publications and government documents relating to individual species, or recovery plans for threatened species;
    - vegetation mapping of the study area in previous reports review of publically available imagery;
    - Threatened species profiles, reference texts and published material.

This assessment presents information on the flora and fauna species that are known to, or have the potential to, occur within the study area given the habitat types present. Flora and fauna identified as potentially occurring through conservative database searches were assessed for their actual likelihood to occur within the study area. The likelihood of occurrence has been defined as:

- Likely – based on the presence of suitable habitat and multiple recent database records from the study area or immediate proximity within the last twenty years;
- Possible – suitable habitat is present for the species, but no or very limited recent (last twenty years) database historic record(s) exist from the study area or proximity;
- Unlikely – there is a lack of suitable habitat for the species (or community) and a lack of proximate historic records which indicate previous or current occurrence.

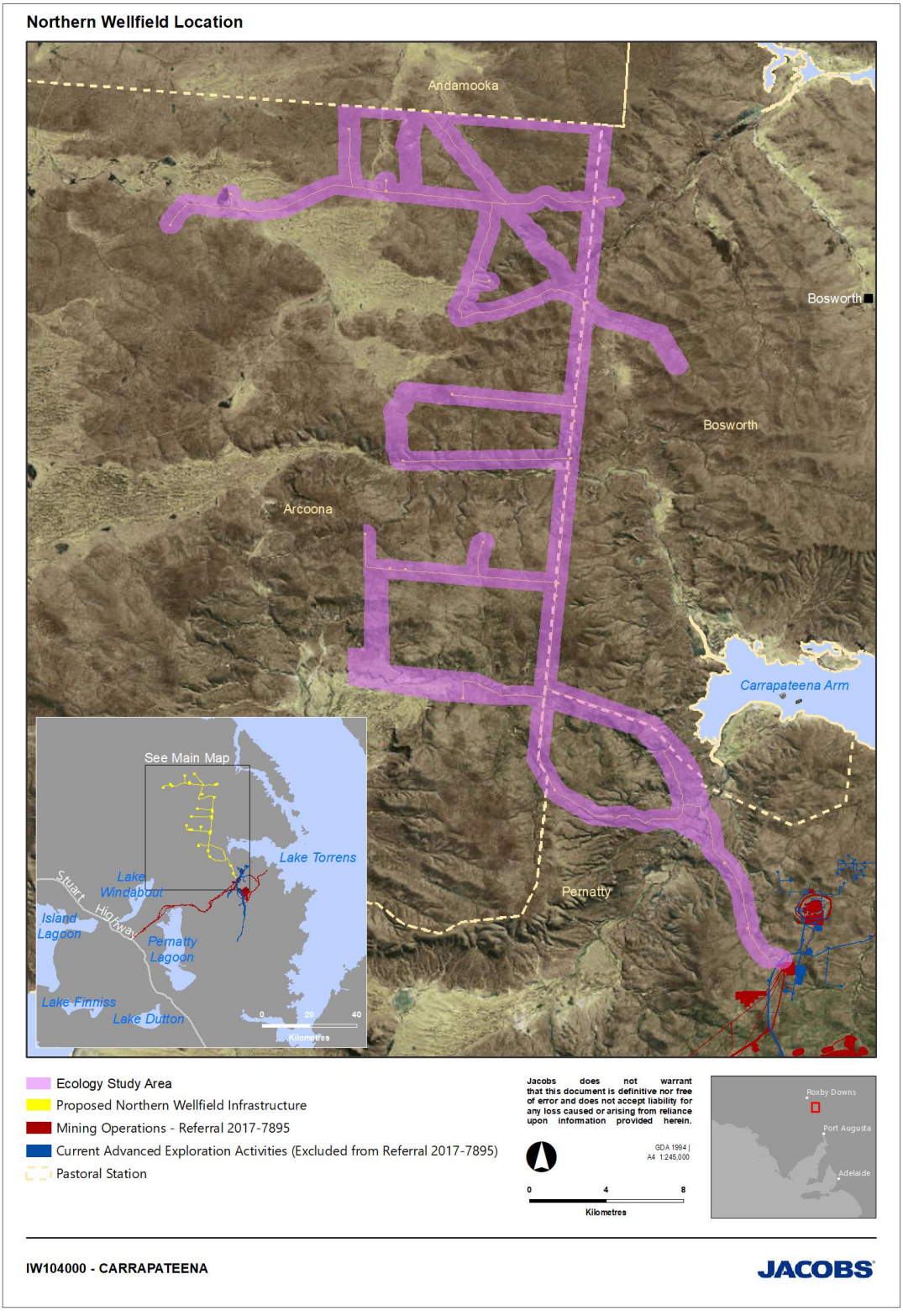

Figure 1 Carrapateena Northern Wellfield: Locality Map

3. Results

3.1 EPBC Threatened Ecological Communities

No Threatened Ecological Communities (TECs) were identified within the vicinity of the Northern Wellfield by the review of the EPBC Act Protected Matters database, accessed via the online search tool (13 March, DOEE 2018). Previous assessments of the broader study area (Jacobs 2018a; EBS 2008; EBS 2013 a,b,c; EBS 2014 b,c,d; EBS 2015 a,b; EBS 2016 a,b; EBS 2017 a,b) also did not identify any TECs within the broader area. As such, TECs are not considered further in this report.

3.2 EPBC Threatened Flora Species

The EPBC Protected Matters Search Tool (PMST) output for the study area (the Northern Wellfield at Carrapateena and a 10 km buffer, Appendix A) indicated that one threatened plant species, or its preferred habitat, have the potential to occur in the study area, namely; *Frankenia plicata* (Southern Sea-heath).

BDBSA records for threatened flora species (and listed migratory and fauna species) are shown in Figure 2 below. The likelihood of occurrence for EPBC listed flora species and justification for the likelihood of occurrence is summarised in Table 1 below.

Table 1 EPBC Listed Threatened flora potentially occurring within the study area

Species Name	Common Name	EPBC Act[1]	NPWS Act[2]	Likelihood of Occurrence	Justification[3]
Plants					
Frankenia plicata	Southern Sea-heath	EN	V	Possible	EPBC PMST suggests species or species habitat known to occur. This species is a low mat-forming shrub. Its preferred habitat is minor drainage lines and outwash plains with stony surfaces and loamy sand or clay sand soils. Most records are from the Stony Plains bioregion, particularly the Breakaways and Stuarts Range north east of Coober Pedy approximately 500 km north west of the Carrapateena site (SA Herbarium vouchers specimen notes 2018 cited in Jacobs 2018b). There is a single historical record (1989) from the outskirts of Woomera township at the base of the Arcoona Plateau (approximately 70 km south-west of the project area) (BDBSA 2018). There are no known database records within the project area, but the species has been historically recorded within 10 km of the Northern Wellfield Project Area: in November 1996, the species was recorded from eight locations within an area of approximately 50 km^2, and all within 10 km of the Northern Wellfield Project Area boundary. However, following collection of

Species Name	Common Name	EPBC Act[1]	NPWS Act[2]	Likelihood of Occurrence	Justification[3]
					specimens during the recent targeted habitat assessment for the Northern Wellfield from the recorded location, the Herbarium has reviewed the existing voucher specimens for this area and now considers them to have been mis-identified (reported in Jacobs 2018a), meaning the nearest confirmed records of the species are a significant distance away, and well outside of the study area. All of the previously recorded locations of the species were associated with drainage lines (BDBSA 2018). The ALA (2017), cited in EBS (2018) indicates that the species occurs on stony and sandy plains, foot slopes on rocky hills, minor drainage lines, major drainage lines, and within road side vegetation. Hence, the species appears to prefer drainage lines, run-ons and swales, which take the first run-off after rain (SA Herbarium voucher notes 2018). The soil within which the species has occurred varies from sandy loam to clay. It has been recorded in the following broad vegetation communities and landscapes (ALA 2017 cited in EBS 2018): Stony plains where *Atriplex spp.*, *Maireana spp.*, *Sclerolaena spp*. dominate the low, very open shrubland; Sandy river, with an open woodland of *Eucalyptus camaldulensis* over Acacia spp.; Drainage lines in low hills, with low woodland of *Acacia papyrocarpa*; and Plain in floodplain system, with *Nitraria billardierei* open shrubland. Therefore, suitable habitat is expected to be well distributed regionally. The species was not detected during extensive baseline and targeted survey effort of Carrapateena study area, or during targeted assessment of Northern Wellfield project area (Jacobs 2018a and b). Suitable habitat was present, but with demonstrated evidence of grazing pressure. Given *Frankenia plicata's* reputed unpalatability due to the high foliage salt content (Badman 1999 cited in DOEE 2018a), the species was not recorded. If present, the species is expected to have been evident within the disturbance footprint. The above information represents a substantial survey effort, investigation of historic records for the species, and a robust

Species Name	Common Name	EPBC Act[1]	NPWS Act[2]	Likelihood of Occurrence	Justification[3]
					understanding of habitat preferences and habitat availability for *Frankenia plicata* within the study area.

[1]*Environment Protection and Biodiversity Conservation Act 1999* Status: Endangered (EN), Vulnerable (VU);

[2]South Australian *National Parks and Wildlife Act 1972* Status: Endangered (E); Vulnerable (V); Rare (R);

[3]Biological Database of South Australia (BDBSA), Protected Matters Search Tool (PMST).

3.3 Threatened Fauna Species

The EPBC PMST output identified four EPBC listed threatened fauna species (including three bird and one mammal species) as potentially occurring (or suitable habitat occurring) within the study area. The location of BDBSA records for threatened fauna species within the vicinity of the study area are shown in Figure 3 below. An assessment of the likelihood of occurrence of these species and justification for the likelihood assessment is provided in Table 2 below.

Figure 2 Northern Wellfield: BDBSA records for EPBC listed threatened flora species

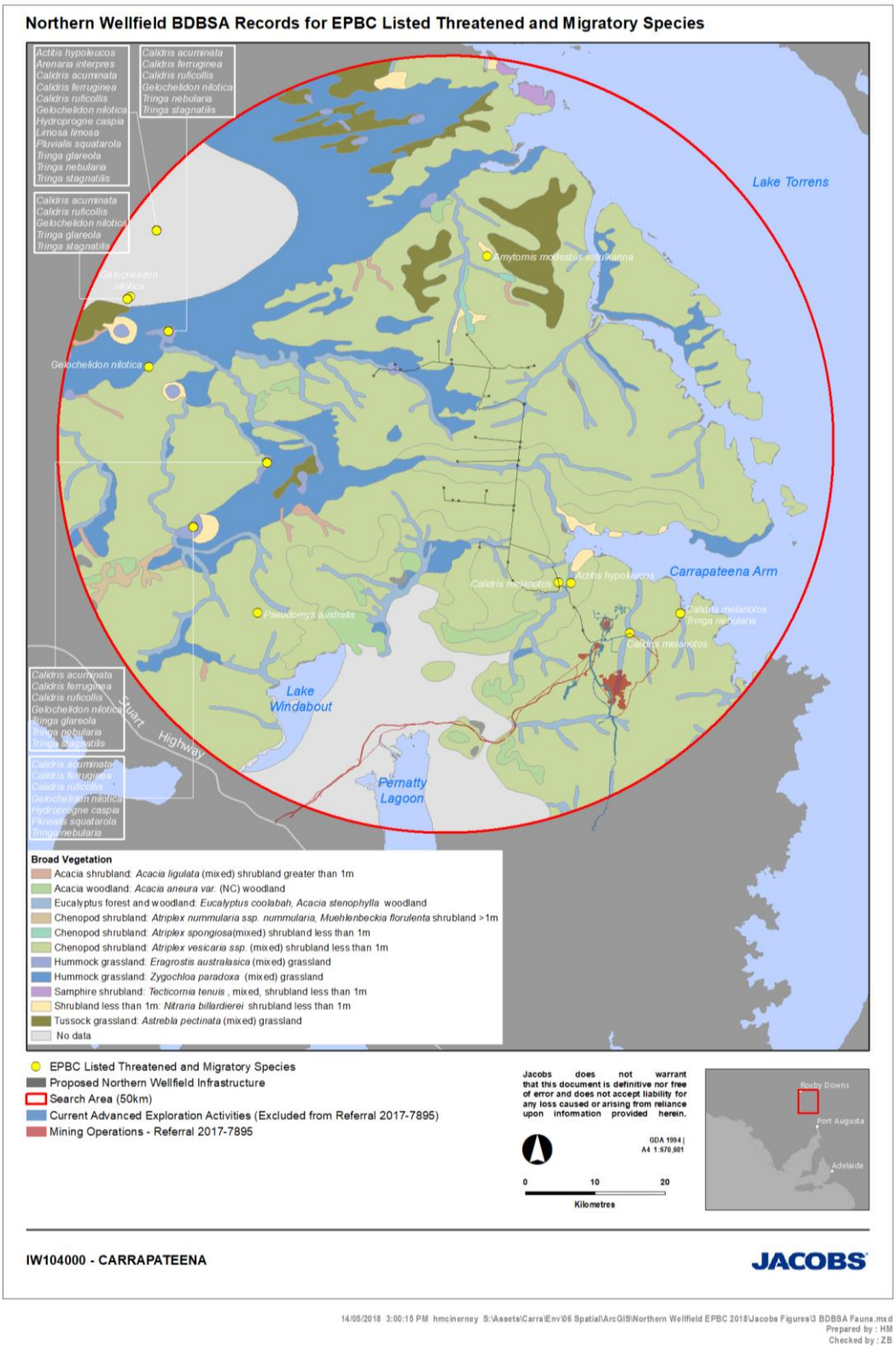

Figure 3 Northern Wellfield: BDBSA records for EPBC listed threatened and migratory fauna species

Table 2 EPBC listed threatened fauna potentially occurring within the study area

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
Birds					
Amytornis modestus	Thick-billed Grasswren (eastern)	VU		Possible	EPBC PMST suggests species or habitat known. An extensive study undertaken by Black et al. (2011) identified four discrete known populations of the species in South Australia; west of Lake Eyre and Lake Torrens (North West), north-east of Lake Eyre (Eyre) (both Lake Eyre subspecies *indulkanna*); around the edges of the Northern Flinders Ranges (Flinders, ssp. *raglessi*) and south-west of Lake Frome (Frome, ssp *curnomona*) (TSSC 2016, Menkhorst et al. 2017). The northern extent of the Northern Wellfield occurs within the southernmost extent of the known range of *Amytornis modestus indulkanna* 'North West' population (Black et al. 2011), which is the larger of the two populations for that subspecies (Menkhorst et al. 2017, Black et al. 2011). Preferred habitat of the eastern species is arid and semi-arid zone chenopod shrublands, especially where dominated by saltbush *Atriplex* spp. (Saltbush) and *Maireana* spp. (Bluebush, Blackbush, Cotton-bush), *Nitraria* (Nitrebush) sometimes with widely scattered trees, both on plains and widely rocky ranges (Higgins et al. 2001, Menkhorst et al. 2017). In SA they have also been recorded in habitats that include *Sclerolaena* spp. (Bindii), *Salsola kali* (Roly-poly), *Tecticornia* spp. (Glasswort / Samphire). and various daisies including *Rhodanthe* spp., *Calotis hispidula* and *Craspedia* spp. (DOEE 2018a). The preferred habitat is generally known to be taller and denser chenopods that occur on drainage lines (DOEE 2018a, NPWS 2002, Black et al. 2011, Menkhorst et al. 2017). The northern portion of the wellfield occurs within the southernmost extent of the currently known broader range of the subspecies *Amytornis modestus indulkanna* and includes isolated sections of preferred taller Chenopod shrubland habitat and minor drainage lines (DEWNR veg mapping). Species not recorded at Carrapateena during baseline and monitoring surveys over five years (summarized in EBS 2017b) or targeted

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					surveys (EBS 2014a). The species has not previously been observed within the Project area nor the Carrapateena Mining Lease. A reported Thick-billed Grasswren nest was however, recorded in 1996, within 20 km of the northern boundary of the Project area (BDBSA 2018). The next closest confirmed recording of the species to the Project area was in 2007, near Andamooka (over 50km from the Project Area) (ALA 2018). Small areas of preferred habitat were identified in the northeast of the wellfield footprint, however this was not based on extensive survey of the site (EBS 2018). Following extensive targeted survey at the broader Carrapateena site, EBS (2018) suggest that the condition and isolation of preferred habitat may not be optimal to support the species at this site. The above information represents a substantial survey effort and understanding of available habitat for the Thick-billed Grasswren.
Calidris ferruginea	Curlew Sandpiper	CE, MW		Possible	EPBC PMST suggests species or habitat likely. Migratory wader, shorebird. Breeds in Siberian high arctic coastal tundra, migrates to Africa, Asia and regular spring/summer migrant to Australia (Geering et al. 2008). Preferred habitat includes exposed intertidal mudflats and less frequently inland freshwater wetlands, saltworks and mudflats (Geering et al. 2008, Simpson and Day 2010). Has not previously been observed within the Project area nor the Carrapateena Mining Lease despite extensive avifauna observations conducted biannually between 2012 and 2017. The species has historically been recorded on four occasions within 20 km of the western boundary of the Project area at Arcoona Lake, with the most recent observation recorded in 1995 (ALA 2018). Dams and areas of shallow open water within the Project area could provide foraging habitat for the species (EBS 2018). Seven historical BDBSA records (1991-1995) within 50 km of the site. No records within the Northern Wellfield area.

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					The above represents a robust understanding of available information, habitat preferences and availability, and a substantial survey effort in relation to Curlew Sandpiper.
Pezoporus occidentalis	Night Parrot	EN		Possible	EPBC PMST suggests extinct within area. Nocturnal / elusive ground-dwelling bird, listed as extinct in SA, however recent evidence suggests a population possibly utilising Samphire low shrubland habitat northeast of Lake Eyre (Night Parrot Recovery Team 2018a), approximately 350 km to the north of the Project area (northeast of Lake Eyre - Kalamurina Station). Extant breeding populations in Qld and WA recorded in *Triodia* spp. (Spinifex) hummock grassland on stony plains and / or chenopod shrublands. Other habitat species include *Sclerolaena* spp*., Maireana* spp*. (Saltbush* spp*.), Astrebla* spp*.* (Mitchell grass*),* shrubby samphire and chenopod associations, scattered trees and shrubs, *Acacia aneura* (Mulga) woodland (TSSC 2016b, DOEE 2018b). EBS (2018) describe habitats that occur across the Carrapateena site, including within the Northern Wellfield. These include stony tablelands with chenopod shrubands, dunefields with *Zylgochloa paradoxa* (Sandhill Canegrass), and an area of Swamp Canegrass (Arcoona plateau). Samphire is also present within the chenopod shrublands throughout the Project area. These habitats would provide potential foraging habitat, within the study area, noting that the site occurs in broad areas of South Australia mapped as potential Night Parrot Habitat (Night Parrot Recovery Team 2018b). It is noted however, that these areas are based on broad vegetation mapping data that covers most of arid South Australia, and a recent targeted survey for Night Parrot, as well as extensive general bird survey effort at the OZ Minerals Carrapateena site over a number of years failed to detect any evidence of Night Parrot across these habitat types. No *Triodia* (roosting / nesting habitat) was identified within the Northern Wellfield Project area during the recent targeted habitat assessment (Jacobs 2018a). There are no BDBSA records for the study

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					area, and extensive bird survey effort and targeted surveys failed to detect this species at the Carrapateena Mine Project area or the Northern Wellfields Project area (Jacobs 2018a, 2018b). Whilst there are no BDBSA records, the species is known to be difficult to detect, and there are renewed observations across its range and there is potential foraging / nesting habitat within the vicinity of the study area. Broadly, Night Parrots have been recorded in *Triodia* grassland, chenopod shrubland and samphire shrubland. Therefore, the species has the possibility to occur within the chenopod shrubland and samphire shrubland that are expected to be well-distributed over the Project area. Areas of samphire shrubland near the edge of the Lake Torrens may provide the most likely areas of foraging habitat for the species (EBS 2018). Therefore the possibility of presence cannot be 100% excluded, so this species is conservatively assessed as being 'possibly' present in the Project area. The above represents a robust understanding of available information, habitat preferences and availability, and a substantial survey effort in relation to Night Parrot.
Mammals					
Pseudomys australis	Plains Rat / Mouse	VU	V	Likely	EPBC PMST suggests species or species habitat likely to occur within the project area. Small arid zone rodent. Prefers gibber (stone-covered) plains, mid slopes with boulders, small stones and gilgais. Primary habitat is considered to be within drainage channels, depressions and deep cracking clays (Brandle et al. 2008, Moseby 2012), but evidence suggests that during population expansions the habitat usage may be more broad temporarily, followed by a retraction to preferred refugia habitat during drier periods. Current known populations largely restricted to the Stony Plains Bioregion in SA, extending into the NT. The species now occupies a north/south band of stony plain habitat to the west of Lake Eyre extending from Pernatty Station in SA to Andado Station in the NT (Moseby 2012). It is generally accepted that the presence of cracking clays is more critical habitat than the

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					type or structure of vegetation. The species has been recorded in several vegetation communities, including *Atriplex nummularia* (Old-man Saltbush) / *Abutilon halophilum* (Plains Lantern-bush) low very open shrubland, *Sclerolaena divaricata* (Tangled Bindyi) / *Eragrostis australasica* (Cane-grass) / *Atriplex vesicaria* (Bladder Saltbush) low open shrubland, *Maireana aphylla* (Cotton-bush)/ *Eragrostis setifolia* (Bristly Love-grass) / *Astrebla pectinata* (Barley Mitchell-grass) / *Atriplex vesicaria* (Bladder Saltbush) low very open shrubland and *Eucalyptus coolabah* (Coolibah) low woodland (Brandle 1998) A number of these flora species occur within the Northern Wellfield site (DEWNR veg mapping, EBS 2018). The Plains Rat has been captured at bi-annual trapping sites in the south of the Project area (Mineral lease 6471, Spring and Autumn 2012, 2013 (EBS 2013a,b,c). The species is also expected to be present further north (in the Northern Wellfield Project Area); however, no trapping was undertaken within these areas and therefore the species was not detected during field surveys. A baseline survey identified at least 32 known areas of suitable refuge habitat (EBS 2018) (such as Canegrass Swamps and large cracking clay areas) with a large amount of suitable Plains Rat habitat also likely to exist away from the existing tracks within the Northern Wellfield Project area (EBS 2018). Single BDBSA record (2001) from within 50 km of the site. Burrows present in creek banks, lush vegetation in creekline and adjacent areas (BDBSA 2018). No record within Northern Wellfield site (see Figure 3 this report). The above represents a substantial survey effort and a robust understanding of available habitat preferences and availability in relation to Plains Mouse.

[1]*Environment Protection and Biodiversity Conservation Act 1999* Status: Critically Endangered (CE); Endangered (EN), Vulnerable (VU); Migratory Marine (MM); Migratory Terrestrial (MT); Migratory Wetland (MW);

[2]South Australian *National Parks and Wildlife Act 1972* Status: Endangered (E), Rare (R), Vulnerable (V);

[3]Biological Database of South Australia (BDBSA), Protected Matters Search Tool (PMST), Atlas of Living Australia (ALA).

3.4 EPBC Listed Migratory Species

The PMST identified nine migratory fauna species that may occur within the search area (Table 3), while a further eight migratory species were identified in the BDBSA output and have therefore been included in this report; namely *Arenaria interpres* (Ruddy Turnstone), *Calidris ruficollis* (Red-necked Stint), *Gelochelidon nilotica* (Gull-billed Tern), *Hydroprogne caspia* (Caspian tern), *Limosa limosa* (Black-tailed Godwit), *Pluvialis squatarola* (Grey Plover), *Tringa glareola* (Wood Sandpiper), *Tringa stagnatilis* (Marsh Sandpiper). Overall, 14 of the migratory species identified could occur within the Project area. The rationale for the likelihood rating of each species is presented in Table 3. All migratory fauna identified by the PMST are shorebirds, except for the Fork-tailed Swift (Apus pacificus). One species, the Curlew Sandpiper was discussed in Table 2 (Section 3.3.) above and is not presented here. Migratory shorebird species would be restricted to dams and areas of shallow water within the Project area, such as saline pans and large pools within major tributaries. The Fork-tailed Swift may occur aerially over all habitats in the Project area.

The EPBC Migratory species are listed together with an assessment of the likelihood of their occurrence (or suitable habitat occurring) in Table 3 below.

Table 3 Likelihood Assessment of EPBC listed Migratory Species

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
Apus pacificus	Fork-tailed Swift	MM		Likely	EPBC PMST suggests species or species habitat likely within study area. Highly mobile, migratory, almost entirely aerial species, flying <1 m to 1000 m above the ground. This species seldom recorded on the ground (Pizzey and Knight 2012, Simpson and Day 2010 (DOTE 2015b). Primarily occurs over inland plains in Australia, but sometimes recorded over coastal cliffs. Feeds on insects whilst flying, roosts on the wing. The entire global population can visit Australia during summer, where it is widespread throughout Australia. In SA, occurs west of Spencer Gulf, Coastal Eyre Peninsula, Flinders Ranges, Maree, Lake Eyre and Innamincka (DOTE 2015b). Species unlikely to utilize terrestrial habitat within the study area, but has been observed within the Carrapateena ML flying-over Tableland. The species occurs aerially over a wide range of habitats, which vary from rainforests to treeless plains. As such, the species could occur aerially over the entire Project area (EBS 2018). No BDBSA records within 50km, records within 50-100 km (Roxby Downs) (BDBSA 2018). Recorded during site surveys at Carrapateena (EBS 2017a). Five Fork-tailed Swifts were recorded at Lake Mary in the Arcoona Lake System (<

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					50 km west of the Project Area) in February 2009.
Actitis hypoleucos	Common Sandpiper	MW	R	Likely	EPBC PMST suggests species or habitat may occur within area. Migratory wader / shorebird. Breeds in northern hemisphere (Eurasia), migrates to Africa, regular summer migrant to Australia (more common in northern than southern Australia (Geering et al. 2008, Simpson and Day 2010). The Common Sandpiper has been observed within the Carrapateena ML at pastoral dams (EBS 2015b,c). Dams and areas of shallow open water within the Northern Wellfield Project area could provide foraging habitat for the species (EBS 2018, when they are in Australia (during non-breeding season September to April)). Last recorded at the site in Autumn 2015 (2 individuals) and in Spring at Euro Springs (1 individual) (EBS 2015b,c). Also recorded at ANZAC Dam in 2012 (EBS 2013a) Historical BDBSA record within 50 km (1991) at Lake Corlay and recent record (2015 - EBS Spring) 10.6 km ENE of Hunter Hill (within Northern Wellfield footprint) (BDBSA 2018). Two small clusters of records occur within 100 km, to the north-west and the south-west of the Project Area (ALA 2018).
Calidris acuminata	Sharp-tailed Sandpiper	MW		Possible	EPBC PMST suggests species or habitat likely to occur within area. Migratory wader / shorebird. Breeds in Siberia, migrates to New Guinea and Australia. Prefers coastal and inland areas, non-tidal fresh or brackish wetlands (Geering et al. 2008, Simpson and Day 2010). The species has been observed within the Carrapateena ML at pastoral dams (Spring 2012, 4 individuals, EBS 2015c). Dams and areas of shallow open water within the Project area could provide foraging habitat for the species (EBS 2018), when they are in Australia (during non-breeding season September to April). The nearest historical records to the Project Area are within the Arcoona Lakes System, within 50 km of the western

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					boundary of the Project Area. Between 1991- 1995, a total of approximately 1050 birds were recorded from 29 visits to five locations –in the Arcoona Lakes system (BDBSA 2018). The most recent records were in 2009 (Outback Field Nats 2009), following the Arcoona Lakes system filling in 2007.
Calidris melanotos	Pectoral Sandpiper	MW	R	Likely	EPBC PMST suggests species or habitat known to occur within area. Migratory wader / shorebird. Breeds in North America and Siberia. Prefers freshwater or brackish wetlands, grassy or lightly vegetated coastal and inland swamps (Geering et al. 2008). Has been observed within the Project area at pastoral dams (Spring 2013, 12 individuals, EBS 2013c). Dams and areas of shallow open water within the Project area could provide occasional foraging habitat for the species, when they are in Australia (during non-breeding season September to April). Other than the two records within the Project Area, the nearest known database records are approximately 200 km north-west of the Project Area (ALA 2018a).. BDBSA records within 50 km (3 records, 2013, within Carrapateena, EBS 2013c).
Charadrius veredus	Oriental Plover	MW		Possible	EPBC PMST suggests species or habitat may occur. Predominantly land based migratory wader / shorebird. Species breeds in China and Mongolia, spring non-breeding migrant to northern Australia (Sept -Mar). Prefers short dry grasslands inland, rarely feeds on wet habitats, but will inhabit mudflats, beaches and coastal habitat during hot conditions and when they first arrive (Geering et al. 2008, DOEE 2018c). Has not been previously been recorded within the Project area nor the Carrapateena ML. Although the Oriental Plover is a migratory shorebird, it can inhabit plains, clay pans, and rolling country far away from water, as well as wetland habitats; including saltmarsh, tidal mudflats and swamps. As such, suitable habitat for the species is expected to occur within the Project area (EBS 2018).

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					No BDBSA records within 50km of study area (BDBSA 2018). The nearest known database record is at Roxby Downs, 50 – 100 km from the Project Area (ALA 2018b).
Motacilla cinerea	Grey Wagtail	MT		Unlikely	EPBC PMST suggests species or habitat may occur. Uncommon migratory wagtail (DOE 2015). Breeds in Europe and Asia and rarely spring/summer non-breeding migrant to Australia (Pizzey and Knight 2012, Menkhorst et al. 2017). Prefers higher altitudes, near fast-running water, rocky substrates, lakes and marshes (DOTE 2015a,b). Has occurred previously in northern Australia from the Kimberley to SE QLD (Simpson and Day 2010, Menkhorst et al. 2017). Vagrant to South Australia with the only two records being from near Adelaide, over 400 km south of the Project Area (ALA 2018c). No records for inland SA (ALA 2018c). In Australia, the species is typically recorded in mesic areas where it inhabits wetlands and/or boggy vegetated areas, including irrigated lawns (EBS 2018). Suitable habitat is absent from the Project area (EBS 2018), species has not been recorded during regular monitoring or baseline surveys at Carrapateena to date (EBS 2017b). No BDBSA records for the study area (BDBSA 2018).
Motacilla flava	Yellow Wagtail	MT		Unlikely	EPBC PMST suggests species or habitat may occur. Uncommon migratory wagtail (DOTE 2015a,b). Breeds in Europe, Africa and Alaska and occasional spring/summer non-breeding migrant to Australia (Pizzey and Knight 2012). Habitat includes well-watered open grasslands, fringes and wetlands. Roosts in mangroves and other dense vegetation (D0TE 2015a,b). Vagrant to South Australia with very few records in the state (EBS 2018). One record for inland SA (Coober Pedy) (ALA 2018d). In Australia, the species is typically

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					recorded in mesic areas where it inhabits wetlands and/or boggy vegetated areas, including irrigated lawns (EBS 2018). Suitable habitat is absent from the Project area (EBS 2018), has not been recorded during regular monitoring or baseline surveys at Carrapateena to date (EBS 2017b). No BDBSA records within 50 km of the study area (BDBSA 2018). Only three known database records are within SA for the Yellow Wagtail, the nearest of which is over 300 km north-west of the Project Area (BDBSA 2018).
Tringa nebularia	Common Greenshank	MW		Possible	EPBC PMST suggests species or habitat may occur. Migratory wader / shorebird. Breeds in northern hemisphere from Europe to Siberia, summer migrant to Australia, Africa and Asia. Prefers intertidal mudflats, fresh and saltwater wetlands of coast and inland (Geering et al. 2008). Has been observed within the Carrapateena ML at pastoral dams and natural waterhole (Spring 2013, 2 individual, EBS 2013c, BDBSA 2018). Dams and areas of shallow open water within the Northern Wellfield Project area could provide foraging habitat for the species (EBS 2018). Twenty four BDBSA records within 50 km (1991-2013) (EBS 2018, BDBSA 2018). There are also several database records within 50 km of the Project Area, between Lake Arcoona and Roxby Downs (BDBSA 2018). Historical records (1991- 1994) where approximately 110 birds were recorded from 33 visits to four locations –in the Arcoona Lakes system (BDBSA database 2018). The most recent records were in 2009 (Outback Field Nats 2009), following the Arcoona Lakes system filling in 2007. In February 2009, six Common Greenshank were recorded at Lake Mary and five from Lake Coorlay.
Migratory species not reporting by the PMST					
Arenaria interpres	Ruddy Turnstone	MW	R	Unlikely	Not identified in EPBC search, however historical BDBSA records for study area. Rarely occurs in inland Australia; where it may inhabit shallow waters and sewage

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					ponds. This species typically inhabits coastal habitats where seaweed wrack covers sandy shores and/or rocks, tidal flats (Simpson and Day 2010, Mehkhorst et al. 2018). Given the rarity of inland occurrences for this species, it is considered unlikely to occur within the Project area (EBS 2018). Last known historical record was in 1993 when one bird was recorded at Lake Coorlay, within 50 km of the Project Area (BDBSA 2018). Not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b).
Calidris ruficollis	Red-necked Stint	MW		Possible	Not identified in EPBC search, however historical BDBSA records for study area. Migratory species, breeding in the northern hemisphere, arctic tundra of Siberia to Alaska (Geering et al. 2008). The population moves in and out of Australia during breeding and non-breeding periods, arriving in between August and September. (DOEE 2018d). In Australia, the Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. They have occasionally been recorded on dry inland gibber plains, with little or no perennial vegetation (Higgins and Davies 1996). They will utilized a wide range of habitats from freshwater to saltwater, tidal flats with wrack, inland wetlands with little vegetation (Geering et al. 2008, Menkhorst et al. 2017). Most common in coastal habitats; however, the species also frequents inland Australia. Dams and areas of shallow open water within the Project area could provide foraging habitat for the species (EBS 2018). Although, not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b). The nearest historical records to the Project Area are within the Arcoona Lakes System, within 50 km of the western boundary of the Project Area (BDBSA 2018). Between 1991- 1994, a total of

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					approximately 500 birds were recorded from 19 visits to five locations –in the Arcoona Lakes system (BDBSA 2018).
Gelochelidon nilotica	Gull-billed Tern	MM		Possible	Not identified in EPBC search, however historical BDBSA records for study area. Large (35-38 cm) species of tern with a broad world-wide distribution, breeding in scattered localities in Europe, Asia, northwest Africa, Australia, and the Americas (Molina et al. 2014). Well distributed over the Australian continent, only absent from the deserts where expanses of open water do not occur. The species is most common in coastal and sub-coastal environments; however, is also frequently recorded inland. The species inhabits beaches, mudflats; fresh, brackish wetlands, including far inland; grasslands, crops, ploughed fields and airfields (Simpson and Day 2010, Menkhorst et al. 2017, EBS 2018). Given the species occurs at inland waterbodies, it is considered to have potential to occur within the Project area. The small salt pans/lakes within the Project area could provide suitable habitat when filled (EBS 2018). Nearest historical record to the Project Area is at Lake Arcoona (in 1993), within 50 km west of the Project Area, when approximately 225 birds were observed over two visits in 1991 and 1993 (BDBSA 2018). Recorded from a further six locations within 50 km of the Project Area, between 1991 and 2007. A total of approximately 875 birds have been recorded at these locations, with from 1 to 300 birds recorded during visits (BDBSA 2018). Not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b), however Whiskered Terns have been observed in Spring 2013 and 2014 (EBS 2017b).
Hydroprogne caspia	Caspian tern	MM		Possible	Not identified in EPBC search, however historical BDBSA records for study area. The largest Tern in Australia, this species is a resident and present throughout the year at sites where breeding occurs year

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					round or is where breeding is protracted. At some sites where breeding does not occur seasonal dispersion occurs. Some birds may move from coastal breeding colonies to inland non-breeding areas. They can follow watercourses inland, though their occurrence at small lakes indicates that at least some movement occurs overland (Higgins & Davies 1996 cited in DOEE 2018e). Can occur at inland waterbodies, and therefore, it considered to potentially occur within the Project area. The small salt pans/lakes within the Project area could provide suitable habitat when filled (EBS 2018). However, within South Australia, most records are coastal, or in the far north-east of the State, with only very sparse records between Lake Eyre and Port Augusta. Historical database records within 50 km of the Project Area are at Lake Coorlay and Lake Richardson where 16 birds were recorded from six visits between 1991-1993 (BDBSA 2018). Not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b), however Whiskered Terns have been observed in Spring 2013 and 2014 (EBS 2017b).
Limosa limosa	Black-tailed Godwit	MW	R	Possible	Not identified in EPBC search, however historical BDBSA records for study area. Migratory wader / shorebird. Breeds in northern hemisphere (Eurasia) and regular summer migrant to Australia. Most common in coastal habitats with large intertidal mudflats and/or sandflats. However, the species also frequents inland Australia, on mudflats and in water less than 10 cm deep (belly depth), around muddy lakes and swamps, fresh and brackish wetlands (Geering et al. 2008, Simpson and Day 2010, Menhorst et al. 2017). Has been historically recorded within 5 km of the Project Area, at Lake Coorlay, on 6 occasions between 1992-1994 (totalling 30 birds) (BDBSA 2018). Dams and areas of shallow open water within the Project area could provide foraging habitat for the species (EBS

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					2018), however not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b).
Pluvialis squatarola	Grey Plover	MW		Unlikely	Not identified in EPBC search, however historical BDBSA records for study area. Medium-sized migratory shorebird. Breeds in the high arctic tundra and migrates to all continents in the Southern Hemisphere, except Antarctica (Geering et al. 2008). Preferred habitats include intertidal sandflats and mudflats in estuaries and bays. Roosts close to feeding grounds at high tide (Geering et al. 2008). Rarely occurs in inland Australia and is typically considered to be a coastal species, restricted to large tidal flay systems (Menkhorst et al. 2017). There are two historical BDBSA records (1991 and 1992) for this species within 50 km of the Project site, namely at Lake Coorlay and Lake Richardson. These are within the Arcoona Lakes System to the west of the Project site (ALA 2018). These records may have been of individuals on a 'pit-stop' during its migration to the southern Australian coastline (EBS 2018). However, this species inhabits mudflats, saltmarshes and estuaries, which are not present at the site (EBS 2018). The next nearest ALA (2018) record is approximately 100 km west of the Project Site. Not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b).
Tringa glareola	Wood Sandpiper	MW	R	Possible	Not identified in EPBC search, however historical BDBSA records for study area. Small migratory shorebird, breeds in Siberia to Europe and migrates to Africa, southern Asia and Australia (Geering et al. 2008). In northern Australia the species mainly occurs on inland freshwater wetlands and rarely on mudflats (Geering et al. 2008). The nearest historical records to the Project Area are within the Arcoona Lakes System, within 50 km of the western boundary of the Project Area (BDBSA 2018). Between 1991- 1994, a total of 9 birds were recorded from 5 visits to four

Species Name	Common Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Justification[3]
					locations –in the Arcoona Lakes system (BDBSA 2018). The most recent records was in 2009 when three birds were observed in Coorlay lagoon (Outback Field Nats 2009), following the Arcoona Lakes system filling in 2007. More recently, has been observed within the Carrapateena ML at pastoral dams (Spring 2016, 1 individual EBS 2017b). Dams and areas of shallow open water within the Project area could provide foraging habitat for the species (EBS 2018).
Tringa stagnatilis	Marsh Sandpiper	MW		Possible	Not identified in EPBC search however historical BDBSA records for study area. Shorebird, breeds in wetlands of eastern Europe to eastern Asia. Migrates to Africa, southern Asia and Australasia (Geering et al. 2008). Most common in coastal habitats (freshwater or saltwater wetlands); however, the species also frequents inland Australia (Geering et al. 2008). Avoids intertidal mudflats, but large numbers can occur on northern Australian beaches prior to migration (Geering et al. 2008). The nearest records to the Project Area are within the Arcoona Lakes System, within 50 km of the western boundary of the Project Area (BDBSA 2018). Sixteen historical BDBSA records within 50 km. Between 1991- 1995, a total of 83 birds were recorded from 16 visits to four locations –in the Arcoona Lakes system (BDBSA 2018). The most recent record was in 2009 when six birds were observed in Coorlay lagoon (Outback Field Nats 2009), following the Arcoona Lakes system filling in 2007. Dams and areas of shallow open water within the Project area could provide foraging habitat for the species (EBS 2018), however not recorded at Carrapateena during baseline and monitoring surveys (EBS 2017b).

[1]*Environment Protection and Biodiversity Conservation Act 1999* Status: Critically Endangered (CE); Endangered (EN), Vulnerable (VU); Migratory Marine (MM); Migratory Terrestrial (MT); Migratory Wetland (MW).

[2]South Australian *National Parks and Wildlife Act 1972* Status: Rare (R); Vulnerable (V); Endangered (E)

[3]Biological Database of South Australia (BDBSA), Protected Matters Search Tool (PMST), Atlas of Living Australia (ALA).

4. EPBC Significant Impact Assessment

4.1 Significant Impact Assessment Criteria

The Significant Impact Criteria relevant to this project are those outlined by DoE (2013), which are summarized in Table 4 below for Critically Endangered and Endangered species, Vulnerable species and Migratory species.

For species listed as Vulnerable, the term 'important population' is used to define a number of the significant impact criteria. For the purpose of this significant impact assessment, we consider 'important populations' of a species to be 'key' or 'core' populations which are defined as strongholds within relevant SPRAT profiles (DOE), or by recent relevant population studies for the target species. A small, isolated population, remote from a core population (or meta-population) as a result of historic habitat fragmentation would also represent an important population. Examples of populations considered to not represent important populations would be small portions of much larger and/or predominantly continuous populations, or discrete populations as part of a larger patchy population distribution as a result of natural habitat variability and islanding of microhabitat features.

Table 4 EPBC Significant Impact Criteria (Critically Endangered, Endangered, Vulnerable and Migratory species).

Criteria	EPBC Significant Impact Criteria (Critically Endangered and Endangered Species)	EPBC Significant Impact Criteria (Vulnerable Species)	EPBC Significant Impact Criteria (Migratory Species)
A	Lead to a long-term decrease in the size of a population?	Lead to a long-term decrease in the size of an important population of a species?	Substantially modify (including by fragmenting, altering fire regimes, nutrient cycles or hydrological cycles), destroy or isolate an area of important habitat for a migratory species?
B	Reduce the area of occupancy of the species?	Reduce the area of occupancy of an important population?	Result in invasive species that are harmful to a migratory species becoming established in an area of important habitat for migratory species?
C	Fragment an existing important population into two or more populations?	Fragment an existing important population into two or more populations?	Seriously disrupt the life cycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of a population of a migratory species?
D	Adversely affect habitat critical to the survival of a species?	Adversely affect habitat critical to the survival of a species?	
E	Disrupt the breeding cycle of a population?	Disrupt the breeding cycle of an important population?	
F	Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	

Criteria	EPBC Significant Impact Criteria (Critically Endangered and Endangered Species)	EPBC Significant Impact Criteria (Vulnerable Species)	EPBC Significant Impact Criteria (Migratory Species)
G	Result in invasive species that are harmful to the endangered or critically endangered species becoming established in the endangered or critically endangered species' habitat?	Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	
H	Introduce disease that may cause the species to decline?	Introduce disease that may cause the species to decline?	
I	Interfere with the recovery of the species	Interfere substantially with the recovery of the species	

4.2 Significant Impact Assessment

Table 5 below presents an assessment of the likelihood that the proposed development would result in significant impacts to EPBC listed flora and fauna which were considered 'likely' to occur, or as 'possible' occurrences within study area during the desktop review undertaken here. No threatened ecological communities were considered here as none were considered likely (or possible) to occur. The assessment was based on the significant impact criteria outlined in Table 4 above (which were sourced from DoE (2013)).

Table 5 EPBC Listed threatened flora Significant Impact Assessment (for species considered 'likely' or as 'possible' occurrences in study area)

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
Threatened Flora						
Frankenia plicata (Southern Sea-heath)	EN	V	Possible	Clearance of individual plants or small populations of plants, or potential habitat for construction and/or modification of access tracks, and land clearance associated with wellhead and water distribution infrastructure. Introduction of invasive weed species or disease.	Undertake site clearance walkover as part of land disturbance permitting prior to construction of tracks and infrastructure, particularly in swales and hillside channels on loamy sands to clay. Flag off any population identified during site clearance walkover to enable disturbance to be avoided. Implement weed hygiene practices, including vehicle hygiene, during construction and implement post construction and annual weed control surveillance and control programs.	**No significant impact predicted** A: Not Likely. Few populations have been recorded in the region. Historic records predominantly known from the south western portion of the Lake Eyre Basin in SA well to the north of the project within minor drainage lines and run-off areas off stony plains and stony hills (well drained soils), and two isolated small populations to the west of Lake Torrens on the Arcoona Plateau, but historic records 10 km north of the Project Area are now considered doubtful as a result of mis-identification (Jacobs 2018a). The species was not detected in a targeted search within the Carrapateena project area (EBS 2018; Jacobs 2018b) or of the Northern Wellfield project area (Jacobs 2018a). The development would not stop future recruitment or gene flow. Proposed mitigation measures, including pre-clearance surveys and micro-aligning the access track and micro-positioning of well pad infrastructure if required would enable disturbance to any identified individuals or population to be avoided. As such, the proposed action is considered unlikely to lead to a long term reduction in the size of a population of this species. B: Not Likely. As above, key population in SA have been recorded from the south western portion of Lake Eyre, with a single record from near Woomera. Historic records of the species to the north of the Northern Wellfields Project area are now considered doubtful. Mitigation measures proposed are expected to enable avoidance of disturbance to any individuals or populations that may be identified within the project footprint, and therefore no reduction to the area of occupancy is expected. C: Not Likely. As above, no known populations of the species are present within the Project Area. Baseline surveys and targeted

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						surveys within the Carrapateena and Northern Wellfields Project areas did not detect the species (EBS 2018, Jacobs 2018a, b) and pre-clearance surveys as part of land disturbance permitting processes prior to construction in key habitats are proposed. If individuals are located during pre-clearance surveys, project impacts are not likely to fragment the population given the type of clearance proposed. Disturbance to any population detected would be avoidable with mitigation measures proposed, and therefore fragmentation of an existing important population is considered highly unlikely. D: Not Likely. Suitable habitat may be present on the footslopes and outwash plains, and other minor drainage lines with stony surface and well drained soils. The proposed infrastructure and track routes are unlikely to occur within the favoured habitat of drainage lines, run-on areas and footslopes, as these habitats by their nature are prone to ephemeral flooding. Species not detected during targeted habitat assessment of Project area. With mitigation measures proposed, the action will not significantly impact on species habitat. E: Not Likely. The majority of historic records of the species are well to the north of the project area around the south western portion of the Lake Eyre Basin, are records immediately north of the Project area are now considered in doubt, so considered unlikely that an important population exists in the project area. Reproduction of *Frankenia plicata* would not be disrupted by an access track if present and avoided during construction. Mitigation measures proposed, including pre-disturbance surveys, enable any populations present to be identified and avoided, so the action will not disrupt the breeding cycle of the species. F: Not Likely. The majority of records for this species are to the north of the project area. The access tracks and infrastructure will result in habitat clearance and modification, but it is not

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						expected to be of sufficient extent to cause this species to decline (given at this stage there are no records of the species in the project area). G and H: Not Likely. The majority of historic records of the species are to the north of the project area around the south western portion of the Lake Eyre Basin, so considered unlikely that a significant population exists in the project area. As such, any introduction of weeds would not result in establishment and degradation of *Frankenia plicata* habitat. Targeted survey and micrositing of infrastructure will ensure the species is avoided if individual plants are detected. Area not in a high risk *Phytophthora* area. Management measures include weed controls during and post construction as well as vehicle hygiene practices, so establishment of new weed species or diseases in the project area is not considered likely. The action is therefore not expected to result in the introduction of invasive species or disease which are harmful to this threatened species. I: Not Likely. The proposed action does not interfere with any recovery actions for this species. The main threats to *Frankenia plicata* are trampling and grazing by livestock. Studies undertaken as part of this project will assist with further defining the distribution of this species. With management measures proposed, this action is not expected to further impact upon, or interfere with recovery of the species.

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
Threatened Fauna						
Amytornis modestus (Thick-billed Grasswren, eastern)	VU	V	Possible	Clearance of potential habitat for access roads, pipeline corridors, staging tanks and land disturbance for well pad construction for well heads and pumps. Soil compaction due to heavy vehicle presence. Introduction of invasive weed species resulting in habitat degradation.	Undertake site clearance walkover as part of land disturbance permitting prior to construction of tracks and infrastructure, to avoid construction of well pads in preferred tall Chenopod shrubland and Lignum communities (Note this vegetation type is typically found fringing minor drainage lines and swamps not suited to pad construction). Flag off any preferred habitat identified during site clearance walkover to enable disturbance to be avoided. Implement weed hygiene practices during construction and implement post construction weed surveillance and control programs.	**No significant impact predicted** A: Not Likely. Whilst the northernmost portion of the Northern Wellfield Project area intersects the southernmost mapped range of one important population of the species (subspecies *A. m. indulkanna*), there is only a single historical record of a nest from within 20 km of the study area, and no definitive patches of preferred habitat were identified during the recent targeted habitat assessment of the Northern Wellfield Project area. Rather, a distinct transition in vegetation type was identified to the north of the Project area, which aligns with the mapped distribution of the species (Jacobs 2018a). As such, it is not considered that an important population of the species extends into the Project area. The proposed action consists of a wellfield footprint which will be scattered throughout potential preferred habitat of this species, along with a low traffic volume, maintenance access tracks (use of existing where possible) which the species will readily cross. Clearance of preferred habitat within the study area will be regionally insignificant when compared with the species distribution, with the key threat of widespread habitat degradation through grazing pressure a more significantly concern for the species. Preferred habitat loss will be minimised with mitigation measures proposed, and this coupled with the lack of evidence for the presence of a significant population means the action is not expected to lead to a long term decrease in the size of a known important population. B: Not Likely. One of four important populations occur immediately north of the study area (Black et al. 2011). Whilst the northernmost portion of the wellfield footprint intersects the southernmost extent of the mapped range of one population of the species, there is only one historical BDBSA of a nest 20 km

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						north of the Project Area, and as such, it is not considered that the important population of the species extends into the project area. In addition, targeted call-playback surveys across the broader Carrapateena site have not located the species (EBS 2014a). Whilst individuals from the northern population may utilise the site, core habitat is not known from the site. Once constructed, the proposed action is not expected to hinder movement of the species across the landscape, or cause a reduction in area of occupancy (aside from minor habitat loss for maintenance track and wellfield pads). With mitigation measures proposed, majority of clearance of preferred habitat should be avoided. Therefore, the area of occupancy areas of an important populations will not be reduced. C: Not Likely. Once constructed, the proposed action is not expected to hinder movement of the species across the landscape, as the borefield will be scattered throughout the habitat, and access tracks will support only very low volumes of traffic and are proposed to be only 5 m wide. The known range of one subspecies occurs immediate north of the study area, and extends north of Oodnadatta. Clearance for tracks and wellfield unlikely to lead to fragmentation of the subspecies range. D: Not Likely. Whilst the northern portion of the wellfield intersects the southernmost extent of the currently known broader distribution of the species, no areas of preferred taller Chenopod shrubland and Lignum habitat in minor drainage lines were identified during the recent targeted habitat assessment of the Project area (Jacobs 2018a), and no known populations have been recorded within the study area. Stronghold populations of the species are well documented by Black et al. (2011) and occur immediately north of the project area, and northeast of Lake Torrens and northeast of Lake Eyre. Mitigation measures proposed such as pre-clearance surveys enable avoidance of important habitats via micro-placement of footings and re-routing

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						of access tracks. Areas of tall dense shrubland if they occur will be avoided wherever practicable. Once constructed, the proposal is not expected to impact movement across the landscape or breeding activity, particularly, given historic grazing impacts at the site. As such, no adverse impacts are expected to habitat which is considered critical for the survival of the species. E: Not Likely. Whilst the known range of one of these subspecies occurs immediately north of the site, it is not known to extend within the project site, and therefore, any clearance of potential habitat associated with the maintenance track or wellfield pads is unlikely to disrupt the breeding cycle of the species as a whole. Once constructed, the wellfield or maintenance track are not expected to disrupt movement across the landscape for this species, so impacts to breeding are not anticipated. F: Not Likely. As above, given the known range of one subspecies occurs immediately north of the study area, clearance of currently potentially utilised habitat within the study area is expected to be minimal, as no areas of preferred taller Chenopod shrubland and Lignum habitat in minor drainage lines were identified during the recent targeted habitat assessment of the Project area. It is therefore not expected that any decrease in quality or quantity of habitat would lead to a decline of the species (from the four important known populations identified by Black et al. (2011)). G and H: Not Likely. One of the known ranges of one of the subspecies of this species occurs immediately north of the project area, to the west Lake Eyre and Lake Torrens, and it is considered unlikely that a significant population of Thick-billed Grasswrens extends into the project area, based on extensive survey within the Carrapateena ML and targeted habitat survey within the northern wellfield project area (EBS 2014a, Jacobs 2018a). As such, any introduction of weeds would not result in establishment and degradation of preferred habitat, particularly given existing grazing pressure. The project area not in a high

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						risk *Phytophthora* area. Management measures include weed controls during and post construction as well as vehicle hygiene practices, so establishment of new weed species or diseases in the project area is not considered likely. The action is therefore not expected to result in the introduction of invasive species or disease which are harmful to this threatened species. I: Not Likely. Key objectives of recovery of this species involve managing feral predators (cats, foxes) and control of grazing impacts from introduced species which cause broad-scale habitat degradation. The four key populations within SA occur north and northeast of the study area will not be impacted by the project. Therefore, with mitigation measures proposed, the proposed action will not substantially interfere with the recovery of the species.
Calidris ferruginea (Curlew Sandpiper)	CE, MW		Possible	Injury or mortality from collisions with infrastructure. Injury or mortality from collisions with vehicles traversing access track.	Proposed infrastructure will not be tall, avoids traversing foraging habitat, e.g. ephemeral lakes, such as Lake Torrens which occurs to the east of the project. Micro-align access roads to avoid traversing foraging habitat. Implement weed hygiene practices during construction and implement post construction weed surveillance and control programs.	**No significant impact predicted** A: Not Likely. Migratory shorebird with global population, breeding outside of Australia. Species is widespread in coastal and subcoastal areas east of Streaky Bay including the Coorong. Important populations do not occur within the study area, and impacts associated with groundwater influences are not covered by this referral. Mitigation measures proposed can readily avoid potential foraging habitat of ephemeral lakes. As such, populations of this species will not decrease in size as a result of the proposed action. B: Not Likely. The area of occupancy is widespread within Australia (and globally) for this migratory species which breeds outside of Australia. Given no minimal preferred habitat occurs within the project footprint, and potential foraging habitats can be easily avoided (e.g. dams and open water), the area of occupancy for this species is not likely to be reduced. C: No. The area of occupancy is widespread within Australia for this migratory species which breeds outside of Australia. Given there

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						is no breeding habitat, no preferred habitat or habitat critical to the survival of the species within the project area, and the project area does not represent a stronghold for the species, the population will not be fragmented. D: No. The area of occupancy is widespread within Australia for this migratory species which breeds outside of Australia. Given there is no breeding habitat, no preferred habitat or habitat critical to the survival of the species within the works footprint, habitat that is critical to the survival of this species will not be adversely affected. E: No. Given the species does not breed in Australia (i.e. breeds in the Arctic Tundra of Siberia (Geerling et al. 2008), the breeding cycle of the population will not be impacted. F: No. There is no preferred habitat (i.e. intertidal mudflats, Geering et al. 2008) within the works footprint. Therefore, quality habitat important to the survival of the species will not be modified, destroyed or removed to the extent that the species will decline. G: Not Likely. The migratory species breeds outside of Australia and prefers intertidal mudflats when visiting Australia. These habitats do not occur within the study area, therefore post construction weed control program and construction adjacent to existing services corridor are unlikely to result in new invasive species. H: Not Likely. Preferred habitats do not occur within the study area, and key populations do not occur within the study area. The proposed construction and operation activities are not expected to introduce disease that would affect the species. I: Not Likely. There is no specific recovery plan for this species. Conservation actions relate to loss of key habitat within the East China Sea. Australian conservation actions relate to reducing impacts from human disturbance, habitat loss, and invasive plants at key feeding grounds. Key feeding grounds do not occur within the study area, therefore, with mitigation measures, the

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						proposed action will not interfere with the recovery of the species.
Pezoporus occidentalis (Night Parrot)	CE		Possible	Minor clearance of Samphire and other Chenopod low open shrubland which represents potential foraging habitat, particularly where adjacent to *Triodia* spp. hummock grassland nesting habitat, if present.	Undertake site clearance walkover as part of land disturbance permitting prior to construction of tracks and infrastructure, to ensure avoidance of any preferred *Triodia* hummock grassland nesting habitat. Minimise clearance of potential foraging habitat	**No significant impact predicted** A to H: Not Likely. Previously considered extinct or near extinct. Recently confirmed extant populations occur in Qld and WA. No key populations have been identified within SA, with the exception of a feather observed at Kalamurina in SA (northeast of Lake Eyre) approximately 350km from the project location. A vast amount of arid-zone habitat has been identified as potential habitat for the species. The proposed project involves minor clearance of potential foraging habitat that is dominant in the study area and present more broadly across the region. The project will not involve clearance of the preferred *Triodia* spp. nesting habitat, and none of this habitat type was identified during the recent targeted habitat assessment of the Northern Wellfields project area (Jacobs 2018a). Therefore, with mitigation measures the proposed action will not lead to a long-term decrease in the size of a population of the Night Parrot, will not reduce the potential area of occupancy and will not fragment an existing population. Habitat that is critical to the survival of this species occurs across WA, SA and Qld. An existing population is not confirmed in SA, therefore the minor clearance of potential foraging habitat will not fragment the habitat or adversely affect critical habitat to the survival of the species. Given that a population is not known and preferred nesting habitat does not occur within the project area, the breeding of this species will not be disrupted, or availability of preferred breeding habitat decreased. Given the vast amount of potential foraging habitat across SA, with mitigation measures proposed, the proposed action is unlikely to result in establishment of invasive species that will impact potential habitat or introduce disease that will impact the species. Whilst this is a low flying species, there is a low risk of collisions

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						with vehicles on access track, however as no night traffic is anticipated on access tracks. There is a low risk of collision with borefield enclosures, if this species occurs at the site. Mitigation measures could include provision of reflectors on borefield fencing to minimse risk of collision. I: Not Likely. A recovery plan is not currently in place for this species. However, recovery actions are the objective of the Night Parrot Recovery Team, given the species has only been rediscovered in two Qld National Parks and in WA (DOEE 2018d), with only a feather being located in SA. General objectives relate to detecting more populations of Night Parrot to better understand distribution and habitat preference. Most of arid SA has the potential to provide habitat for the species (Night Parrot Recovery Team 2018b), and feral predatory animals are expected to be the key threat to this ground dwelling and nesting species. No key populations or key breeding habitats have been identified within the survey area, and it is therefore considered unlikely that the regionally minor clearance for this project (that is adjacent previously disturbed areas) will impact any recovery actions for this species.
Pseudomys australis (Plains Mouse)	VU		Likely	Clearance of potential habitat for access roads, pipeline corridors, staging tanks and land disturbance for well pad construction for well heads and pumps. Soil compaction due to heavy vehicle presence. Introduction of invasive weed species resulting in	Undertake site clearance walkover as part of land disturbance permitting prior to construction of tracks, pipeline route and infrastructure to identify and avoid potential refuge habitat of deep cracking clay gilgais or broad run-on interdune swales. Flag off any preferred habitat identified during site clearance walkover to	**No significant impact predicted** A: Not Likely. This species has a highly irruptive life cycle and uses a broader range of habitat types during irruptive cycles. The potential habitat for this species during these periods is widespread across the Project Area, and more broadly, the Arcoona Plateau. The vegetation clearance footprint within this habitat will be comparatively minor and represents a very small portion of available habitat regionally. In addition, mitigation measures including identification and avoidance of potential refuge habitat (important to the species survival during non-boom years or drought periods) when positioning infrastructure and access tracks will mean the action is unlikely to lead to a long

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
				habitat degradation.	enable disturbance to be avoided. Where possible avoid land disturbance of potential refuge habitat (noting that the "run on" nature of this habitat/soil type is typically not suited to tracks, staging tanks and well pads, and will be avoided in final designs). Develop clear protocols for management of waste during construction to avoid an increase in, or attraction of, feral pest animals to the project area.	term decrease in an important population of this species. B: Not Likely. Whilst the species is known to occur at the Carrapateena site, important strongholds occur north of the site in the Stony Plains with the range extending from Pernatty Station in SA (south of the site) through to Anado Station in the NT. This species has a highly irruptive life cycle and that during boom years, records can be collected well outside of refuge habitats or important population strongholds. General habitat use during irruptive cycles is broad spread across huge areas in the region and in no way confined to the project area. Regionally insignificant clearance within potential habitat for tracks, well pad and staging tank construction and therefore the action is unlikely to lead to a significant reduction to the area of occupation of an important population of this species. C: Not Likely. Clearance for access track and clearance for wellfield pads and pipeline is considered unlikely to inhibit movement nor restrict gene flow of this species across the landscape. The targeted assessment of habitats within the Northern Wellfield area reviewed existing pipelines in the area and noted numerous and regulars gaps beneath the pipeline as a result of ground surface irregularities, allowing water and small rodents to move unimpeded across the landscape (Jacobs 2018a). Therefore, the action will not cause fragmentation of any population of plains mouse. Whilst it is known from the area, occurring north of the site in Stony Plains Habitat, the plains mouse range extends from Pernatty Station in SA to Andado Station in the Northern Territory, and it has been recorded from Carrapateena in small numbers during irruptive years, no important population is documented from the project area or identifiable from historic records. Cracking clays are considered to provide important refugia for this species (Brandle et al. 2008, Moseby 2012). A site survey will determine that micro-siting of wellfield pads, pipelines and tracks

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						avoids preferred refugia sites, if present within the Northern Wellfield area. D: Not Likely. Potential habitat is widespread for this species on the Arcoona Plateau and with mitigation measures proposed to avoid clearance or impacts to important refuge habitat of drainage channels and depressions with deep cracking clays, the action is unlikely to significantly impact habitat critical for survival of the species. E: Not Likely. Minimal clearance of potential refuge habitat will occur with the implementation of proposed mitigation measures, and once constructed, the development is unlikely to stop movement across the landscape or interrupt the species breeding cycle. F: Not Likely. Minimal clearance of potential habitat important for the species (i.e. refuge habitat) is anticipated with implementation of proposed control measures, and the action is therefore unlikely to significantly impact on habitat extent and quality which would lead to a decline in the species population. G and H: Not Likely. The species is known to occur north of the site, extending from Pernatty Station in SA to Andado Station in the Northern Territory. This species is known to expand and contract it's range depending on climatic conditions (e.g. contracts to preferred refugia during drier times (Brandle et al. 2008, Moseby 2012). Individuals have been captured during biannual surveys at the wider Carrapateena site. Cracking clays are considered to provide important refugia for this species. A site survey will determine that micro-siting of wellfield pads, pipelines and tracks avoids preferred refugia sites, if present within the Northern Wellfield area. As such, any introduction of weeds is not considered likely result in establishment and degradation of preferred habitat. The project area not in a high risk *Phytophthora* area. Management measures include weed controls during and post construction as well as vehicle hygiene practices, so establishment of new weed species or diseases in

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
						the project area is not considered likely. Existing tracks exist within the project area, so the proposal is not expected to result in an increase in abundance of feral predator species. The action is therefore not expected to result in the introduction of invasive species or disease which are harmful to this threatened species. I: Not Likely. Recovery actions for this species include better understanding of locations and distributions of important populations and critical habitat, and to better understand threats to current populations. The proposed actions will not interfere with the recovery of the species.
Migratory Waders (Functional Group)						
Actitis hypoleucos (Common Sandpiper), *Calidris acuminata* (Sharp-tailed Sandpiper), *Calidris melanotos* (Pectoral Sandpiper), *Charadrius veredus* (Oriental Plover), *Tringa nebularia* (Common Greenshank), *Limosa limosa*, (Black-tailed Godwit), *Calidris ruficollis*, Red-necked Stint, *Tringa glareola* (Wood Sandpiper), *Tringa stagnatilis*	MW			Injury or mortality from collisions with vehicles traversing access track. Siltation of any existing dams Disturbance due to human activity or vehicles in close proximity	Micro-align access road, pipe line, and infrastructure to avoid traversing foraging habitat (dams, open water). Note, however, that this habitat is typically not suited to tracks, staging tanks and well pads, and will be avoided in final designs). Flag off any preferred habitat identified during site clearance walkover to enable disturbance to be avoided. Implement weed hygiene practices during construction and implement post construction weed surveillance and control programs. Manage any naturally	**No significant impact predicted** A: Not likely. Any impacts associated with groundwater drawdown are not part of the referral decision for the Northern Wellfield. The north-eastern corner of the project area abuts Lake Torrens, which provide the most suitable habitat for the migratory waders. Elsewhere within the Project Area there may be small areas of open water along ephemeral drainage lines. Clay pans also occur sporadically within areas of low-relief in the western sector of the Project area. The proposed tracks, pipelines and infrastructure will not be located on areas of open or shallow water. These species breed overseas, or in significant areas of wetland or intertidal habitat which will not be influenced by this project. As such, the action will not substantially modify, destroy or isolate an area of important habitat for a migratory wader species. B: Not likely. Mitigation measures proposed will control the spread of weed species during construction of the project and post construction. Existing service corridors and tracks run through the project area, meaning that new invasive species are unlikely. The project will not impact on important habitat features to migratory wader species, such as inland ephemeral lakes or

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
(Marsh Sandpiper)					occurring areas of shallow water to ensure natural hydrological regimes are maintained.	wetland areas. C: Not likely. The project is not located in an area where an ecologically significant proportion of a population of migratory species exists. Potential foraging habitat will be avoided. The project will not seriously disrupt the life cycle of an ecologically significant proportion of the populations of migratory species.
Migratory Marine Avifauna						
Seabirds *Hydroprogne caspia,* (Caspian Tern), *Celochelidon nilotica* (Gull-billed Tern)	MM		Possible	Injury or mortality from collisions with vehicles traversing access track. Siltation of any existing dams Disturbance due to human activity or vehicles in close proximity	Micro-align access road, pipe line, and infrastructure to avoid traversing foraging habitat (dams, open water). Note, however, that this habitat is typically not suited to tracks, staging tanks and well pads, and will be avoided in final designs). Implement weed hygiene practices during construction and implement post construction weed surveillance and control programs. Manage any naturally occurring areas of shallow water to ensure natural hydrological regimes are maintained. Prevent human access to areas considered highly suitable habitat, and ensure no disturbance beyond essential vegetation	**No significant impact predicted** A: Not likely. The north-eastern corner of the project area abuts Lake Torrens, which provide the most suitable habitat for the migratory seabirds to forage. Elsewhere within the Project Area there may be small areas of open water along ephemeral drainage lines. Clay pans also occur sporadically within areas of low-relief in the western sector of the Project area. The proposed tracks, pipelines and infrastructure will not be located on areas of open or shallow water. These species breed on offshore coastal islands (Caspian Tern), or on large ephemeral lakes and wetlands (Gull-billed Tern) which will not be influenced by this project. As such, the action will not substantially modify, destroy or isolate an area of important habitat for a migratory wader species. B: Not likely. Mitigation measures proposed will control the spread of weed species during construction of the project and post construction. Existing service corridors and tracks run through the project area, meaning that new invasive species are unlikely. The project will not impact on important habitat features to migratory seabirds, such as inland ephemeral lakes or wetland areas and offshore coastal islands are not present. C: Not likely. The project is not located in an area where an ecologically significant proportion of a population of migratory seabirds exists. Potential foraging habitat will be avoided. The project will not seriously disrupt the life cycle of an ecologically

Species Name	EPBC Act[1]	NPW Act[2]	Likelihood of Occurrence	Potential Impacts from proposed action	Proposed Mitigation Measures	Significant Impact Assessment (following mitigations) against significant impact criteria
					clearance footprint.	significant proportion of populations of migratory seabird species.
Apus pacificus (Fork-tail Swift)	MM		Possible	Injury or mortality from collisions with tall infrastructure, however no tall infrastructure is proposed with the exception of borefield fencing.	None proposed.	**No significant impact predicted** A: Not likely. Given the species migratory, breeding in eastern Asia, the proposed wellfield is not anticipated to impact the breeding of this species. The species is almost exclusively aerial, feeding on the wing above a variety of habitats (from inland open plains to wooded areas) across large portions of Australia during summer months (DOTE 2015). Species generally flies well above the height of the proposed wellfield infrastructure, up to 1000m. The proposed action will therefore not substantially modify, destroy or isolate an area of important habitat for this migratory species. B: No. Weed control programs during and post construction would minimise the likelihood of new invasive species being introduced to the project area. In addition, invasive species that are harmful to this species are unknown, given the aerial nature of the species. The broad distribution of this species across multiple continents also makes weed invasions as a result of the project highly unlikely to result in significant impacts to this species. C: Not likely. Given the species is a non-breeding migrant to Australia, the action, will not seriously disrupt the life cycle of an ecologically significant proportion of the populations of this migratory species.

[1]*Environment Protection and Biodiversity Conservation Act 1999* Status: Critically Endangered (CE); Endangered (EN), Vulnerable (VU); Migratory Marine (MM); Migratory Terrestrial (MT); Migratory Wetland (MW);[2]South Australian *National Parks and Wildlife Act 1972* Status: Endangered (E), Rare (R), Vulnerable (V).

5. Potential Impacts and mitigations

The following provides a broad overview of potential impacts and outlines mitigation measures proposed to avoid or reduce residual risks to wildlife populations and important habitat. Potential impacts and mitigation measures specific to individual listed species (or groups of species) are provided in the tables above.

5.1 Vegetation Clearance

Vegetation clearance will be required for the construction and/or modification of access tracks, and land clearance associated with pipelines and staging complexes. These works may include fencing, flagging or pegging of construction areas, stripping and stockpiling of topsoil and subsoils plus grading and ground consolidation works.

Mitigation measures associated with access track upgrade or construction will include flow disruptors and diversion drains to minimise erosion. Design and construction of new access tracks will also be such as to manage surface water run-off (OZM Carrapateena Pty Ltd, 2018). At ford crossings, the streambed would be concrete lined to preserve the shape and natural hydrology of the stream bed as much as possible. Project infrastructure has been sited on flat land wherever possible to minimise surface water runoff.

Vegetative cover is expected to grow on the slopes of the stockpiles, and is likely to provide some erosion protection. In addition, stockpile sediment would be captured using such measures as silt control fences, hay bales and sediment traps (OZM Carrapateena Pty Ltd, 2018). Stockpiles would not be placed directly in drainage lines to avoid water migration through the stockpiles.

Wherever possible, the transfer pipelines will be installed parallel to existing pastoral tracks to minimise land disturbance.

Further mitigation measures will include pre-construction site surveys as part of the land disturbance permit system which is in place for OZ Minerals operations to identify and avoid impacts to important habitat. This will enable avoidance of disturbance to known or potential core habitat for EPBC listed species through micro-positioning of infrastructure and tracks where practicable. Vegetation clearance in these areas will be avoided or minimised where possible during the design phase by locating well heads and the proposed new access track in alternative locations. It is noted that important habitat for several EPBC listed species coincides with drainage lines and run-on areas which are typically not suitable as sites for wellhead and water distribution infrastructure. In general, habitat types present are well represented across the broader landscape, and do not provide critical refuge for any of the species discussed here.

It is noted that for the majority of species that are considered as likely to be present, or as ‘possible’ to occur within the survey area, habitats for the species are readily available within SA. For example, suitable habitat (namely gilgais soils) for the nationally threatened Plains Rat is distributed throughout the Project area (EBS 2018) through into Northern Territory. Given that the footprint for the project will impact a very small proportion of the available habitat, significant impacts to EPBC listed species and their habitats are not predicted.

5.2 Weed Hygiene and pest species

The introduction of weeds, disease or improved accessibility to an area by feral predators are project risks to significant species in the project area. The proposed wellfield will require upgrades to existing tracks and the construction of new access tracks with increased vehicle traffic. The existing track infrastructure in the area reduces the risk of the introduction of new invasive weed species or pests, or facilitating increased predator levels, as the ‘threatening processes’ are already in place in the project area. Wherever possible, the transfer pipelines will be installed parallel to existing pastoral tracks to minimise land disturbance and the need for new access tracks. Nevertheless, to reduce the risk of introducing weeds into the area, best-practice construction hygiene procedures are proposed, including:

- Implementing vehicle inspections and wash-down procedures
- Weeds should be controlled within the work area according to the requirements of the Natural Resource Management Act (2004).
- All noxious weeds which are cleared as part of the project must be disposed of appropriately.
- Conduct post construction weed survey and control program with particular focus on any weed infestations identified in pre-construction surveys.

5.3 Fauna passage and pipelines

The Northern Wellfield project involves establishing water distribution infrastructure to connect groundwater wells and pumping infrastructure to the mining operation raw water storages. A key component of this is laying of PVC and plastic pipelines along the ground surface, which has the potential to impede fauna migration (and water flows) across the landscape. A review of existing pipelines already in place around the Carrapateena operation during the targeted habitat assessment for the Northern Wellfield (Jacobs 2018a) identified that the pipes do not lay flush with the ground, as a result of regular inconsistencies with the ground surface and the presence of rocky strew. As a result, there are numerous and regular opportunities along the pipeline for the movement of small mammals, reptiles and water across the landscape.

As part of routine maintenance inspections, identify any areas where sediment accumulation may result in a build-up of materials beneath the pipeline which could impede movement across the landscape (and water flow). Should this be identified, earthen mounds over the pipeline, or elevation of the pipeline at regular spacing is proposed to ensure movement of fauna across the landscape is not restricted, resulting in potential population fragmentation.

5.4 Wildlife collisions with vehicles

The Northern Wellfield construction period would be up to 18 months in duration, and would necessitate up to approximately 10 heavy vehicle movements, and some associated light vehicle movements for construction personnel, per day along well access tracks. Vehicles traversing access tracks pose a risk to wildlife as a result of direct collisions. Best-practice construction traffic management procedures are proposed, including all vehicles stay on tracks, speed restrictions and effective signage where potential ecological constraints exist to raise awareness and further control speeds in these areas. Site induction processes to include awareness training regarding the conservation significance of flora and fauna species in the area.

Following completion of construction, it is envisaged that vehicle traffic will be less frequent and limited to light vehicles, and impacts on wildlife are anticipated to be rare occurrences, not resulting in significant alterations to any populations.

5.5 Noise and Dust

During the land clearance activities, possible raised dust will be suppressed using minor quantities of saline water. Elevated noise and dust levels will occur during construction of the wellfield however this impact will be localised and temporary and will cease once construction is complete. For ongoing operations, vehicles and machinery would be fitted with the appropriate emission, dust and noise control equipment and maintained and serviced frequently (OZM Carrapateena Pty Ltd 2018). Speed limits will be restricted to 60 km/hr along access tracks to limit dust generation.

6. Conclusion

This report presents the findings of a detailed assessment of EPBC listed Protected Matters which are relevant to the Carrapateena Northern Wellfield. The assessment involved a review of the likelihood of occurrence of Protected Matters in the area, followed by a detailed assessment of the potential for significant impacts upon those Protected Matters which were considered likely to be present within the study area, or as possible occurrences within the study area. The significant impact assessment addressed the significant impact criteria for Endangered, Vulnerable and Migratory species outlined by DoTE (2013).

No Threatened Ecological Communities were identified within the study area.

One plant species were identified as potentially present based on a review of the Protected Matters database; *Frankenia plicata*. This species was not detected during extensive baseline and targeted survey effort of the Carrapateena study area, including survey effort specifically targeting the Northern Well field area. The closest historic records of the species to the Project area are now in doubt and under review. There is a remote chance that the species is present, but if it is, it is not likely to represent an important population and with the implementation of the proposed mitigation measures, including targeted pre construction site walk-overs to inform micro-placement of footings and track alignments to avoid any Protected Matters present, no significant impacts are anticipated to any this plant species as a result of the project.

Four threatened fauna species, including three birds and a single mammal were identified as potentially present in the study area based upon a review of the Protected Matters database.

Three of these threatened species, the Thick-billed Grasswren (eastern species), Curlew Sandpiper and Night Parrot were considered to possibly be present at the site, despite these species not being detected during extensive baseline and targeted survey effort of the Carrapateena study area, including survey effort specifically targeting the Northern Well field area. The proposed activity is predicted to result in no significant impacts to any of these three fauna species as a result of the project, since the development does not significantly reduce the area of occupancy, fragment any populations, or substantially reduce the size of any population. Existing infrastructure in the area means that the introduction of new weed species or an increase in pest numbers as a result of the project is unlikely. Successful implementation of proposed mitigation measures, including targeted site walkovers prior to construction to identified locations of any preferred habitat, would result in a further reduction of impacts to any matters of national environmental significance which are possibly present.

The fourth threatened species, The Plains Mouse, was considered likely to be present within the project and study area based upon historic records within the Carrapateena project area, an irruptive life-cycle, and a broad distribution throughout arid South Australia. The proposed activity is predicted to result in no significant impacts to Plains Mouse since the development does not significantly reduce the area of occupancy, fragment the population, or substantially reduce the size of the population. Successful implementation of proposed mitigation measures, including targeted site walkovers prior to construction to identified locations of important refuge habitat, would result in a further reduction of impacts to Plains Mouse, and therefore no significant impacts are anticipated to this species as a result of the project.

Seventeen migratory species were assessed in the review (nine highlighted in the PMST, eight highlighted in the BDBSA output). The proposed activity will not affect ephemeral lakes and wetland habitat, and therefore no significant impacts are expected for migratory species as a result of the project.

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Appendix A. Protected Matters Report

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

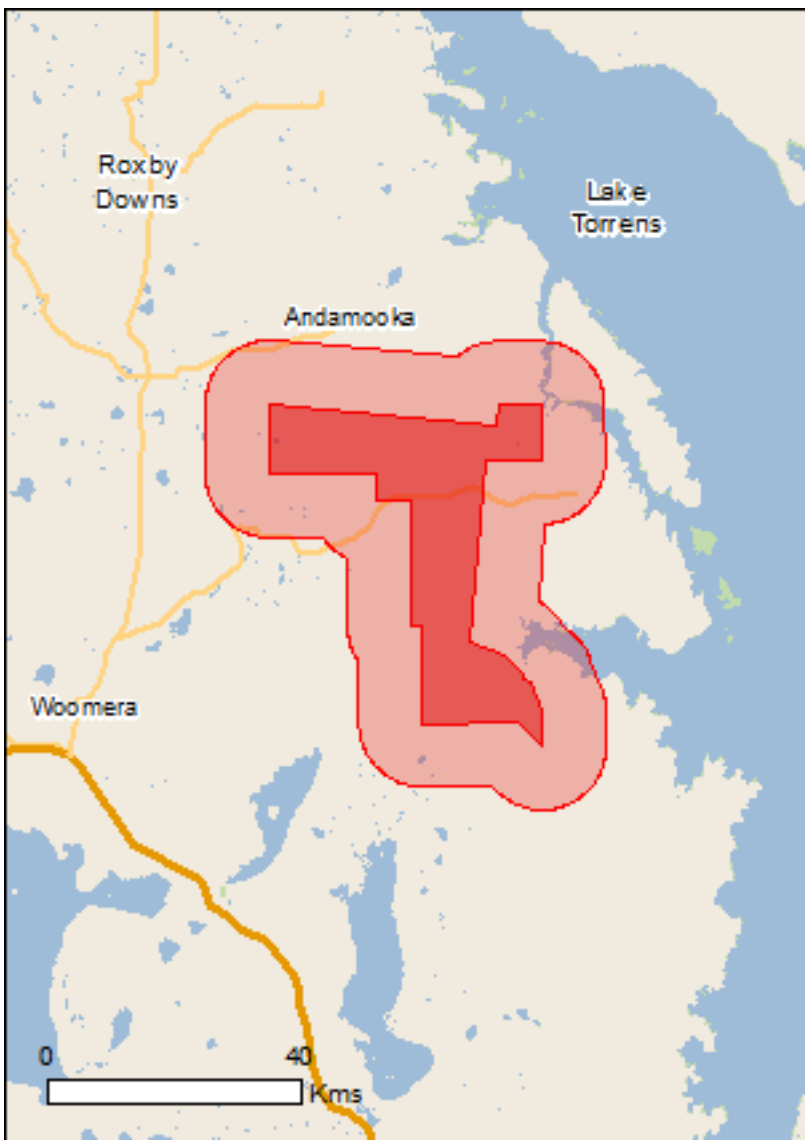
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 13/03/18 16:31:24

Summary
Details
Matters of NES
Other Matters Protected by the EPBC Act
Extra Information
Caveat
Acknowledgements



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Coordinates

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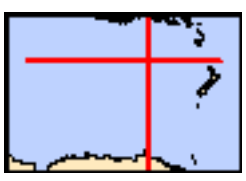

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	5
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	16
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Amytornis modestus Thick-billed Grasswren [84121]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Extinct within area
Mammals		
Pseudomys australis Plains Rat, Palyoora [108]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Frankenia plicata [4225]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Lake Torrens	SA

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cylindropuntia spp. Prickly Pears [85131]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Inland Saline Lakes	SA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-30.83062 137.08465,-30.85552 137.40678,-30.8319 137.40817,-30.83187 137.46825,-30.8992 137.4698,-30.90061 137.392,-31.11802 137.37003,-31.13438 137.41795,-31.15826 137.44291,-31.16245 137.44355,-31.16737 137.4551,-31.20247 137.47064,-31.24516 137.47063,-31.21485 137.43483,-31.21734 137.30132,-31.09853 137.30132,-31.09853 137.28466,-30.94852 137.28466,-30.94853 137.23466,-30.9152 137.23466,-30.9152 137.08466,-30.83062 137.08465

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix B. EPBC Species Targeted Habitat Assessment; Northern Wellfield

EPBC Species Targeted Habitat Assessment

Northern Wellfield Carrapateena

OZ Minerals

IW104000-0000-NE-RPT-002 | FINAL

28 May 2018

EPBC Species Targeted Habitat Assessment, Northern Wellfield

Project No:	IW104000
Document Title:	EPBC Species Targeted Habitat Assessment
Document No.:	IW104000-0000-NE-RPT-002
Revision:	FINAL Rev0
Date:	28 May 2018
Client Name:	OZ Minerals
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Executive Summary

OZ Minerals is an Australian-based modern mining company with a focus on copper and gold. Carrapateena is an OZ Minerals copper-gold project located in South Australia, 65 km east of Woomera, on the eastern margin of the Gawler Craton. Construction on Carrapateena is underway and is scheduled to be complete in Q4 2019 when the site will move into a steady state operation.

OZ Minerals propose to construct a project wellfield to support the mining operations (the Project) authorised under State Government Approval (ML6471) and EPBC Referral (2017/7895). The wellfield is to be located to the north of the Project and is referred to as the Northern Wellfield.

The proposed Northern Wellfield would include access roads, pipeline corridors, staging tanks and construction of well heads and pumps. Access will be achieved through the existing access road that connects to the existing mining operations, and any impacts to groundwater or resulting indirect impacts to ephemeral lake systems have already been assessed in EPBC Referral 2017/7895.

An assessment of Protected Matters listed under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) which are relevant to the Carrapateena Northern Wellfield was prepared by Jacobs (2018 a). The assessment includes a review of the likelihood of occurrence of Protected Matters in the area, followed by a detailed assessment of the potential for significant impacts upon those Protected Matters which were considered likely to be present within the study area, or as possible occurrences within the study area.

A substantial investment in baseline assessments within the Carrapateena project area and the preliminary findings of the above targeted EPBC assessment indicated that four EPBC threatened species (or suitable habitat to support threatened species) may be present within the proposed Northern Wellfield project area, namely:

- *Frankenia plicata* (Southern Sea-heath): Endangered EPBC Act
- *Pezoporus occidentalis* (Night Parrot): Endangered EPBC Act
- *Amytornis modestus* (Thick-billed Grasswren): Vulnerable EPBC Act
- *Pseudomys australis* (Plains Mouse): Vulnerable EPBC Act

A survey targeting the above EPBC species, or their preferred habitat, within the proposed Northern Wellfields footprint was undertaken by a Jacobs ecologist (1 to 3 May, 2018) to support the above EPBC assessment. This report presents the findings of the targeted survey, discusses the background to each species, and presents the methods employed during the survey.

This targeted survey covered the proposed Northern Wellfield area including well sites and pipeline alignments with a particular focus on habitats where *Frankenia plicata* has been historically recorded in the broader region. No *Frankenia plicata* was identified during this survey. Although there have been several records from the Arcoona Plateau, including a record from approximately 10 km north of the Northern Wellfield project area, a preliminary review of the voucher specimens for these records indicates that they may have been incorrectly identified as *Frankenia plicata*. This finding, if confirmed, would lead to a re-evaluation of the preferred habitat and known distribution of this species.

This targeted survey primarily focused on identifying preferred Night Parrot roosting/nesting habitat of *Triodia* (Spinifex) hummock grassland within the proposed Northern Wellfield project area and builds on the findings of a recent targeted survey of the broader Carrapateena project area (Jacobs, 2018 b). No Night Parrots, evidence of Night Parrots, nor areas of preferred *Triodia* spp. habitat, were observed during this survey.

The survey for Thick-billed Grasswren primarily focused on the identification of suitable habitat for the species during vehicular and foot traverses of the Northern Wellfield project area. The Northern Wellfield

area lies just south of the current known distribution of Thick-billed Grasswren (Lake Eyre sub-species) and it is considered that shrub height and cover in the drainage lines of the project area provide sub-optimal habitat for this species. Thick-billed Grasswren have not been recorded in the broader Carrapateena project area despite extensive repeated surveys undertaken since 2008 (EBS, 2014 b, EBS, 2017a, b) and targeted survey in 2014 (EBS, 2015 a) and it is considered unlikely that this species is extant in the Northern Wellfield project area.

The survey for Plains Mouse primarily focused on the identification of suitable habitat for the species. As identified in previous surveys of the broader Carrapateena project area and the desktop study for the Northern Wellfield project area, preferred refuge Plains Mouse habitat of depressions, run-on areas and gilgais with deep cracking clays was found to be widespread throughout the surveyed area and the species has been recorded at numerous locations within the broader Carrapateena project area following good seasonal conditions. Northern Wellfield infrastructure including wells, turkey nests and pumps and generators will be located on higher ground to avoid damage from flood events, thereby minimizing clearance and disturbance to the lower-lying Plains Mouse refuge habitat.

Important note about your report

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client; OZ Minerals, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

The sole purpose of this report and the associated services performed by Jacobs is to document results of targeted surveys for EPBC listed species Frankenia plicata, *the Night Parrot, Thick-billed Grasswren and Plains Mouse at the Northern Wellfields site. The report is based on a desktop review of available data and field survey. The scope of services, as described in this report, was developed with the Client, OZ Minerals.*

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs collected data at the Northern Wellfields site and derived additional data in this report from information sourced from the Client and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

1. Introduction

OZ Minerals propose to construct a project wellfield to support Carrapateena mining operations (the Project) authorised under State Government Approval (ML6471) and EPBC Referral (2017/7895). The wellfield is to be located to the north of the Project and is referred to as the Northern Wellfield. The location of the Northern Wellfield is shown in Figure 1-1.

The proposed Northern Wellfield would include access roads, pipeline corridors, staging tanks and construction of well heads and pumps. Access will be achieved through the existing access roads that connect to the existing mining operations. Existing access tracks will be widened where required.

The project components will consist of:

- Establishing pumping infrastructure (e.g. diesel tanks, gensets, well metering) at each production groundwater well within the area previously cleared as a component of the groundwater exploration works. There is no additional land clearance associated with the installation of this infrastructure.
- Establishing water distribution infrastructure, including associated land disturbance, connecting each groundwater well to the mining operation raw water storages approved under EPBC Referral (2017/7895), specifically:
  - The installation of water pipelines
  - The installation of staging complexes along the pipeline corridors
  - The construction of access tracks or widening of existing access tracks where required
  - The construction of pipeline laydown areas

The groundwater production wells are equipped with submersible pumps, flow meters, telemetric controls, pole-mounted transformer, contactors and a motor starting panel.

An assessment of the potential impacts to EPBC Protected Matters arising from the construction and operation of the Northern Wellfield project is currently being undertaken by OZ Minerals, including supporting studies by Jacobs (2018a). This assessment includes a review of an earlier desktop study of the general area of the Northern Wellfield precinct (EBS, 2015a) and assessments and survey reports covering Carrapateena project tenements (EBS, 2014a and Jacobs, 2018b). These have identified four EPBC listed threatened species that may potentially occur, or that suitable habitat may occur, within the Northern Wellfield project area. These species are:

- *Frankenia plicata* (Southern Sea-heath): Endangered EPBC Act
- *Pezoporus occidentalis* (Night Parrot): Endangered EPBC Act
- *Amytornis modestus* (Thick-billed Grasswren): Vulnerable EPBC Act
- *Pseudomys australis* (Plains Mouse): Vulnerable EPBC Act

1.1 Purpose of the targeted survey

The purpose of this study was to undertake targeted surveys of the proposed Northern Wellfield project area to provide information to support the assessment of whether significant impacts are considered possible as a result of the project to the four EPBC listed species identified in previous studies. Information collected was to further inform likelihood of occurrence assessments, and significant impact assessments, as a result of the construction and operation of the Northern Wellfield project. Whilst the survey included foot traverses to detect the presence of *Frankenia plicata* within the project area, the methodology and duration of the survey was primarily aimed at recording suitable habitat for the targeted bird and mammal species, rather than the detection through capture or observation of populations.

Section 2 of this report outlines background information including historic survey effort for each species. Section 3 outlines the survey methods and survey effort undertaken here. Section 4 provides the results of the targeted surveys. The location of the Northern Wellfield project area is shown in Figure 1-1 below.

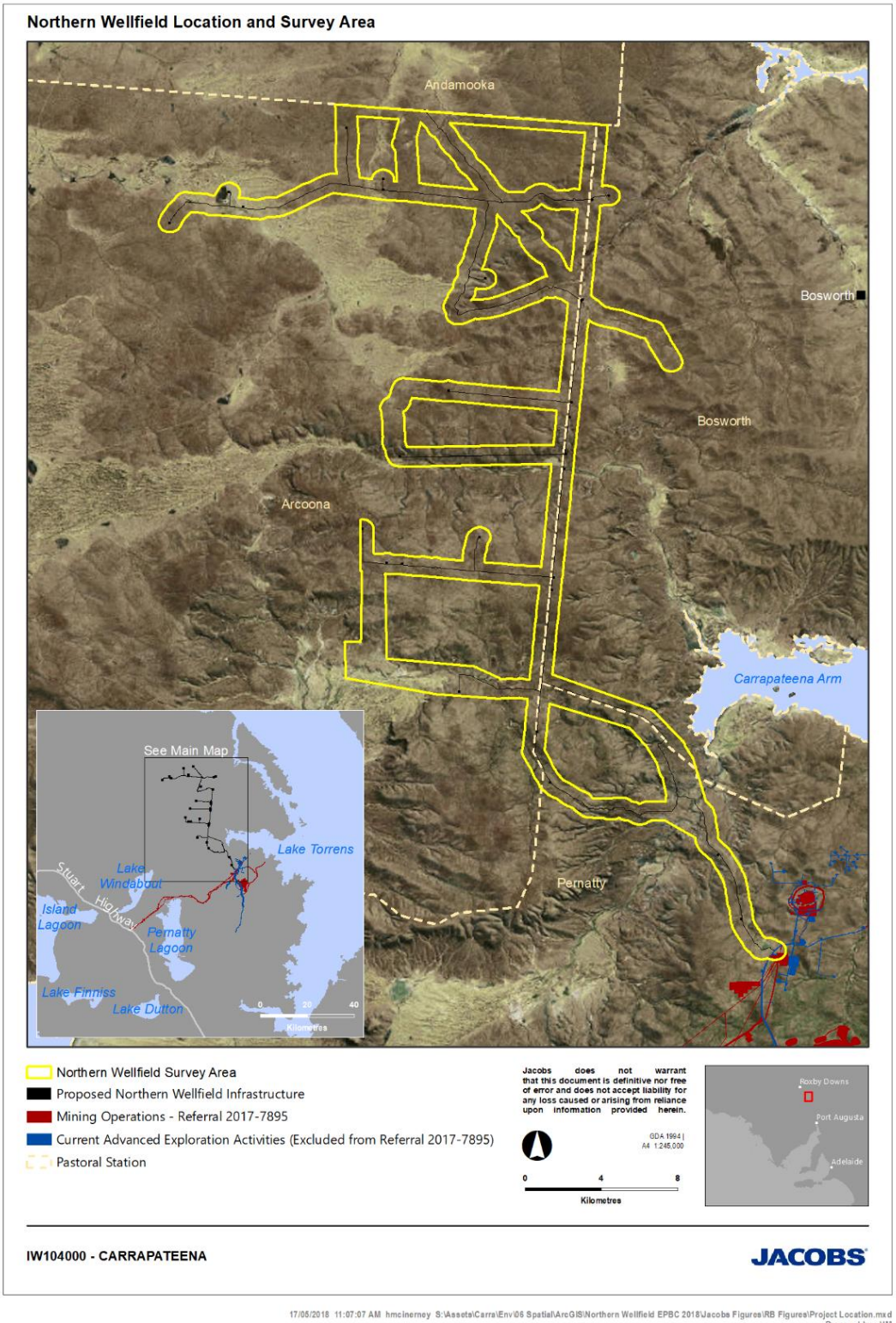

Figure 1-1: Northern Wellfield Project Area: Locality Map

2. EPBC Target Survey Species: Background

2.1 *Frankenia plicata* (Southern Sea-heath)

2.1.1 History

Frankenia plicata (Southern Sea-heath) listed as Endangered under the EPBC Act, is a low mat-forming or ascending shrub with a distribution predominantly confined to the western and south western portion of the Lake Eyre Basin in the Lake Eyre (LE) floristic region of SA, with several records for the Arcoona Plateau in the Gairdner Torrens (GT) floristic region (Jessop et al.1986). The species is listed as Endangered under the EPBC Act (Commonwealth) and Vulnerable under Regulations of the National Parks and Wildlife Act (South Australia).

2.1.2 Known distribution

The Southern Sea-heath has been collected from less than 50 locations, with most specimens lodged with the SA herbarium. Historic records indicate that the preferred habitat for this species is minor drainage lines and outwash plains with stony surfaces and loamy sand or clay sand soils. Most records are from the Stony Plains bioregion, particularly the Breakaways and Stuarts Range north east of Coober Pedy approximately 500 km north west of the Carrapateena site (SA Herbarium vouchers specimen notes 2018). This species has also been recorded on minor flood outs within the Arcoona Plateau, approximately 10 km north of the Northern Wellfield project area and 40 km south of the Carrapateena mine project area in 1996. The location of historical records of *Frankenia plicata* in the region are shown in Figure 2-1 below.

Previous studies and a review of the SA herbarium vouchers and associated notes indicate that suitable habitat may be present on the foots lopes, outwash plains and minor drainage lines of the Arcoona Plateau within the Carrapateena Mineral Lease (ML 6471) and Miscellaneous Purpose Licence, particularly where the Western Infrastructure Corridor (MPL 152) and Southern Access Road and Radial Wellfield (MPL 154) intersects this habitat in the vicinity of Yeltacowie Creek (EBS 2017 & SA Herbarium voucher specimen notes 2018). It should be noted however that the taxonomy of the *Frankenia* genus is under review and preliminary findings of a re-examination of several voucher specimens (May 2018), including those from the Arcoona Plateau to the north and south of the Carrapateena tenements undertaken by SA Herbarium taxonomist Helen Vonow indicate that these specimens may have been previously been misidentified are not *Frankenia plicata*. These vouchers will be further reviewed by a *Frankenia* specialist Dr. Molly Whalen in the coming months.

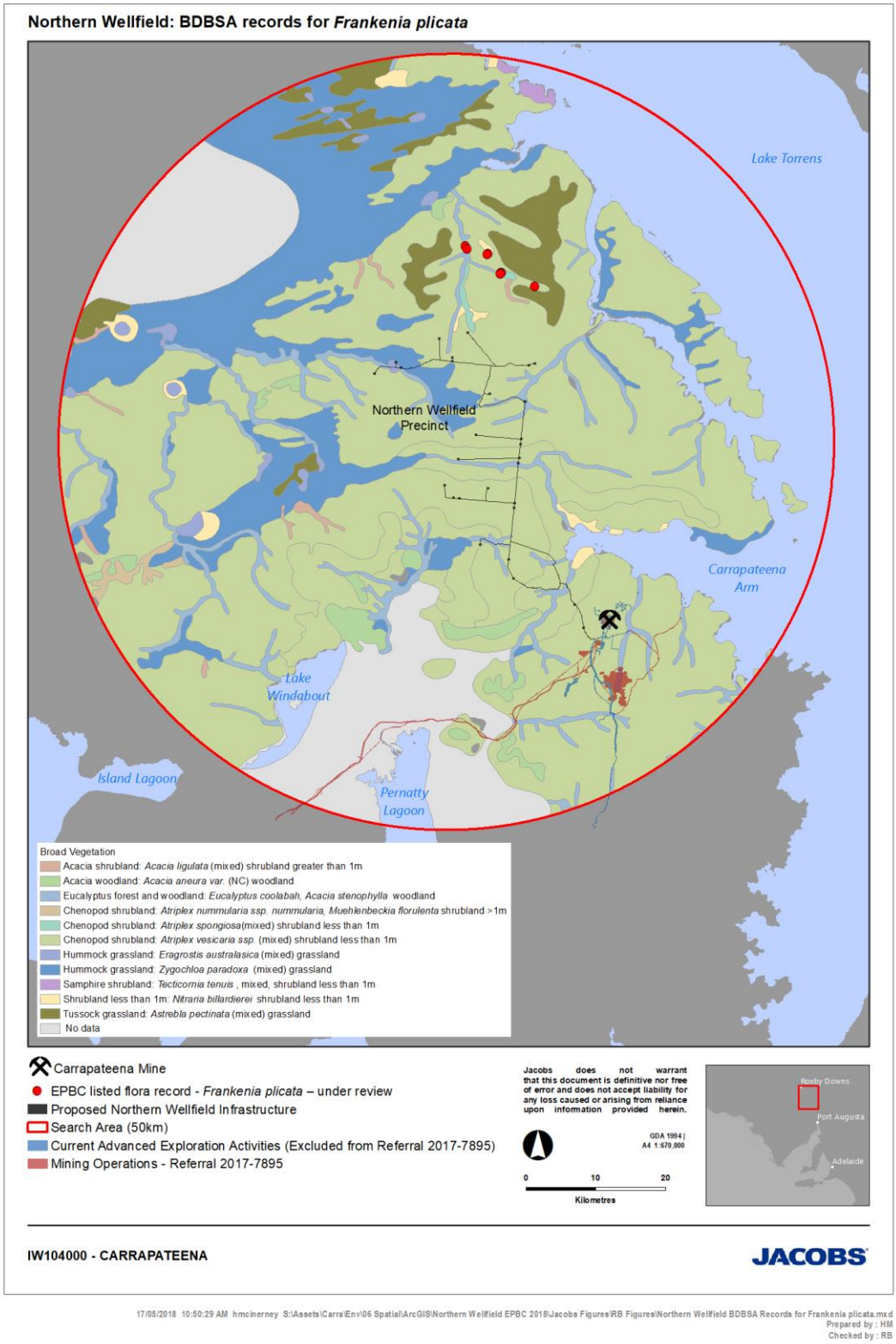

Figure 2-1: Historical records for *Frankenia plicata* within 50 km of the Northern Wellfield project area

2.1.3 Threats

While the high salt content in the foliage of all shrubs in the *Frankenia* genus renders them unpalatable to livestock and other grazers, impacts from livestock trampling and associated erosion from increased overland water flows has been identified as the main threat to populations of this species (Badman 1999 cited in DOEE 2018a). It is noted that the preferred habitat for this species in run-off broad drainage lines within sloping tableland country coincides with areas favorable for dam construction, which is likely to increase the risk and severity of direct and indirect impacts from livestock grazing and potentially historic vegetation clearance for dam construction. It is also noted that this habitat type is unsuitable for construction of wellfield infrastructure due to the risk of ephemeral flooding.

2.1.4 Historic survey effort at Carrapateena

Frankenia plicata has not been recorded during biannual floristic surveys undertaken since 2012 which covered the range of vegetation communities present on the Carrapateena OZ Minerals tenements which are located immediately south of the Northern Wellfield precinct (EBS 2013a, b, c; EBS 2014a, b, c, d; EBS 2015a, b; EBS 2016a, b; EBS 2017a, b). *Frankenia plicata* was also not identified during a recent targeted survey for the species of the Carrapateena project area (Jacobs 2018b). Field assessments of the Northern Wellfields precinct, including broad vegetation and habitat descriptions were also undertaken in 2014 (EBS 2015c).

Surveys undertaken in Spring and Autumn since 2012 at the site have reported floristic make-up at up to 47 flora sites within the Carrapateena project area, recording all plant species within a 1 ha plot following the SA Biological Survey methodologies (Heard and Channon 1997). In addition, observations of flora species not recorded at specific flora survey sites were recorded opportunistically during this period.

Previous flora surveys of the Carrapateena tenements and Northern Wellfield precinct have frequently recorded one species of the *Frankenia* genus, namely *Frankenia serpyllifolia* (Bristly Sea-heath) (Figure 2-2). This variable low shrub to about 40 cm tall is a widespread and common component of *Atriplex vesicaria* / *Tecticornia medullosa* low open shrubland community that is dominant on the stony tablelands of the Arcoona Plateau. The species is also patchily present on *Maireana aphyllya* / *Atriplex vesicaria* low open shrubland found on the broad alluvial plains and outwash areas on the margins of the Arcoona Plateau and internal minor drainage features. An additional species, *Frankenia subteres* was recorded during a recent survey on a stony gypsiferous hillslope on the western margin of the Carrapateena radial wellfield tenement (Jacobs 2018b).

Frankenia species are often difficult to distinguish in the field and usually require microscopic dissection to obtain a positive identification. Macro features that distinguish *Frankenia plicata* from *F. serpyllifolia* include a more procumbent, spreading habit and denser clustering of leaves. In addition, the revolute margins of *F. plicata* typically obscure the leaf mid-rib which remains visible in *F. serpyllifolia*. Photos of *F. plicata*, including SA Herbarium specimen are provided in Figure 2-3 and Figure 2-4 below.

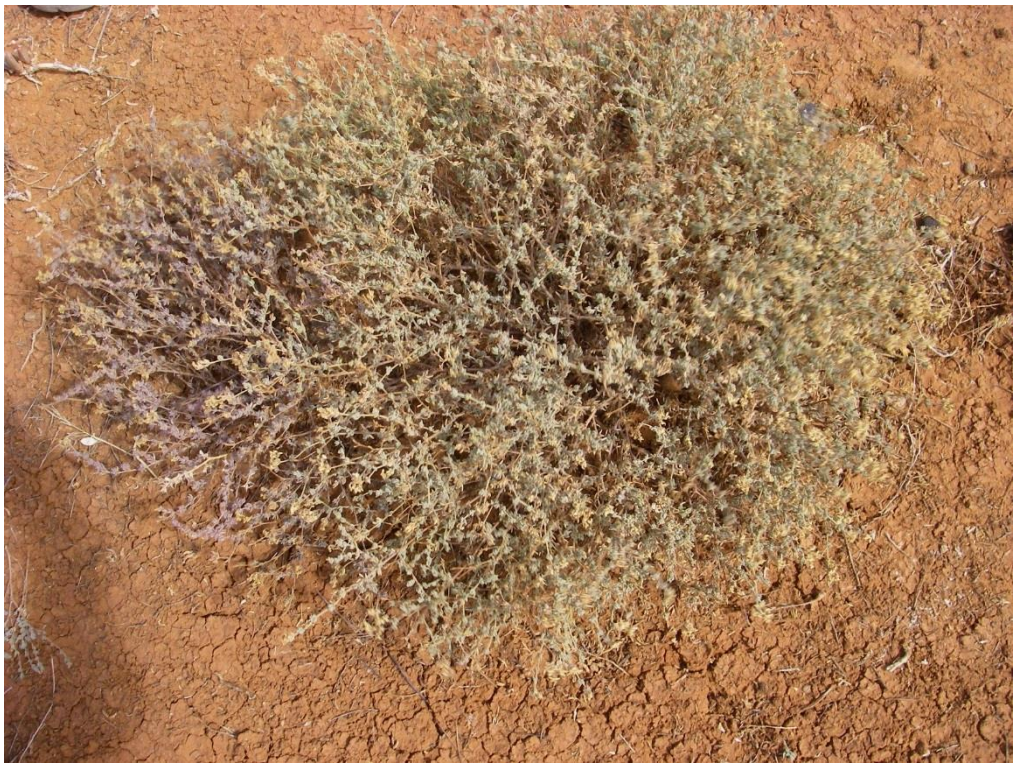

Figure 2-2: *Frankenia serpyllifolia* (Bristly Sea-heath), a common component of the stony tableland that dominates the Northern Wellfield precinct

Figure 2-3: *Frankenia plicata* (source: SA Seed Bank, 2018)

Figure 2-4: SA Herbarium (confirmed) specimen of *Frankenia plicata* from Evelyn Downs Station approximately 400 km north west of The Northern Wellfield project area

2.2 Night Parrot (*Pezoporus occidentalis*)

2.2.1 History

The Night Parrot (*Pezoporus occidentalis*), Endangered under the EPBC Act, is a highly elusive ground dwelling parrot that occurs in arid and semi-arid zones of Australia. It was previously thought to be extinct, but has recently been rediscovered with now known populations / occurrences in Queensland (Pullen Reserve, Goneaway National Park, Diamantina National Park) and Western Australia (near Broome) (Palaszczuk & Miles 2017, Jones 2017 cited in DOEE 2018b). These known occurrences are thought to be small isolated groups or small loosely connected populations and the species is still considered to be highly threatened and potentially on the brink of extinction (Night Parrot Recovery Team (NPRT) 2018). There are also newer reports of possible Night Parrot occurrence in the Northern Territory (based on potential calls in Spinifex habitat) and South Australia (based on a feather found in a Zebra finch nest at Kalamurina, approximately 350 km north of Carrapateena) (NPRT 2018).

Night parrots have not been recorded in South Australia for over 100 years. The recent finding of a feather, followed an image on a camera trap in an ungrazed, remote location, accessed via helicopter. The feather was found in a Zebra Finch nest (who are known to line their nests with feathers) beneath a Wedge-tailed Eagle nest adjacent to dense samphire habitat on Kalamurina Nature Reserve. Kalamurina is located north of Lake Eyre (Kati – Thanda) connected to a major tributary in an area that is destocked (feral herbivore free) and which contains a healthy population of dingoes (which may reduce the threat from feral cats) (NPRT 2018).

2.2.2 Known distribution

The approved conservation advice for the species (TSSC 2016) indicates that the current distribution of the species is unknown with few substantiated records since 1935. Despite a number of unverified sightings, several dedicated searches and public campaigns, there are only two areas (western Queensland and the Pilbara in WA) where reliable records indicate that populations may persist (NPRT 2016, cited in TSSC 2016). The TSSC (2016) diverts to information collected since 2013, since observations prior to this time

are considered anecdotal, spurious, or based on erroneous assumptions. Garnett et al. (2011) report most habitat records are from *Triodia* grassland and / or Chenopod shrubland. Subsequently, Murphy (2015) suggests that roosting and nesting sites are consistently reported within clumps of dense vegetation, primarily old (unburnt) and large spinifex clumps, but occasionally other vegetation types.

Potential habitat within South Australia (provided by NPRT 2018) is provided in Figure 2-5 below. Vast expanses of habitat broadly characterized as Chenopod and Lignum occur east of the Woomera and south east of Roxby Downs where the Carrapateena project (including the Northern Wellfield) is located. Historical Night Parrot records for South Australia are shown in Figure 2-6 below.

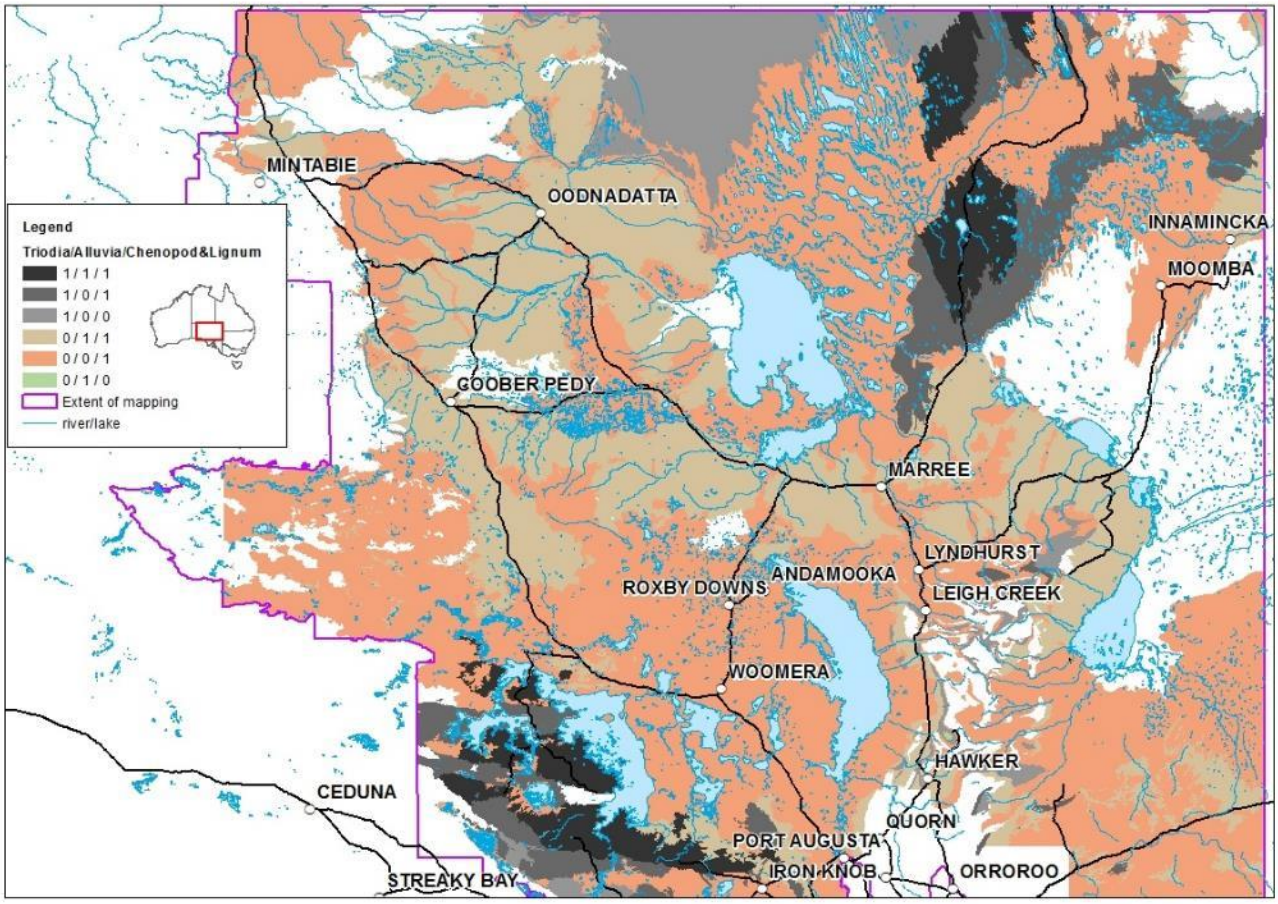

Figure 2-5: Potential Night Parrot Habitat Across South Australia (NPRT 2018).

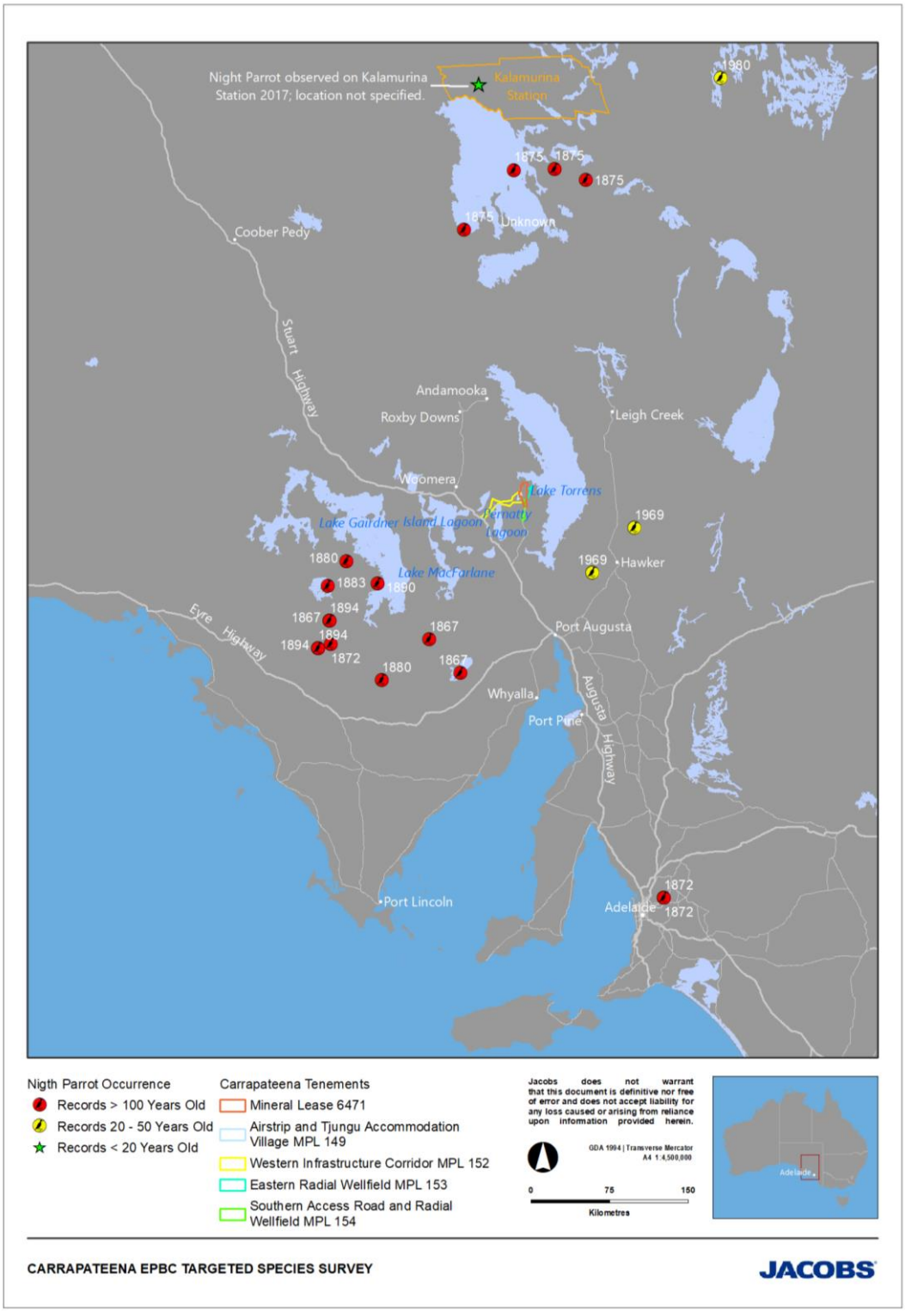

Figure 2-6: Historical records of Night Parrot in South Australia

2.2.3 Threats

It is noted in the approved conservation advice for Night Parrot (TSSC 2016) that there are no existing or adopted recovery plans for this species, with the exception of an interim Recovery Plan for Western

Australia, which directs the reader to the NPRT website. Research priorities of the species are documented in the Night Parrot Research Plan (Murphy 2014).

TSSC (2016) indicate that there are currently no know threats to Night Parrots, and that the causes of the presumed decline are essentially guesswork. A number of potential threats are listed including predation by feral cats and foxes, soil disturbance, land degradation as a result of introduced stock and feral herbivores (including to land around water points), and a reduction in water availability through overuse of water holes by camels and a lack of water hole maintenance. It is noted that the Threat Abatement Plans considered relevant to Night Parrot include management of feral cats and foxes, and competition and land degradation by rabbits. Existing management at the Carrapateena site includes a commitment to reporting any sightings or evidence of calls or activity to the NPRT throughout the Carrapateena operation and control of feral animal populations, including cats and foxes, aligning with the Threat Abatement Plans considered relevant by TSSC (2016a).

Studies in Queensland have also suggested King Brown Snakes are a common predator of the Night Parrot, following DNA analysis of damaged eggs at a known Night Parrot roost (Olsen et al. 2016).

2.2.4 Historic survey effort at Carrapateena

At Carrapateena, bird surveys have been undertaken as part of the fauna survey baseline studies, and have followed the widely recognised methodology outlined in the South Australian Vertebrate Survey Guidelines (Owens 2000). These surveys have occurred biannually from 2012 to 2017 (6 years, 12 surveys) and involved area searches for 30 minutes in the morning (before 11am) and afternoon (after 2pm) using call-playback where practicable at 16 sites on each occasion.

2.3 Thick-billed Grasswren (*Amytornis modestus*)

2.3.1 History

The Thick-billed Grasswren, listed as Vulnerable under the EPBC Act, is a ground-dwelling passerine species endemic to inland Australia and is distinguished from other Grasswren species by its comparatively short, thick bill and paler plumage which lacks striations associated with others of the genus.

2.3.2 Known distribution

An extensive study undertaken by Black et al. (2011) identified four discrete known populations of the species in South Australia; west of Lake Eyre and Lake Torrens (North West), north-east of Lake Eyre (Eyre) (both Lake Eyre ssp. *indulkanna)*; around the edges of the Northern Flinders Ranges (Flinders, ssp. *raglessi*) and south-west of Lake Frome (Frome, ssp. *curnomona*) (TSSC 2016, Menkhorst et al. 2017). The northern extent of the Northern Wellfield occurs within the southernmost extent of the known range of *Amytornis modestus indulkanna* 'North West' population (Black et al. 2011), which is the larger of the two populations for that subspecies (Menkhorst et al. 2017, Black et al. 2011).

Preferred habitat of the eastern species is arid and semi-arid zone chenopod shrublands, especially where dominated by saltbush *Atriplex spp*. (Saltbush) and *Maireana spp*. (Bluebush, Blackbush, Cotton-bush), *Nitraria* (Nitrebush) sometimes with widely scattered trees, both on plains and widely rocky ranges (Higgins et al. 2001, Menkhorst et al. 2017). In SA they have also been recorded in habitats that include *Sclerolaena spp.* (Bindii), *Salsola australis* (Roly-poly), *Tecticornia* spp. (Glasswort / Samphire) and various daisies including *Rhodanthe* spp., *Calotis hispidula* and *Craspedia* spp. (DOEE 2018a). The preferred habitat is generally known to be taller and denser chenopods that occur on drainage lines (DOEE 2018a, NPWS 2002, Black et al. 2011, Menkhorst et al. 2017).

The northern portion of the Northern Wellfield project area occurs within the southern-most extent of the currently known broader range of the subspecies *Amytornis modestus indulkanna* and includes isolated sections of preferred taller Chenopod shrubland habitat and minor drainage lines (DEWNR veg mapping). BDBSA records for Thick-billed Grasswren within 50 km of the Northern Wellfield precinct are shown on Figure 2-7 below.

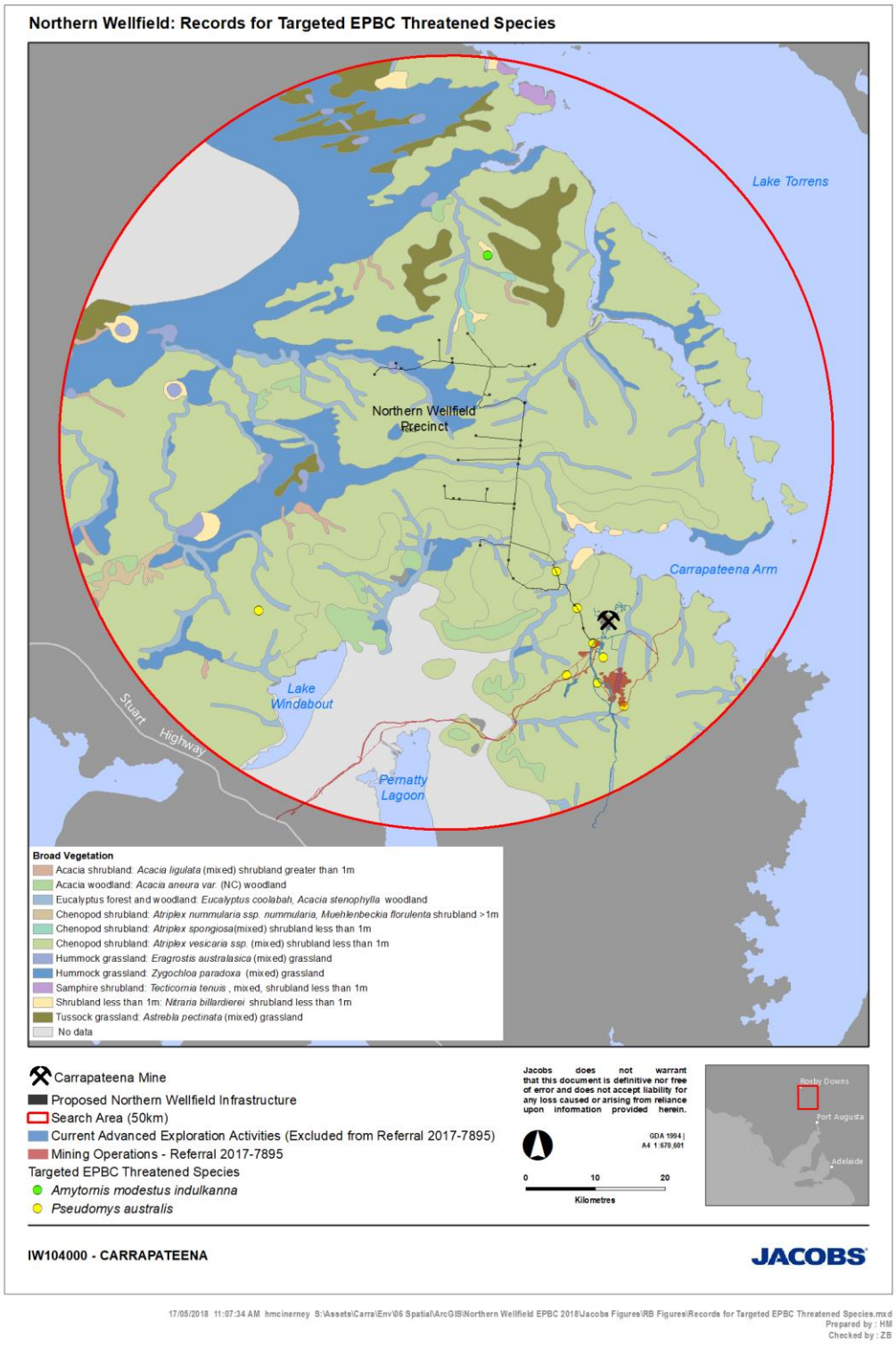

Figure 2-7: Records for targeted survey EPBC species within 50 km of Northern Wellfield precinct

2.3.3 Threats

Grazing by domestic stock and subsequent habitat degradation has been nominated as the main factor leading to a contraction in the range of Thick-billed Grasswren with increased predation from feral predators also cited as contributing to their decline (TSSC, 2016b).

2.3.4 Historic survey effort at Carrapateena

The species has not been recorded at Carrapateena during baseline and monitoring surveys over five years (summarized in EBS 2017b) or during targeted surveys for the species (EBS 2014a).

The species has not previously been observed within the Project area nor the Carrapateena Mining Lease. A reported Thick-billed Grasswren nest was however, recorded in 1996, within 20 km of the northern boundary of the Northern Wellfields precinct (BDBSA 2018). The next closest confirmed recording of the species to the Project area was in 2007, near Andamooka (over 50 km from the Project area) (ALA 2018).

Small areas of preferred habitat were identified in the northeast of the wellfield footprint, however this was not based on extensive survey of the site (EBS 2018). Following extensive targeted survey at the broader Carrapateena site, EBS (2018) suggest that the condition and isolation of preferred habitat may not be optimal to support the species at this site.

2.4 Plains Mouse (*Pseudomys australis*)

2.4.1 History

The Plains Mouse, listed as Vulnerable under the EPBC Act, is a medium-sized arid zone rodent that prefers gibber (stone-covered) plains, mid slopes with boulders, small stones and gilgais. Primary habitat is considered to be within drainage channels, depressions and deep cracking clays (Brandle et al. 2008, Moseby 2012), but evidence suggests that during population expansions the habitat usage may be more broad temporarily, followed by a retraction to preferred refugia habitat during drier periods.

2.4.2 Known distribution

Current known populations largely restricted to the Stony Plains Bioregion in SA, extending into the NT. The species now occupies a north/south band of stony plain habitat to the south west of Lake Eyre extending from Pernatty Station in SA to Andado Station in the NT (Moseby 2012).

It is generally accepted that the presence of cracking clays is more critical habitat than the type or structure of vegetation. The species has been recorded in several vegetation communities, including *Atriplex nummularia* (Old-man Saltbush) / *Abutilon halophilum* (Plains Lantern-bush) low very open shrubland, *Sclerolaena divaricata* (Tangled Bindyi) / *Eragrostis australasica* (Cane-grass) / *Atriplex vesicaria* (Bladder Saltbush) low open shrubland, *Maireana aphylla* (Cotton-bush)/ *Eragrostis setifolia* (Bristly Love-grass) / *Astrebla pectinata* (Barley Mitchell-grass) / *Atriplex vesicaria* (Bladder Saltbush) low very open shrubland and *Eucalyptus coolabah* (Coolibah) low woodland (Brandle 1998) A number of these flora species and communities occur within the Northern Wellfield site (DEWNR veg mapping, EBS 2018).

2.4.3 Threats

A number of factors that may have led to a decline in the distribution on Plains Mouse have been cited including impact from domestic stock grazing through direct completion for forage, trampling of burrows and soil erosion leading to in-fill of gilgais (Moseby, 2012). Increased predation by foxes and cats, particularly when Plains Mouse populations have contracted to refugia, may lead to local extinctions (Moseby, 2012).

2.4.4 Historic survey effort at Carrapateena

The Plains Mouse has been captured at bi-annual trapping sites in the south of the Project area (Mineral lease 6471, Spring and Autumn 2012, 2013 (EBS 2013a, b, c). The species is also expected to be present further north (in the Northern Wellfield Project Area); however, no trapping was undertaken within these areas and therefore the species was not detected during field surveys. A baseline survey identified at least 32 known areas of suitable refuge habitat (EBS 2018) (such as canegrass swamps and large cracking clay

areas) with a large amount of suitable Plains Mouse habitat also likely to exist away from the existing tracks within the Northern Wellfield Project area (EBS 2018). The BDBSA data base also records a 2001 Plains Mouse capture from the Arcoona Plateau approximately 45 km south west of the Northern Wellfield precinct. of the site. Plains Mouse records within 50 km of the Northern Wellfield precinct are shown on Figure 2-7 above.

3. Methods

The targeted EPBC habitat assessment survey of the northern wellfields project area was undertaken by a Jacobs ecologist from 1 to 3 May 2018 and covered the proposed alignment of linear infrastructure including pipelines and access tracks plus a 500 m buffer either side. The surveyed area is shown on Figure 1-1 above and the survey include the following elements:

- Surveys of proposed non-linear infrastructure footprint areas (groundwater bores, tanks) were undertaken and comprised a walk-over covering a minimum of 1 hectare (in line with SA standard biological survey methodology) (Heard & Channon, 1997) encompassing the range of vegetation and landforms present, as well as potential preferred habitat areas;
- A total of 58 traverse or point searches were undertaken and each were logged on a GPS with vegetation community, dominant flora species and landform descriptions noted;
- Photo log for each traverse;
- Samples of any *Frankenia* species. encountered were vouchered and pressed for subsequent verification.

Particular note was taken of the presence and characteristics of gilgais and other areas of cracking clays or crab holes (preferred Plains Mouse refugia habitat) and drainage lines with taller, dense Chenopod shrubland (preferred Thick-billed Grasswren habitat). Searches were also undertaken to identify any areas of *Triodia* spp. (Spinifex) hummock grassland considered to be core Night Parrot roosting/nesting habitat.

The survey also included a traverse of the site of a 1996 record of *Frankenia plicata* from Andamooka station located approximately 10 km north of the Northern Wellfield precinct representing the nearest record for the species. Specimens of *Frankenia* present at the site were vouchered for subsequent review by the SA Herbarium.

A total of 58 point and linear searches were undertaken during the targeted survey and these are listed in Table 3-1 below and Figure 3-1 depicts the vegetation associations mapped for the project area and depicts the location of targeted species and habitat searches undertaken during the survey.

Table 3-1: Targeted Species survey effort – Northern Wellfield May 2018

Site No	Coordinates	Vegetation / Landform Description	Potential Habitat [1]	Comment
1	53 J 734721 6543159	Myall low open woodland minor drainage line in tableland		
2	53 J 733346 6546550	*Atriplex vesic*aria low open shrubland tableland		Bores MD 1/MD2
3	53 J 732724 6548639	*Melaleuca xerophylla* major drainage line		*Frankenia subteres* collected on gypiferous rocky slope south of Hogan Dam
4	53 J 731803 6548742	*Maireana pyramidata* + *Acacia tetragonphylla / A ligulata* minor drainage line	2	Heavily grazed adjacent to Hogan Dam; sub-optimal Thick-billed Grasswren habitat
5	53 J 731476 6550904	*Atriplex vesicaria* low open shrubland tableland	3	Bore P18 and turkeys nest, moderate sized gilgais; myall minor drainage line 150 metres to north of bore
6	53 J 728506 6553915	*Sclerolaena ventricose / S. brachyptera / Frankenia serpyllifolia* low forbland		Very few gilgais
7	53 J 726081 6555777	Myall low open woodland over *Maireana aphylla*	1	Very stony

Site No	Coordinates	Vegetation / Landform Description	Potential Habitat [1]	Comment
		minor drainage line in tableland		
8	53 J 725409 6554896	*Maireana aphylla* low open shrubland tableland with *Eragrostis australasica* in deeper gilgais	1	Deeper gilgais widespread in vicinity
9	53 J 723255 6555150	*Maireana aphylla* minor drainage line in tableland	1	Near Bosworth Hut
10	53 J 723303 6555070	*Maireana aphylla* low open shrubland minor drainage line in tableland	1	Near Bosworth Hut
11	53 J 723361 6555026	*Maireana aphylla* low open shrubland minor drainage line in tableland	1	Near Bosworth Hut
12	53 J 721109 6555530	Myall low open woodland over *Maireana aphylla* minor drainage line in tableland	2	Bosworth Creek
13	53 J 720771 6555516	Myall low open woodland over *Maireana aphylla* minor drainage line in tableland	2	Linear traverse from 12 to 13
14	53 J 719592 6555678	*Atriplex vesic*aria/*Tecticornia medullosa* low open shrubland in broad saline drainage line	1	South east of Hickman Dam
15	53 J 719671 6555386	Wedge-tailed eagle nest in red gum creek		Search for Night Parrot feathers
16	53 J 719460 6555785	*Atriplex vesic*aria/*Tecticornia medullosa* low open shrubland in broad saline drainage line	1	Linear traverse 14 to 16
17	53 J 717671 6556288	*Eragrostis australasica* swamp	3	Linear traverse 17 to 18; widespread deeper gilgais
18	53 J 716882 6556425	*Eragrostis australasica*	3	widespread deeper gilgais
19	53 J 719916 6561199	Chenopod low open shrubland tableland	3	On boundary fence; good gilgais
20	53 J 723157 6560816	Chenopod low open shrubland tableland	3	Traverse to NT 10; good gilgais
21	53 J 723433 6562565	*Atriplex vesic*aria/*Tecticornia medullosa* low open shrubland tableland		NT10 well and turkey nest
22	53 J 723325 6562533	*Eragrostis australasica* in deeper gilgais	3	Canegrass gilgai 100m to west; Frankenia spp collected
23	53 J 725662 6560525	*Atriplex vesicaria* tableland		Few shallow gilgais
24	53 J 726614 6560507	*Atriplex vesicaria* tableland		Few shallow gilgais
25	53 J 727172 6565787	Myall low open woodland minor drainage line in tableland		
26	53 J 727257 6566534	Chenopod low open shrubland tableland		Linear traverse 26 to 28

Site No	Coordinates	Vegetation / Landform Description	Potential Habitat [1]	Comment
27	53 J 727158 6566619	Chenopod low open shrubland tableland		Linear traverse 26 to 28
28	53 J 727156 6566622	Chenopod low open shrubland tableland		Linear traverse 26 to 28
29	53 J 726260 6567124	Chenopod low open shrubland tableland		NT 18 well and turkey nest; hill top location
30	53 J 719899 6566808	Chenopod low open shrubland tableland		NT 17 well and turkey nest
31	53 J 719819 6569426	*Eragrostis australasica* swamp and deeper gilgais	3	Canegrass swamp; dense stand of *Frankenia* spp (vouchered)
32	53 J 722183 6570220	Chenopod low open shrubland tableland		NT 8 well, and turkey nest; no gilgais
33	53 J 725780 6569783	Chenopod low open shrubland tableland		NT 9 well and turkey nest; hill side location, no gilgais
34	53 J 730717 6573515	Chenopod low open shrubland tableland		NT 7 well and turkey nest; well low value – to be rehab
35	53 J 731514 6573114	Chenopod low open shrubland tableland		Turn-off to NP4
36	53 J 732261 6571544	Chenopod low open shrubland tableland		NP 4 well and turkey nest; no giligais
37	53 J 729418 6573877	Chenopod low open shrubland tableland	3	Shallow gilgais
38	53 J 726671 6575618	Chenopod low open shrubland tableland		Turn off to NT 15
39	53 J 726986 6577261	*A vesicaria/Maireana eriantha* low open shrubland tableland		NT 15 well and turkey nest; hill side location
40	53 J 722661 6574238	Chenopod low open shrubland tableland		Turn-off to NO2 and NO3
41	53 J 723964 6576067	*A vesicaria/Maireana eriantha* low open shrubland tableland		NO2 and NO3 well and turkey nest; hillside location Myall creek 300 m to east
42	53 J 724804 6580021	*Maireana eriantha* low open shrubland tableland	3	NT 4 well and turkey nest; shallow gilgais
43	53 J 720612 6580680	Chenopod low open shrubland tableland		Turn-off to NT 2
44	53 J 721446 6584863	*Maireana eriantha/ T medullosa* low open shrubland tableland	3	NT 2 well and turkey nest; shallow gilgais
45	53 J 715228 6585532	*A vesicaria/Maireana eriantha* low open shrubland tableland	3	NT 1 well and turkey nest; flat terrain; scattered small gilgais
46	53 J 719226 6585093	Myall low open woodland minor drainage line in tableland		Shrubs typically <0.5m not preferred `Thick-billed GR habitat
47	53 J 720310 6591570			On Andamooka Station – outside study area
48	53 J 725705 6593086	Forbland and ephemeral broad drainage line		Location of *Frankenia plicata* record 1996. *Frankenia sp* vouchered
49	53 J 719490 6581331	*T medullosa/ M oppositfolia* low open shrubland		NT 13 well and turkey nest; shallow gilgais
50	53 J 717850 6584064	*A vesicaria/Maireana eriantha* low open shrubland tableland		NT 12 well and turkey nest; myall minor drainage line 70 m to south

Site No	Coordinates	Vegetation / Landform Description	Potential Habitat [1]	Comment
51	53 J 712515 6580824	*M aphylla* broad drainage line		N0 1; 0.5 k Nth of White Dam Small crabholes; canegrass swamp 200m to west
52	53 J 712810 6580009	*Eragrostis australasica* (Canegrass)/*M aphylla* swamp	3	South west of White Dam; south of pipeline route
53	53 J 712837 6579989	*Eragrostis australasica* (Canegrass) swamp	3	*Frankenia sp* vouchered
54	53 J 712811 6580044	*Eragrostis australasica* (Canegrass)/*M aphylla* swamp	3	South west of White Dam; south of pipeline route
55	53 J 709853 6579260	Chenopod low open shrubland tableland		NT 11 well and turkey nest; on hillside
56	53 J 727761 6575275	Chenopod low open shrubland tableland		En route to NP 5
57	53 J 728492 6574722	Chenopod low open shrubland tableland		Turn-off to NP 5
58	53 J 729608 6580264	*T medullosa/A vesicaria/M eriantha* low open shrubland	3	NT 5 well and turkey nest; moderate gilgais; hillside location

1 = potential *Frankenia plicata* habitat; 2 = potential Thick-billed Grasswren habitat; 3 = potential Plains Mouse habitat

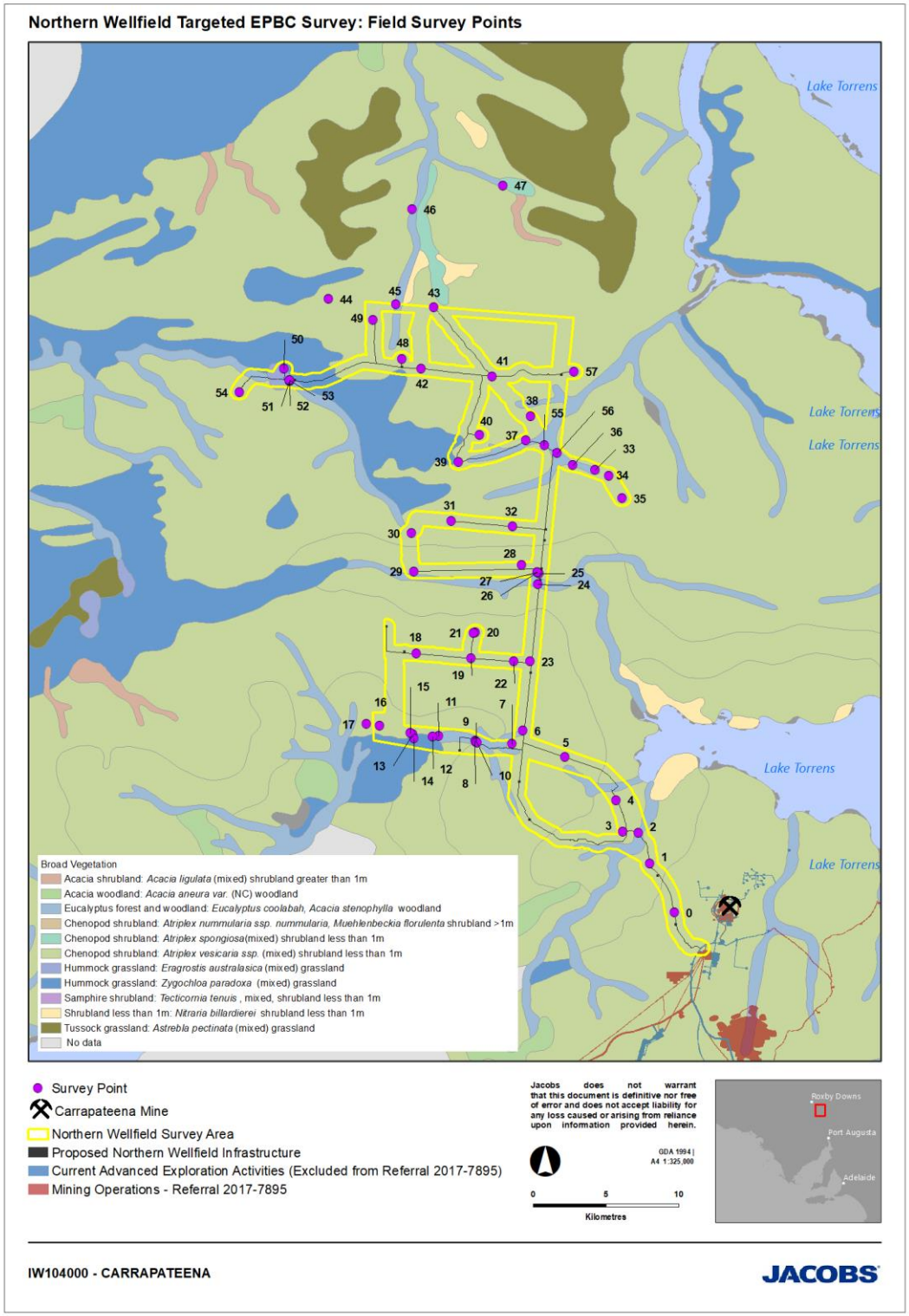

Figure 3-1: Vegetation associations with location of targeted survey sites

4. Results

4.1 *Frankenia plicata*

4.1.1 Survey results

Frankenia plicata was not recorded during the targeted survey. A single population of *Frankenia subteres* (Round Sea-heath), previously recorded for the Eastern Radial Wellfield (MPL 153) (Jacobs, 2018 b) was recorded on a gypsiferous hillslope near Hogan Dam (survey site 3) in the southern portion of the Northern Wellfield precinct. This species is depicted in Figure 4-1 below.

As noted in Section 2 above, and initial SA Herbarium review of the BDBSA 1996 Arcoona Plateau vouchers indicates that these specimens are unlikely to be *Frankenia plicata*. Similarly, specimens of *Frankenia* spp. vouchered during the current survey at the site of the 1996 BDBSA record (10 km north of the Northern Wellfield precinct) were examined by SA Herbarium taxonomist Helen Vonow and initial results indicate that the specimens are also not *Frankenia plicata*. The vouchers from this survey and the 1996 vouchers will now be further reviewed by specialist taxonomist Dr. Molly Whalen.

Figure 4-1: *Frankenia subteres* recorded on a gypsiferous hillslope in the southern portion of the Northern Wellfield precinct

4.2 Night Parrot

4.2.1 Survey results

A single wedge-tailed eagle nest was searched (above and below) for evidence of conspicuous green Night Parrot feathers. No Night Parrot feathers were identified. A number of smaller nests were checked for evidence of feathers. No Night Parrot Feathers were identified. Locations surveyed for *Frankenia plicata* (58 point and linear traverses) were also searched for feathers with no Night Parrot feathers recorded.

No preferred Night Parrot roosting/nesting habitat of *Triodia spp*. (Spinifex) hummock grassland has been detected in previous extensive flora surveys and vegetation mapping across the site and none was recorded during this targeted survey.

4.3 Thick-billed Grasswren

4.3.1 Survey Results

The Northern Wellfield survey area includes numerous minor drainage lines that support Chenopod low open shrubland however the shrub layer is typically quite sparse and usually less than 0.5 m in height and therefore not considered to be preferred Thick-billed Grasswren habitat (Figure 4-2) (Black *et al*, 2011). Drainage lines supporting taller, denser shrubland communities were recorded in this survey in a small number of locations including 3 survey transect sites (Table 3-1) however these were dominated by Cassias (*Senna* spp.) and Emubush (*Eremophila* spp.) rather than tall Chenopods considered to be preferred Thick-billed Grasswren habitat.

It was noted that drainage lines on Andamooka Station (located to the north of the Northern Wellfield study area) were dominated by stands of *Atriplex nummularia* ssp. *omissa* (Oodnadatta Saltbush) which provide the taller, denser shrub layer preferred by Thick-billed Grasswren. This medium sized shrub was not recorded in the Northern Wellfield project area and its distribution north of the Northern Wellfield precinct coincides with the current known distribution of Thick-billed Grasswren (Lake Eyre sub-species) (*Amytornis modestus ssp indulkanna*) as reported by Black et al.(2011).

It was noted that test wells and turkey nests have typically been positioned on higher ground and have therefore avoided impacting on preferred Thick-billed Grasswren drainage line habitat.

Figure 4-2: Minor drainage lines with Chenopod low open shrubland provide sub-optimal Thick-billed Grasswren habitat

4.4 Plains Mouse

4.4.1 Survey Results

As identified in previous surveys of the broader Carrapateena project area and the desktop study of the Northern Wellfield project area, preferred Plains Mouse habitat of depressions and gilgais with deep cracking clays was found to be widespread throughout the surveyed area with almost a quarter of the point and linear sites recorded as preferred Plains Mouse habitat (see Table 3-1). The larger deeper depressions and gilgais support *Eragrostis australasica* (Swamp Canegrass) tussock grassland (Figure 4-3) while the smaller gilgais are typically dominated by *Sclerolaena intricata* (Tangled Bindyi) and *Eragrostis setifolia* (Bristly Lovegrass) (Figure 4-4).

It should be noted that test wells and turkey nests have typically been positioned on hillslopes and have avoided swamps, drainage lines and deeper gilgais depressions and therefore minimised disturbance to preferred Plains Mouse habitat (Figure 4-5).

Figure 4-3: Preferred Plains Mouse habitat of *Eragrostis australasica* (Swamp Canegrass) tussock grassland in deeper depressions and gilgais

Figure 4-4: Shallow gilgais with *Sclerolaena intricata* (Tangled Bindyi) and *Eragrostis setifolia* (Bristly Lovegrass) also provide Plains Mouse habitat

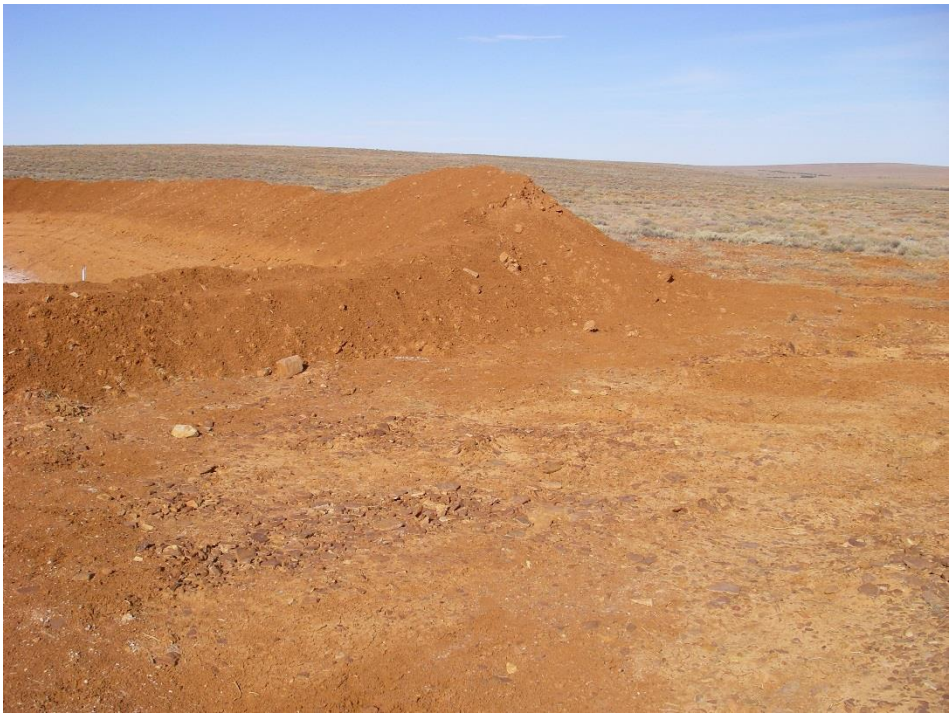

Figure 4-5: Test wells and turkey nests have typically been positioned on hillslopes thereby avoiding preferred Plains Mouse habitat

5. Conclusion

5.1 Frankenia plicata

This targeted survey covered the proposed Northern Wellfield project area including well sites and pipeline alignments with a particular focus on habitats where *Frankenia plicata* has been historically recorded in the broader region. No *Frankenia plicata* was identified during this survey.

Frankenia plicata has rarely been recorded with less than 50 historical records from South Australia. The majority of the historic records are from the Breakaways closer to Coober Pedy nearly 300 km north west of the Carrapateena project area. Although there have been several records from the Arcoona Plateau, including a record from10 km north of the Northern Wellfield precinct, a preliminary review of the voucher specimens for these records indicates that they may have been incorrectly identified as *Frankenia plicata*. This finding, if confirmed, would lead to a re-evaluation of the preferred habitat and known distribution of this species.

Key points are as follows:

- Extensive flora surveys have been conducted across the broader Carrapateena project site since 2008 with no records for *Frankenia plicata*.
- Common species of *Frankenia* have been recorded throughout the broader Carrapateena site and within the Northern Wellfield precinct during this survey.
- *Frankenia plicata* was not identified during this survey.
- A preliminary review of SA herbarium *Frankenia plicata* vouchers from the Arcoona Plateau indicates that these specimens are not *Frankenia plicata* and if confirmed by subsequent review by a taxonomic specialist, would lead to a contraction of the known distribution of this species and an assessment that it is unlikely to be present within the broader Carrapateena region.
- *Frankenia plicata* is not expected to be present within the northern wellfields project area.

5.2 Night Parrot

This targeted survey primarily focused on identifying preferred roosting/nesting habitat and covered the proposed Northern Wellfield precinct and builds on the findings of a recent targeted survey of the broader Carrapateena project area (Jacobs, 2018 b). No Night Parrots, or evidence of Night Parrots, were observed during this survey.

There have been extensive flora and fauna surveys conducted across the broader Carrapateena project area during prefeasibility studies and for the collection of robust baseline ecological data about the site and surrounds. Whilst Night Parrot was previously considered highly unlikely to occur at the site and was therefore not a specific focus of the surveys, the extensive presence of ecological survey teams at the site over a number of years (e.g. pre-feasibility surveys in 2008, Autumn and Spring surveys 2012-2017) did not detect any presence of the night parrot (e.g. unusual calls, flushing of individuals, bright conspicuous feathers, unidentified low flying ground-dwelling birds during nocturnal searches). Similarly, habitat at the Northern Wellfield precinct is not considered optimal or to represent the preferred habitat of the species as there is no *Triodia* hummock grassland present and the vegetation across the site has been impacted by historic grazing.

Whilst it is possible that the elusive species does occurs at the site, it is considered very unlikely. If it is present, it persists in a pastoral environment with historic grazing impacts, coupled with a human presence as early mine related studies and activities are ongoing. This differs to recent confirmed locations of extant Night Parrot populations (Qld and WA) which were located within pristine undisturbed environments. Any individuals that may occur could move across the vast expanses of similar ‘non-preferred’ habitat which is present broadly across the region. It is considered valid that the site commits to reporting any future observations or evidence that may be detected as part of ongoing activities or monitoring.

Key points are as follows:

- No patches of known breeding / roosting habitat (e.g. Spinifex hummock grassland) occur across the broader Carrapateena project area or within the Northern Wellfield precinct.
- Whilst Samphire (known foraging habitat) and Chenopod shrubland occurs broadly across the precinct, the area is grazed by livestock (in some instances heavily), with other grazers present (Red and Euro Kangaroo, Rabbits, Goats). Hence the diversity and condition of the shrubland is not pristine and would not constitute core foraging habitat for the species, but rather supplementary / refuge habitat within a vast landscape of available habitat across arid SA.
- The Northern Wellfield precinct comprises vast amounts of potential foraging habitat when certain species are available in fruit (e.g. common *Sclerolaena, Atriplex,* Samphire spp.*)*
- The species is highly secretive / elusive, and has existed undetected in Australia for over 30 years, and the last record in SA (prior to the feather of 2017), being 1980 approximately 450 km north-northeast of the project site in pristine remote habitat.
- The species may be nomadic and appear in areas following decent rains, but may also be sedentary in areas with preferred roosting and nesting / breeding habitat and high floristic diversity.
- If present, Night Parrots are active at night and persist despite existing levels of activity at the site (e.g. grazing present, human presence as a result of ongoing mine related studies and activities.
- Previous extensive surveys of the broader Carrapateena project area have not detected the species.
- Whilst presence cannot be entirely ruled out, it is considered highly unlikely that a core population exists and is reliant on habitat present at the Northern Wellfield precinct.

5.3 Thick-billed Grasswren

The Northern Wellfield precinct lies just south of the current known distribution of Thick-billed Grasswren (Lake Eyre sub-species) and it is considered that shrub height and cover in the drainage lines of the precinct provides sub-optimal habitat for this species. Thick-billed Grasswren have not been recorded in the broader Carrapateena project area despite extensive repeated surveys undertaken since 2008 and it is considered unlikely that this species is extant in the Northern Wellfield precinct. Notwithstanding this, wells and turkey nests have been positioned on higher ground and have therefore avoided preferred Thick-billed Grasswren drainage line habitat and it is considered that impact on this species (if present) arising from the construction and operation of the Northern Wellfield, will not be significant.

Key points are as follows:

- Drainage line habitat within the Northern Wellfield project area is considered sub-optimal for Thick-billed Grasswren and it is unlikely that this species is present.
- Notwithstanding the above, drainage lines will not be cleared or disturbed during the construction and operation of the Northern Wellfield infrastructure.

5.4 Plains Mouse

Preferred Plains Mouse habitat of gilgais and swamps with deep cracking clays are a common component of the tableland country that dominates the Northern Wellfield precinct and the species has been recorded at numerous locations within the broader Carrapateena project area following good seasonal conditions. Wells, turkey nests and pumping infrastructure will be located on higher ground thereby minimizing clearance and disturbance to preferred lower-lying Plains Mouse habitat.

Key Points area as follows:

- Plains Mouse habitat is widespread within the tableland country that dominates the Northern Wellfield project area and more broadly in the region.

- Whilst Plains Mouse may be present during irruptive period of it's life cycle, the Northern Wellfield project infrastructure is not expected to disturb the important refuge habitat in low lying run-on areas, deeper gilgais or drainage lines.

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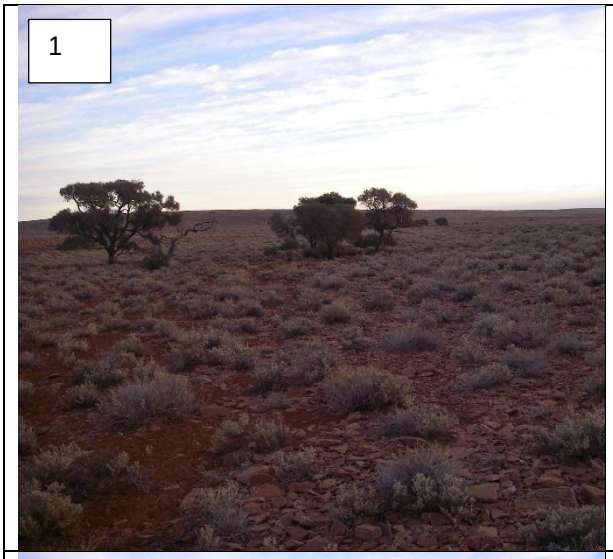
Appendix A: Survey Point and Transect Photo Log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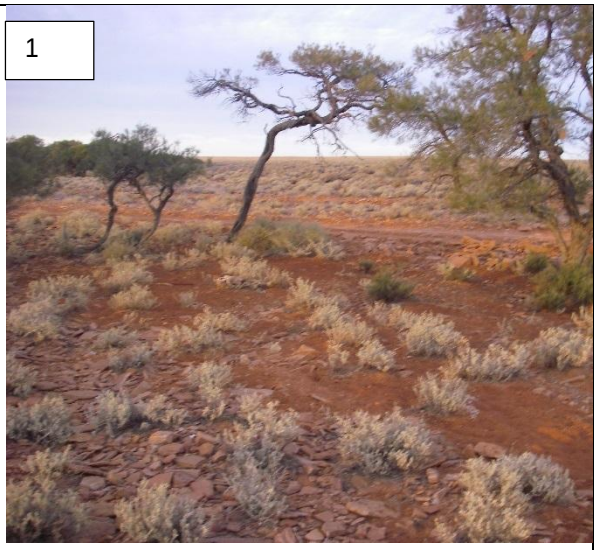
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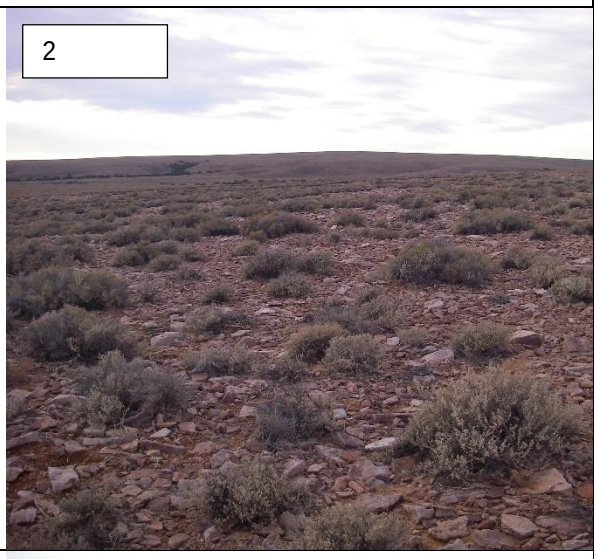
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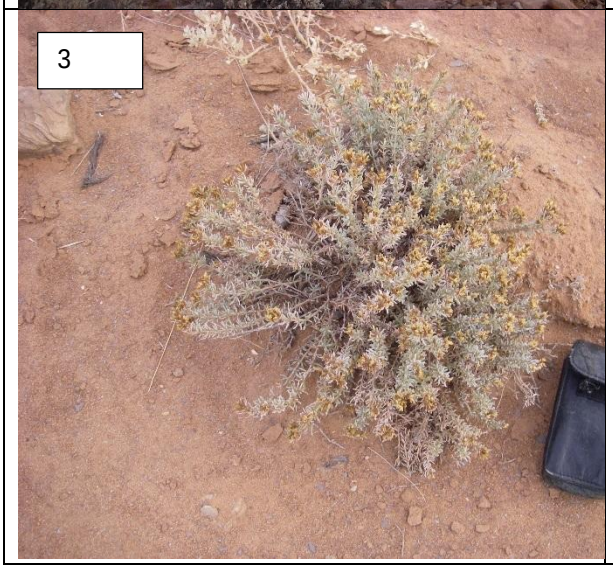
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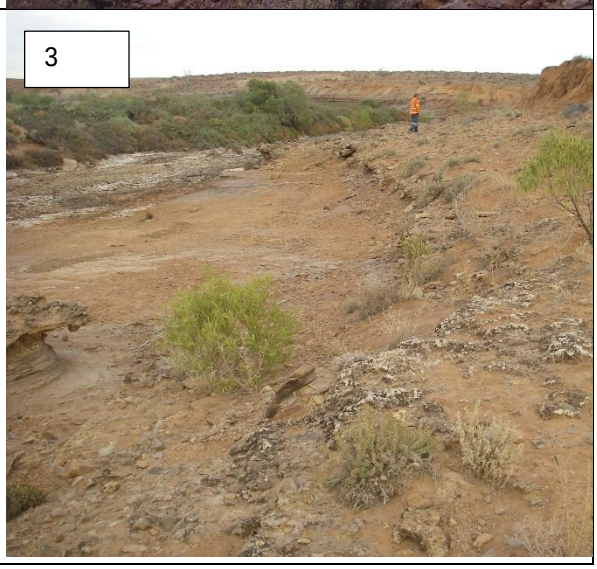
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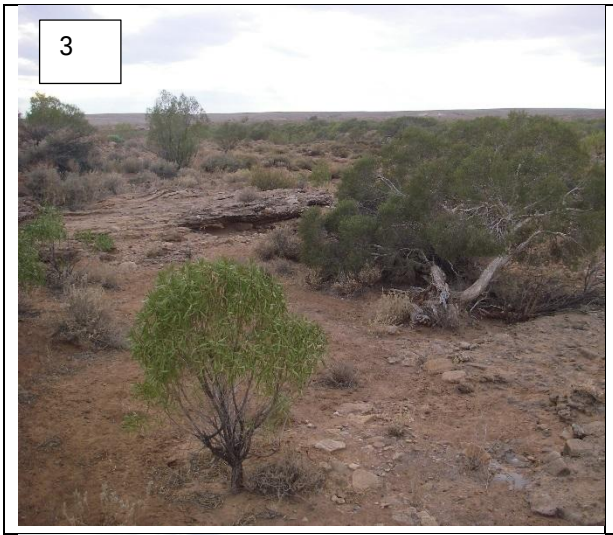

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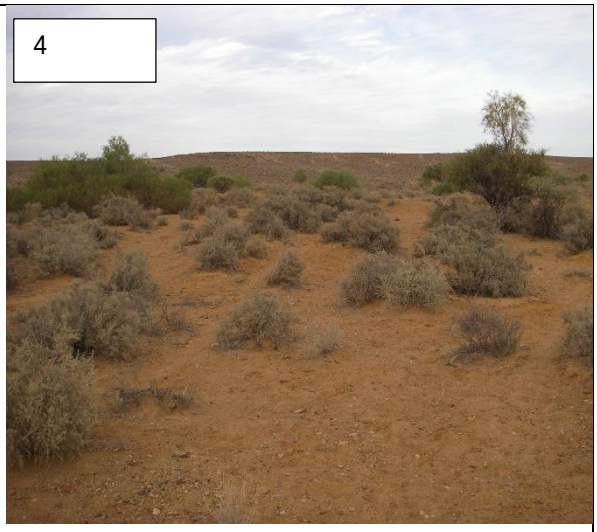

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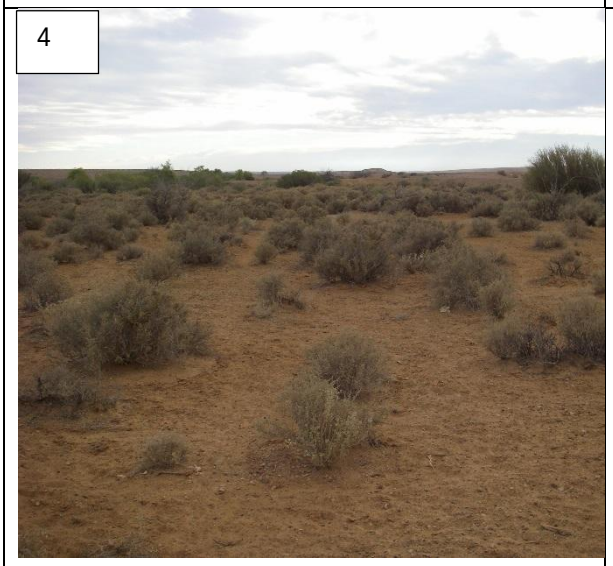

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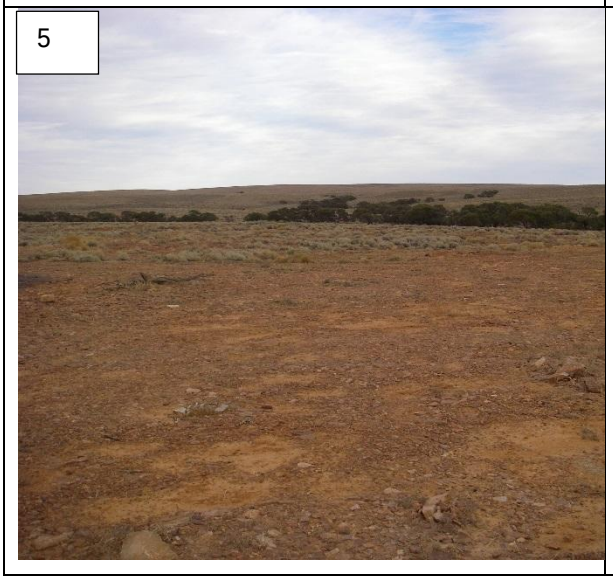

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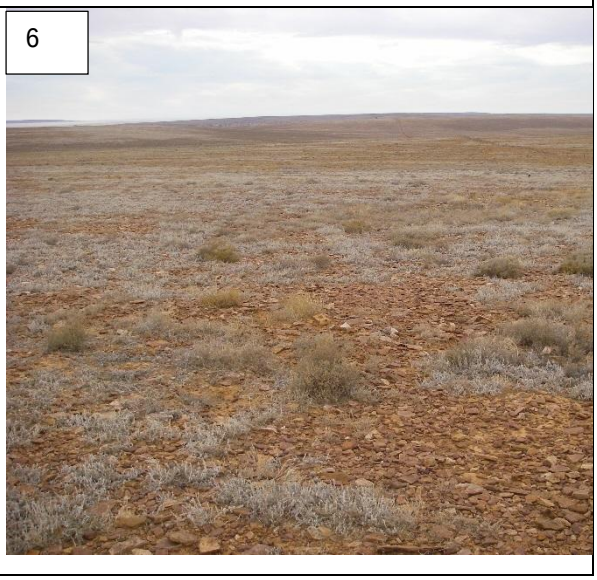

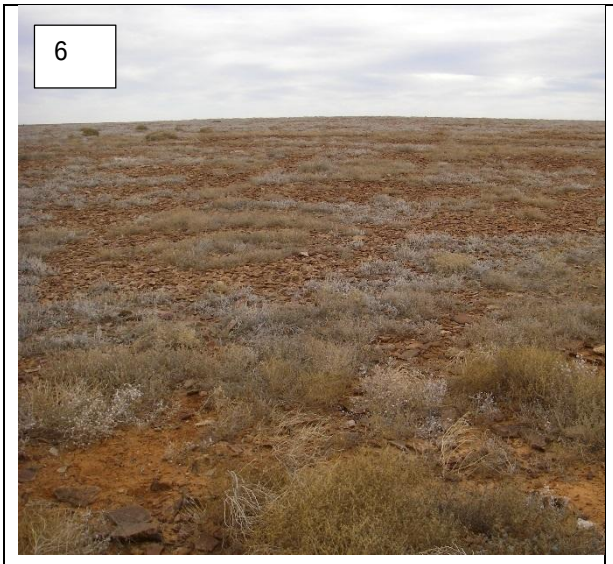
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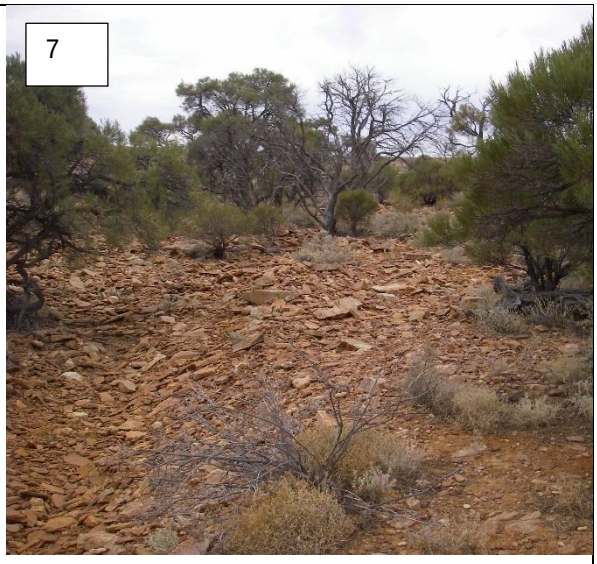
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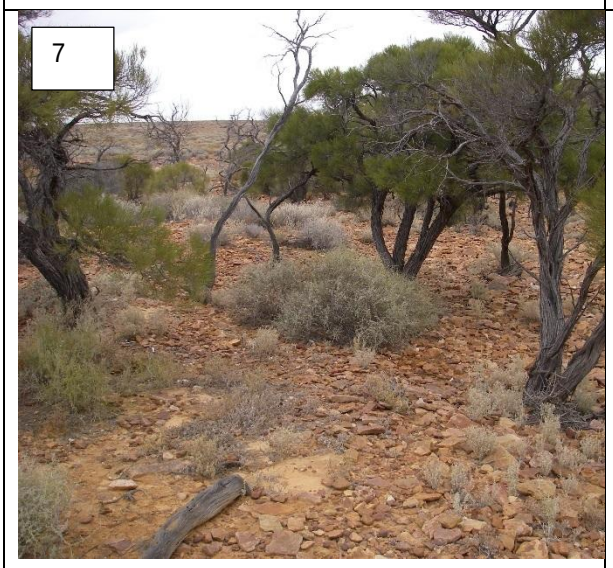
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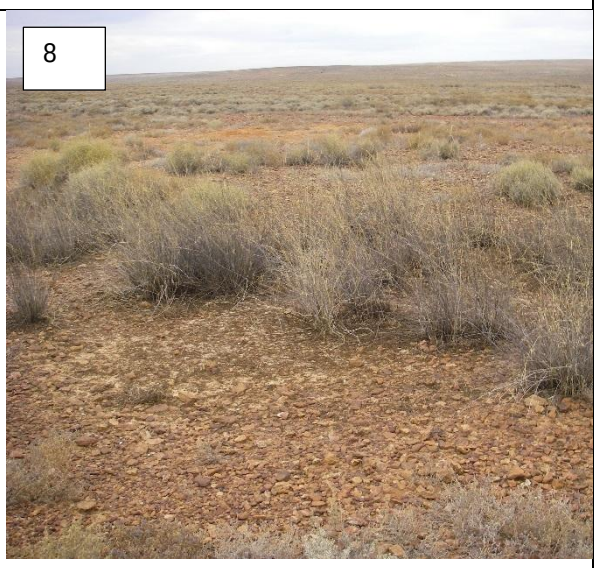
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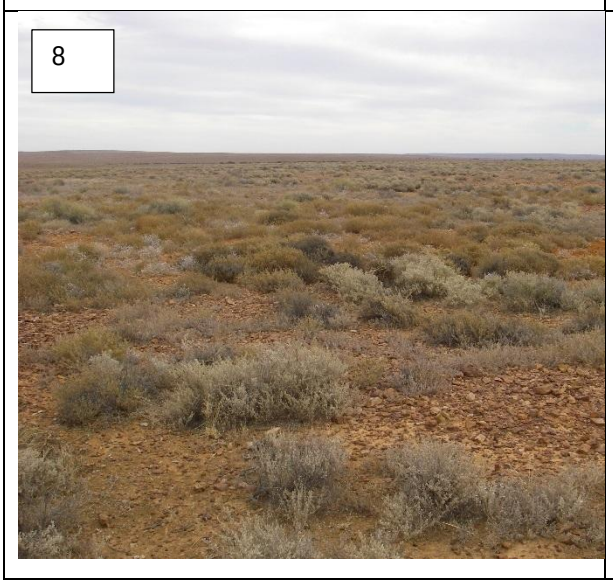
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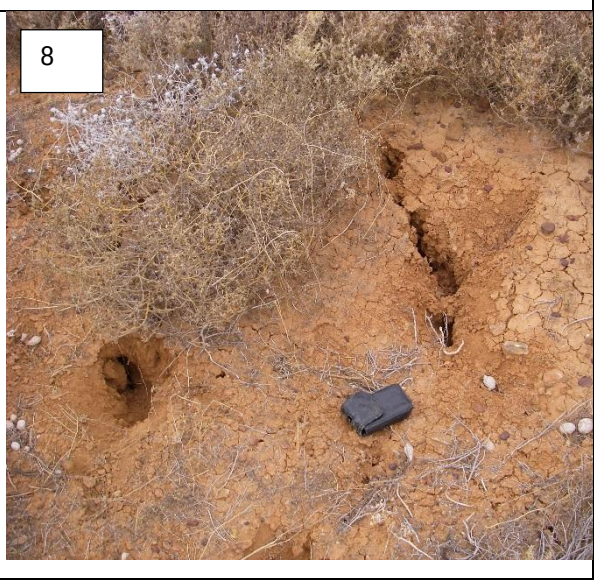
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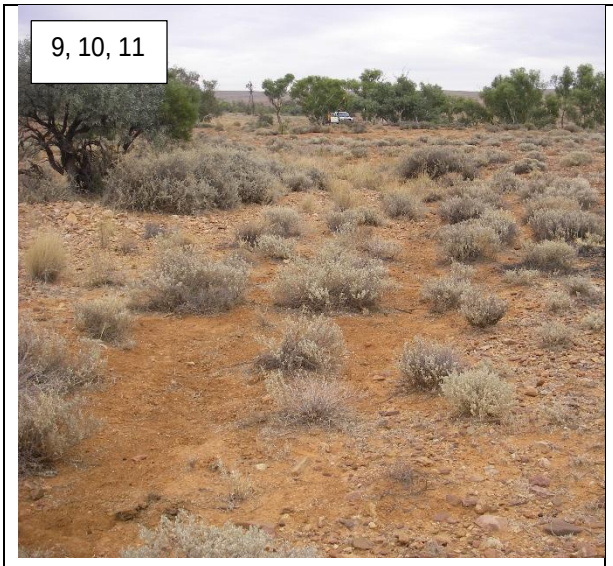
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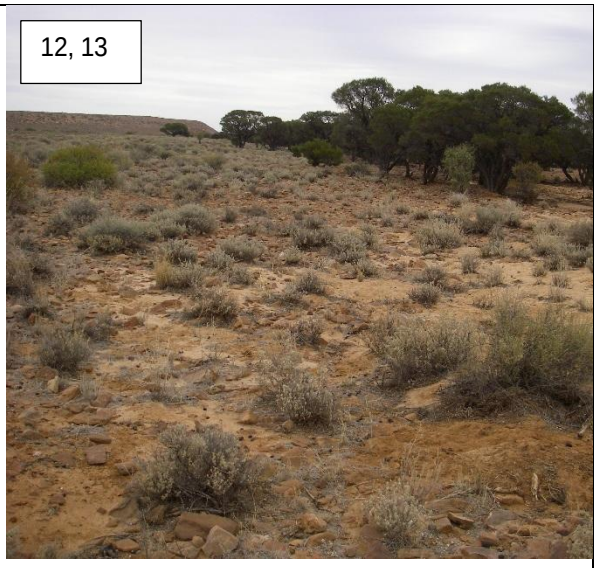
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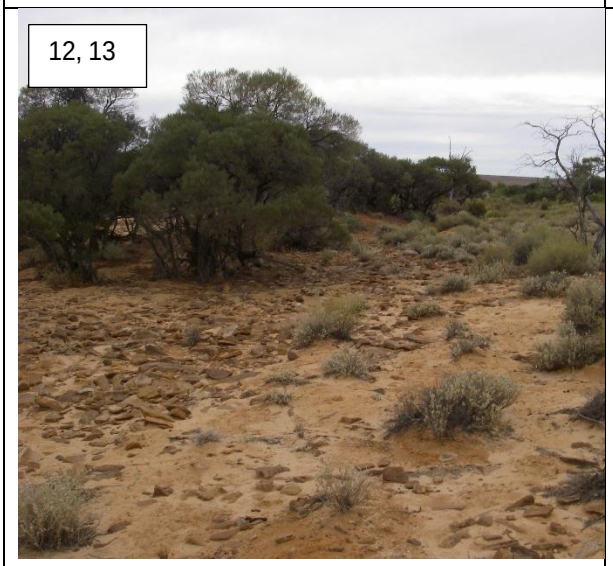
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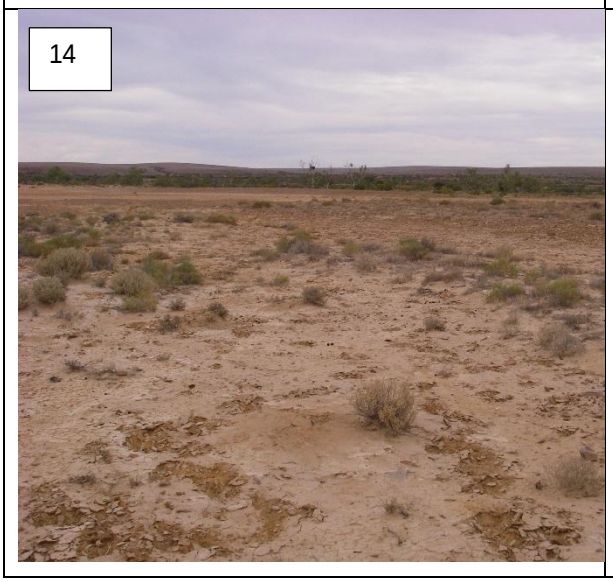
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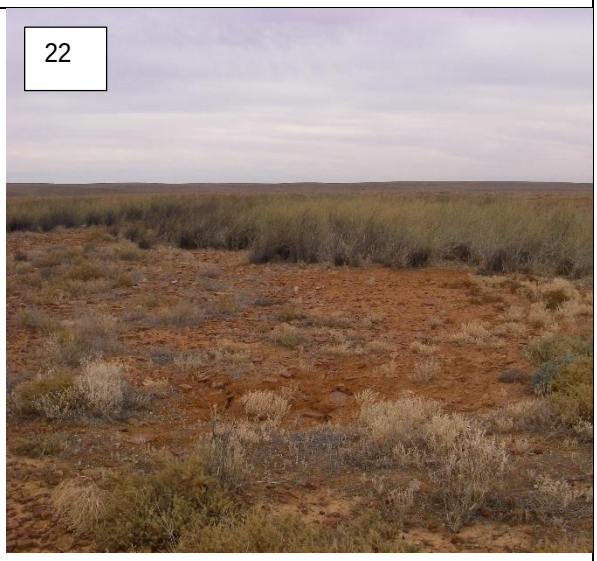
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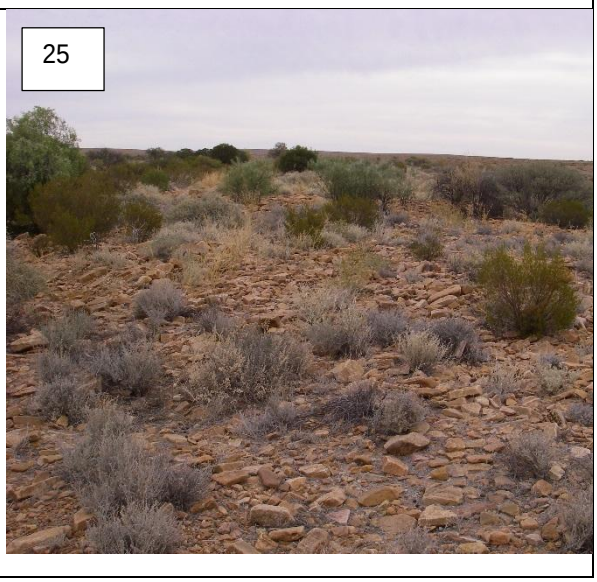
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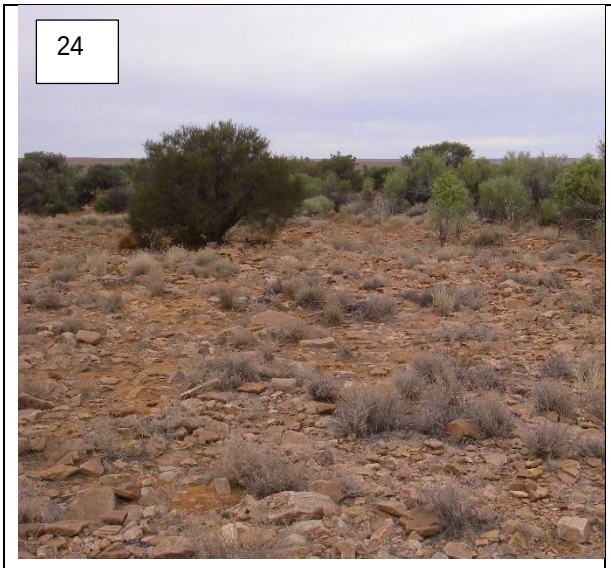
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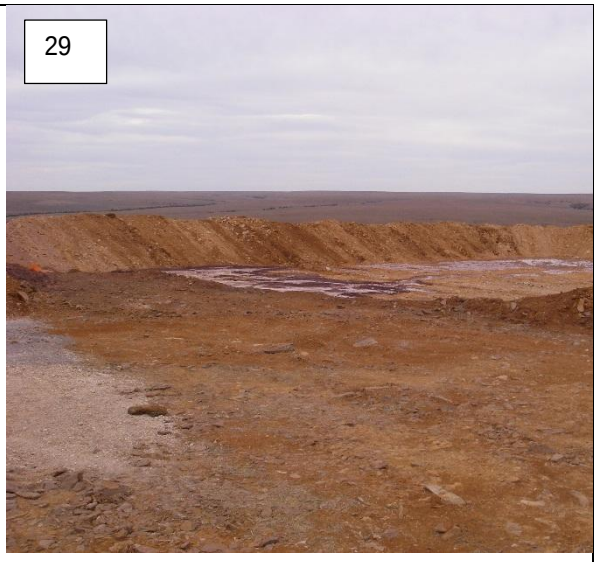
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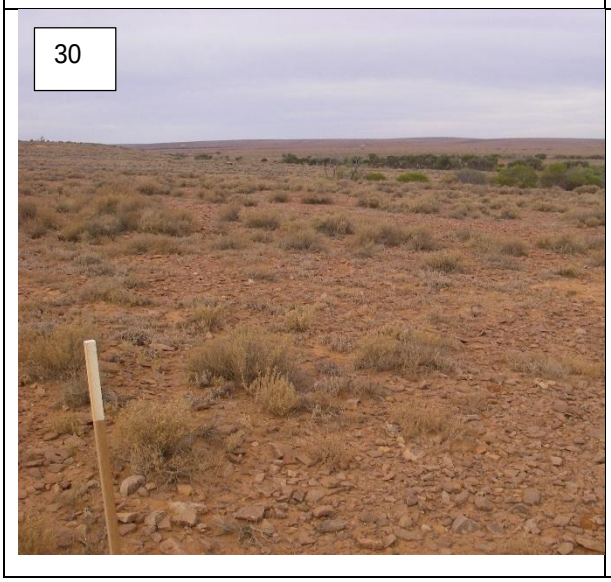
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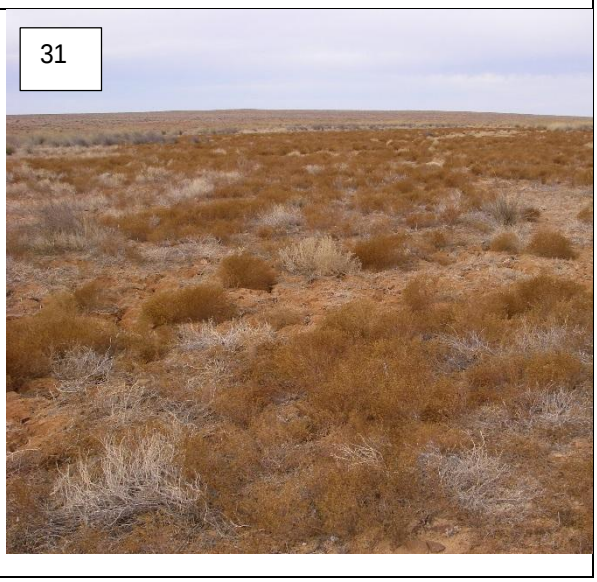
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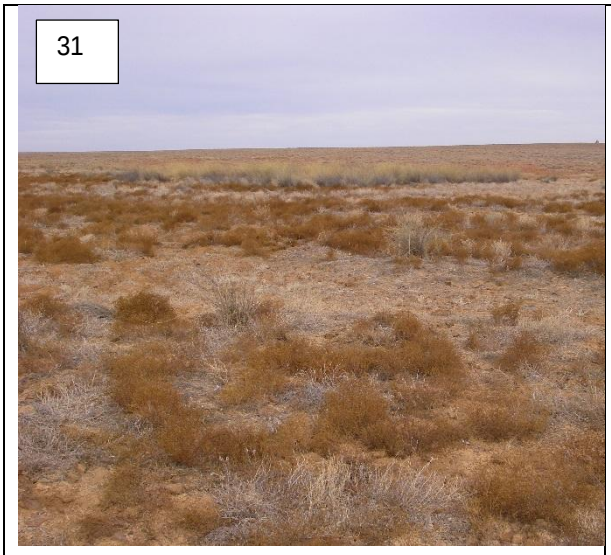

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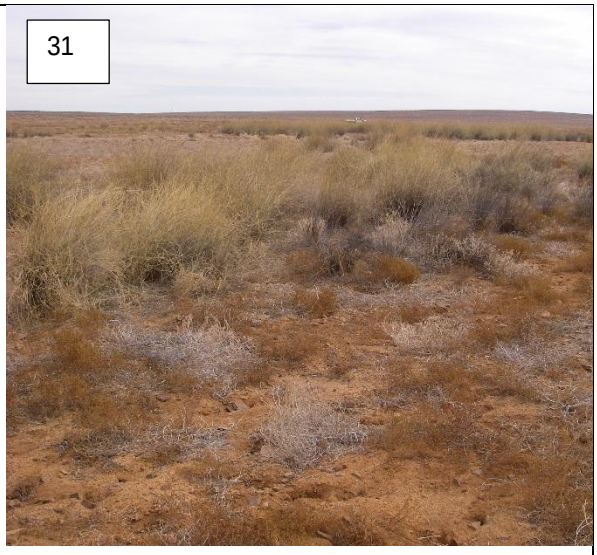

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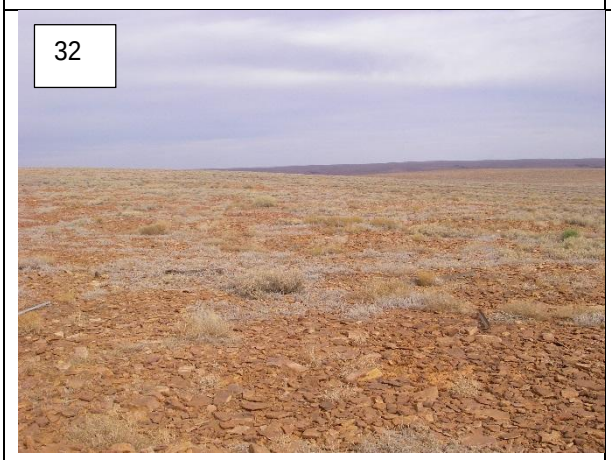

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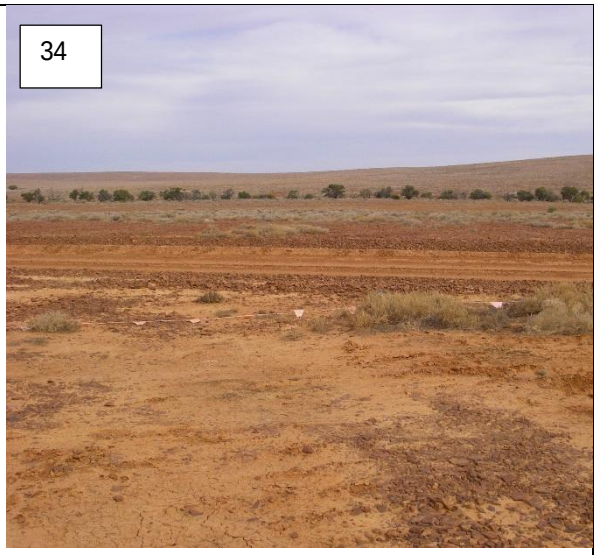
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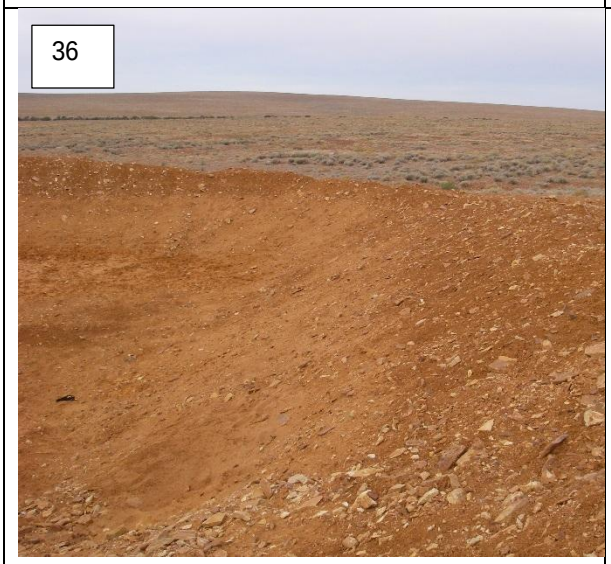
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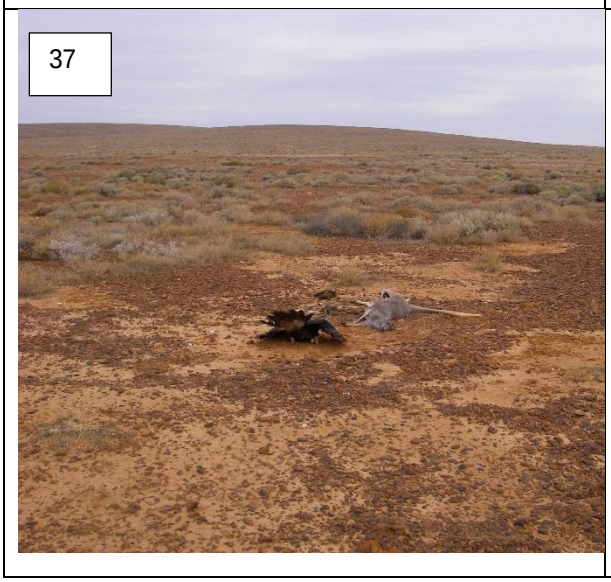
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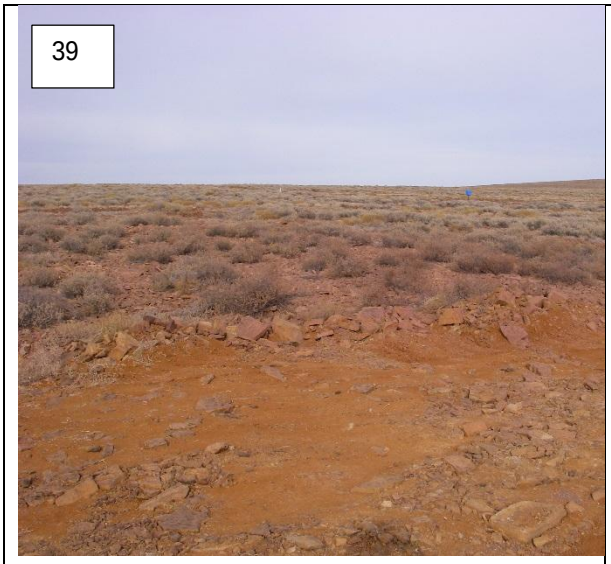

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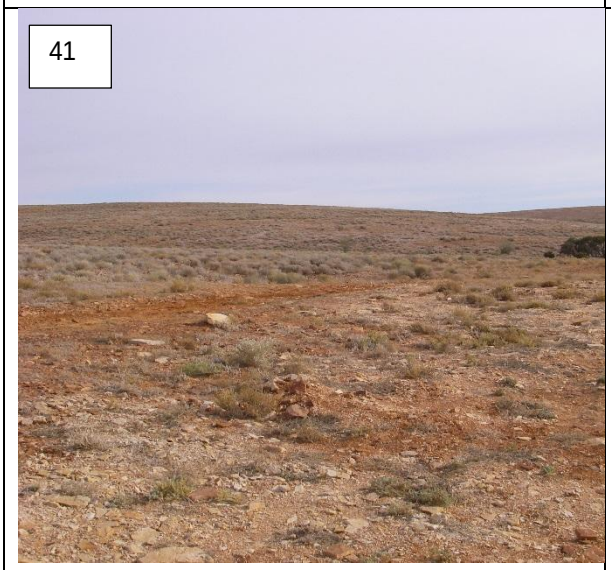

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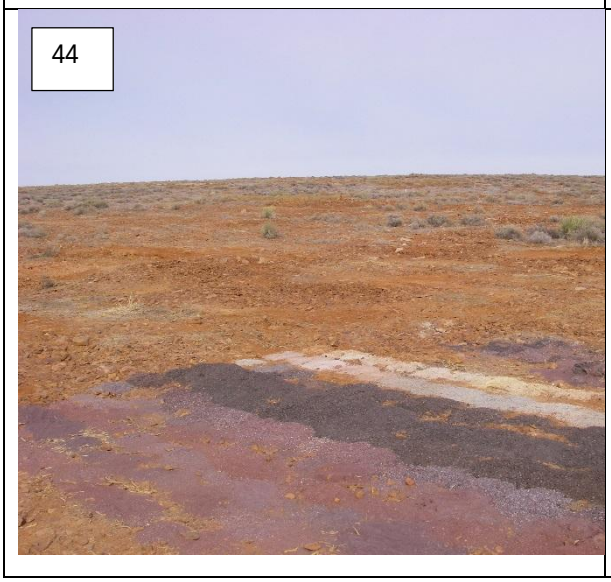

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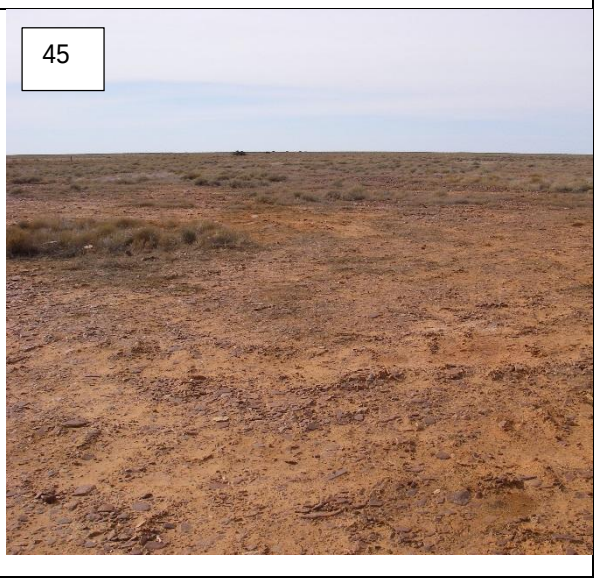

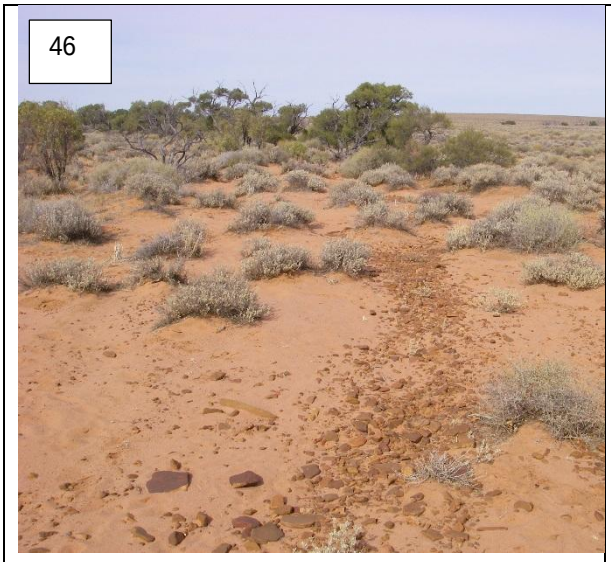
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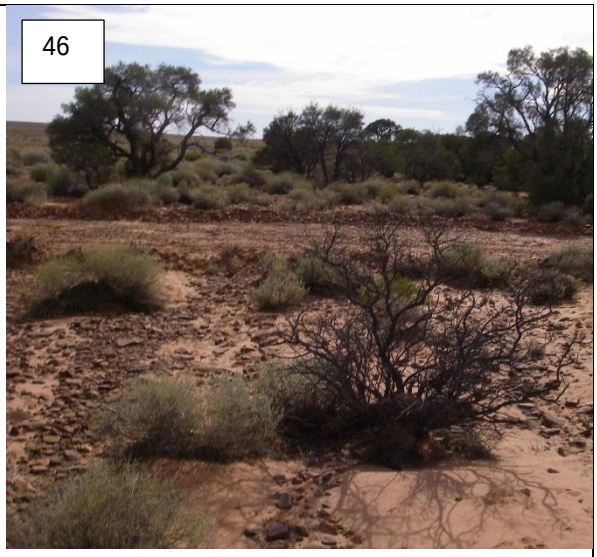
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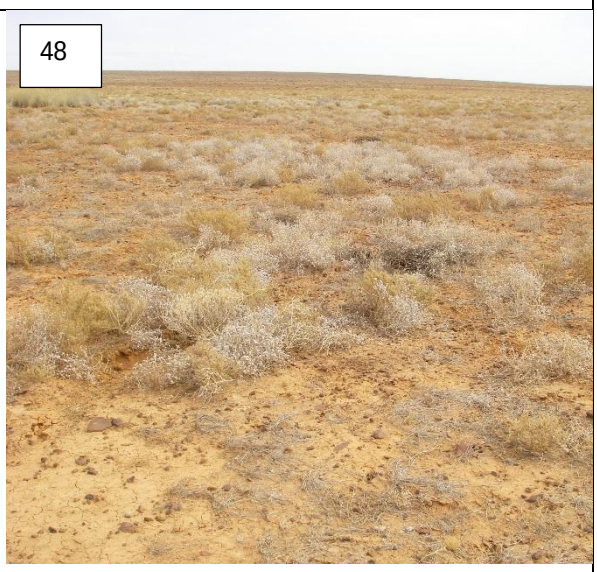
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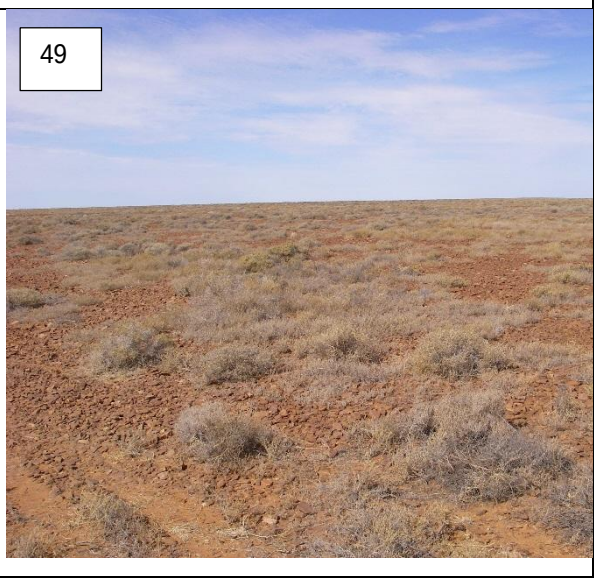
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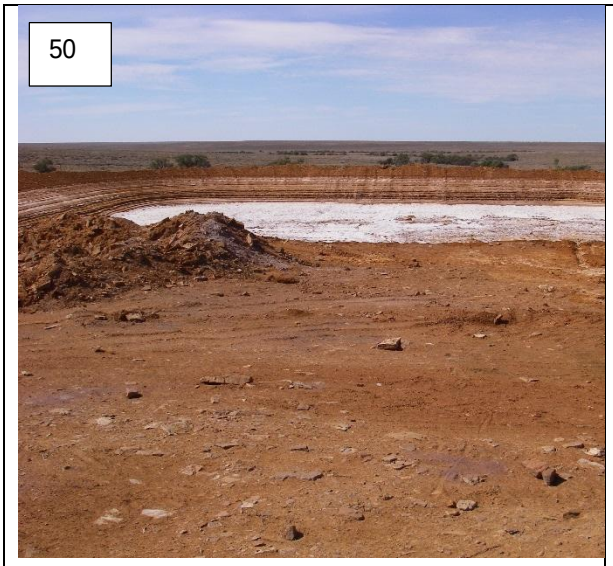
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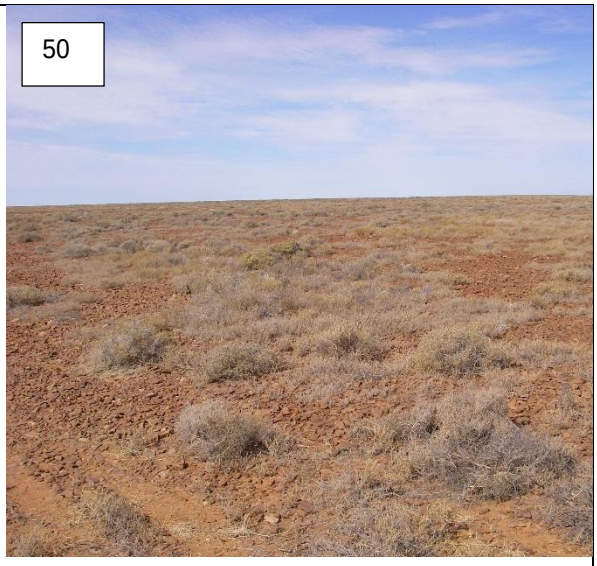
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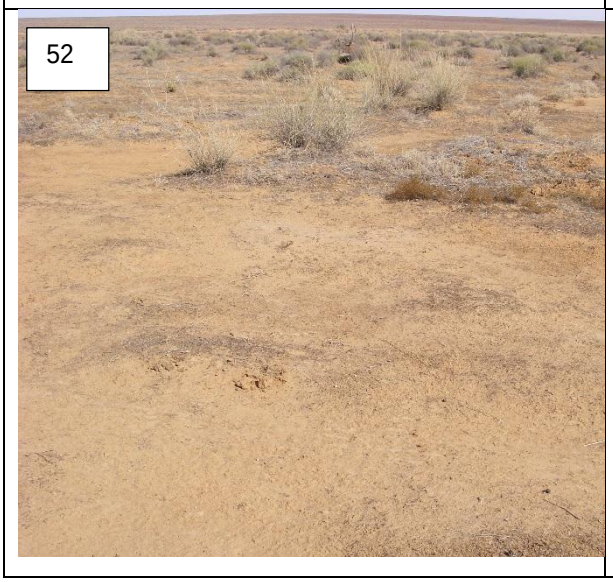
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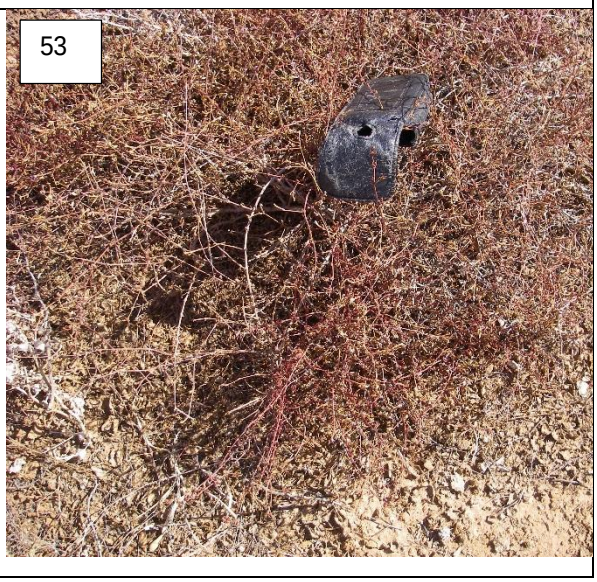
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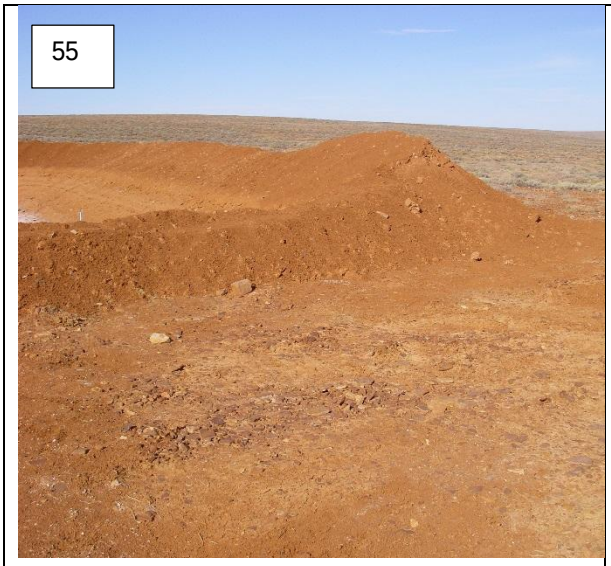
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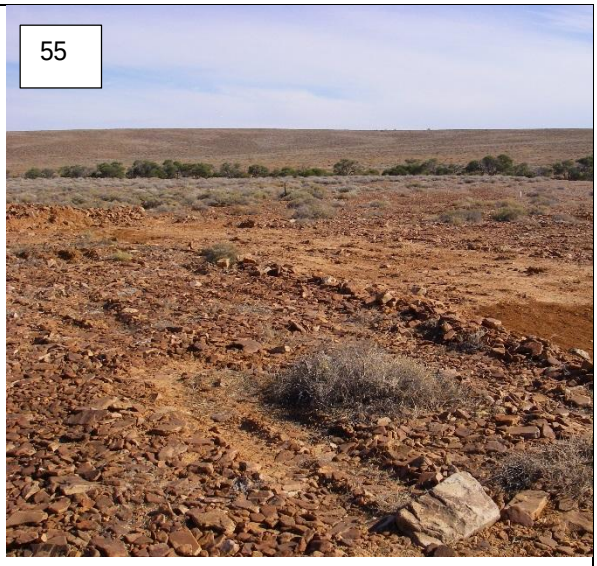
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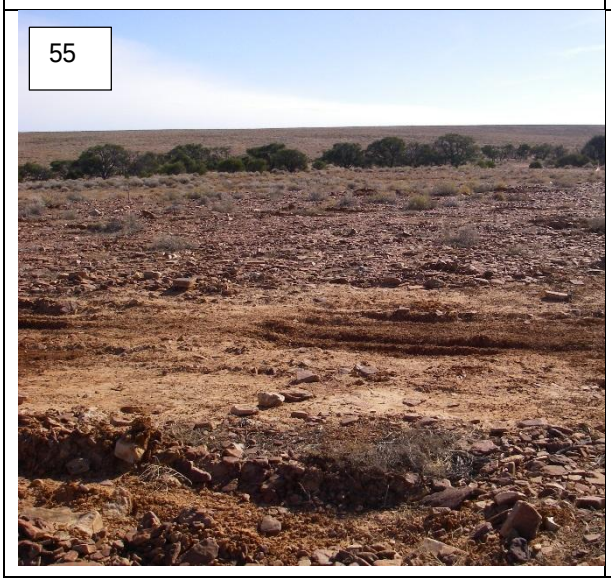
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APPENDIX B TARGETED THREATENED SPECIES SURVEY, CARRAPATEENA; NIGHT PARROT AND *FRANKENIA PLICATA*

Targeted Threatened Species Survey, Carrapateena

Night Parrot and *Frankenia plicata*

OZ Minerals

IW104000-0000-NE-RPT-003 | FINAL Rev0

29 May 2018

Targeted Threatened Species Survey, Carrapateena

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Document Title:	Night Parrot and *Frankenia plicata*
Document No.:	IW104000-0000-NE-RPT-003
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Client Name:	OZ Minerals
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Executive Summary

OZ Minerals is an Australian-based modern mining company with a focus on copper and gold. Carrapateena is an OZ Minerals copper-gold project located in South Australia, 65 km east of Woomera, on the eastern margin of the Gawler Craton. Construction on Carrapateena is underway and is scheduled to be complete in Q4 2019 when the site will move into a steady state operation.

A referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) (OZ Mineral 2017) was submitted for the project which reviewed the potential for significant impacts to threatened species at the site as a result of the project. The EPBC referral for the Carrapateena Project (EPBC 2017/7895, plus variation (received 2 June 2017)) was approved by the Department of Environment and Energy on 29 March 2018. Whilst the controlling provision for Listed Threatened species and communities (section 18 and 18A) was approved, conditions were attached to the approval relating to two Nationally Endangered species; *Frankenia plicata* (Southern Sea-heath), and *Pezoporus occidentalis* (Night Parrot). The conditions (6 and 8) required that targeted surveys be undertaken within the project envelope for both of these species. This report provides the outcomes of targeted surveys which were undertaken at the site in March 2018 for Southern Sea-heath and Night Parrot, and discusses the background to each species and the methods employed, including survey effort associated with each species.

Previous surveys for the Carrapateena Project have located a common Sea-heath, *Frankenia serpyllifolia* (Bristly Sea-heath) and this species was observed throughout the site during the targeted survey. Another species not previously recorded was also observed, namely *F. subteres*, however *F. plicata* was not observed. It was noted that most areas considered to be preferred habitat for *F. plicata* within the project area were located near to stock dams and have been heavily impacted from livestock grazing which may contribute to the absence of the species in the area surveyed.

Historical flora and fauna surveys at the site had not previously located the elusive Night Parrot or evidence of this species (e.g. conspicuous green feathers). The preferred nesting / roosting habitat of the Night Parrot does not occur within the project site. Given the extensive historical survey within potential foraging habitat of the Night Parrot at the site, of which vast areas occur across South Australia, water points were targeted during this survey. The timing of the survey followed high rainfall over summer, which can promote Autumn breeding in arid zone species, including the Night Parrot. Night Parrots are known to call more during breeding (NPRT 2018). Water points were targeted for passive observation and listening an hour before dawn and an hour after dusk as the best time for species detection, as suggested by the Night Parrot Recovery Team (NPRT 2018). In addition, extensive searches for feathers were undertaken at and around water points, under and in Wedge-tail Eagle nests, and within potential foraging habitat in conjunction with searches for *Frankenia plicata*. The results of the survey indicated a number of arid zone species were breeding and regularly utilizing the water points. Numerous feathers were observed at water points and trapped in vegetation throughout the site. No Night Parrot feathers or calls were detected during the survey, and no Night Parrots were observed.

While it is possible the elusive Night Parrot utilizes the site, no core preferred roosting / breeding habitat of *Triodia* (Spinifex) occurs and the site. In addition, the potential foraging habitat that occurs across the site (Chenopod / Samphire shrubland) is extensive across the state and not unique to the site. The potential foraging habitat at the site is also impacted by historic and current grazing activity. So while it is possible the Night Parrot occurs at the site, it is considered very unlikely that a large population occurs at the site, and it is considered very unlikely that mining activities at the site would significantly impact the species. Known populations of Night Parrot in Qld and WA (and potentially northern SA) occur in Nature Reserves or National Parks within pristine / intact vegetation.

Based on the survey results documented here, it is considered unlikely that either species occurs at the site. Condition 28.3 of the Mine Lease (6471) for the operation includes reporting to relevant authorities any observations of the Night Parrot collected during regular site activities and ongoing compliance ecological monitoring. Biannual monitoring for fauna will therefore include opportunistic Night Parrot records during any

spotlighting undertaken in potential foraging habitats or opportunistically at watering points, prior to call play-back for other Nocturnal species at the times where greater detection is likely i.e. pre-dawn and post dusk. Call-playback for Night Parrot could be added to the spotlighting schedule, but specific ethics approval would be required. Given the lack of potential breeding habitat at the site, call play back would not be seen as disruptive to the species, as the call-playback would not be in optimal habitat where known populations exist.

This survey undertaken and this report meet Conditions 6 and 8 of the EPBC referral approval. Conditions 7 and 9 are not required as neither species was identified on site.

Important note about your report

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client; OZ Minerals, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

The sole purpose of this report and the associated services performed by Jacobs is to document results of targeted surveys for Frankenia plicata *and the Night Parrot at the Carrapateena site. The report is based on a desktop review of available data and field survey. The scope of services, as described in this report, was developed with the Client, (Oz Minerals).*

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs collected data at the Carrapateena site and derived additional data in this report from information sourced from the Client and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

1. Introduction

1.1 Carrapateena Mine: Mineral Lease and Miscellaneous Purpose Licence

OZ Minerals is an Australian-based modern mining company with a focus on copper and gold. Listed on the Australian Securities Exchange (ASX200), OZ Minerals has a growth strategy focused on creating value for all stakeholders, including shareholders, employees, traditional owners, pastoralists and the wider communities in which they operate.

Carrapateena is an OZ Minerals copper-gold project located in South Australia on the eastern margin of the Gawler Craton. Construction on Carrapateena is underway and is scheduled to be complete in Q4 2019 when the project will move into a steady state operation. The Carrapateena project will be an underground copper gold mine using a sub-level cave mining method. Onsite there will be a processing plant, tailings storage facility, village and airstrip.

The Project is located approximately 500 km north of Adelaide and 160 km north of Port Augusta. Nearby towns include Woomera (approximately 65 km to the west) and Roxby Downs (approximately 90 km to the north-west). The project occurs on pastoral leases including Pernatty, Bosworth and South Gap Stations in an arid environment. In addition, the area is subject to the Kokatha (Part A) Native Title Determination and Native Title agreements are in place between Oz Minerals and the Kokatha Aboriginal Corporation. The location of the site is shown in Figure 1-1.

The project has been approved with a Mining Lease Proposal (MLP) and Miscellaneous Purposes Licence (MPL) Management Plan (MP) (hereby referred to as the MLP) submitted to the Government of South Australia's Department of the Premier and Cabinet (DPC) on 26 May 2017 (references 2016/1245, 2016/1246 and 2016/1247).

1.2 EPBC Referral

In addition to the State Government approvals received for the project, an EPBC referral (OZ Mineral 2017) was submitted for the project. The referral reviews the potential for threatened species to occur at the site, and the potential for significant impacts to matters protected under the EPBC Act. *Pezoporus occidentalis* (the Night Parrot) and *Frankenia plicata* (Southern Sea-heath), both EPBC listed as Endangered under the EBPC Act, were considered unlikely to occur at the site, justified by the following statements made following extensive baseline surveys:

- Night Parrot - Long thought extinct, this species historically occupied much of semi-arid and arid Australia. Habitat appears to be mainly open grasslands consisting principally of *Triodia* in stony or sandy environments. Present distribution of the species is unknown, with the only confirmed location being in South-western Queensland. The species is believed to be highly nomadic, moving into areas with preferred habitat when resources are good (EPBC referral 2017/7895).

- *Frankenia plicata* - The species is a low, mat-forming perennial shrub on lower slopes of hills and in small run-off channels. Isolated records of this species have been on the Arcoona Plateau to the north and south of the Carrapateena site however most confirmed records of this species are from the Breakaways region several hundred km to north west of the project area (EPBC referral 2017/7895).

The EPBC referral for the Carrapateena Project copper-gold mining and processing, 65 km east of Woomera, SA (EPBC 2017/7895, plus variation (received 2 June 2017)) was approved by the Department of Environment and Energy (29 March 2018). Whilst the controlling provision for Listed Threatened species and communities

(section 18 and 18A was approved), the following conditions were attached to the approval relating to *Frankenia plicata* and Night Parrot:

- Condition 6) Prior to the commencement of the action, the person taking the action must engage a suitably qualified expert to undertake a Night Parrot survey within the development envelope. The Night Parrot survey must be undertaken in' accordance with the EPBC Act Night Parrot survey guidelines. Within three months of the Night Parrot survey being completed, the person taking the action must provide the Department with the Night Parrot survey results.

- Condition 7) Should the Night Parrot or evidence of the Night Parrot be recorded during the survey, the person taking the action must submit for the Minister's approval, a Night Parrot Management Plan that must include:

  a. Details of the Night Parrot survey results, including the methodology, timing and area surveyed.

  b. An assessment of the impacts to the Night Parrot that will result from the action.

  c. Management actions that will avoid, minimise and/or offset both the immediate and long-term impacts of the action on the Night Parrot.

  d. Monitoring and reporting requirements that demonstrate the management actions are effectively being implemented and achieve the intended results. This should include the frequency, intensity and duration of monitoring.

  The person taking the action must not commence the action prior to the Minister approving the Night Parrot Management Plan. The approved Night Parrot Management Plan must be implemented.

- Condition 8) Prior to the commencement of the action, the person taking the action must engage a suitably qualified expert to undertake a *Frankenia plicata* survey within the development envelope. The *Frankenia plicata* survey must be undertaken in accordance with contemporary survey methods. Within three months of the *Frankenia plicata* survey being completed, the person taking the action must provide the Department with the *Frankenia plicata* survey results.

- Condition 9) Should the *Frankenia plicata* be recorded during the survey, the person taking the action must submit for the Minister's approval, a *Frankenia plicata* Management Plan that must include:

  a. Details of the *Frankenia plicata* survey results, including the methodology, timing and area surveyed.

  b. An assessment of the impacts to *Frankenia plicata* that will result from the action.

  c. Management actions that will avoid, minimise and/or offset both the immediate and long-term impacts of the action on the *Frankenia plicata*.

  d. Monitoring and reporting requirements that demonstrate the management actions are effectively being implemented and achieve the intended results. This should include the frequency, intensity and duration of monitoring.

  The person taking the action must not commence the action prior to the Minister approving the *Frankenia plicata* Management Plan. The approved *Frankenia plicata* Management Plan must be implemented.

1.3 Purpose of surveys

The purpose of this study was to undertake targeted surveys at the Carrapateena project site to fulfill the requirements of the EPBC Referral (2017/7895) Approval Conditions 6 and 8 (as per Section 1.2 above). Section 2 of this report outlines background information including historic survey effort for each species. Section 3 outlines the survey methods and survey effort undertaken here. Section 4 provides the results of the targeted surveys. The location of the site it shown in Figure 1-1.

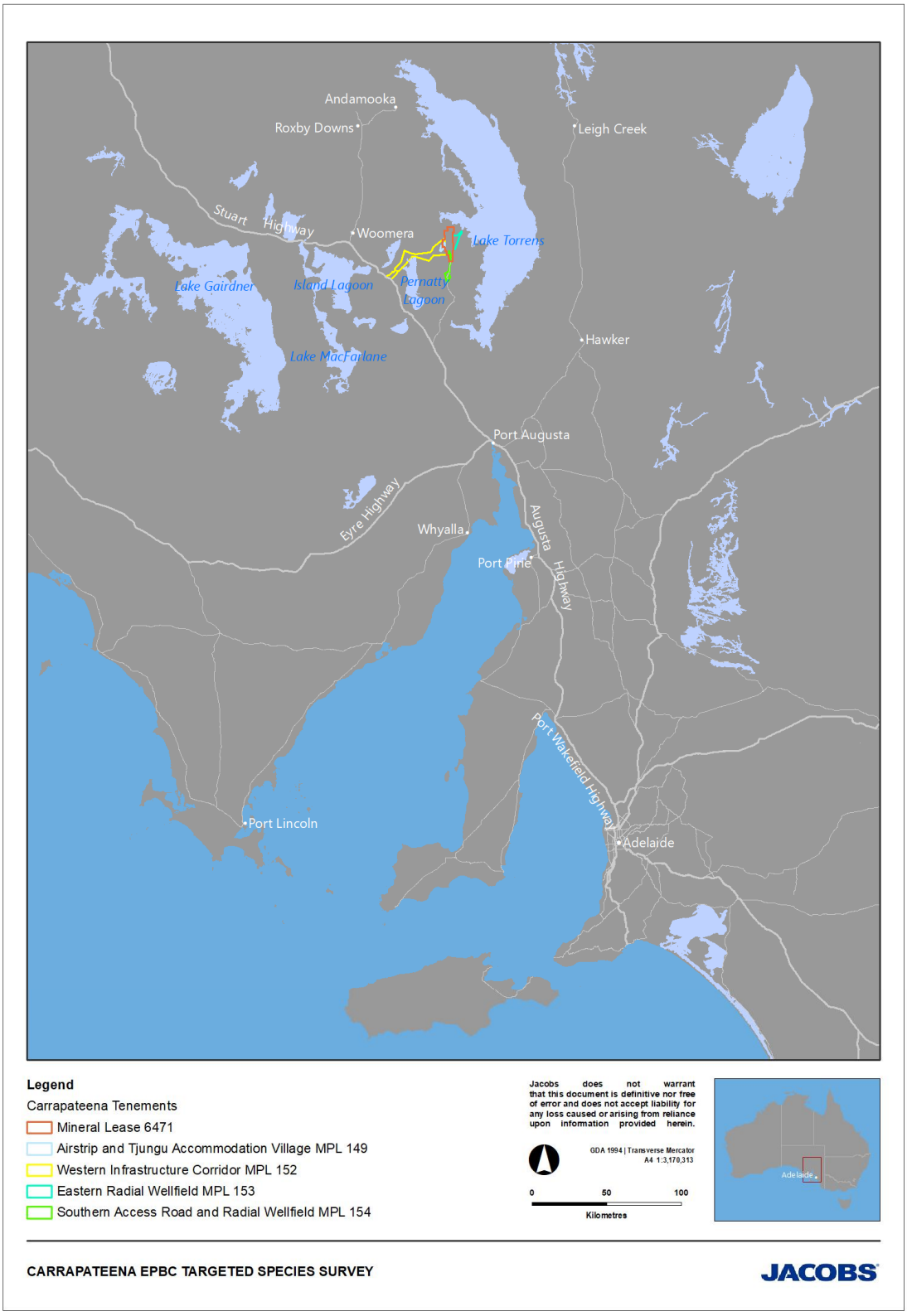

Figure 1-1: Location of project

2. Target Species

2.1 *Frankenia plicata* (Southern Sea-heath)

2.1.1 History

Frankenia plicata (Southern Sea-heath) is a low mat-forming or ascending shrub with a distribution predominantly confined to the western and south western portion of the Lake Eyre Basin in the Lake Eyre (LE) floristic region of SA, with several records for the Arcoona Plateau in the Gairdner Torrens (GT) floristic region (Jessop et al.1986). The species is listed as Endangered under the EPBC Act (Commonwealth) and Vulnerable under Regulations of the National Parks and Wildlife Act (South Australia).

2.1.2 Known distribution

The Southern Sea-heath has been collected from less than 50 locations, with most specimens lodged with the SA herbarium. Historic records indicate that the preferred habitat for this species is minor drainage lines and outwash plains with stony surfaces and loamy sand or clay sand soils. Most records are from the Stony Plains bioregion, particularly the Breakaways and Stuarts Range north east of Coober Pedy approximately 500 km north west of the Carrapateena site (SA Herbarium vouchers specimen notes 2018). This species has also been recorded on minor flood outs within the Arcoona Plateau, approximately 45 km north and 40 km south of the Carrapateena project area in 1996. A recent review of these BDBSA 1996 Arcoona Plateau voucher specimens by the SA Herbarium (instigated by a 2018 targeted survey of the northern wellfield area, Jacobs 2018) indicates that these specimens are unlikely to be *Frankenia plicata*. Specimens of *Frankenia* vouchered at the site of the 1996 BDBSA record were also recently examined by SA Herbarium taxonomist Helen Vonow, and initial results indicate that the specimens are also not *Frankenia plicata*. Those vouchers, along with the 1996 vouchers are currently under further reviewed by specialist taxonomist Dr. Molly Whalen. A single record from the outskirts of Woomera township at the base of the Arcoona Plateau (approximately 50 km west of the project area) was made in 1989. The location of historical records of *Frankenia plicata* in the region are shown in Figure 2-1 below.

Previous studies and a review of the SA herbarium vouchers and associated notes indicate that suitable habitat may be present on the footslopes, outwash plains and minor drainage lines of the Arcoona Plateau within the Carrapateena Mineral Lease (ML 6471) and Miscellaneous Purpose Licence, particularly where the Western Infrastructure Corridor (MLP 152) and Southern Access Road and Radial Wellfield (MLP 154) intersects this habitat in the vicinity of Yeltacowie Creek (EBS 2017 & SA Herbarium voucher specimen notes 2018).

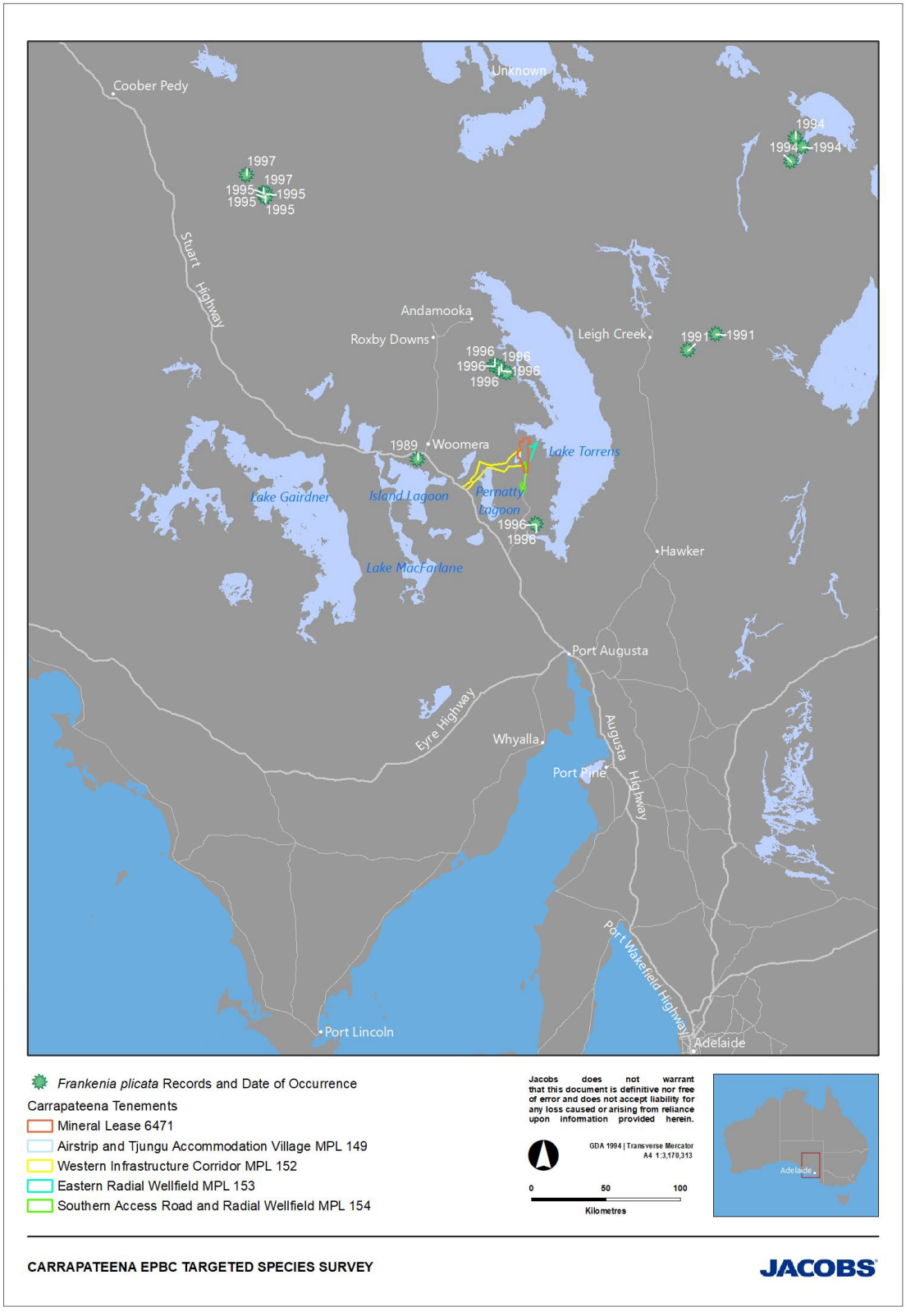

Figure 2-1: Historical records for *Frankenia plicata*

2.1.3 Threats

While the high salt content in the foliage of all shrubs in the *Frankenia* genus renders them unpalatable to livestock and other grazers, impacts from livestock trampling and associated erosion from increased overland water flows has been identified as the main threat to populations of *this species* (Badman 1999 cited in DOEE 2018a). It is noted that the preferred habitat for this species in run-off broad drainage lines within sloping tableland country coincides with areas favorable for dam construction, which is likely to increase the risk and severity of direct and indirect impacts from livestock grazing and potentially historic vegetation clearance for dam construction.

2.1.4 Historic survey effort at Carrapateena

Frankenia plicata has not been recorded during biannual floristic surveys undertaken since 2012 which covered the range of vegetation communities present on the Carrapateena Oz Minerals tenements (EBS 2013a, b, c; EBS 2014a, b, c, d; EBS 2015a,b; EBS 2016a, b; EBS 2017a,b). Additional surveys were also undertaken in 2008. Flora and fauna surveys and associated reporting at the site to date include:

- EBS (2008) Carrapateena Flora and Fauna Baseline Survey. Report to Coffey Natural Systems on behalf of Teck Cominco. Environmental and Biodiversity Services, Adelaide.
- EBS (2013a) Carrapateena Flora and Fauna Monitoring Baseline Survey 2012. Report to OZ Minerals. EBS Ecology, Adelaide.
- EBS (2013b) Carrapateena Autumn 2013 fauna and flora survey Monitoring. (Final 13 June 2014)
- EBS (2013c) Carrapateena Retention Lease Compliance Monitoring Report, Flora and Fauna, 2013. Report to OZ Minerals. EBS Ecology, Adelaide (SPRING)
- EBS (2014a) Carrapateena Targeted Northern Pastoral lease survey; Thick-billed Grasswren and unidentified *Sclerolaena*. EBS Ecology, Adelaide.
- EBS (2014b) Carrapateena Project Terrestrial Ecology Baseline Assessment. EBS Ecology, Adelaide.
- EBS (2014c) Carrapateena Autumn 2014 fauna and flora monitoring. Report to Oz Minerals EBS Ecology, Adelaide.
- EBS (2014d) Carrapateena spring 2014 Flora and Fauna Monitoring. Report to Oz Minerals EBS Ecology, Adelaide. (CA-6920-ENV-REP-0107)
- EBS (2015a) Carrapateena autumn 2015 Flora and Fauna Monitoring. Report to Oz Minerals EBS Ecology, Adelaide. (CA-6920-ENV-REP-0119)
- EBS (2015b) Carrapateena Spring Flora and Fauna Report 2015. Report to Oz Minerals. EBS Ecology, Adelaide. (CA-6920-ENV-REP-0118)
- EBS (2016a) Carrapateena Autumn Flora and Fauna Monitoring Report. Report to OZ Minerals. EBS Ecology, Adelaide, South Australia.
- EBS (2016b) Carrapateena Autumn Flora and Fauna Monitoring Report. Report to OZ Minerals. EBS Ecology, Adelaide, South Australia.
- EBS (2017a) Carrapateena Fauna and Flora Monitoring Report Autumn 2017. Report to OZ Minerals. EBS Ecology, Adelaide (E70302)

- EBS (2017b) Carrapateena Project Flora and Fauna Monitoring Report Spring 2017. Report to OZ Minerals. EBS Ecology, Adelaide (E70803)

Surveys undertaken in Spring and Autumn since 2012 at the site have reported floristic make-up at up to 47 flora sites within the Carrapateena project area, recording all plant species within a 1 ha plot following the SA Biological Survey methodologies (Heard and Channon, 1997). In addition, observations of flora species not recorded at specific flora survey sites were recorded opportunistically during this period.

Previous flora surveys of the Carrapateena tenements have recorded only one species of the *Frankenia* genus, namely *Frankenia serpyllifolia* (Bristly Sea-heath) (Figure 2-2). This variable low shrub to about 40 cm tall is a widespread and common component of *Atriplex vesicaria / Tecticornia medullosa* low open shrubland community that is dominant on the stony tablelands of the Arcoona Plateau. The species is also patchily present on *Maireana aphyllya / Atriplex vesicaria* low open shrubland found on the broad alluvial plains and outwash areas on the margins of the Arcoona Plateau and internal minor drainage features.

Frankenia species are often difficult to distinguish in the field and usually require microscopic dissection to obtain a positive identification. Macro features that distinguish *Frankenia plicata* from *F. serpyllifolia* include a more procumbent, spreading habit and denser clustering of leaves. In addition, the revolute margins of *F. plicata* typically obscure the leaf mid-rib which remains visible in *F. serpyllifolia*. Photos of *F. plicata*, including SA Herbarium specimen are provided in Figure 2-3 and Figure 2-4 below.

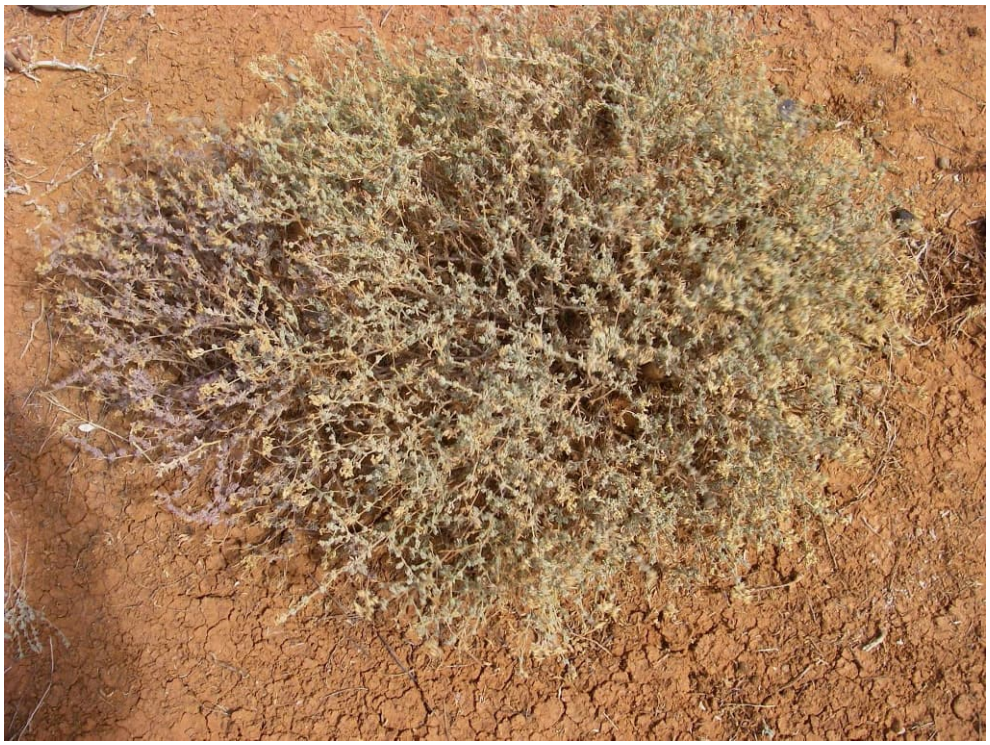

Figure 2-2: *Frankenia serpyllifolia* (Bristly Sea-heath), a common component of the stony tableland that dominates the Carrapateena tenements

Figure 2-3: *Frankenia plicata* (source: SA Seed Bank, 2018)

Figure 2-4: SA Herbarium specimen of *Frankenia plicata* from Mt Eba Station approximately 500 km north west of Carrapateena project area (F. Badman, 2000)

2.2 Night Parrot (*Pezoporus occidentalis*)

2.2.1 History

The Night Parrot (*Pezoporus occidentalis*), Endangered under the EPBC Act, is a highly elusive ground dwelling parrot that occurs in arid and semi-arid zones of Australia. It was previously thought to be extinct, but has recently been rediscovered with now known populations / occurrences in Queensland (Pullen Pullen Reserve, Goneaway National Park, Diamantina National Park) and Western Australia (near Broome) (Palaszczuk & Miles 2017, Jones 2017 cited in DOEE 2018b). These known occurrences are thought to be small isolated groups or small loosely connected populations and the species is still considered to be highly threatened and potentially on the brink of extinction (Night Parrot Recovery Team (NPRT) 2018). There are also newer reports of possible Night Parrot occurrence in the Northern Territory (based on potential calls in Spinifex habitat) and South Australia (based on a feather found in a Zebra finch nest at Kalamurina, approximately 350 km north of Carrapateena) (NPRT 2018).

Night parrots have not been recorded in South Australia for over 100 years. The recent finding of a feather, followed an image on a camera trap in an ungrazed, remote location, accessed via helicopter. The feather was found in a Zebra Finch nest (who are known to line their nests with feathers) beneath a Wedge-tailed Eagle nest adjacent to dense samphire habitat on Kalamurina Nature Reserve. Kalamurina is located north of Lake Eyre (Kati – Thanda) connected to a major tributary in an area that is destocked (feral herbivore free) and which contains a healthy population of dingoes (which may reduce the threat from feral cats) (NPRT 2018).

2.2.2 Known distribution

The approved conservation advice for the species (TSSC 2016) indicates that the current distribution of the species is unknown with few substantiated records since 1935. Despite a number of unverified sightings, several dedicated searches and public campaigns, there are only two areas (western Queensland and the Pilbara in WA) where reliable records indicate that populations may persist (NPRT 2016, cited in TSSC 2016). The TSSC (2016) diverts to information collected since 2013, since observations prior to this time are considered anecdotal, spurious, or based on erroneous assumptions. Garnett et al. (2011) report most habitat records are from *Triodia* grassland and / or Chenopod shrubland. Subsequently, Murphy (2015) suggests that roosting and nesting sites are consistently reported within clumps of dense vegetation, primarily old (unburnt) and large spinifex clumps, but occasionally other vegetation types.

Potential habitat within South Australia (provided by NPRT 2018) is provided in Figure 2-5 below. Vast expanses of habitat broadly characterized as Chenopod and Lignum occur east of the Woomera and south east of Roxby Downs where Carrapateena is located.

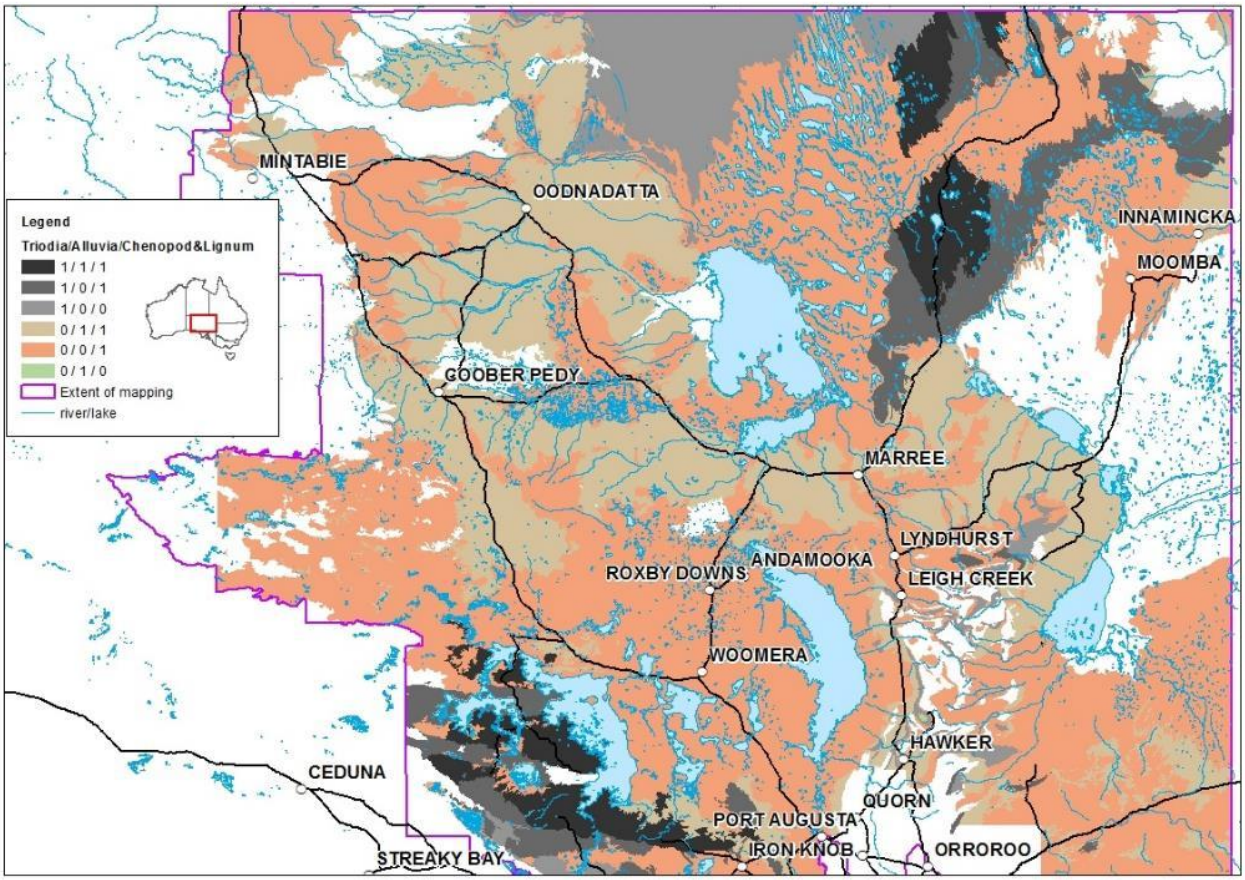

Figure 2-5: Potential Night Parrot Habitat Across South Australia (NPRT 2018).

Figure 4 of Appendix B6 of the EPBC referral (the ecological baseline assessment report, EBS 2017) indicates the vegetation associations across the Carrapateena Project area. The site consists of widespread chenopod shrubland with low woodland or open woodland adhering to the natural drainage lines across the area. Two-three, very small and isolated patches of *Eragrostis australasica* (Swamp Cane-grass) are identified, but no patches of *Triodia* grassland have been located across the site. It should be noted that the areas of Swamp Cane-grass will not be impacted by the project as they are protected for Cultural reasons. In addition, no *Triodia* was identified in the assessment of the western infrastructure corridor either, with only a small area of *Zygochloa paradoxa* (Sandhill Canegrass) present (EBS 2017 EPBC referral). Night Parrots have (historically) been observed within chenopod shrublands and samphire which are present on site, but *Triodia* grasslands are considered the predominant habitat type for Night Parrots (as stated by NPRT 2018). The majority of old historic records (pre-1980) in South Australia are from within, or in the vicinity of, *Triodia* grassland, and there are no records within South Australia since the 1980 record approximately 430 km NNE of the project site, with the exception of the feather recently found at Kalamurina Station, approximately 350 km north of Carrapateena. Given the absence of *Triodia* from the western flank of Lake Torrens, the chenopod habitat within the project area is considered unlikely to be important habitat for this species, but rather contribute to the vast amount of potential foraging habitat in the region. Historical Night Parrot records for South Australia are shown in Figure 2-6 below.

More detailed information and current best-knowledge about preferred habitats of the Night Parrot are provided at the Night Parrot Recovery Team web link (NPRT 2018) which suggests that Night Parrots are known to use areas that have a mix of Triodia, alluvial and stony pavement (gibber) habitats. In these habitats associated

species include shrubby Samphire and Chenopod associations, scattered trees and shrubs such as Acacia aneura (Mulga), Sclerolaena spp., Maireana spp. (Saltbush), Ptilotus spp. (Mulla Mulla). The team state that all recent Night Parrot records have primarily been associated with Triodia longiceps, but that other Triodia (Spinifex) species might also be important. Triodia longiceps growing near escarpments and without high densities of trees or shrubs are thought to be favoured, although some Night Parrots have been found living in Triodia areas a long way from escarpments. The Triodia habitats are used for roosting, breeding and feeding, while alluvia and stony habitats are used mainly for feeding. In southwestern Queensland, regular acoustic monitoring results (Murphy 2015; 2016) suggests that the birds remain in an area (roosting in Spinifex) even during dry times when no Spinifex seed was available. This is in contrast to historical suggestions that the birds were nomadic across the range, moving between Samphire and Spinifex (Higgins 1999). Hence, it is now thought that some populations may be nomadic and some may be more sedentary (NPRT 2018). More recently long-unburnt Spinifex that has not collapsed is thought to provide protection of roosting sites (NPRT 2018), similar to other small nocturnal fauna (e.g. Sandhill Dunnart).

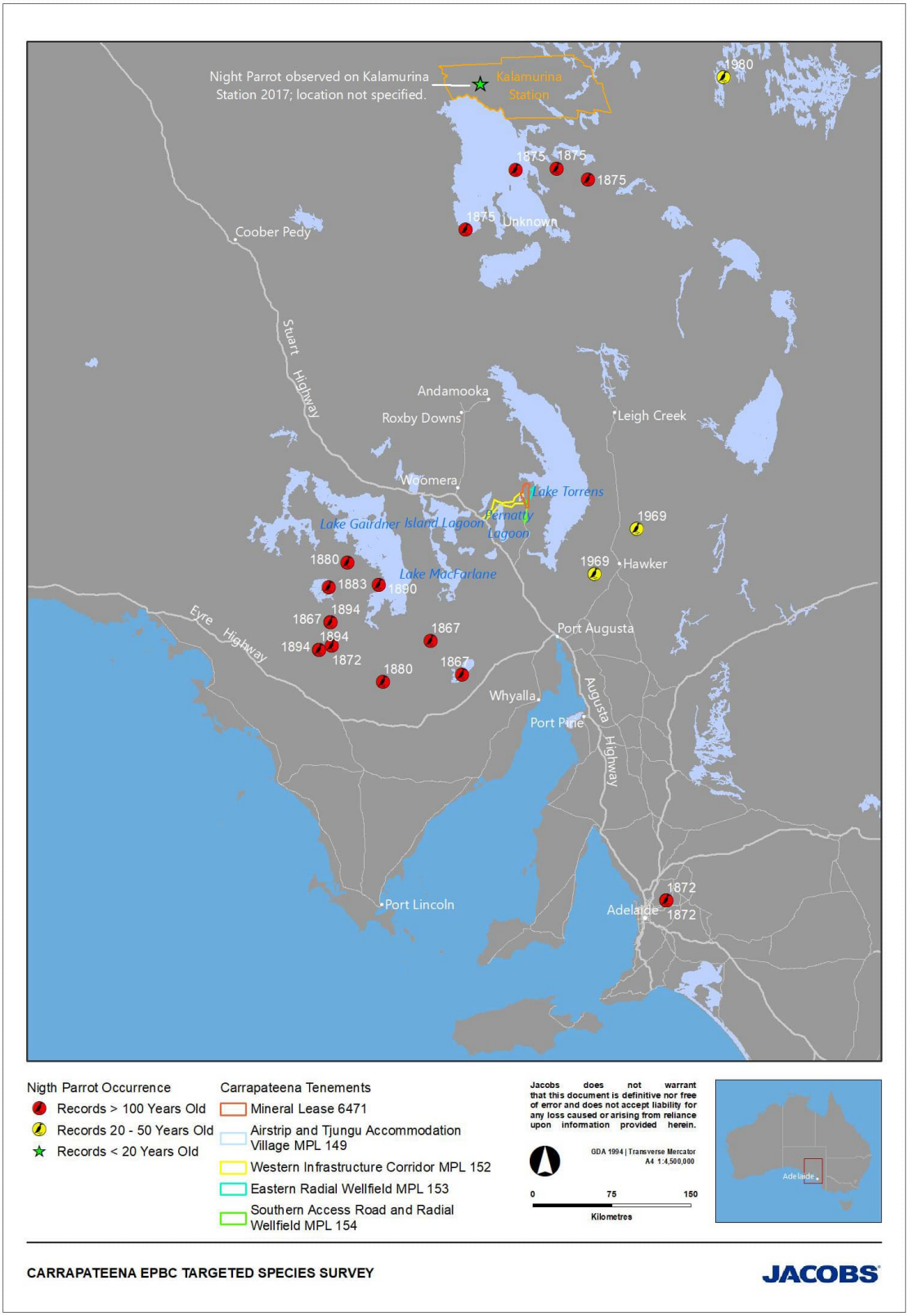

Figure 2-6: Historical records of Night Parrot in South Australia

2.2.3 Threats

It is noted in the approved conservation advice for Night Parrot (TSSC 2016) that there are no existing or adopted recovery plans for this species, with the exception of an interim Recovery Plan for Western Australia, which directs the reader to the NPRT website. Research priorities of the species are documented in the Night Parrot Research Plan (Murphy 2014).

TSSC (2016) indicate that there are currently no know threats to Night Parrots, and that the causes of the presumed decline are essentially guesswork. A number of potential threats are listed including predation by feral cats and foxes, soil disturbance, land degradation as a result of introduced stock and feral herbivores (including to land around water points), and a reduction in water availability through overuse of water holes by camels and a lack of water hole maintenance. It is noted that the Threat Abatement Plans considered relevant to Night Parrot include management of feral cats and foxes, and competition and land degradation by rabbits. Existing management at the Carrapateena site includes a commitment to reporting any sightings or evidence of calls or activity to the NPRT throughout the Carrapateena operation and control of feral animal populations, including cats and foxes, aligning with the Threat Abatement Plans considered relevant by TSSC (2016).

Studies in Qld have also suggested King Brown Snakes are a common predator of the Night Parrot, following DNA analysis of damaged eggs at a known Night Parrot roost (Olsen et al. 2016).

2.2.4 Survey effort and methods

The “Survey Guidelines for Australia’s Threatened Birds: Guidelines for detecting birds listed as threatened under the EPBC Act” (DEWHA 2010) provides recommendation for survey of Night Parrot, *Pezoporus occidentalis*, including an erratum which was added in April 2017. The original advice listed in DEWHA (2010) suggests an “unknown” period of survey hours or days for targeted searches, area searches and for the use of sniffer dogs. It also suggests that area searches via camels may improve habitat access and coverage whist providing the observer with higher vantage and greater field of view. Both sniffer dogs and camel-back surveys were considered impracticable for the project site, and the very low shrubland vegetation across the site does not warrant use of camels for greater vantage point. The initial guidelines also suggest that targeted searches and evening watches at waterholes, area searches for feathers, and searches for feathers around waterholes, may be useful, and that a considerable amount of undefined effort would be required (DEWHA 2010).

More recently, the NPRT (2018) suggest minimal disturbance techniques including passive observation and listening, supplemented by habitat surveys and remote image analysis. Night Parrot calls are provided on the NPRT website to assist passive listening surveys. The NPRT suggest that individuals or pairs of Night Parrot call from Spinifex (*Triodia*) roosting habitat mostly in the first hour after sunset and the last hour before dawn. Outside of these time the birds move to other habitats to feed. It is also noted that during and immediately after wetter periods, Night Parrots call more frequently and they are known to call when feeding in non-*Triodia* habitats, such as floodplains. Increases in calling following wetter periods can be associated with opportunistic breeding events, similar to other arid species. Night Parrots are also known to drink at free standing water, and may do so more during hot weather. Earlier reports suggested that Night Parrots call when coming in to drink (NPRT, 2018). The NPRT suggest that passive listening should occur in *Triodia* habitats (if present), at dams, raised stock tanks or other free standing water bodies within 10-15 km of roosting habitats (NPRT 2018).

Night Parrots are also known to drink at dams and or other water bodies which can be up to 10-15 km away from their roosting habitats. Historically, they have been recorded drinking water in northeastern South Australia and northwestern Australia (Higgins 1999). There are also more recent suggestions that they may not rely on surface water, but may obtain water from foraging resources during (e.g. the leaves of succulent species such as *Sclerolaena*) when available (TSSC 2016). Recent modelled of Night Parrot water budget estimates suggest that whilst the nocturnal arid species would have specific adaptations to cope with lack of water (similar to Budgerigars and related to roosting location and lack of day time movement), they may be able to cope without daily visits to water during winter, but would need access to succulents (with 55% or greater water content) or

standing water during summer or warmer periods (Kearney et al. 2016). Based on the above it is considered that survey of water points during warmer weather would increase likelihood of detection.

It is noted that the NPRT (2018) suggest that use of call-play back is considered a potentially disturbing research technique, and is not encouraged by the NPRT without appropriate permits. Although the survey team at Carrapateena have a track record of applying for and working under correct ethics permits, given the low likelihood of the habitat at the site being suitable habitat for Night Parrots, particularly preferred breeding habitat, targeted survey via call-playback was not previously considered necessary.

2.2.5 Historic survey effort at Carrapateena

At Carrapateena, bird surveys have been undertaken as part of the fauna survey baseline studies, and have followed the widely recognised methodology outlined in the South Australian Vertebrate Survey Guidelines (Owens 2000). These surveys have occurred biannually from 2012 to 2017 (6 years, 12 surveys) and involved area searches for 30 minutes in the morning (before 11am) and afternoon (after 2pm) using call-playback where practicable at 16 sites on each occasion. Note, call-playback for Night Parrot was not deployed as the species was considered unlikely to occur at the site. Ten of the 16 sites were located within *Atriplex versicaria* (Bladder Saltbush) (+/-) *Tecticornia medullosa* (Samphire) low chenopod / samphire shrubland (which is not the preferred *Triodia* habitat of Night Parrot, but is considered the most suitable habitat for Night Parrot present at the site). This equates to approximately 10 hours of bird survey effort (spread across approx. 6 days per field survey) within 'target habitat' on site, for each of 12 separate survey periods, accounting for seasonal and annual variations, i.e. 120 hours of bird survey effort within the most appropriate habitat on site over multiple years. In addition, other targeted surveys have been conducted at the site (e.g. targeted Thick-billed Grasswren and unidentified *Sclerolaena* survey, EBS 2014a) as well as other preliminary surveys of the area (EBS 2008), also adding to the cumulative survey effort at the site. It is acknowledged that the Night Parrot is a nocturnal bird and may not have been detected during daylight surveys and it is known to be secretive in nature. However, daytime bird survey and flora survey effort would be expected to flush individuals or detect feathers if present, and each survey period included night time searches with spotlights to identify fauna visibly or by their vocalizations, which also represent opportunities for Night Parrot identification. Spotlighting was undertaken during 2012-2014 (see 2.1.4 above (EBS 2013a, b; EBS 2014a, b,c,d; EBS 2015a,b; EBS 2016 a, b; EBS 2017a,b)) at fauna survey locations, and included driving to and from sites in the dark at slow speeds which would contribute to the overall level of nocturnal survey effort at the site**.** During these surveys a range of nocturnal fauna were detected (e.g. Australian Owlet Nightjar, Spotted Nightjar, Tawny Frogmouth, Australian Barn Owl, Little Button Quail, Southern Spiny-tailed Gecko, Pernatty Knob-tailed Gecko, Curl Snake, Tree Dtella, Bynoes' Gecko, Black-headed Scaly-foot, Fox, Rabbit and Centralian Blind-Snake). In addition, the 2014 Spring Survey deployed 4 camera traps to detect elusive species, as well as a Harp trap to detect micobats (EBS 2014d). No Night Parrots or evidence of Night Parrots were detected in any of the previous extensive surveys (daytime fauna and flora surveys, spotlighting, camera traps, Harp Traps). The amount of survey effort undertaken, in association with the extensive desktop and habitat descriptions for the site, was previously considered sufficient. However, in light of recent observations of the Night Parrot in Qld, WA and the feather found on Kalamurina Station in SA (NPRT 2018), the approvals conditions require some additional targeted searches. The targeted survey for Night Parrot at Carrapateena is presented below.

3. Methods

Conditions 6 and 8 of the EPBC referral approval indicated that survey of both species should be undertaken by suitably qualified experts, a requirement of the EPBC conditions. The targeted surveys were undertaken by Dr Zeta Bull (Phd Ecology, awarded in 1999; consulting in Ecology since 2002, including undertaking numerous flora and fauna surveys and targeted species surveys; SA Accredited Native Vegetation Consultant) and Rick Barratt (Diploma of Applied Science NRM, awarded 1979, 30+ years experience in arid zone botany and ecology; currently on the SA Arid Lands NRM Board, numerous flora and fauna surveys and targeted species surveys).

The Survey was undertaken from 14th to 17th of March 2018.

3.1 *Frankenia plicata* survey

Surveys of proposed non-linear infrastructure footprint areas were undertaken and comprised a walk-over by two ecologists covering a minimum of 1 hectare (in line with SA standard biological survey methodology) (Heard & Channon, 1997) encompassing the range of vegetation and landforms present, as well as potential preferred habitat areas. Surveys of proposed linear infrastructure features such as access roads and pipelines consisted of linear foot traverses of a 100 m wide strip on either side of the linear infrastructure footprint.

A total of 57 traverse or point searches were undertaken and each were logged on a GPS with vegetation community, dominant flora species and landform descriptions noted. A photo log for each traverse was also undertaken. Samples of any *Frankenia* species. encountered were vouchered and pressed for subsequent verification.

3.2 Night Parrot survey

Surveys for Night Parrot at Carrapateena involved several approaches. Review of historical site habitat data revealed a lack of potential roosting and breeding habitats (i.e. no *Triodia* present). Potential feeding habitat is extensive across the site, however the site is heavily grazed by sheep and a large population of Red Kangaroos and Euro Kangaroos are also present. Given the historical survey effort within 16 locations across the site (daytime avifauna surveys, nocturnal spotlighting, historical camera traps described above), the focus of the present targeted survey was at key water points, knowing that Night Parrots may mobilise 10-15 kms to water each day. In addition, active daytime searches for feathers were conducted at water points, beneath Wedge-tailed Eagle nests, at all *Frankenia* sites, and in other smaller nests / Finch nests as located.

Night Parrot Surveys at the site involved the following:

- Pre dawn / pre dusk passive observation and listening surveys at water points (dams)
    - Night Parrots calls were obtained from the NPRT website (NPRT 2018) to use as reference
    - One passive listening walk was undertaken in habitat leading away from a dam
    - All fauna present at the site were noted (fauna seen and or heard).
- Active Feather Search
    - At Water points in surrounding vegetation which acted as feather traps (e.g. grasses, sedges, low shrubs)
    - In (using binoculars) and under Wedge-tailed Eagle nests
    - In smaller nests as located across the project area, e.g. Finch nests

- General search during *Frankenia plicata* survey (i.e. very small low shrub, in open grazed environment)
- Photos of trapped feathers were taken as examples of capacity of environment to reveal presence of species.

- Habitat searches
  - Bluff walk (NP13 / NP 14) to search for *Triodia*, given similar geology to Uro Bluff where *Triodia irritans* (Spinifex) hummock grassland is known to be present (DEWNR BDBSA search 2018).
  - *Eragrostis australasica* (Swamp Canegrass) swamps – were the only type of dense grassland areas present on site, small patches. However, it is noted that all examples of this vegetation community are protected from project works as part of cultural heritage protection.
  - Habitats with Chenopods, *Sclerolaena* and Samphire were searched, as well as opportunistic water points and creek crossings / river beds.

4. Results

Survey site conditions were optimal for detecting avifauna, particularly nocturnal and diurnal fauna. Temperatures ranged from 24 to 38 degrees, there was little or no wind and calls of fauna that were present could be clearly identified, including the White-striped Freetail Bat which is the only micro bat audible to humans.

Similarly, whilst conditions were warmer and plants were drier, the open grazed environment provided clear visibility for *Frankenia* species that were present.

4.1 Frankenia plicata

4.1.1 Survey effort

A total of 57 area and linear searches were undertaken during the targeted survey and these are listed in Table 4-1 below. Reference photos of these locations are provided in Appendix A. Nineteen search sites were located in preferred broad alluvial plains with *Maireana aphylla* (Cottonbush) low open shrubland which is considered to be preferred *Frankenia plicata* habitat based on historical records from the broader region. Figure 4-1 depicts the vegetation associations mapped for the project area and depicts the location of *Frankenia plicata* searches undertaken during the targeted survey.

Table 4-1: *Frankenia plicata* survey effort – Carrapateena March 2018

Site No	Easting	Northing	Vegetation / Landform Description	Preferred *F. plicata* habitat	Comment
F1	0738211	6529836	*Maireana aphylla* / *Atriplex vesicaria* broad drainage line	yes	Sth Eliza Dam area
F2	0738152	6529638	*Maireana aphylla* / *Atriplex vesicaria* broad drainage line	yes	Sth Eliza Dam area
F3	0738140	6529462	*Maireana aphylla* / *Atriplex vesicaria* broad drainage line	yes	Sth Eliza Dam area
F4	0738166	6529817	*Maireana aphylla* / *Atriplex vesicaria* broad drainage line	yes	Sth Eliza Dam area
F5	0738730	6530135	*Atripex vesicaria* / *Tecticornia medullosa* stony tableland		NE borefield track
F6	0740400	6532895	*Atripex vesicaria* / *Tecticornia medullosa* stony tableland		NE borefield track EBS site flora and fauna site 12
F7	0742088	6535211	*Acacia papyrocarpa* minor drainage line		
F8	0742681	6536024	*Acacia papyrocarpa* minor drainage line		
F9	0743952	6537816	*Atriplex vesicaria* low open shrubland / gypsiferous rise		*Frankenia subteres* collected
F10	0740539	6541944	*Eucalyptus camaldulensis* / major drainage line		Eliza Creek
F11	0741754	6547677	*Maireana aphylla* / *Atriplex vesicaria* broad drainage line	yes	South of North Eliza Dam,
F12	0741671	6547678	*Maireana aphylla* / *Atriplex vesicaria* broad drainage line	yes	
F13	0735700	6539206	*Acacia papyrocarpa* minor drainage line		
F14	0735982	6539578	*Acacia papyrocarpa* minor drainage line		

Site No	Easting	Northing	Vegetation / Landform Description	Preferred *F. plicata* habitat	Comment
F15	0736133	6539905	*Atripex vesicaria / Tecticornia medullosa* stony tableland		processing plant site
F16	0736495	6540250	*Atripex vesicaria / Tecticornia medullosa* stony tableland		processing plant site
F17	0735620	6538973	*Atripex vesicaria / Tecticornia medullosa* stony tableland		processing plant site
F18	0735036	6538473	*Atripex vesicaria / Tecticornia medullosa* stony tableland		processing plant site
F19	0734480	6537984	*Atripex vesicaria / Tecticornia medullosa* stony tableland		processing plant site
F20	0737545	6534452	*Atriplex vesicaria* tableland		Within Tailing Storage Facility footprint
F21	0738089	6535023	Major drainage line *Acacia papyrocarpa* tall shrubland		Within Tailing Storage Facility footprint
F22	0738610	6535056	*Atriplex vesicaria* tableland		Within Tailing Storage Facility footprint – tableland community
F23	0739115	6535022	Major drainage line *Acacia papyrocarpa* tall shrubland		Eliza Creek TSF footprint
F24	0739078	6534910	*Atriplex vesicaria* tableland		TSF footprint
F25	0739304	6535025	deep gilgai run-on depression *Atriplex vesicaria* tableland		Within Tailing Storage Facility footprint – tableland community
F26	0739268	6535684	*Atriplex vesicaria* tableland		along Eliza Creek nest and *Frankenia* search
F27	0739152	6535710	*Eucalyptus camaldulensis* woodland		along Eliza Creek nest and *Frankenia* search
F28	0738610	6535349	*Eucalyptus camaldulensis* woodland		along Eliza Creek nest and *Frankenia* search
F29	0738847	6535949	*Eucalyptus camaldulensis* woodland		along Eliza Creek nest and *Frankenia* search
F30	0739162	6536607	*Maireana aphylla./ Atriplex vesicaria* run on depression	yes	Adjacent to Eliza Creek TSF footprint (embankment)
F31	0738105	6544024	*Atripex vesicaria / Tecticornia medullosa* tableland		Orebody subsidance area
F32	0737234	6543805	*Atripex vesicaria / Tecticornia medullosa* tableland		Orebody subsidance area
F33	0738100	6543799	*Atripex vesicaria / Tecticornia medullosa* tableland		Orebody subsidance area
F34	0737752	6542332	*Atripex vesicaria / Tecticornia medullosa* tableland		Orebody subsidance area
F35	0736863	6539865	*Atripex vesicaria / Tecticornia medullosa* tableland		Mine Portal
F36	0729138	6532999	*Atripex vesicaria / Tecticornia medullosa* tableland		Western Access Road *Sclerolaena* "Pernatty" collected
F37	0732380	6532723	*Atripex vesicaria / Tecticornia medullosa* tableland		Air Strip SE corner
F38	0732816	6534313	*Atripex vesicaria / Tecticornia medullosa* tableland		Air Strip NE corner
F39	0725327	6530740	*Maireana aphylla./ Atriplex vesicaria* run on depression	yes	Western Access Road

Site No	Easting	Northing	Vegetation / Landform Description	Preferred *F. plicata* habitat	Comment
F40	0725351	6530763	*Maireana aphylla./ Atriplex vesicaria* run on depression	yes	Western Access Road
F41	0724808	6529447	Broad sandy alluvial plain *Tecticornia medullosa/Maireana pyramidata/ Gunniopsis quadrifida low shrubland*	yes	Western Access Road; heavy grazing impact
F42	0724895	6528423	Broad sandy alluvial plain *Tecticornia medullosa / Maireana pyramidata/ Gunniopsis quadrifida* low open shrubland	yes	Western Access Road Yeltacowie Creek crossing
F43	0725017	6527772	*Maireana aphylla / Frankenia serpyllifolia* low open shrubland	yes	Western Access Road; heavy grazing impact
F44	0722723	6526892	*Maireana aphylla / Frankenia serpyllifolia/ Tecticornia medullosa* low open shrubland	yes	Western Access Road; heavy grazing impact
F45	0708232	6525180	Stony alluvial plain *Atriplex vesicaria / Maireana aphylla* low open shrubland	yes	Southern Access Road
F46	0738881	6545594	*Atripex vesicaria / Tecticornia medullosa* tableland		Northern Ore Body road
F47	0737847	6531329	*Atripex vesicaria / Tecticornia medullosa* tableland		RP4 pipeline track; search both sides
F48	0736463	6529127	*Atripex vesicaria / Tecticornia medullosa* tableland		RP4 bore, pump and tank
F49	0736424	6529107	*Atripex vesicaria / Tecticornia medullosa / M pyramidata* tableland		RP4 bore, pump and tank
F50	0736443	6529261	*Atripex vesicaria / Tecticornia medullosa / M pyramidata* tableland		RP4 bore, pump and tank
F51	0736953	6529325	*Atripex vesicaria / Tecticornia medullosa / M pyramidata* tableland		RP4 bore, pump and tank
F52	0737449	6529851	*Atripex vesicaria / Tecticornia medullosa / M pyramidata* tableland		RP4 pipeline track; search both sides
F53	0737021	6517117	Broad drainage line with *Acacia papyrocarpa* (Myall) / *Maireana aphylla* / *Duma florulenta* (Lignum) / *Atriplex vesicaria*	yes	Southern Access Road; search both sides
F54	0736909	6516344	Broad alluvial plain *Atripex vesicaria / Tecticornia medullosa / Acacia victoriae*	yes	Southern Access Road; search both sides
F55	0735661	6514689	Broad alluvial plain *Maireana aphylla / Myoporum montanum / Acacia victoriae*	yes	Southern Access Road; search both sides
F56	0736597	6504829	Broad alluvial plain *Maireana aphylla / Atriplex vesicaria* low open shrubland	yes	Southern Access Road; search both sides
F57	0736540	6504832	Broad alluvial plain *Maireana aphylla / Frankenia serpyllifolia* low open shrubland	yes	Southern Access Road; search both sides; *F. serpyllifolia* collected

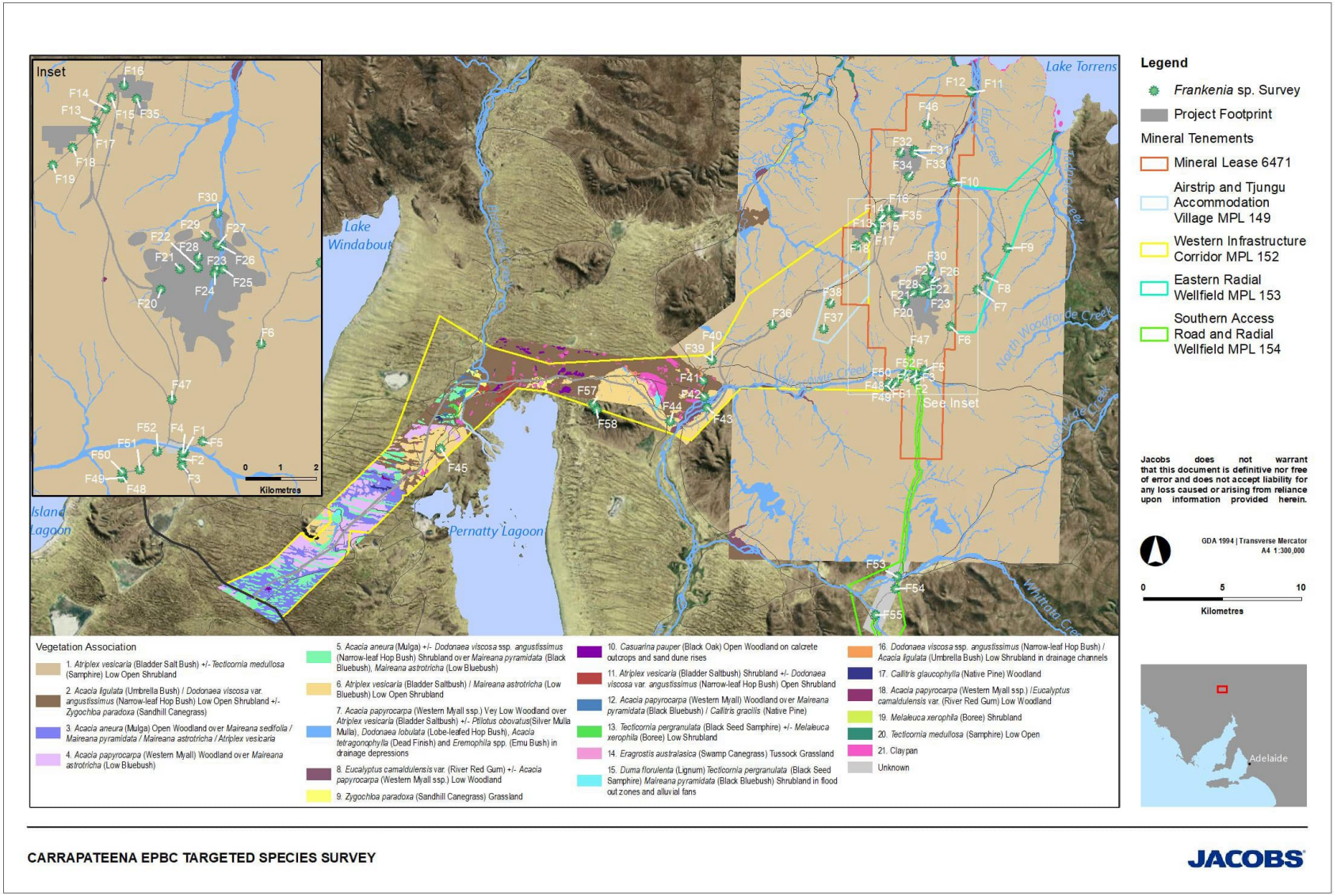

Figure 4-1: Location of *Frankenia plicata targeted* survey sites (over vegetation associations)

4.1.2 Survey results

Frankenia plicata was not recorded during the targeted survey. A single population of *Frankenia subteres* (Round Sea-heath), not previously recorded for the Carrapateena site was recorded during the targeted survey on a low gypsiferous rise on the Eastern Radial Wellfield (MPL 153). The location for the *F. subteres* population recorded in this targeted survey (F9) is shown on Figure 4-1 above and the species is depicted in Figure 4-2 below.

Figure 4-2: *Frankenia subteres* recorded on a low gypsiferous rise in the north east of the Carrapateen project area

4.2 Night Parrot

4.2.1 Survey effort

The survey effort for Night Parrot involved the following:

- Active survey between 14 March and 17 March 2018 (equating to 3 nights, 3.5 days)
- Pre-Dawn and post-dusk passive listening and observation surveys at water points, and in potential foraging habitat (total of 20.9 hours)
- Active day-time searches around water points for feathers
- Searches within (using binoculars) and below Wedge-Tailed Eagle nests
- Opportunistic searches within smaller abandoned nests and along creeklines
- Habitat search for *Triodia* (Bonny Bluff search)

Given the open chenopod environment, all areas that were actively searched for *Frankenia* were concurrently searched for conspicuous green parrot feathers during the day (59 sites over 3.5 days, see Figure 4-1 and Figure 4-3.

Night Parrot Survey locations are provided in Figure 4-3, with reference photos and further information provided in Appendix B and C respectuvely. A summary of the details for each location is provided in Table 4-2 (listening / observation survey effort), Table 4-3 (images of water points) and Table 4-4 (active feather / nest survey effort).

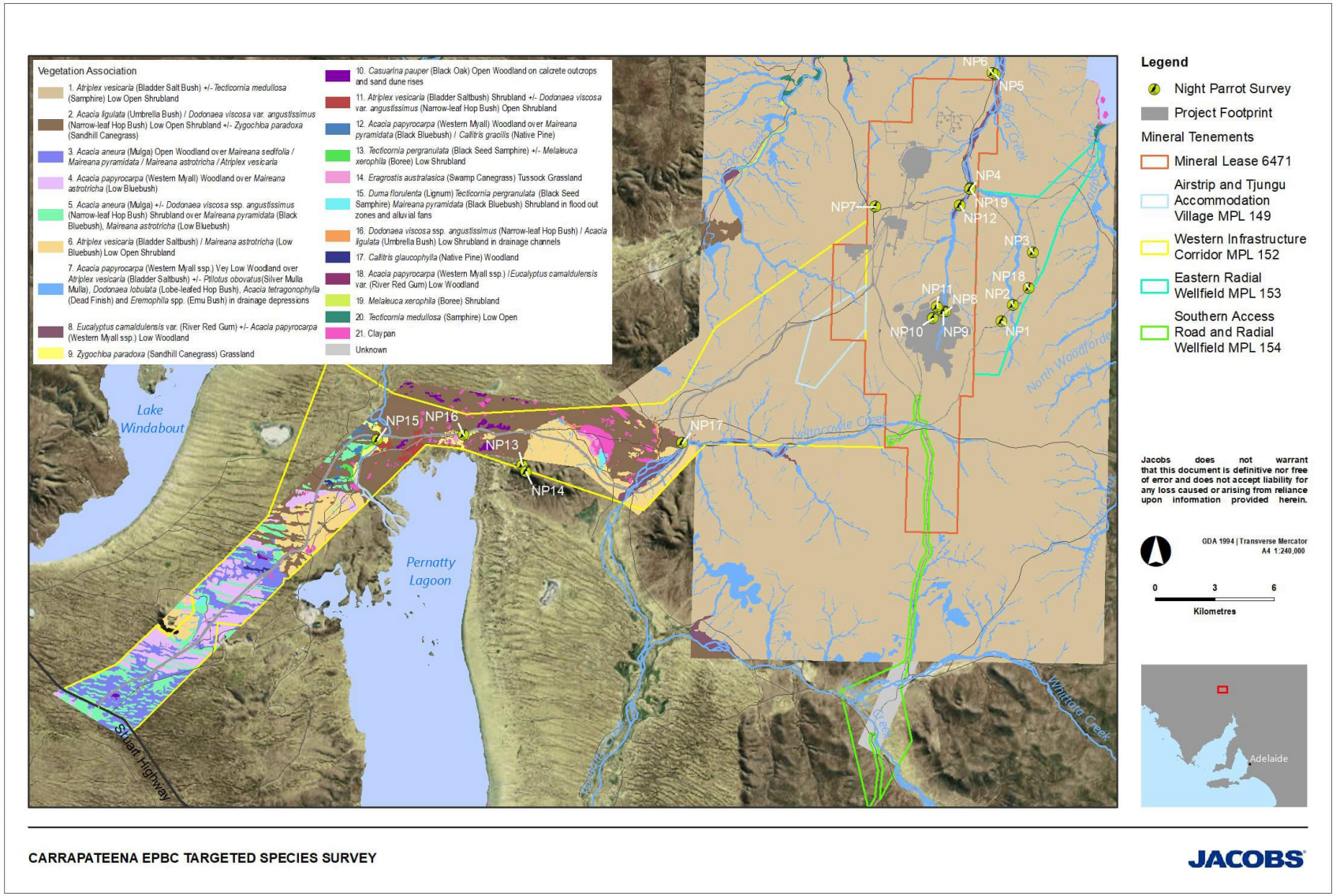

Figure 4-3: Location of Night Parrot Survey Locations at Carrapateena by vegetation association

Table 4-2: Night Parrot passive observation and listening surveys

	Pre-dawn survey	Post-dusk survey	Total hours (2 observers)
Anzac Dam	17/03/18 6.30am – 7.30am Two locations at the site 120 mins observation	14/03/18 6.30pm – 8.50pm Two locations at the site 280 mins observation	6.7
Dawson Dam	15/3/18 6.15am-7.30am Two locations at the site 150 mins observation	16/03/18 6.40pm-9pm Two locations at the site 280 mins observation	7.2
Eliza North Dam	16/03/18 6.20am-7.45am One location at the site 85 mins observation	15/03/18 6.55pm-9pm Two locations at the site 250 mins observation	5.6
Habitat walk (NP3-NP18)	17/03/18 6.06 am – 7.30 am ~4km loop in Chenopod shrubland 85 mins observation	-	1.4
		Total	**20.9**

Table 4-3: Key Water points surveyed at Carrapateena

Anzac Dam	Anzac Dam edge
North Eliza Dam	North Eliza Dam edge
Dawson Dam	

Table 4-4: Active Day-time Feather Searches

Location / Site	Time	Effort	Comments
Anzac Dam	14/03/18; 11-11.30 am	30 mins	Feathers present on banks, trapped in shrubs / reeds. No Night Parrot feathers
Eliza North Dam	14/03/18; 2-2.20 pm	30 mins	Feathers present, no Night Parrot feathers
NP 12 - (Eliza Creek South)	15/03/ 8; 11.45 am	10 mins	WTE nest 1 in River Red Gum. No Night Parrot Feathers present.
NP13 - (Elizabeth Creek South)	16/03/18; 12.30 pm	10 mins	WTE nest 2 in Callitris. No Night Parrot feathers present.
NP14 - (Western Infrastructure Corridor)	16/03/ 8; 12.54 pm	10 mins	WTE nest 3 in Myall. No Night Parrot feathers present.
NP15 - (Yeltacowie Creek)	16/03/18; 1.30 pm	10 mins	WTE nest 4 in River Red Gum. No Night Parrot feathers present.
Smaller nests (NP1, NP2)	14/03/18; 9-9.30 am	30 mins	Finch and other nests. No Night Parrot feathers present.
All *Frankenia* sites as per Table 4-1	14/3/18-17/3/18 throughout the day	3.5 days	Numerous feathers encountered trapped in low arid shrubs. No Night Parrot feathers present.

WTE = Wedge-tailed Eagle; NP = Night Parrot locations as per Figure 4-3.

4.2.2 Survey results

4.2.2.1 Pre-dawn / post-dusk surveys

Timing of the survey (mid March) was chosen because there was an increased chance of detection of the Night Parrot due to potential for opportunistic breeding event related to rainfall in the preceding months. As mentioned earlier, Night Parrot are known to call more frequently during breeding. Rainfall at the site for the 4 months prior to the survey was high (> 140mm, site data A. Oswald), which often results in arid zone species that normally breed in Spring, breeding opportunistically in Autumn.

As mentioned above site conditions were optimal for detecting avifauna, particularly nocturnal and diurnal fauna due to the warm evenings and lack of wind which enabled calls of fauna that were present to be clearly identified, including the White-striped Freetail Bat which is the only micro bat audible to humans.

A range of fauna, primarily avifauna, were observed at the water points during the survey (see Table 4-5). It was noted that a number of species had juveniles present (e.g. Black-fronted Dotterel, Coots, Variegated Fairy-wren, Blue Bonnet Parrots, Mulga Parrots, Grebes, Welcome Swallows) or were exhibiting breeding plumage / in pairs (e.g. Hoary and Australasian Grebes, Blue Bonnet Parrots, Mulga Parrots, Ring-neck Parrots, Red-rumped Parrots, Blue-billed Ducks, Pink-eared Ducks). Presence of young and breeding birds aligns with the high rainfall preceding the survey providing optimal conditions for a number of species to undertake a late summer / early autumn breeding event. Presence of juveniles of very small ground living species (e.g. Dotterel and Fairy-wren) may be indicative that predator presence is low, particularly cats. Known presence of dingoes in the region that have breached the dog fence also suggests cat presence may be low. No cats or scats were sighted during the targeted Night Parrot or *Frankenia plicata* surveys. Several dead birds were observed at one of the water points (e.g. Spotted Nightjar), and a live Wedge-tailed Eagle was also noted at this dam during the day time.

The diversity of avifauna observed at the water points suggested the locations were well utilized by the avifauna that occur in the region; 18 family groups were represented (e.g. Estrildidae, Eurostopodidae, Hirundinidae, Maluridae, Meliphagidae, Monarchidae, Motacillidae, Podicipedidae, Psittacidae, Rallidae, Rhipiduridae, Accipitridae, Anatidae, Artamidae, Cacatuidae, Columbidae, Charadriidae, Corvidae). A number of parrot species were observed that were cautious at water points often arriving just after dawn, particularly on the hottest night (e.g. Ring-necked Parrots (see Figure 4-4), Mulga Parrots (see Figure 4-4), Blue Bonnet Parrots and Red-rumped Parrots).

Table 4-5: Fauna species observed during NP surveys

Species Name	Common Name	Anzac Dam		Dawson Dam		Eliza North Dam		Opportunistic / Comment
		(Dusk)	(Dawn)	(Dusk)	(Dawn)	(Dusk)	(Dawn)	
Acanthiza sp. (Acanthiza apicalis or *A. iredalei iredalei)*	Inland Thornbill or Common Slenderbill Thornbill		1		1	1		
Anas gracilis	Grey Teal	5					4	Anzac / Eliza North dams during day
Anas superciliosa	Pacific Black Duck				8			
Anthus richardi	Richard's Pipit	2		1				Camp, throughout site
Aquila audax	Wedge-tailed Eagle							Eliza north during day
Aquila audax	Zebra Finch						7	Anzac / Eliza North dams during day
Artamus cinereus	Black-faced Wood swallow							F1, Eliza North dam during day, Eliza Creek, camp
Artamus cinereus	Black-faced Woodswallow		5					
Artamus cyanopterus	Dusky Wood Swallow							Anzac / Eliza North dam during day
Barnardius zonarius zonarius	Ring-neck Parrot						2	Pair / photo
Calamanthus campestris	Rufous Fieldwren							Site Frankenia 33
Capra hircus	Goat			3				
Corvus sp.	Raven	>10	4	3		3		
Coturnix pectoralis	Stubble Quail				1			Female, ran to water dark / some light
Elseyornis melanops	Black-fronted Dotterel	1		2	3J	2	2	Anzac dam / Eliza North Dam during day. Pairs, calls day and during dark

Species Name	Common Name	Anzac Dam		Dawson Dam		Eliza North Dam		Opportunistic / Comment
		(Dusk)	(Dawn)	(Dusk)	(Dawn)	(Dusk)	(Dawn)	
Eolophus roseicapilla	Galah	>10				>20	4	
Epthianura albifrons	White-fronted Chat			1				Male near dam
Epthianura aurifrons	Orange Chat			1				Male near dam
Eurostopodus argus	Spotted Nightjar		1			1	1	Nocturnal appears dusk & dawn, silent, flying overwater and alighting on bank
Fulica atra	Eurasian Coot	9	9	15	10	>20	23	Anzac dam / Eliza North dam during day
Gavicalis virescens	Singing Honeyeater				6		1	Anzac dam during day
Grallina cyanoleuca	Magpie Lark	2	1			3	3	
Hirundo neoxena	Welcome Swallow			2		3	5	
Macropus robustus	Euro Kangaroo	4						
Macropus rufus	Red Kangaroo	29		5		19	3	
Malacorhynchus membranaceus	Pink Eared Duck	5	2			8	7	Anzac dam / Eliza North dam during day
Malurus lamberti	Variegated Fairy-wren							Eliza Creek, Juvenile present
Microhiroptera (family)	Micro bat sp.							Not audible to human
Northiella haematogaster haematogaster	Blue Bonnet						4	Eliza Creek; 2 adult, 2J
Ocyphaps lophotes	Crested Pigeon	2				3	1	Eliza Creek
Ovis aries	Sheep (Dorper)		many					
Oxyura australis	Blue-billed Duck					6	2	Eliza North dam during day; Both sexes

Species Name	Common Name	Anzac Dam		Dawson Dam		Eliza North Dam		Opportunistic / Comment
		(Dusk)	(Dawn)	(Dusk)	(Dawn)	(Dusk)	(Dawn)	
Phaps chalcoptera	Common Bronzewing Pigeon	7	5	5		10	8	Secretive, appeared at dusk and dawn, silent, between vegetation and water's edge
Poliocephalus poliocephalus	Hoary-headed Grebe	2	5	6 (2F, 2J, 2M)	3 (1M, 2F)	>15	15	Breeding plumage
Psephotus haematonotus	Red-rumped Parrot						3	F1, Juveniles present
Psephotus varius	Mulga Parrot		7 (4M, 3F drinking				9J	Eliza Creek
Ptilotula penicillata	White-plumed Honeyeater							Anzac dam during day
Rhipidura leucophrys	Willie Wag Tail	1	5	3	1	3	2	F1, Eliza North during day
Tachybaptus novaehollandiae	Australasian Grebe	2		3M	4(F/M/J)			Breeding plumage,
Tadarida australis	White-striped Freetail Bat			1		4		Seen / heard (audible to human ear)
Petrochelidon nigricans	Tree Martin		1				4	

Abbreviations as follows: F = female, M = male, J = Juveniles present; Site F1 = *Frankenia* survey site.

Figure 4-4: Birds utilizing dam habitats at Carrapateena

Pink-eared Ducks North Eliza Dam	Galahs North Eliza Dam
Ring Neck Parrots adjacent North Eliza Dam	Mulga Parrots Anzac Dam

4.2.2.2 Active feather searches

Four wedge-tailed eagle nests were searched (above and below) for evidence of conspicuous green Night Parrot feathers. No Night Parrot feathers were identified (see Appendix B)

A number of smaller nests were checked for evidence of feathers. Only one white feather was observed. No Night Parrot Feathers were identified (see Appendix B).

One hour of searching for feathers was undertaken at water points. A number of feathers were located (see Appendix B). No Night Parrot Feathers were observed.

57 locations surveyed for *Frankenia plicata* were also searched for feathers. Several feathers were observed. No Night Parrot feathers were observed.

4.2.2.3 Habitat searches

Bluff walk (NP13 / NP 14 / F57 / F58) was searched for *Triodia*, given similar geology to Uro Bluff where *Triodia irritans* (Spinifex) hummock grassland is known to be present. No Triodia was present on top of the Bluff. See Figure 4-5.

No *Triodia spp*. (Spinifex) hummock grassland has been detected in previous extensive flora surveys and vegetation mapping across the site and none was recorded during this targeted survey. Refer vegetation associations depicted in Figure 4-3 and Figure 4-5.

Historical surveys at the site identified habitats within *Atriplex versicaria* (Bladder Saltbush) (+/-) *Tecticornia medullosa* (Samphire) low chenopod / samphire shrubland (which is not the preferred *Triodia* habitat of Night Parrot, but is considered the most suitable habitat for Night Parrot if they are present at the site). These habitats are represented by Vegetation Associations 1, 6, 11, 13, 15, and 20 in Figure 4-3. Noting that all of the Night Parrot survey locations occurred within or adjacent these habitats.

Numerous species of Bindyi or Copperburr (*Sclerolaena* genus) are found in the stony tableland community that dominates the Carrapateena project area. Species include *Sclerolaena intricata* (Tangled Copperburr), *S. ventricosa* (Salt Copperburr) and *S. divaricata* (Pale Povertybush). Recent dry conditions meant that foliage of these species contained little moisture at the time of survey, however the seeds are retained on the plants for long periods, so would provide a protein source for Night Parrots (and other species).

Figure 4-5: Bluff habitat, no *Triodia* present. Lake Torrens in the background.

5. Conclusion

5.1 Frankenia plicata

This targeted survey covered the proposed Carrapateena project footprint including mine infrastructure, pipeline alignments and access routes with a particular focus on habitats where this species has been historically recorded in the broader region. No *Frankenia plicata* was identified during this survey.

Frankenia plicata has rarely been recorded with less than 50 historical records from South Australia. The majority of the historic records are from the Breakaways closer to Coober Pedy nearly 300 km north west of the Carrapateena project area. Although there have been several records from the Arcoona Plateau between 40 and 50 km from the project area, there have been no records of this species since 1996 despite extensive flora surveys being conducted throughout the Carrapateena project area since 2007, including both spring and autumn surveys since 2012.

It is noted that most areas considered to be preferred habitat for *Frankenia plicata* within the project area are located near to stock dams as a result of the natural run-on features of the landscape in these locations, and these locations have been heavily impacted from livestock grazing which may contribute to the absence of the species in the areas surveyed.

Key points are as follows:

- Extensive flora surveys have been conducted across the site.
- Common species of *Frankenia* have been recorded throughout the site.
- A single population of a new common species of *Frankenia* was recorded during this survey, *Frankenia subteres.*
- Habitat that would be considered suitable for the species (e.g. areas with natural run-on) were heavily impacted by grazing.
- *Frankenia plicata* was not identified during this survey.

5.2 Night Parrot

This targeted survey covered the proposed Carrapateena project area, focusing on areas most likely to support extant population of Night Parrot. No Night Parrots, or evidence of Night Parrots, were observed during the survey.

There have been extensive flora and fauna surveys conducted across the Carrapateena site during prefeasibility studies, as for collection of robust baseline ecological data about the site and surrounds. Whilst Night Parrot was previously considered highly unlikely to occur at the site and was therefore not a specific focus of the surveys, the extensive presence of ecological survey teams at the site over a number of years (e.g. pre-feasiblity surveys in 2008, Autumn and Spring surveys 2012-2017) did not detect any presence of the night parrot (e.g. unusual calls, flushing of individuals, bright conspicuous feathers, unidentified low flying ground-dwelling birds during nocturnal searches). Similarly, habitat at the site is not considered optimal or to represent the preferred habitat of the species as there is no *Triodia* grasslands present and the vegetation across the site is impacted by historic grazing.

This targeted survey focused on water points, given the extensive survey effort in potential foraging habitat that has previously been undertaken, and given the warm weather during the survey period. In addition, whilst

Sclerolaena species were present during the survey which may represent a water source for Night Parrots, the leaves and immature fruits were dry and contained little moisture, similar to most vegetation present. It was therefore considered likely that if Night Parrots were present they would be relying on surface water sources to supplement their water needs during the survey period. The survey identified a lack of preferred roosting or breeding habitat, and no evidence was detected of the Night Parrot in the form of calls, feathers, unidentified ground-dwelling low flying birds or unidentified calls. Whilst it is possible that the elusive species does occurs at the site, it is considered very unlikely. If it is present, it persists in a pastoral environment with historic grazing impacts, coupled with a human presence as early mine related studies and activities are ongoing. This differs to recent confirmed locations of extant Night Parrot populations (Qld and WA) which were located within pristine undisturbed environments. Any individuals that may occur could move across the vast expanses of similar 'non-preferred' habitat which is present broadly across the region. It is considered valid that the site commits to reporting any future observations or evidence that may be detected as part of ongoing activities or monitoring.

Key points are as follows:

- No patches of known breeding / roosting habitat occur across the project area (e.g. Spinifex grassland)
- Whilst Samphire (known foraging habitat) and Chenopod shrubland occurs broadly across the site, the site is grazed by Dorper Sheep (in some instances heavily), with other grazers present (Red and Euro Kangaroo, Rabbits, Goats). Hence the diversity and condition of the shrubland is not in pristine condition and would not constitute core foraging habitat for the species, but rather supplementary / refuge habitat within a vast landscape of available habitat across arid SA (refer Figure 2-5).
- The site comprises vast amounts of potential foraging habitat when certain species are available in fruit (e.g. common *Sclerolaena, Atriplex,* Samphire spp.*)*
- The species is highly secretive / elusive, and has existed undetected in Australia for over 30 years, and the last record in SA (prior to the feather of 2017), being 1980 approximately 450 km north-northeast of the project site in pristine remote habitat.
- The species may be nomadic and appear in areas following decent rains, but may also be sedentary in areas with preferred roosting and nesting / breeding habitat and high floristic diversity.
- If present, Night Parrots are active at night and persist despite existing levels of activity at the site (e.g. grazing present, human presence as a result of ongoing mine related studies and activities, including lights, presence of vehicles and regular trucks).
- The targeted survey was undertaken at the right time of year (e.g. in early Autumn, following large rainfall over summer, potential for opportunistic breeding event and greater potential for detection). There was evidence that other arid-zone species had exhibited opportunistic breeding events following rainfall of preceding months with aA number of other avian families present with juveniles or in breeding plumage / pairs).
- The targeted Survey detected a range of nocturnal / diurnal fauna by observation (e.g. Spotted Nightjar, Common Bronzewing, Stubble Quail – all silent) and calls (e.g. Pink-eared Duck, Black-fronted Dotterel, Grebes, Willie-wagtail, Coots).
- Previous extensive surveys at the site have not detected the species.
- Whilst presence cannot be entirely ruled out, it is considered highly unlikely that a core population exists and is reliant on habitat present at the site, particularly given the condition of the habitat at the site, relative to vast amounts of suitable habitat in nature reserves north of the site.

5.3 Closing Statement

Neither *Frankenia plicata* or the Night Parrot (*Frankenia plicata*) was identified during the targeted survey across the Carrapateena project area. Based on the survey results, it is considered very unlikely that either species occurs at the site. This survey meets Conditions 6 and 8 of the EPBC referral approval. Given that neither

species was identified on site, Conditions 7 and 9 of the EPBC approval (development of management plans for the species) are not required.

It is noted that OZ Minerals have committed to Condition 28.3 of the Mine Lease (6471) for the operation which includes reporting to relevant authorities of any observations of the Night Parrot collected during regular site activities and ongoing compliance ecological monitoring. Biannual monitoring for fauna at the site will therefore include opportunistic Night Parrot records during any spotlighting undertaken in potential foraging habitats or opportunistically at watering points. This would be undertaken prior to call play-back for other Nocturnal species at the times where greater detection is likely i.e. pre-dawn and post dusk.

6. References

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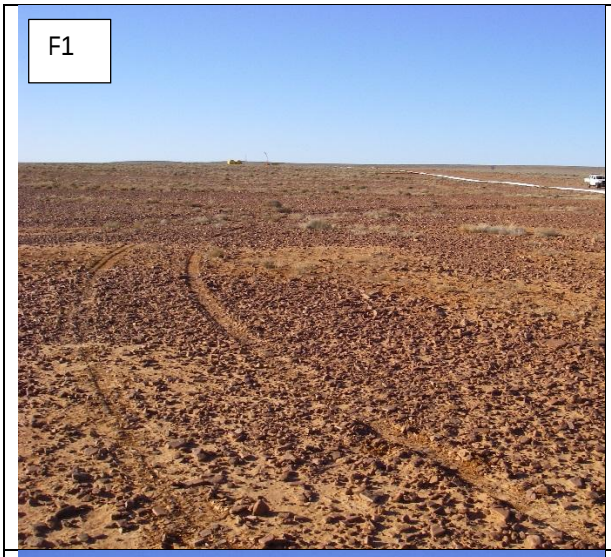
Appendix A. Habitat and *Frankenia* photo log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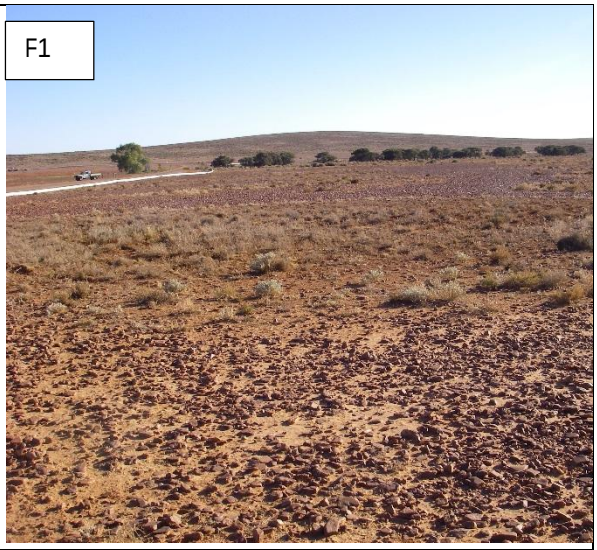
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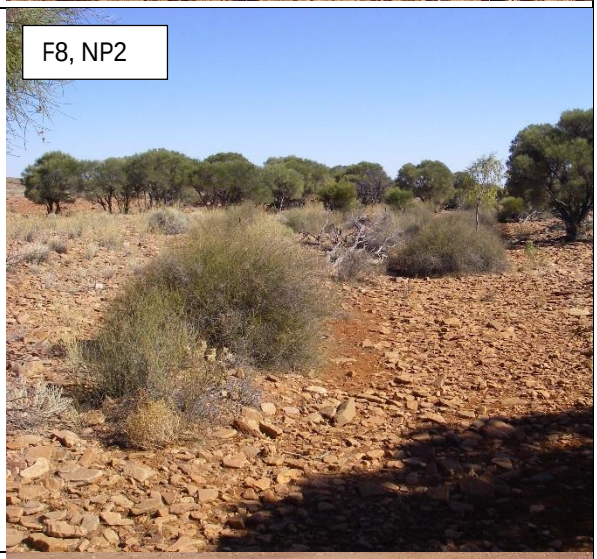
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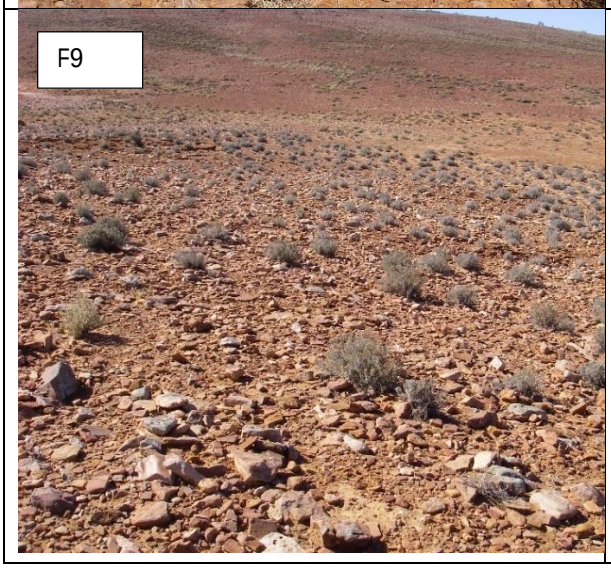
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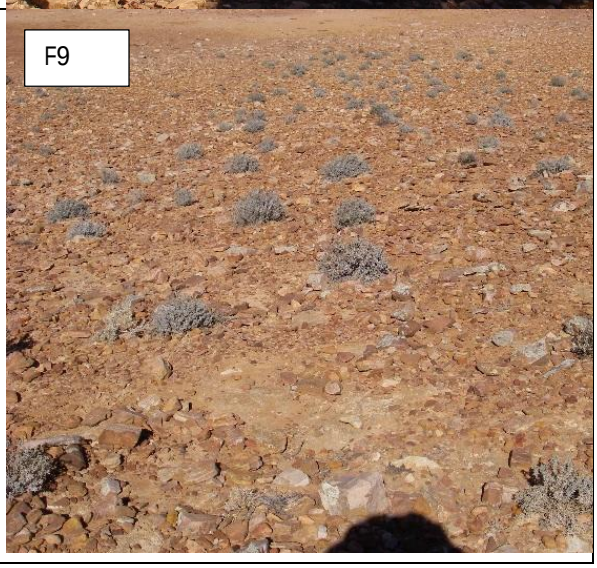
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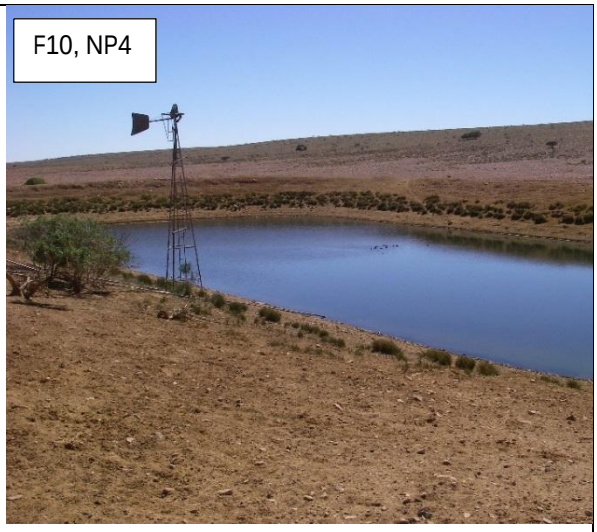
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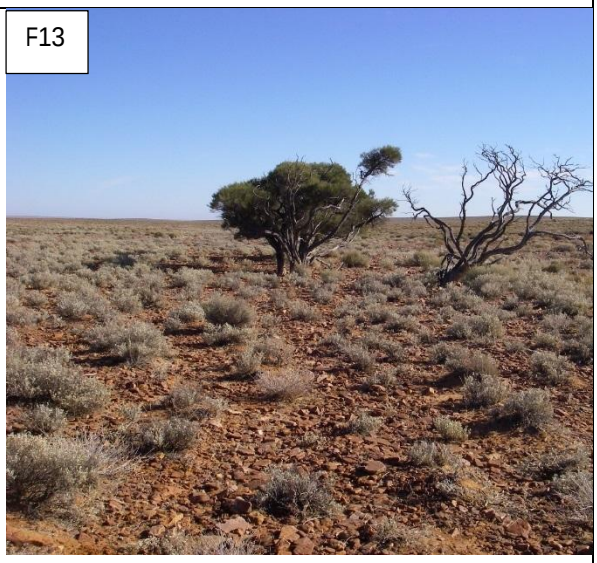
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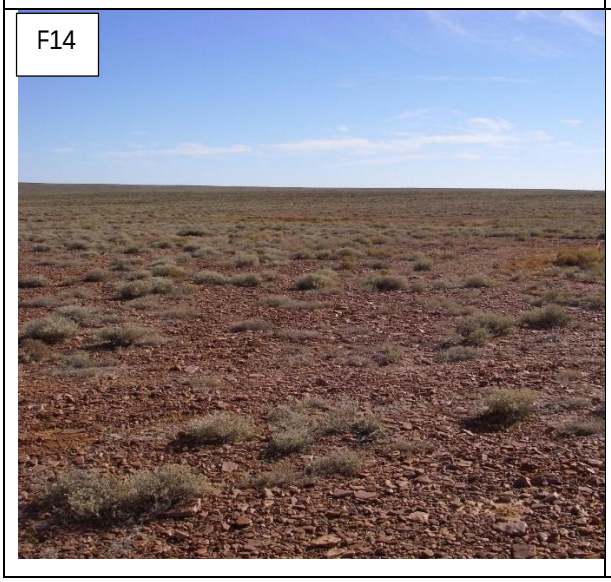
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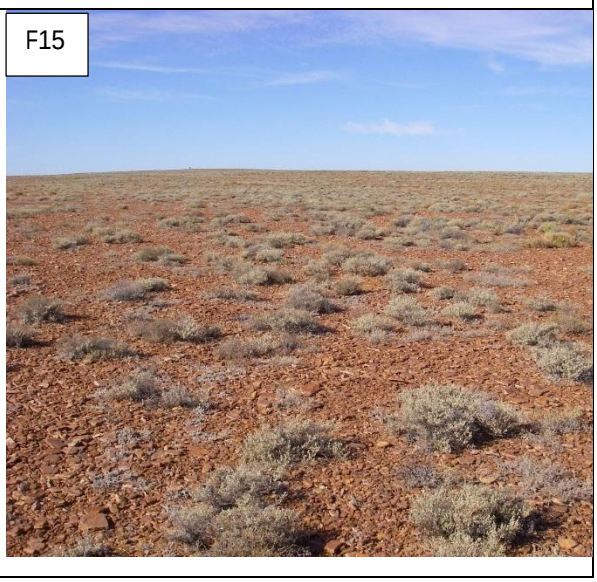
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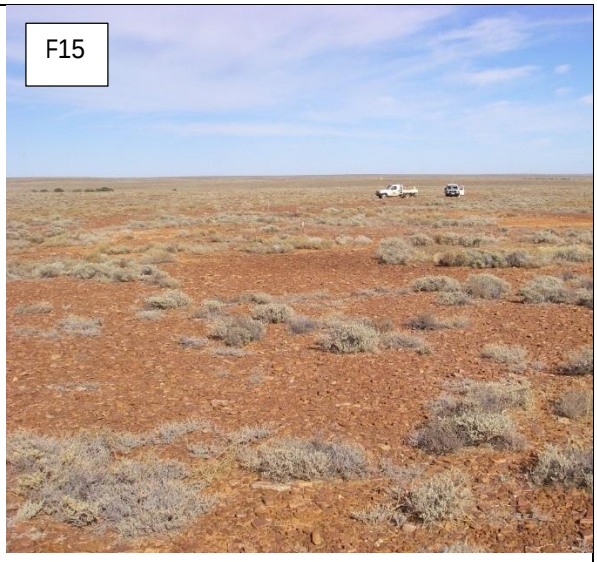
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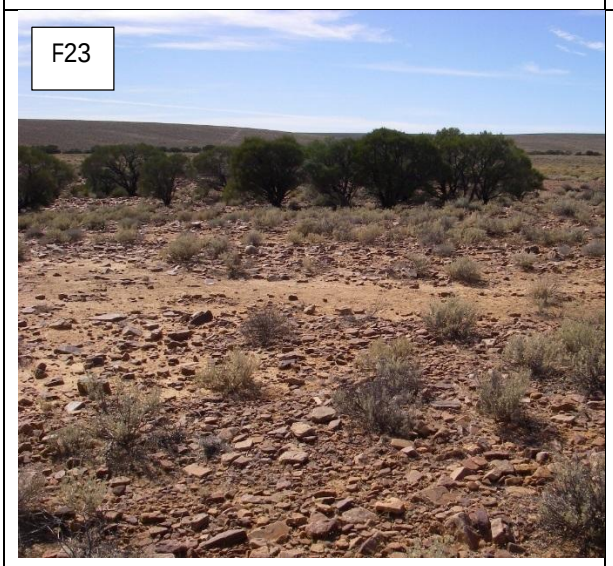
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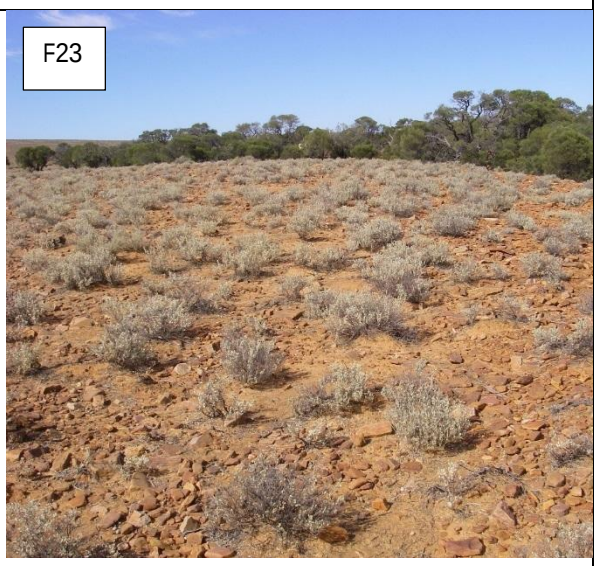
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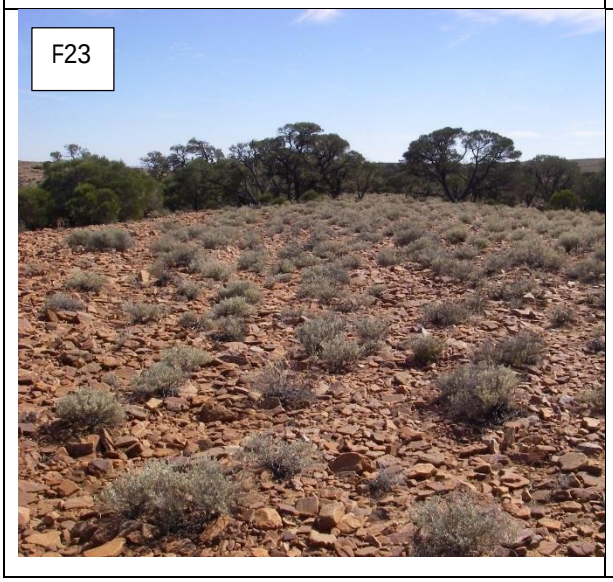
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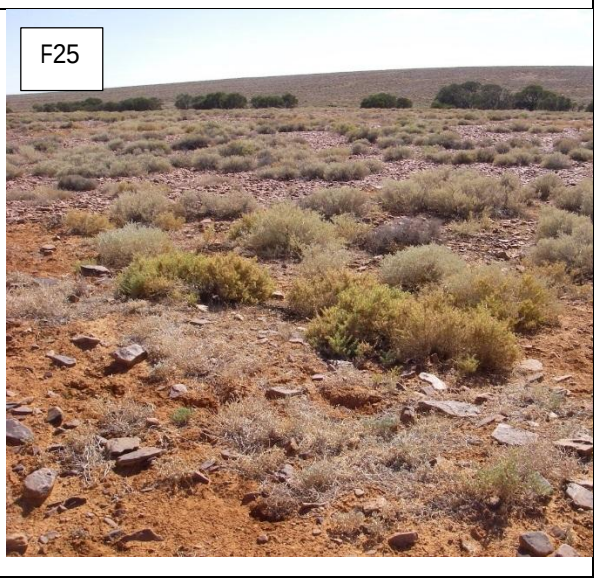
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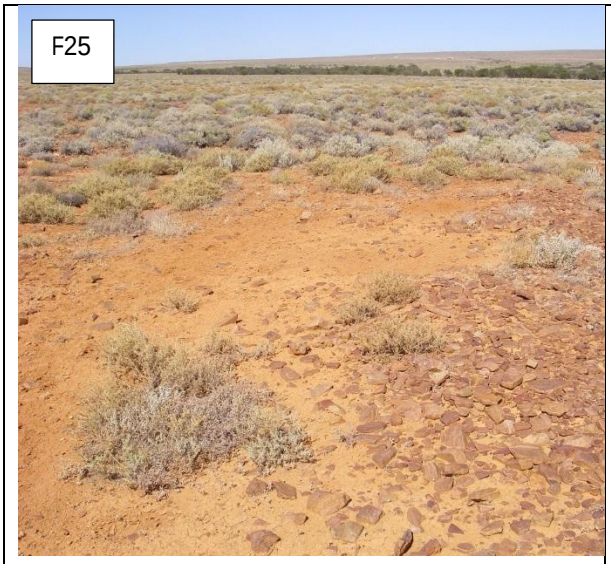
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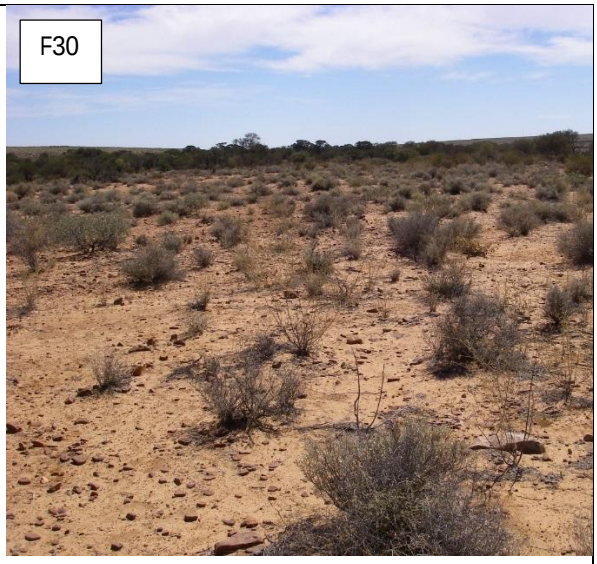
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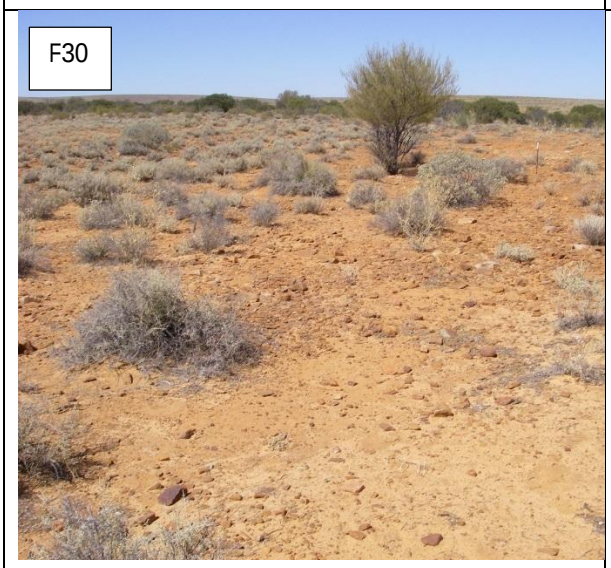
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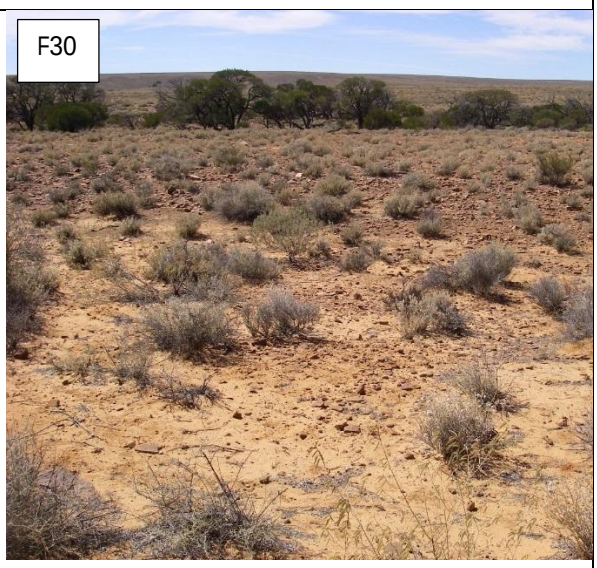
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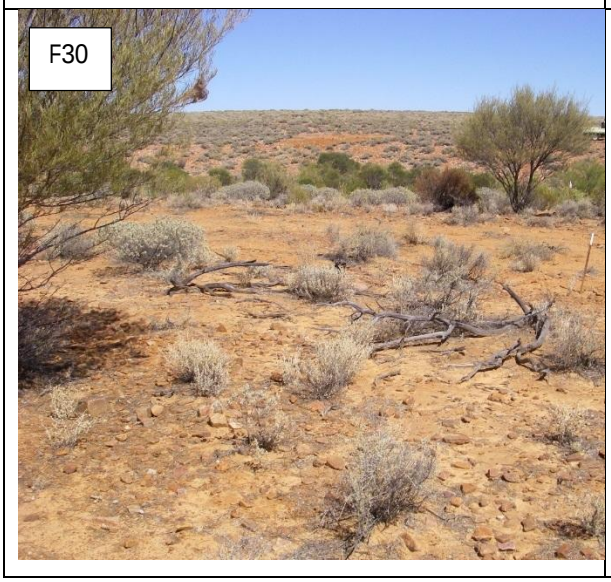
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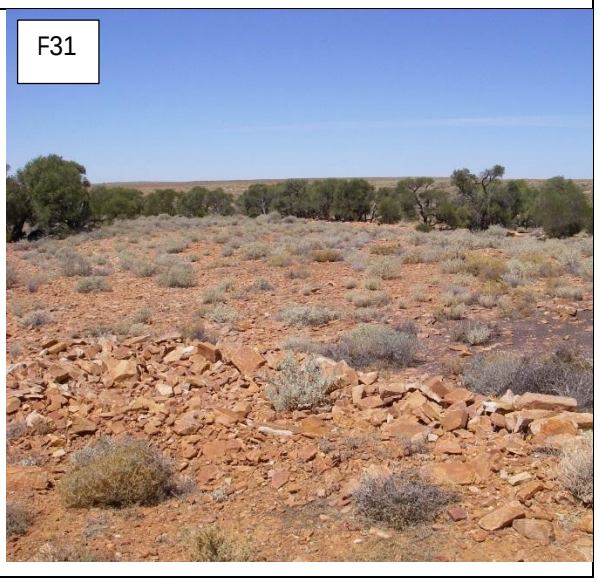
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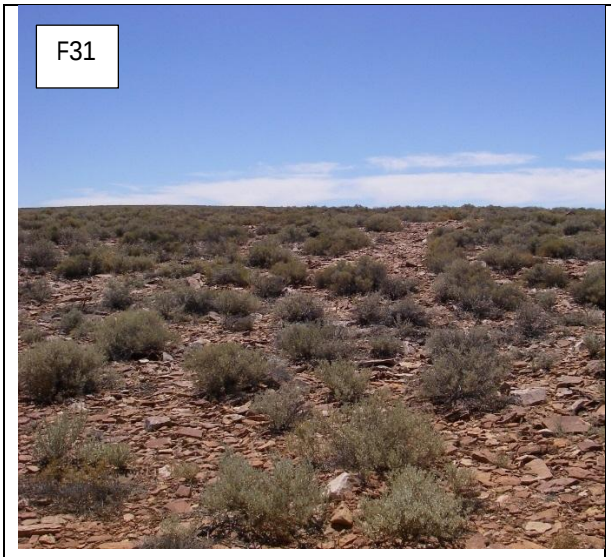
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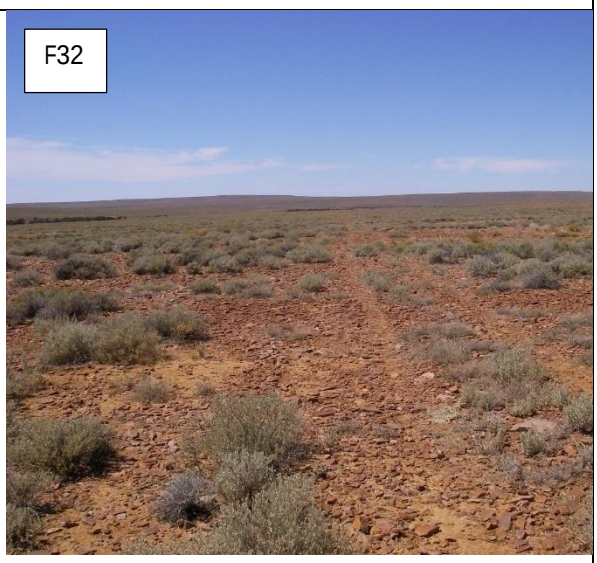
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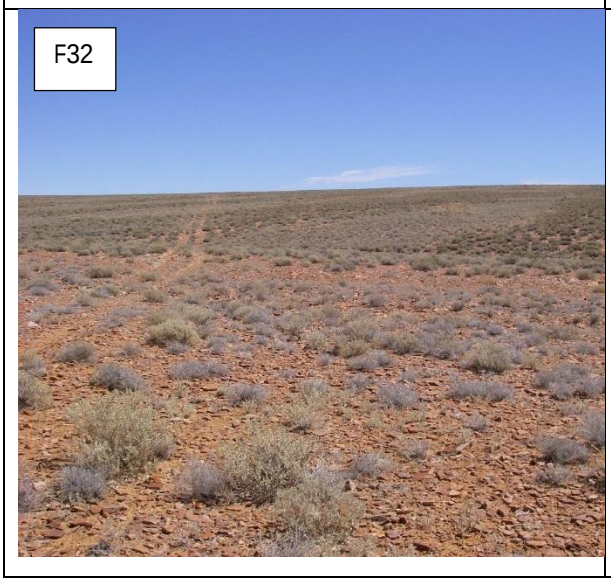
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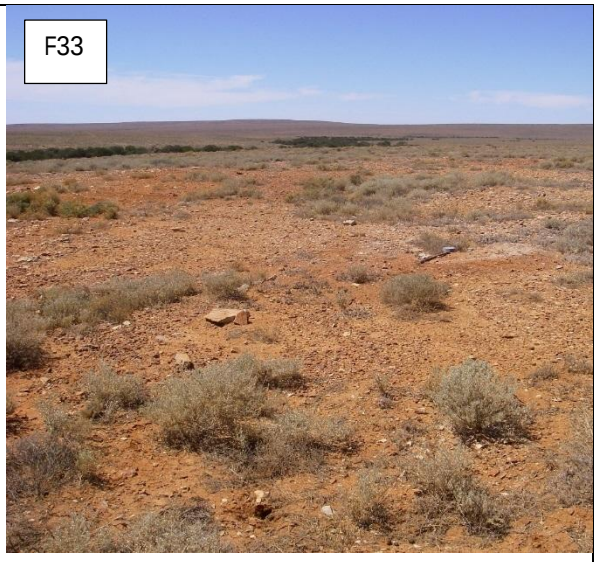
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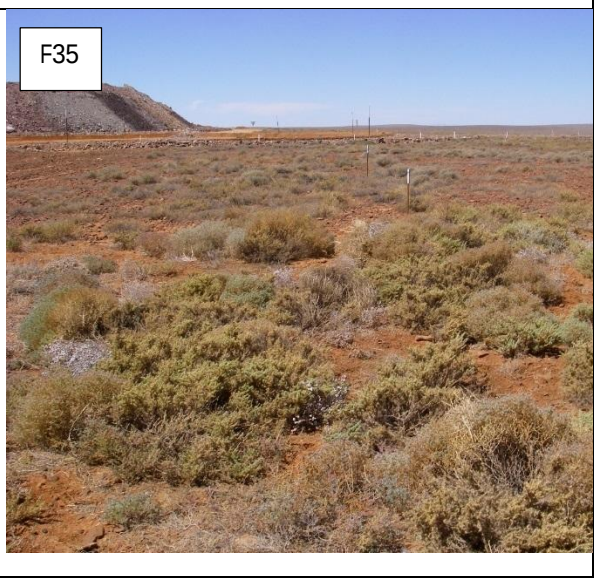
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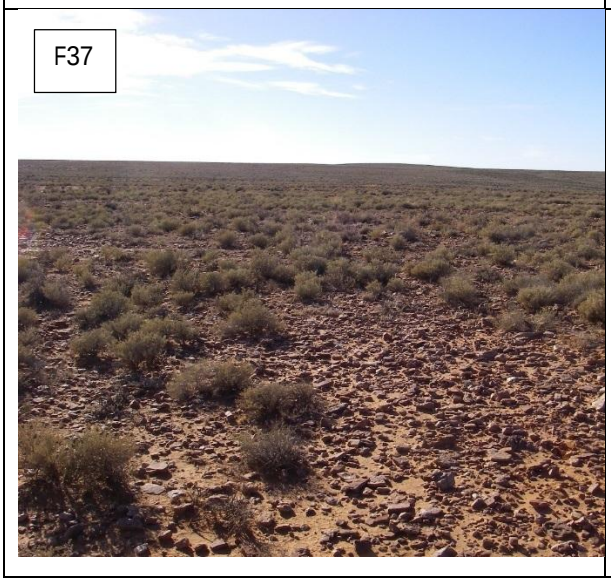

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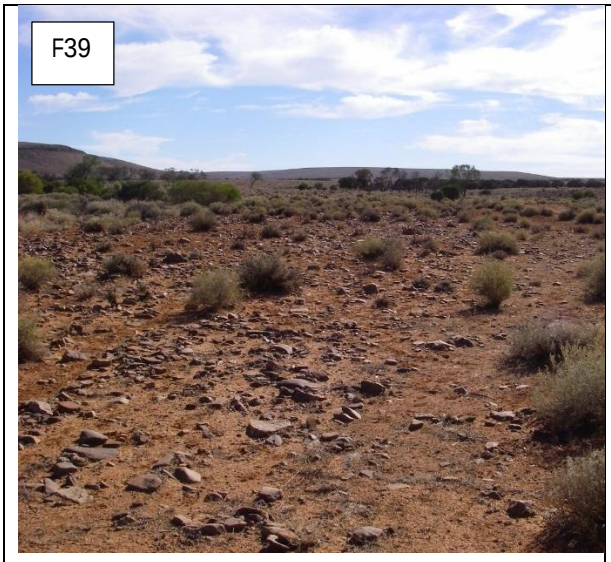
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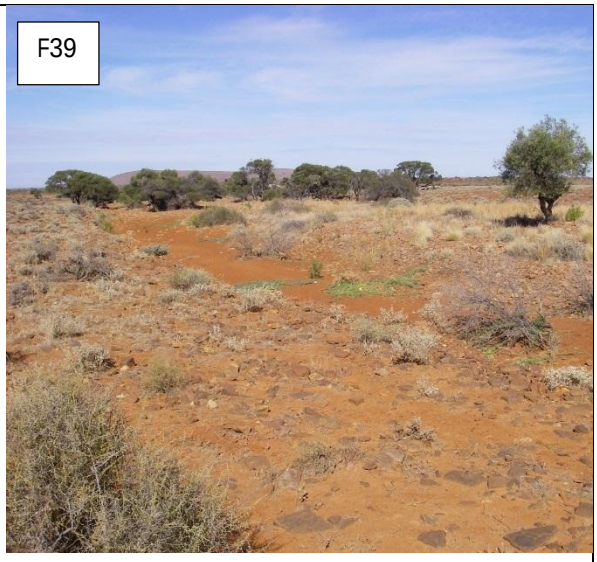
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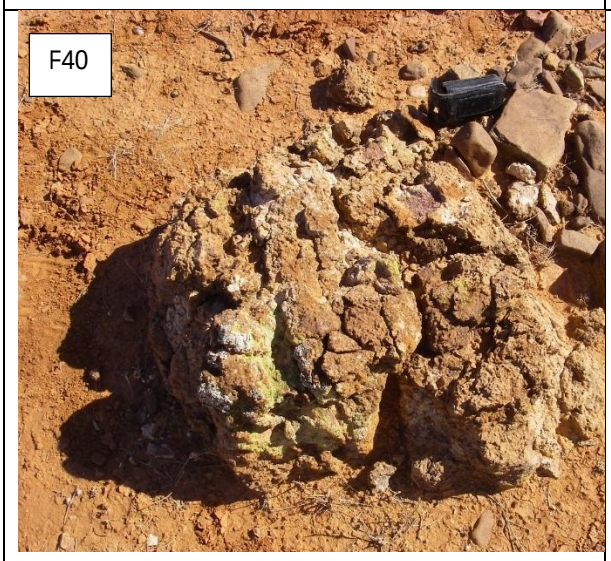
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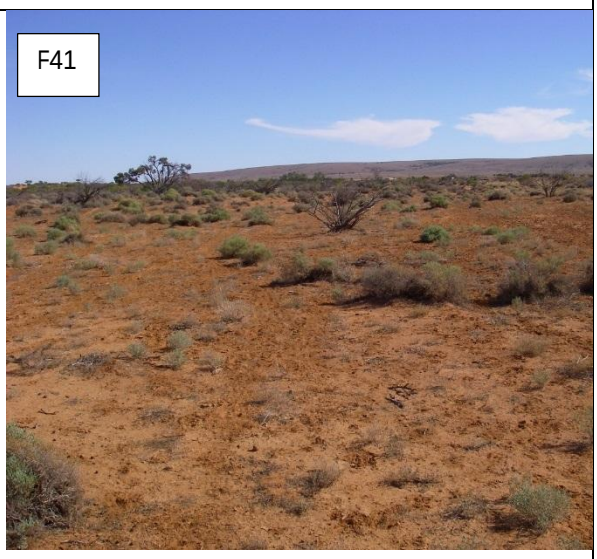
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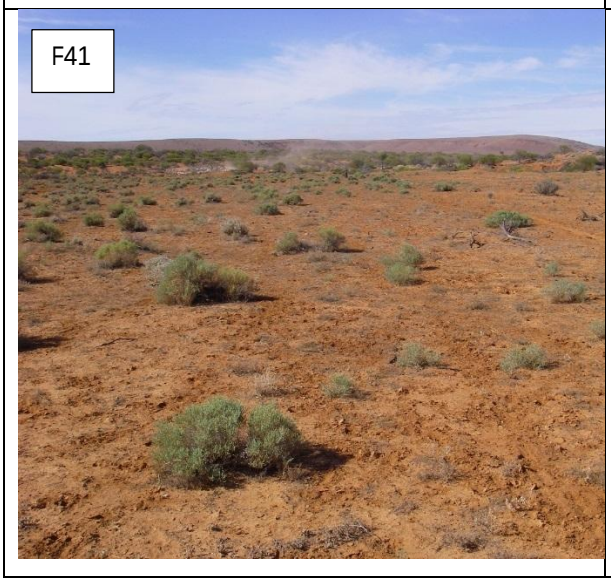
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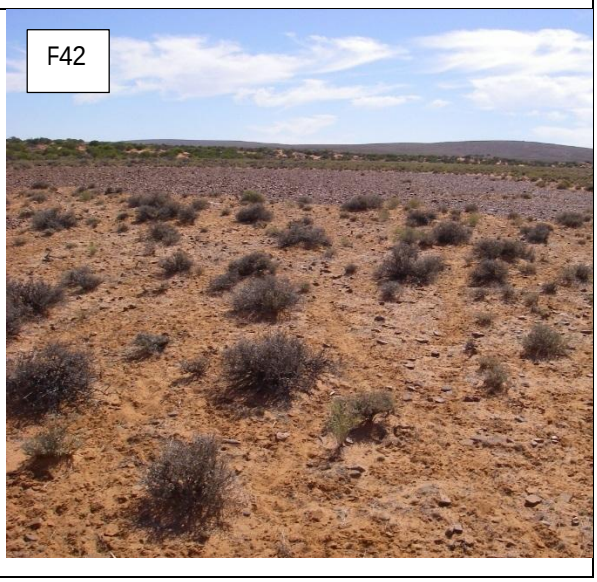
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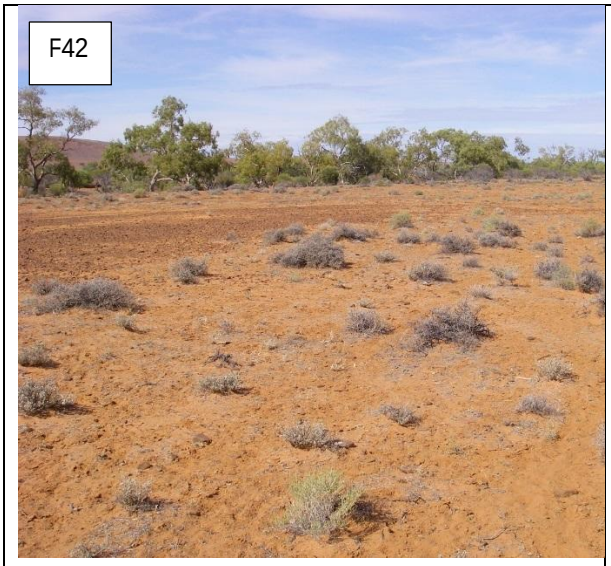
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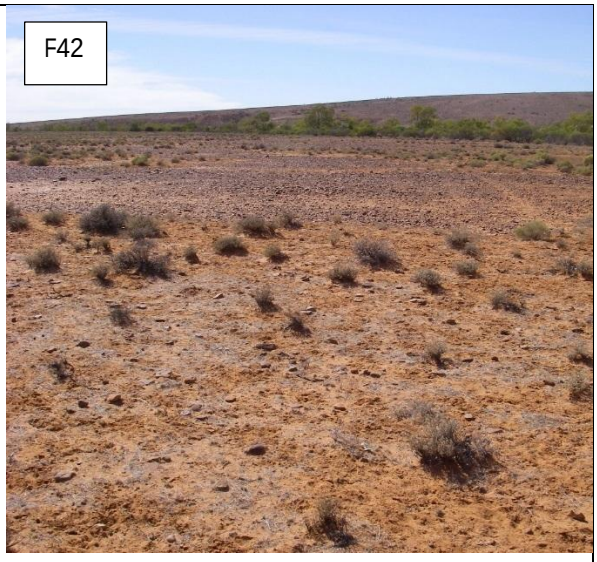
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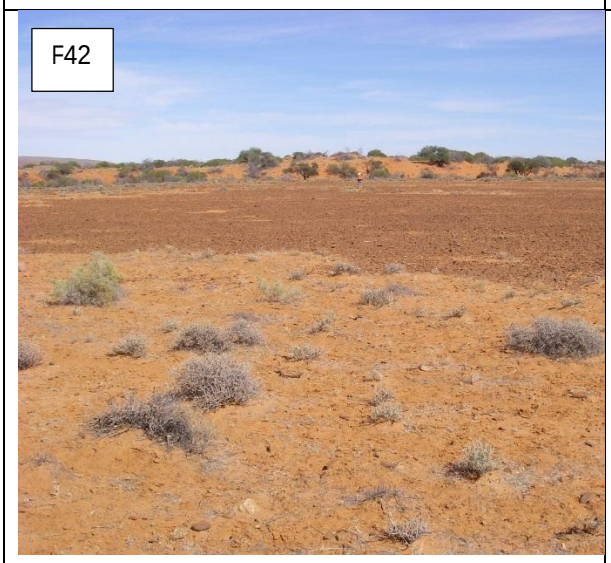
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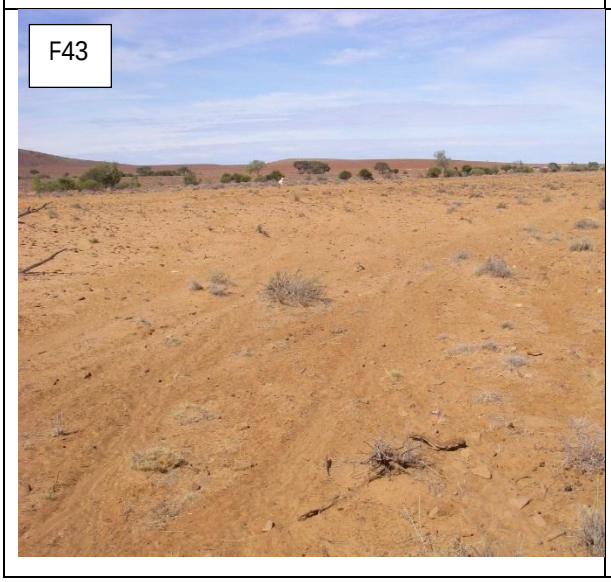
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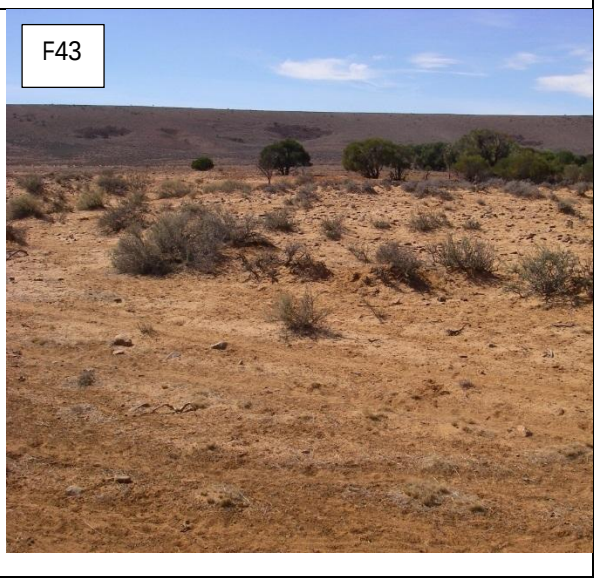
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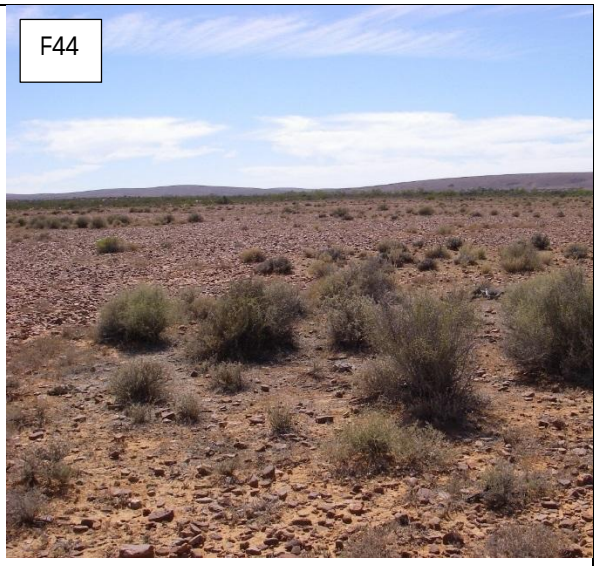
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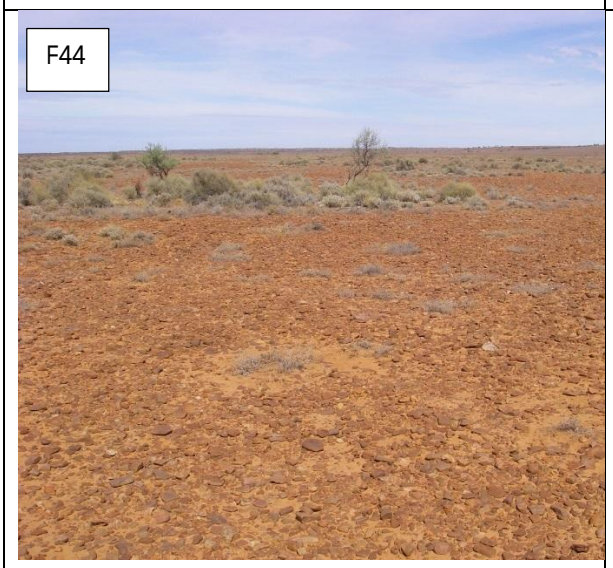
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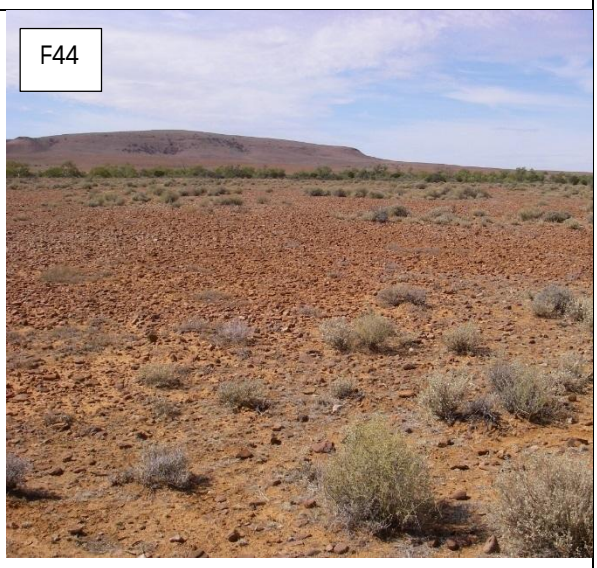
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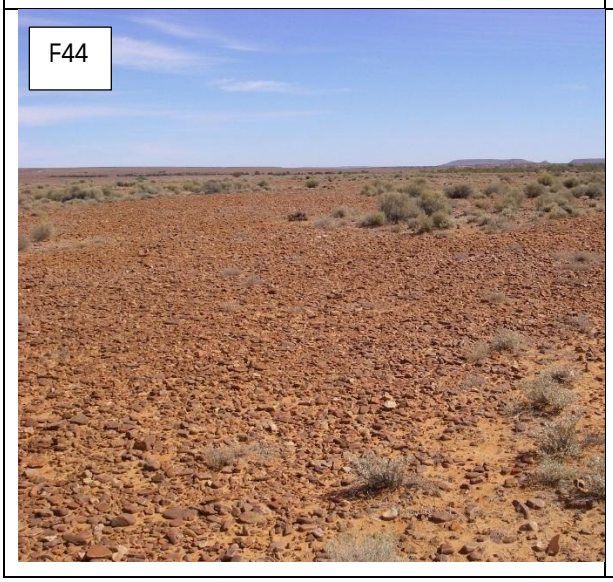
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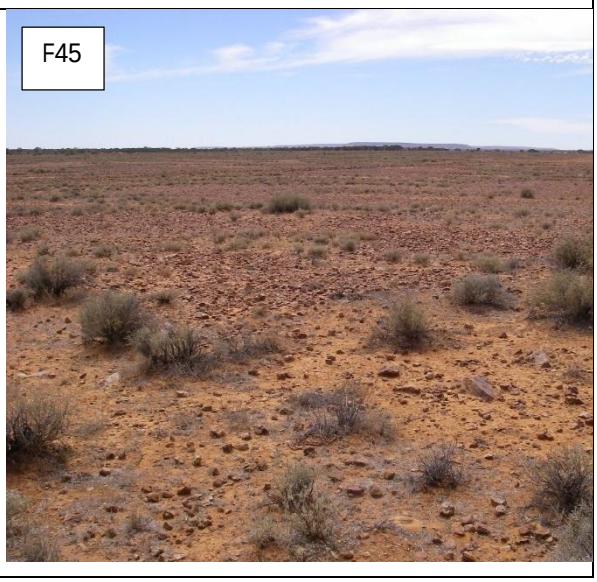
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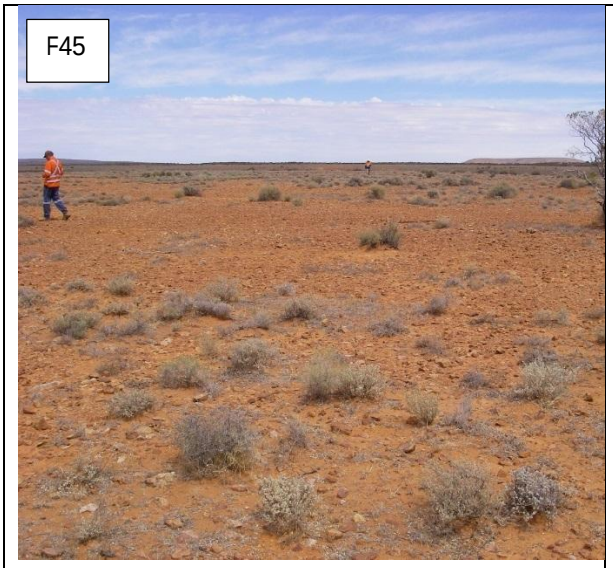

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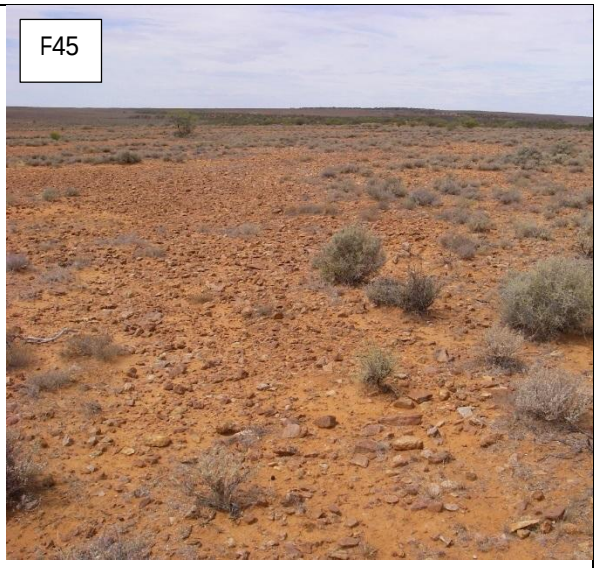

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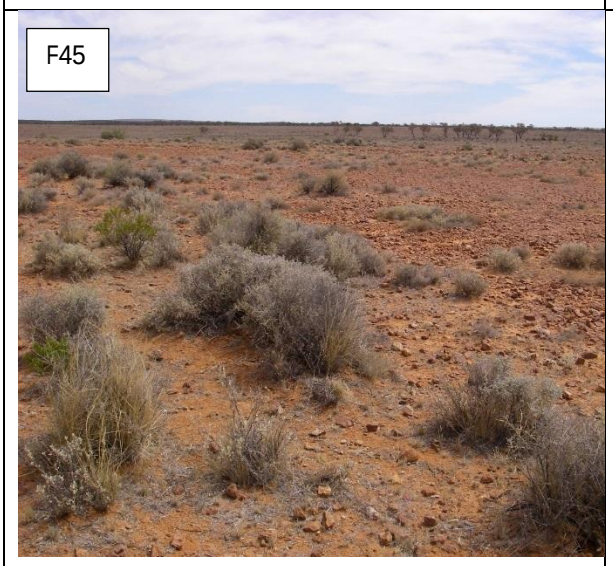

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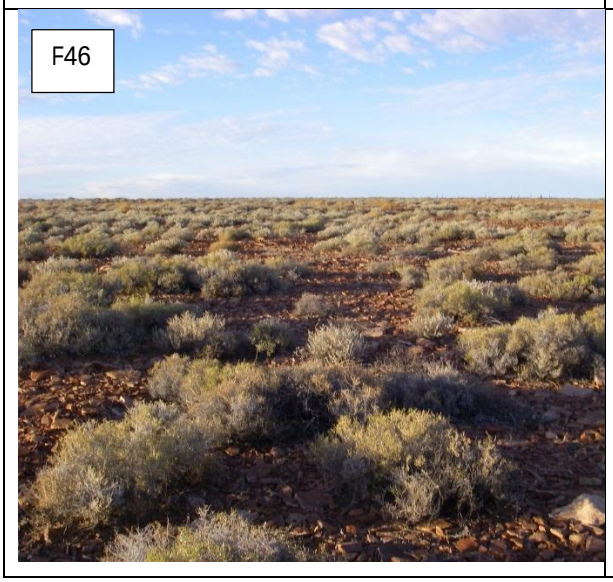

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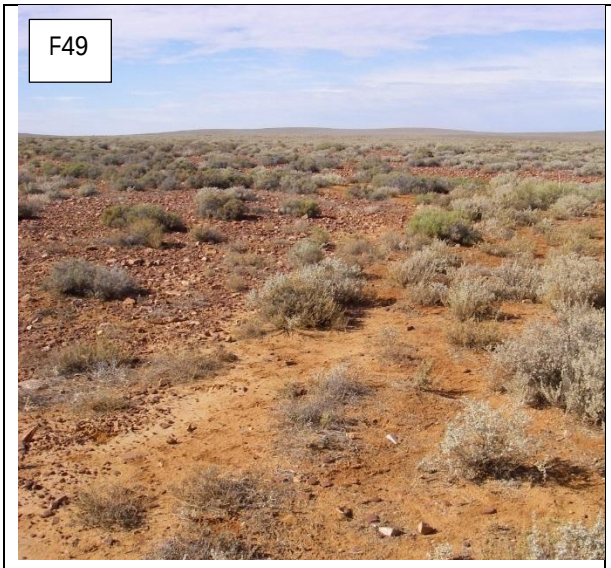

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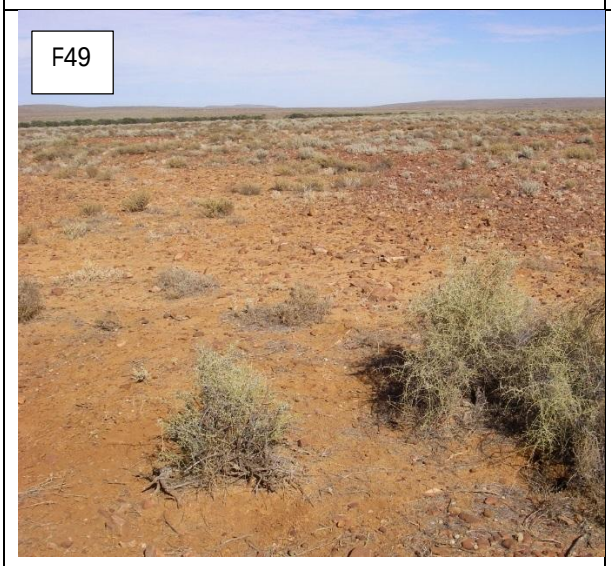

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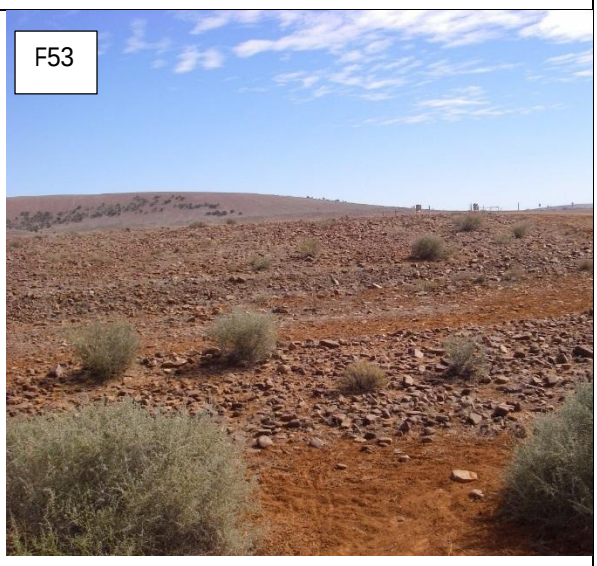

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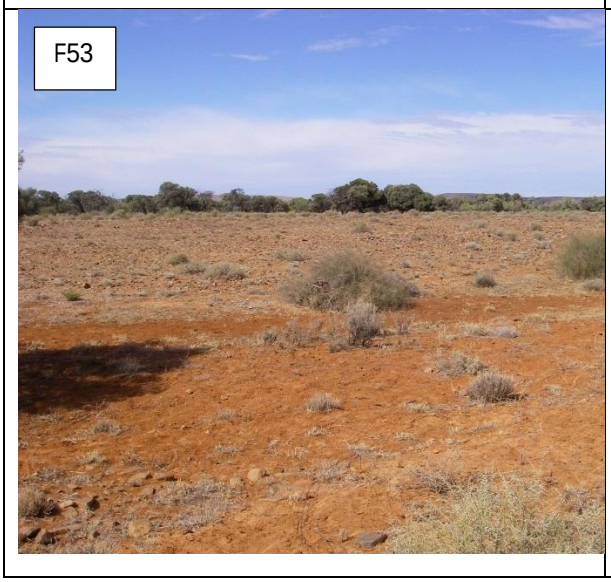

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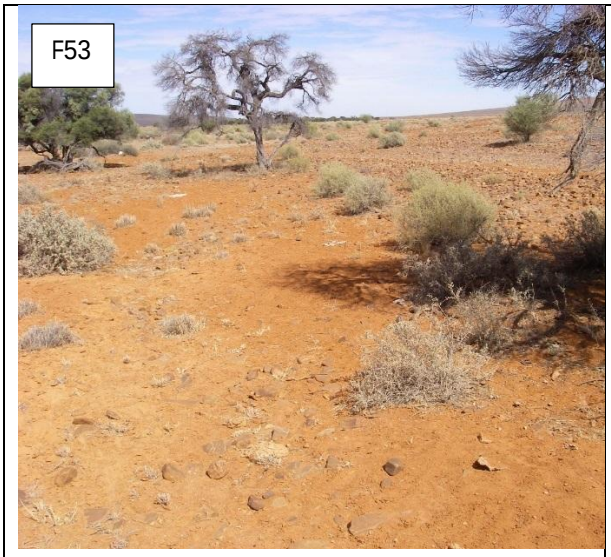
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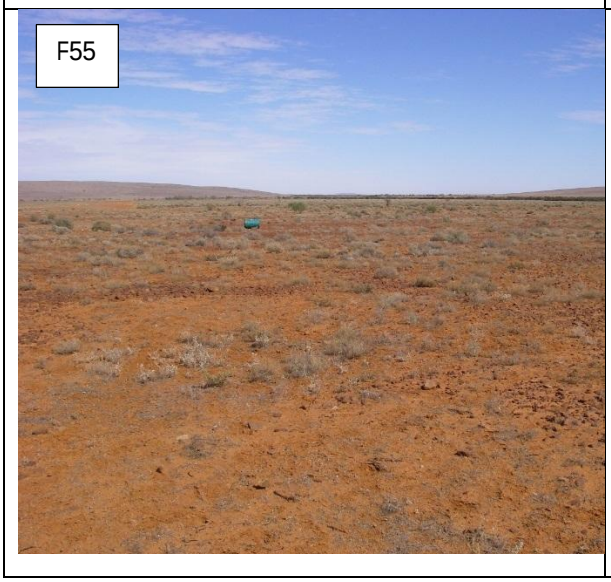
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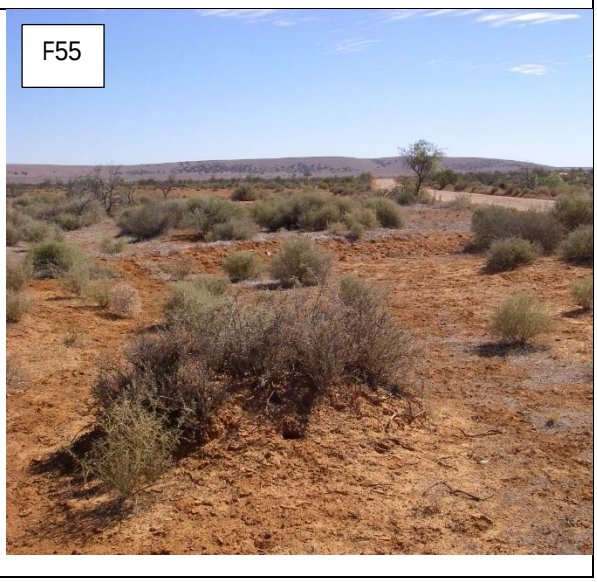
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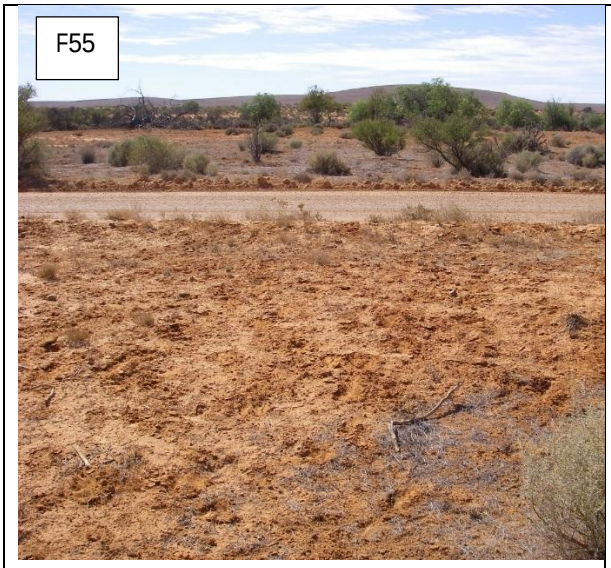
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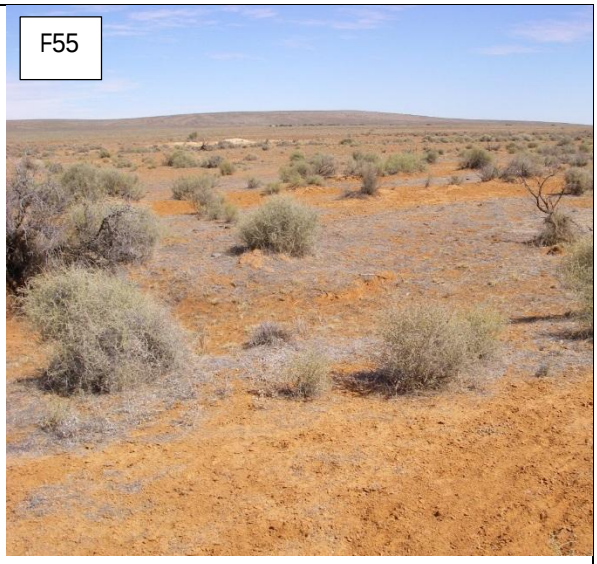
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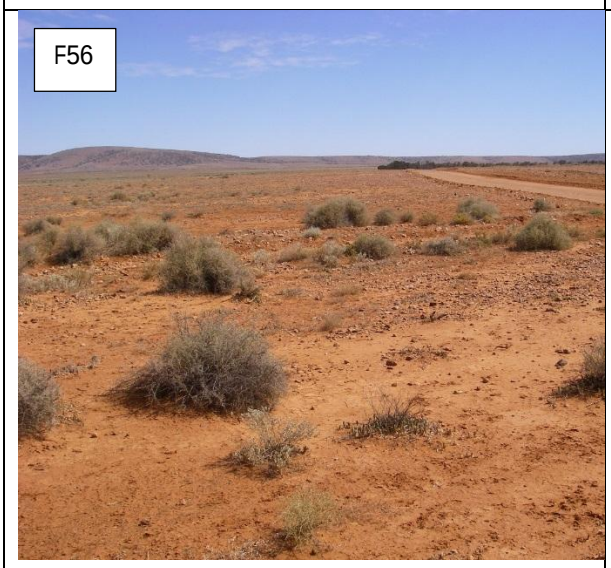
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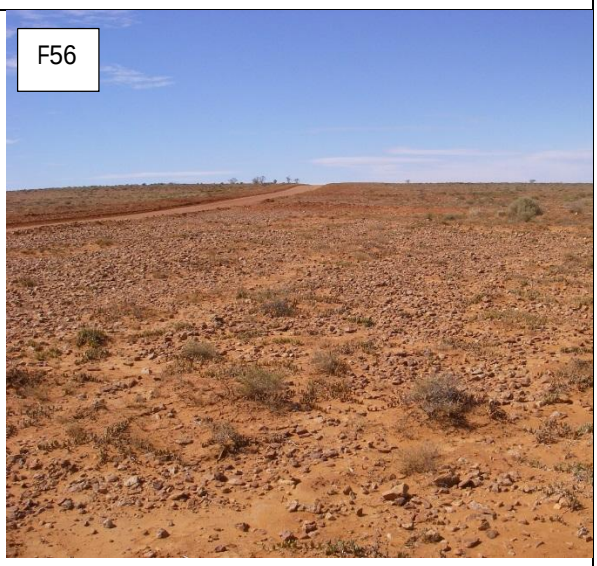
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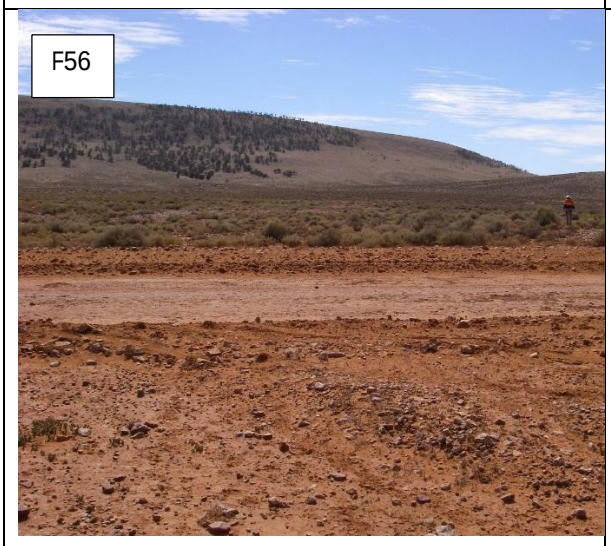
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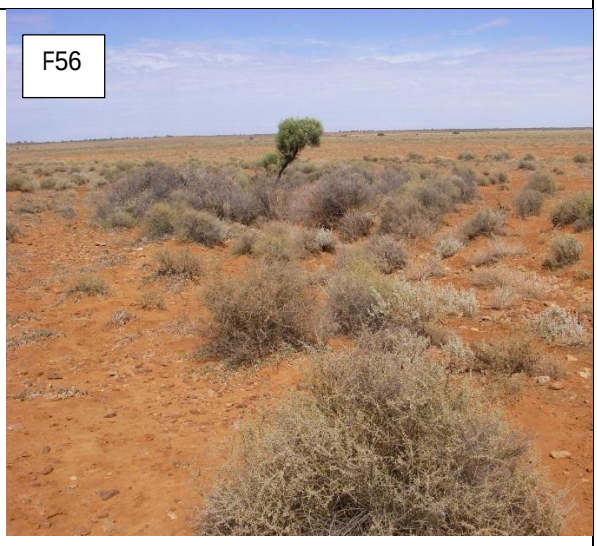
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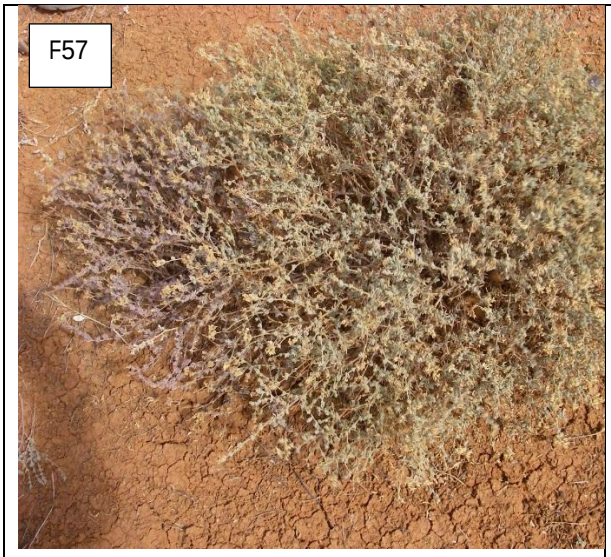
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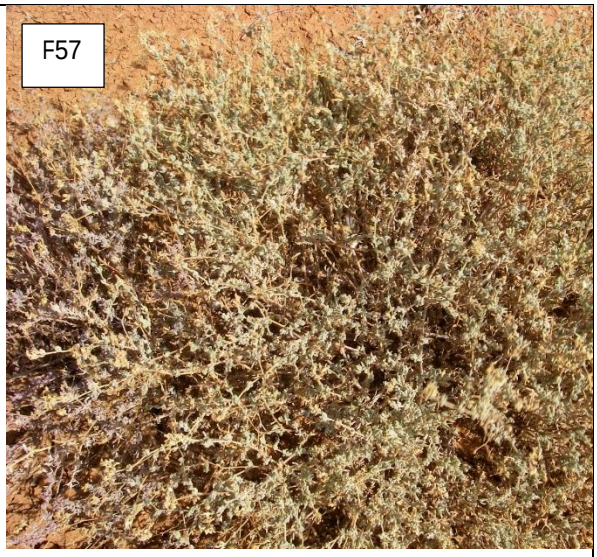
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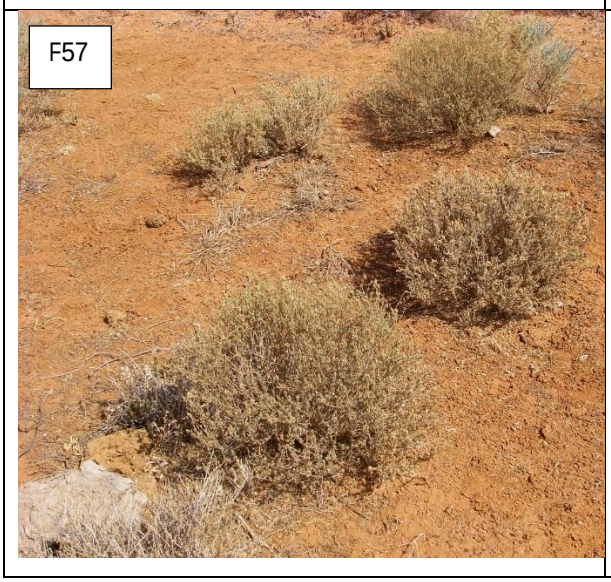

F57

Appendix B. Active feather searches / nest searches

Site NP1 / 2 (F7 / F8), feather and nest searches

Site NP1 / 2 (F7 / F8), feather and nest searches

Site NP3 Feathers (no Night Parrot)

Site NP3 Feathers (no Night Parrot)

Site NP4 Feather / nest search

Site NP4 Feather / nest search

NP6 Feather search, no Night Parrot

NP6 Feather search, no Night Parrot

	NP8 Search for Finch nests / NP feathers in Eliza creek
	NP12 Wedge-tailed Eagle Nest and Raptor nest in River Red Gum, Eliza Creek South. Nankeen Kestrel flew overhead. Juvenile Variegated Fairy-wrens also observed here.
NP15 Wedge-tailed Eagle nest in Callitris, Elizabeth Creek	NP15 Wedge-tailed Eagle nest in Callitris, Elizabeth Creek

South	South
NP 16 Wedge-tailed Eagle nest in old Western Myall. No Finch nests.	NP 16 Wedge-tailed Eagle nest in old Western Myall. No Finch nests.
NP17 Wedge-tailed Eagle Nest in River Red Gum Yeltacowie Creek	NP17 Wedge-tailed Eagle Nest in River Red Gum Yeltacowie Creek

Appendix C. Night Parrot Survey Points

Easting	Northing	Night Parrot Survey Point	Description
0742088	6535211	NP1	Night Parrot, Myall creek Finch nest / feather search
0742681	6536024	NP2	Night Parrot, Myall creek Finch nest / feather search
0743697	6538696	NP3	Night Parrot Anzac Dam, Finch nest search, evening and morning passive observation and listening, feather search
0740539	6541944	NP4	Night Parrot, Red gum creek Finch nest / feather search
0741754	6547677	NP5	Sth of Nth Eliza Dam Finch nest / Night Parrot feather search
0741648	6547735	NP6	Nth Eliza Dam and catch, evening and morning observations / passive listening, feather search, bird photos, coffer dam
0735715	6540998	NP7	Dawsons Dam, evening and morning observations / passive listening, feather search
0739268	6535684	NP8	Search along creek for Finch nests / NP feathers
0739152	6535710	NP9	Search along creek for Finch nests / NP feathers
0738610	6535349	NP10	Search along creek for Finch nests / NP feathers
0738847	6535949	NP11	Search along creek for Finch nests / NP feathers
0739983	6541064	NP12	WTE nest, raptor nests (Red Gum), Nankeen Kestrel flying over
0717880	6527960	NP13	Bonney Bluff, habitat search for *Triodia* – none present
0718090	6527628	NP14	Bonney Bluff top, similar to Euro bluff - habitat search for Triodia - none present
0710568	6529244	NP15	WTE nest *Callitris* glauca NP feather search, Elizabeth Creek south
0714928	6529488	NP16	WTE nest in old Myall no Finch nests - western infrastructure corridor
0725974	6529081	NP17	WTE nest in Yeltacowie Ck Red Gum, white feather – no NP
0743455	6536898	NP18	Passive listening / observation foraging habitat (loop from NP3 to NP18)
0740517	6541877.993	NP19	Eliza creek nest / feather search
0710568	6529244	NP15	WTE nest Callitris glauca NP feather search, Elizabeth Creek south
0714928	6529488	NP16	wedgy nest in old myall no finch nests - western infra corridor
0725974	6529081	NP17	eagle nest in Yeltacowie Ck red gum, white feather

APPENDIX C RANGELANDS ASSESSMENT SCORESHEETS

Appendix C1. Carrapateena Clearance RAM sheets (for clearance post 1 July 2017)

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Radial Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	29/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	2
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.03

Size of the Block	6000
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.06

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	No
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0

Note; Blocks will score a minimum Landscape Context Score of 1

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.14**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is 2, <50% is 1, and 0 is 0)			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	0	2	1	Mixed	16.90
Tecticornia medullosa	0	P	2	1	0	Mixed	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	Carra 23	**SIZE OF SITE (Ha)**	20.45
VEGETATION ASSOCIATION DESCRIPTION	Atriplex vesicaria/Tecticornia medullosa low open shrubland		
LANDSCAPE TYPE	Plain – undulating		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☑	☐	1
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**9**

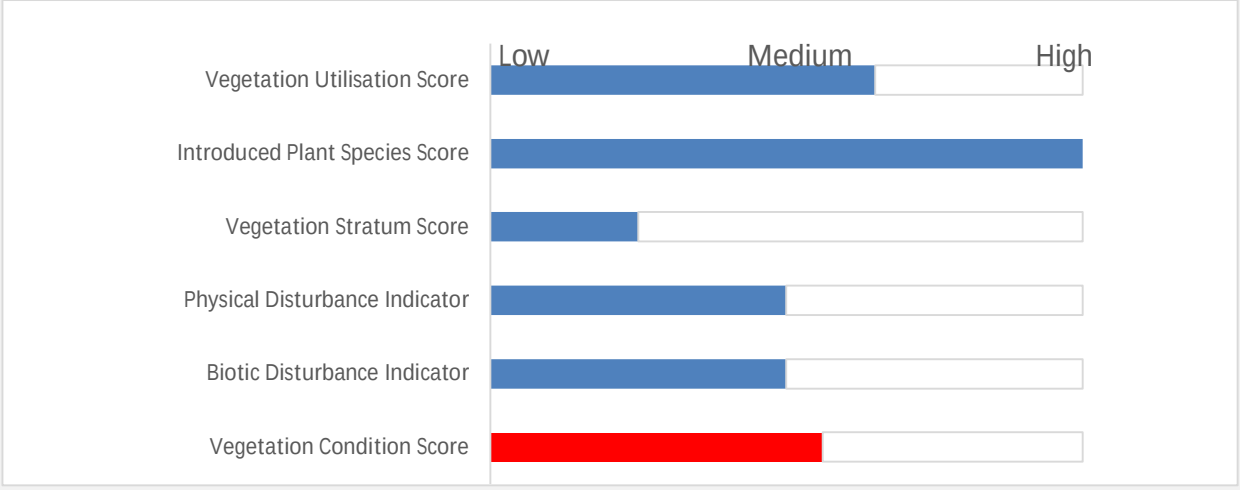
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☐	☐	
Total Score (Max 16 - weighted by 4)			**4**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
Total Score (Max 10 - weighted by 2.5)		**10**

Vegetation Utilisation Score	
Total Score (Max 26)	16.90

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**44.90**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.14**
VEGETATION CONDITION SCORE	**44.90**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	55.28
Total Biodiversity Score (Biodiversity Score x hectares)	1130.49

Photo Point and Vegetation Survey Location

Direction of the Photo	
north	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	742589
Northing (7 digits)	6535956
Description	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0	**SEB Points required**	1187.02
Loadings for clearance of protected areas		Hectares required	148.38
Reductions for rehabilitation of impact site		Mean Annual rainfall for the site (mm)	
SEB Points of loss	**1130.49**	Payment into the fund (GST Exclusive)	**$0.00**
		Administration fee (GST Inclusive)	**$0.00**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Radial Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	29/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	2
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.03

Size of the Block	6000
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.06

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	Yes
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	No
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.08

Note; Blocks will score a minimum Landscape Context Score of 1

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.22**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is 2, <50% is 1, and 0 is 0)			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	0	2	1	Mixed	11.62
Acacia papyrocarpa	Western Myall	HP	0	2	1	Mixed	
Duma florulenta	Lignum	P	2	1		Adult	
Acacia tetragonophylla	Dead Finish	P	2	1		Mixed	
Enchylaena tomentosa	Ruby Saltbush	P	1	2		Mixed	
Ptilotus obovatus	Silver Mulla Mulla	P		1	2	Mixed	
Rhagodia spinescens	Spiny Saltbush	P		2	1	Mixed	
Casuarina pauper	Black Oak	P		1	2	Adult	
Lycium australe	Australian Boxthorn	U		2	1	Adult	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Stictonetta naevosa	Freckled Duck		V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	Carra 24	**SIZE OF SITE (Ha)**	0.01
VEGETATION ASSOCIATION DESCRIPTION	Acacia papyrocarpa low open woodland		
LANDSCAPE TYPE	Drainage lines / floodouts		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☑	☐	☐	2
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☑	☐	☐	2
	Total Score (Max 10 - weighted by 2.5)			**10**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☐	☑	☐	1
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**15**

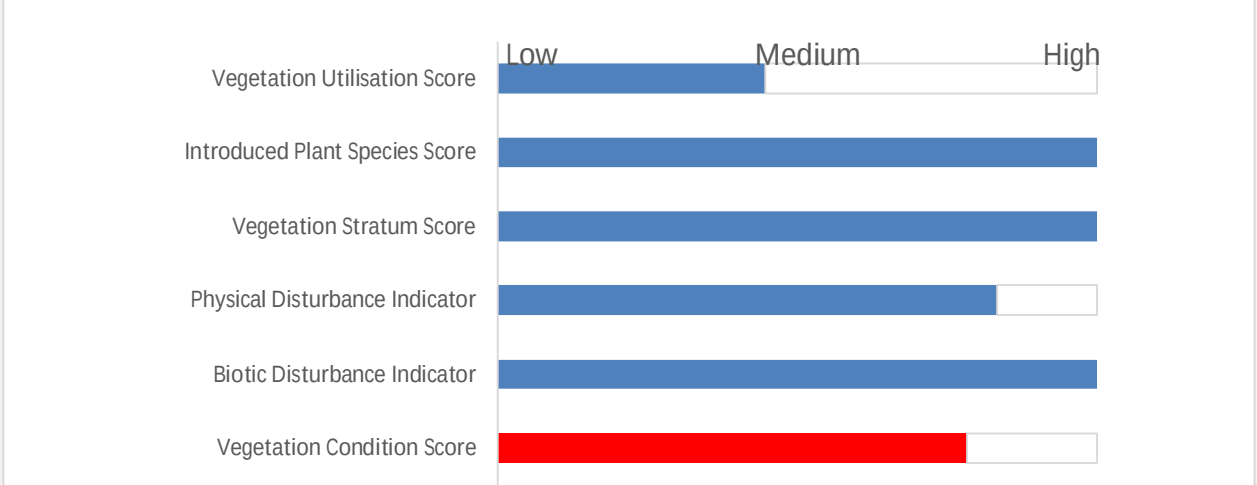
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☑	☐	
Shrubs 1- 3m	☑	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
Total Score (Max 16 - weighted by 4)			**16**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
Total Score (Max 10 - weighted by 2.5)		**10**

Vegetation Utilisation Score	
Total Score (Max 26)	11.62

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**62.62**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	2
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**7**
Score	0.06
CONSERVATION SIGNIFICANCE SCORE	**1.06**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.22**
VEGETATION CONDITION SCORE	**62.62**
CONSERVATION SIGNIFICANCE SCORE	**1.06**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	80.98
Total Biodiversity Score (Biodiversity Score x hectares)	0.81

Photo Point and Vegetation Survey Location

Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	742682
Northing (7 digits)	6535957
Description	
in drainage line: southern-most extent of spill	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**0.81**

SEB Points required	0.85
Hectares required	0.11
Mean Annual rainfall for the site (mm)	
Payment into the fund (GST Exclusive)	**$0.00**
Administration fee (GST Inclusive)	**$0.00**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Radial Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	29/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	2
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.03

Size of the Block	6000
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.06

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	Yes
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	No
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.08

Note; Blocks will score a minimum Landscape Context Score of 1

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.22**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is 2, <50% is 1, and 0 is 0)			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	0	2	1	Mixed	10.64
Acacia papyrocarpa	Western Myall	HP	0	2	1	Mixed	
Duma florulenta	Lignum	P	2	1		Adult	
Acacia tetragonophylla	Dead Finish	P	2	1		Mixed	
Enchylaena tomentosa	Ruby Saltbush	P	1	2		Mixed	
Ptilotus obovatus	Silver Mulla Mulla	P		1	2	Mixed	
Rhagodia spinescens	Spiny Saltbush	P		2	1	Mixed	
Dodonaea lobulata	Lobed-leaf Hop-bush	U	1	2		Adult	
Scaevola spinescens	Spiny Fanflower	P		2	1	Adult	
Santalum lanceolatum	Plumbush	HP		1	2	Mixed	
Minuria cunninghamii	Bush Minuria	P		0	2	Adult	
Chenopodium curvispicatum	Cottony Goosefoot	P		2		Mixed	
Teucrium racemosum	Grey Germander	U		1		Mixed	
Eremophila serrulata	Green Emubush	U		2	1	Adult	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Stictonetta naevosa	Freckled Duck		V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	Carra 25	**SIZE OF SITE (Ha)**	0.01
VEGETATION ASSOCIATION DESCRIPTION	Acacia papyrocarpa low open woodland		
LANDSCAPE TYPE	Drainage lines / floodouts		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☑	☐	☐	2
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☑	☐	☐	2
	Total Score (Max 10 - weighted by 2.5)			**10**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☐	☑	☐	1
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**15**

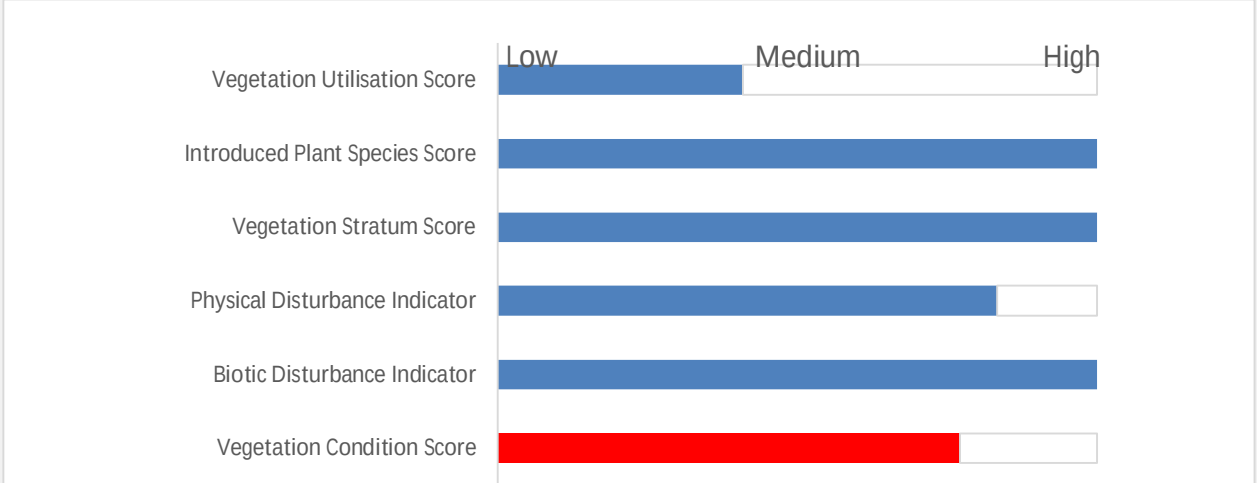
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☑	☐	
Shrubs 1- 3m	☑	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
Total Score (Max 16 - weighted by 4)			**16**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
Total Score (Max 10 - weighted by 2.5)		**10**

Vegetation Utilisation Score	
Total Score (Max 26)	10.64

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**61.64**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	2
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**7**
Score	0.06
CONSERVATION SIGNIFICANCE SCORE	**1.06**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.22**
VEGETATION CONDITION SCORE	**61.64**
CONSERVATION SIGNIFICANCE SCORE	**1.06**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	79.72
Total Biodiversity Score (Biodiversity Score x hectares)	0.80

Photo Point and Vegetation Survey Location

Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	742656
Northing (7 digits)	6536077
Description	
in drainage line: near northern-most extent of spill	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**0.80**

SEB Points required	0.84
Hectares required	0.10
Mean Annual rainfall for the site (mm)	
Payment into the fund (GST Exclusive)	**$0.00**
Administration fee (GST Inclusive)	**$0.00**

Appendix C2. Northern Wellfield Clearance RAM sheets

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	1	2	0	Mixed	11.92
Tecticornia medullosa	0	P	2	1		Mixed	
Abutilon halophilum	#N/A	###					

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 1	**SIZE OF SITE (Ha)**	115.91
VEGETATION ASSOCIATION DESCRIPTION	Atriplex vesicaria/Tecticornia medullosa low open shrubland		
LANDSCAPE TYPE	Plain – undulating		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

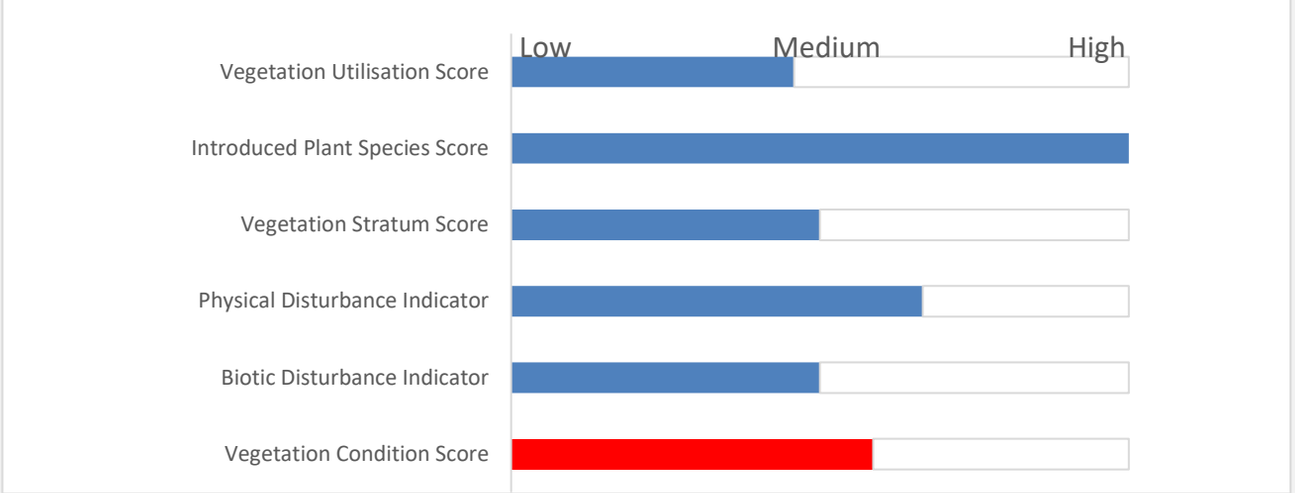
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	11.92

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**46.92**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**46.92**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	59.79
Total Biodiversity Score (Biodiversity Score x hectares)	6930.33

Photo Point and Vegetation Survey Location

Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	731467
Northing (7 digits)	6550885
Description	
Stony tableland site adjacent to NT 26	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**6930.33**

SEB Points required	7276.84
Hectares required	909.61
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$377,486.33**
Administration fee (GST Inclusive)	**$20,761.75**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	2	1	0	Mixed	15.38
Maireana appressa	Pale-fruit Bluebush	P	2	1		Adult	
Tecticornia medullosa	0	P	2	1		Mixed	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 2	**SIZE OF SITE (Ha)**	115.91
VEGETATION ASSOCIATION DESCRIPTION	Atriplex vesicaria/Tecticornia medullosa low open shrubland		
LANDSCAPE TYPE	Plain – undulating		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

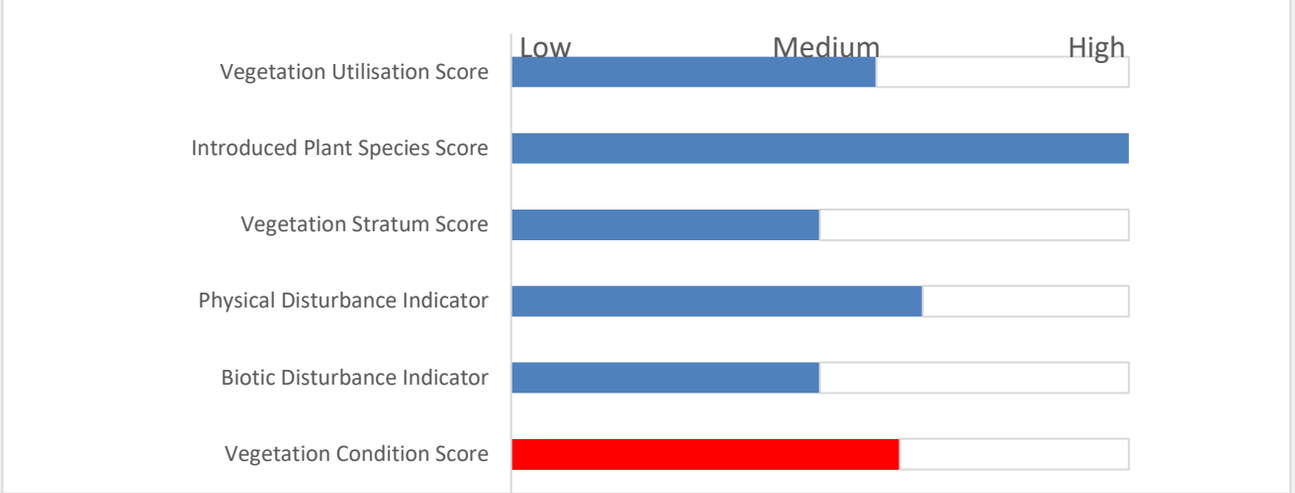
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	15.38

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**50.38**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

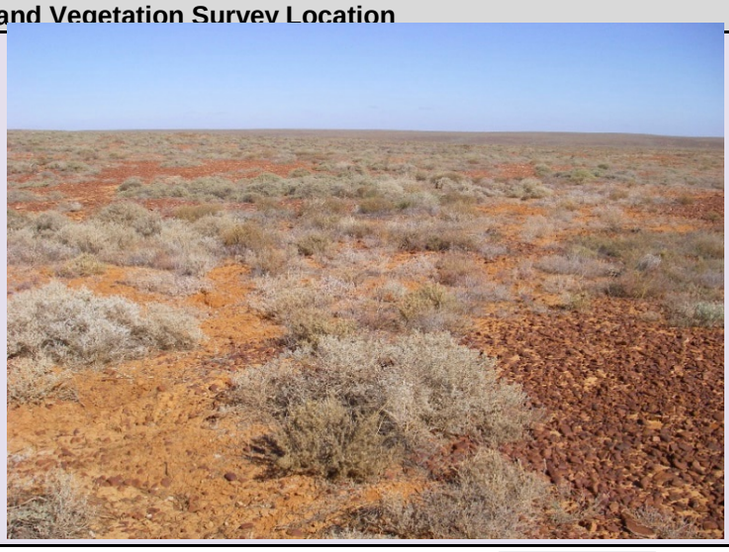
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**50.38**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	64.20
Total Biodiversity Score (Biodiversity Score x hectares)	7441.18

Photo Point and Vegetation Survey Location



Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	723416
Northing (7 digits)	6562532
Description	
Stony tableland site adjacent to NT 10	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**7441.18**

SEB Points required	7813.24
Hectares required	976.65
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$405,311.70**
Administration fee (GST Inclusive)	**$22,292.14**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	2	1	0	Mixed	15.81
Maireana aphylla	Cotton-bush	P	2			Adult	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 3	**SIZE OF SITE (Ha)**	115.91
VEGETATION ASSOCIATION DESCRIPTION	Atriplex vesicaria/Maireana aphylla low open shrubland		
LANDSCAPE TYPE	Plain – undulating		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

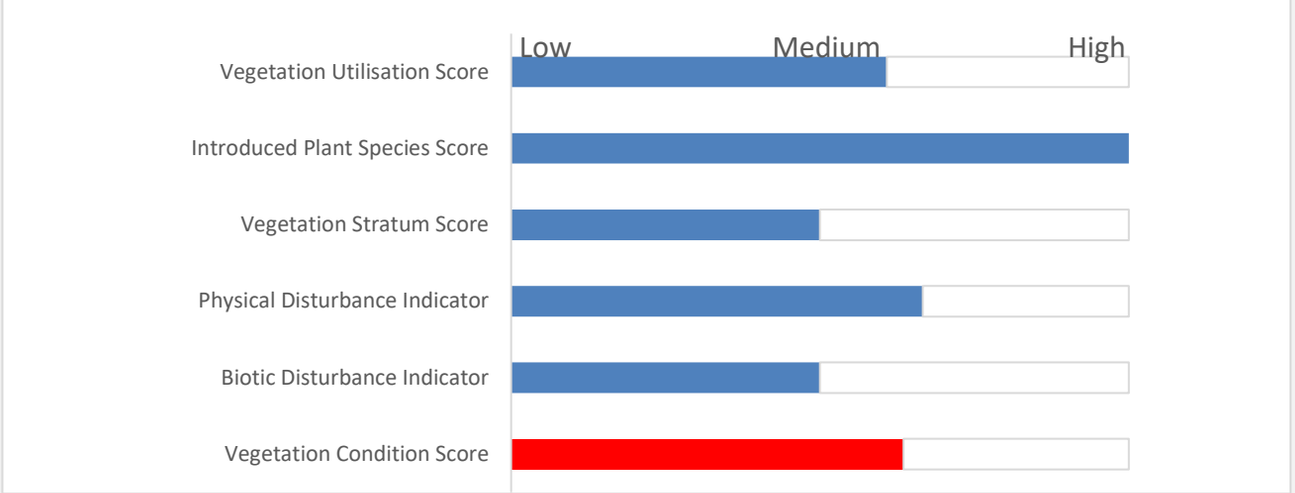
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	15.81

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**50.81**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**50.81**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	64.76
Total Biodiversity Score (Biodiversity Score x hectares)	7505.80

Photo Point and Vegetation Survey Location

Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	726318
Northing (7 digits)	6567129
Description	
Stony tableland site adjacent to NT 18	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**7505.80**

SEB Points required	7881.09
Hectares required	985.14
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$408,831.77**
Administration fee (GST Inclusive)	**$22,485.75**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Atriplex vesicaria	Bladder Saltbush	HP	1	2	0	Mixed	19.50

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 4	**SIZE OF SITE (Ha)**	115.91
VEGETATION ASSOCIATION DESCRIPTION	Atriplex vesicaria/Maireana eriantha low open shrubland		
LANDSCAPE TYPE	Plain – undulating		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

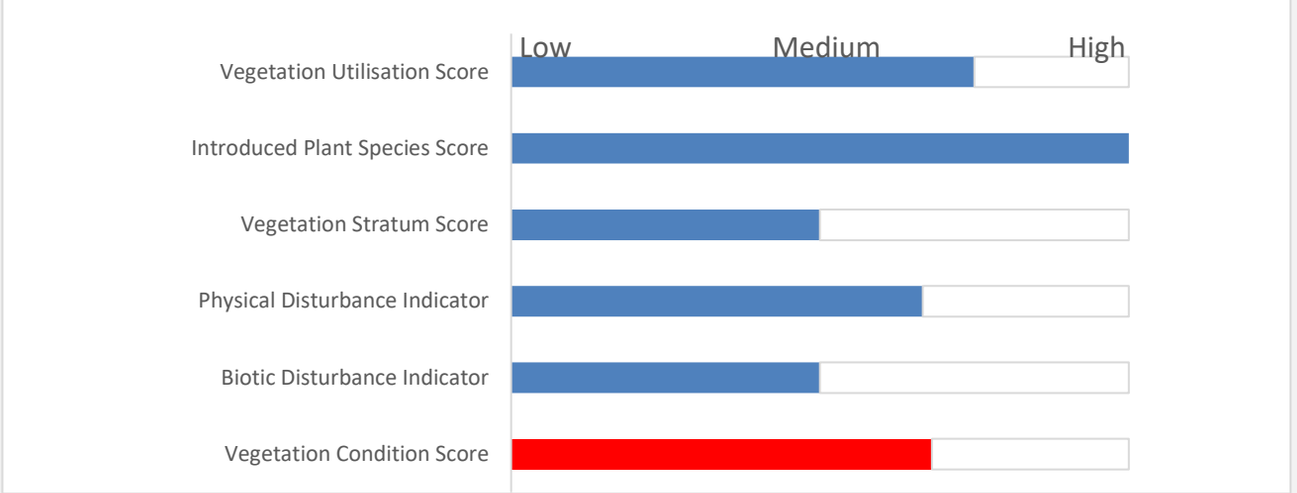
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	19.50

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**54.50**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

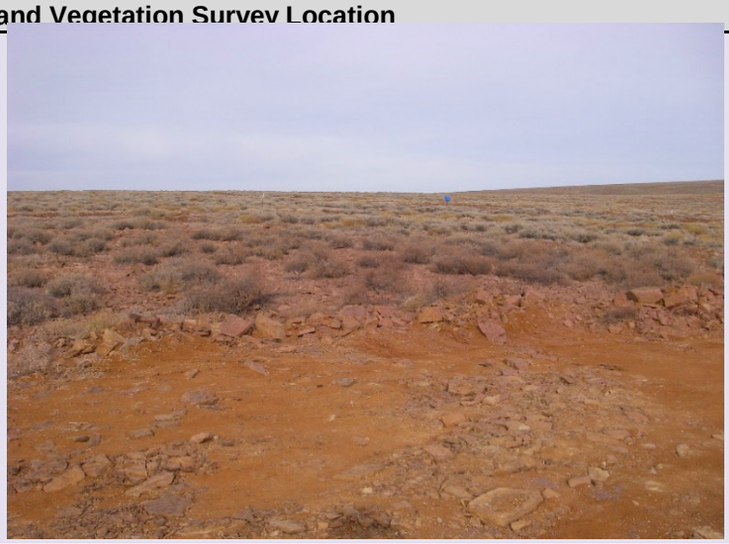
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**54.50**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	69.45
Total Biodiversity Score (Biodiversity Score x hectares)	8050.51

Photo Point and Vegetation Survey Location



Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	726986
Northing (7 digits)	6577261
Description	
Stony tableland site adjacent to NT 15	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**8050.51**

SEB Points required	8453.03
Hectares required	1056.63
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$438,500.99**
Administration fee (GST Inclusive)	**$24,117.55**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Tecticornia medullosa	0	P	2	1	0	Mixed	12.50
Maireana appressa	Pale-fruit Bluebush	P	2	1		Adult	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 5	**SIZE OF SITE (Ha)**	115.91
VEGETATION ASSOCIATION DESCRIPTION	Tecticornia medullosa/Maireana eriantha low open shrubland		
LANDSCAPE TYPE	Plain – undulating		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

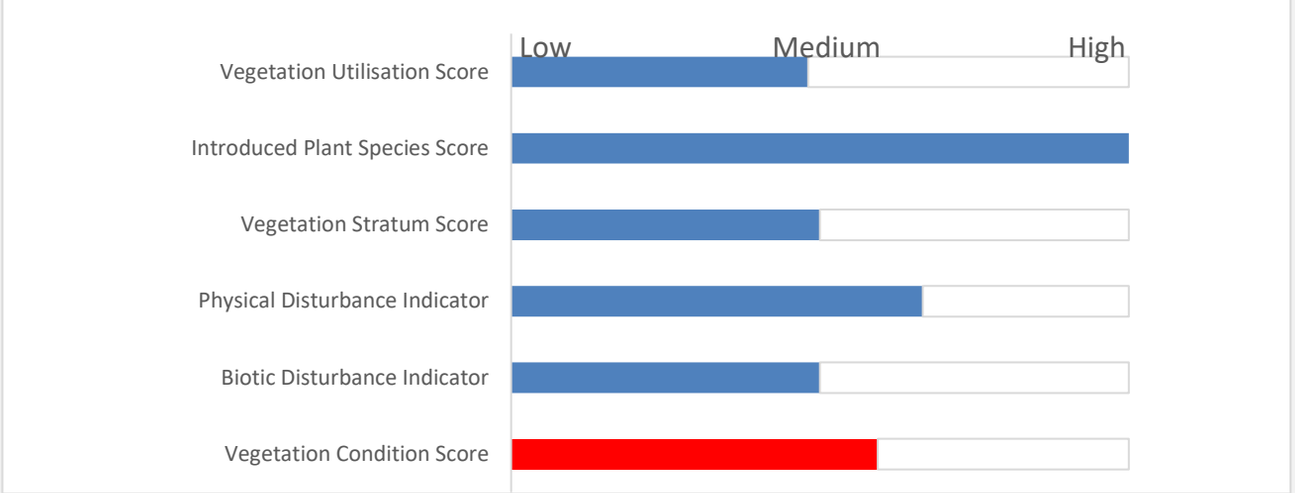
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	12.50

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**47.50**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

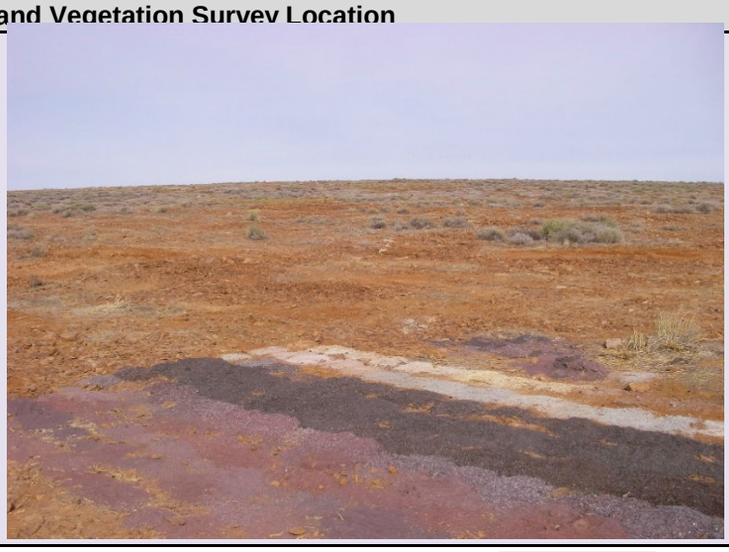
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**47.50**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	60.53
Total Biodiversity Score (Biodiversity Score x hectares)	7016.50

Photo Point and Vegetation Survey Location



Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	721446
Northing (7 digits)	6584863
Description	
Stony tableland site adjacent to NT 2, shallow gilgais	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**7016.50**

SEB Points required	7367.32
Hectares required	920.92
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$382,179.76**
Administration fee (GST Inclusive)	**$21,019.89**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Maireana aphylla	Cotton-bush	P	1	2	0	Mixed	10.38
Eragrostis australasica	Cane-grass	P		2	1	Adult	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 6	**SIZE OF SITE (Ha)**	0
VEGETATION ASSOCIATION DESCRIPTION	Maireana aphylla +/- Eragrostis australasica low open shrubla		
LANDSCAPE TYPE	Drainage lines / floodouts		
SURFACE CHARACTER **Dominant**	Cracking	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

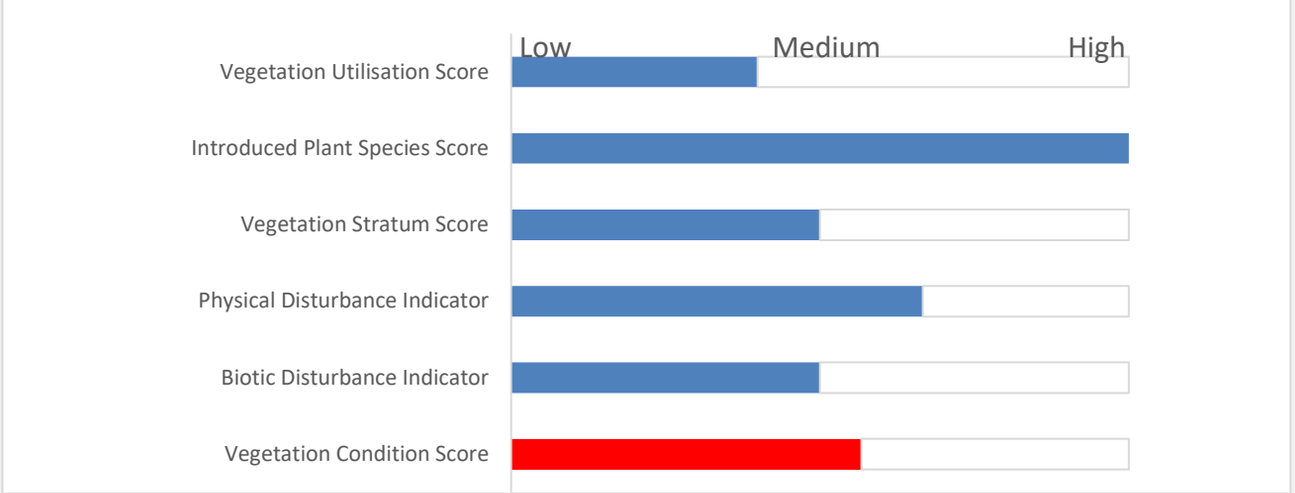
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	10.38

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**45.38**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**45.38**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	57.83
Total Biodiversity Score (Biodiversity Score x hectares)	0.00

Photo Point and Vegetation Survey Location

Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	712515
Northing (7 digits)	6580824
Description	
Crab hole clay run-on flat adjacent to N0 1; approx 500m from White Dam - heavily grazed; Eragrostis setifolia, Eragrostis dielsii,Sclerolaena divaricata	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**0.00**

SEB Points required	0.00
Hectares required	0.00
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$0.00**
Administration fee (GST Inclusive)	**$0.00**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Maireana aphylla	Cotton-bush	P	1	2	0	Mixed	14.63
Eragrostis australasica	Cane-grass	P	1	2		Mixed	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Pseudomys australis	Plains mouse	VU	V	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 7	**SIZE OF SITE (Ha)**	0
VEGETATION ASSOCIATION DESCRIPTION	Maireana aphylla / Eragrostis australasica low open shrubland		
LANDSCAPE TYPE	Drainage lines / floodouts		
SURFACE CHARACTER **Dominant**	Cracking	**Minor**	Gilgai

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☐	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☐	☐	☐	1
	Total Score (Max 10 - weighted by 2.5)			**5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

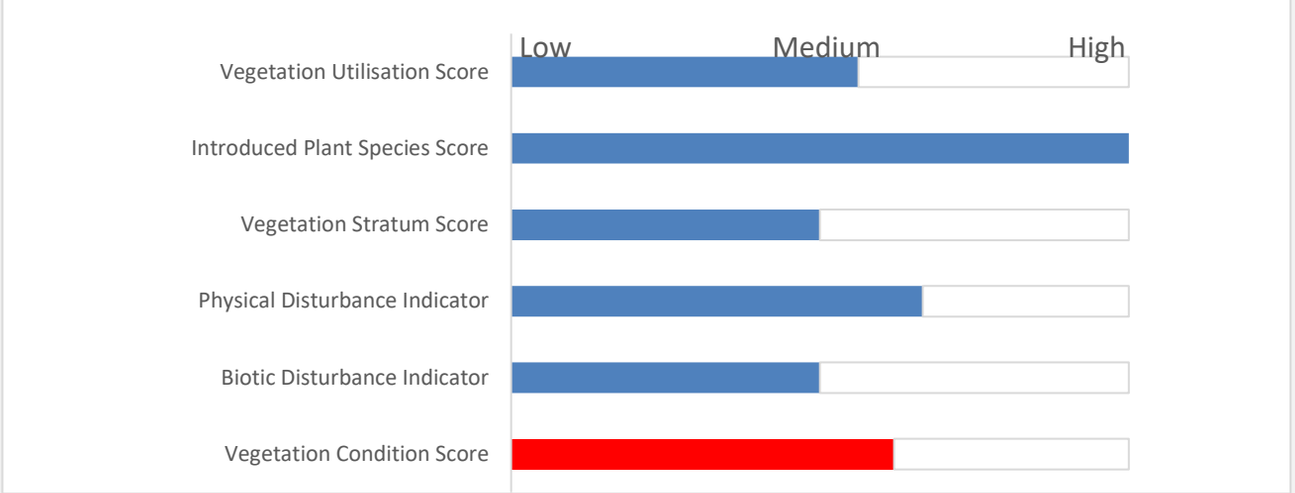
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☐	☐	
Shrubs 1- 3m	☐	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**8**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	14.63

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**49.63**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	1
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**14.5**
Score	0.08

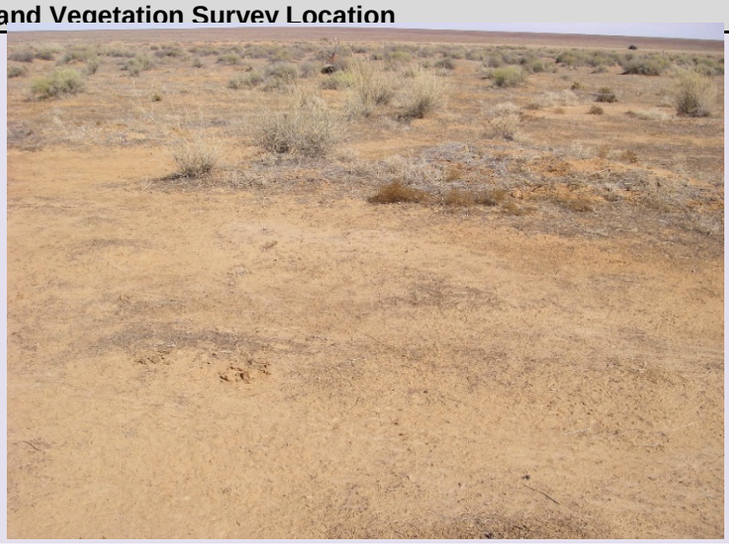
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**49.63**
CONSERVATION SIGNIFICANCE SCORE	**1.08**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	63.24
Total Biodiversity Score (Biodiversity Score x hectares)	0.00

Photo Point and Vegetation Survey Location



Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	712837
Northing (7 digits)	6579989
Description	
Crab hole clay run-on flat adjacent with cotton bush and canegrass located approx 600 m east of White Dam - heavily grazed. Site located on proposed piupeline alignment (note avoids clearance of canegrasst. Other species Sclerolaena divaricata, Dissocarpus paradoxus	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**0.00**

SEB Points required	0.00
Hectares required	0.00
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$0.00**
Administration fee (GST Inclusive)	**$0.00**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Acacia papyrocarpa	Western Myall	HP	1	2	0	Mixed	14.17
Rhagodia spinescens	Spiny Saltbush	P	1	2		Mixed	
Santalum lanceolatum	Plumbush	HP		2	1	Mixed	
Senna artemisioides ssp. helms	Blunt-leaf Senna	P	1	2		Mixed	
Maireana astrotricha	Low Bluebush	P		2	1	Adult	
Maireana aphylla	Cotton-bush	P	1	2		Mixed	
Atriplex vesicaria	Bladder Saltbush	HP		2	1	Mixed	
Ptilotus obovatus	Silver Mulla Mulla	P		2	1	Mixed	
Acacia tetragonophylla	Dead Finish	P	2	1		Mixed	
Acacia aneura (includes brachy	Mulga	HP		2	1	Adult	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 8	**SIZE OF SITE (Ha)**	13.32
VEGETATION ASSOCIATION DESCRIPTION	Acacia papyrocarpa very low woodland stony drainage line		
LANDSCAPE TYPE	Drainage lines / floodouts		
SURFACE CHARACTER **Dominant**	Stony	**Minor**	

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☑	☐	☐	2
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☑	☐	☐	2
	Total Score (Max 10 - weighted by 2.5)			**10**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

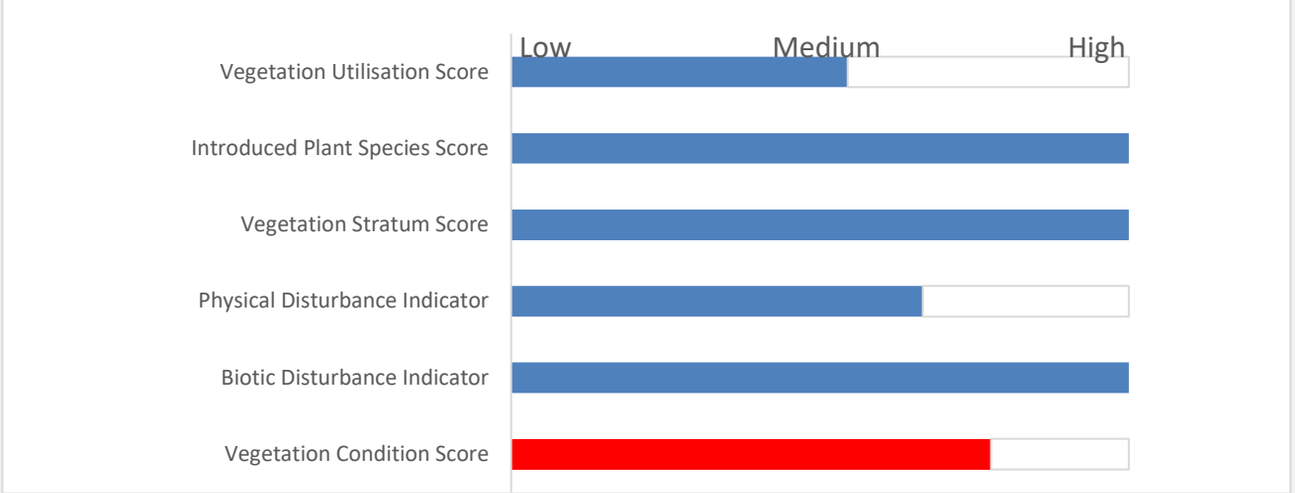
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☑	☐	
Shrubs 1- 3m	☑	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**16**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	14.17

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**62.17**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	2
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**4.5**
Score	0.04

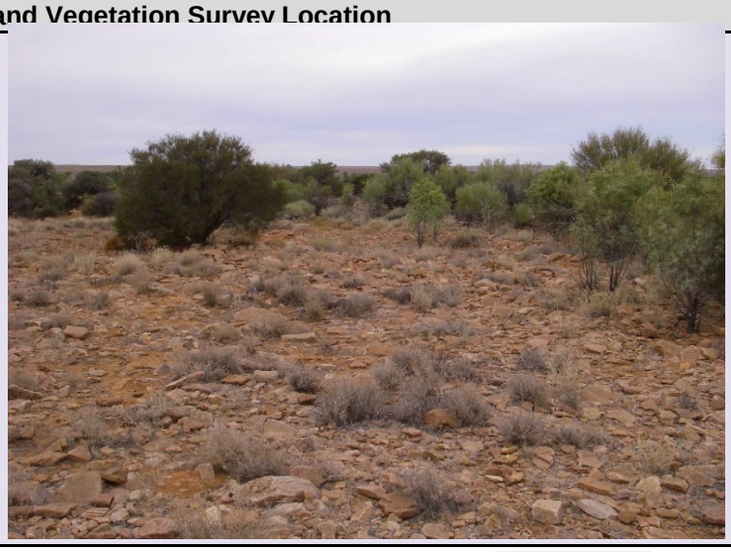
CONSERVATION SIGNIFICANCE SCORE	**1.04**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**62.17**
CONSERVATION SIGNIFICANCE SCORE	**1.04**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	76.29
Total Biodiversity Score (Biodiversity Score x hectares)	1016.21

Photo Point and Vegetation Survey Location



Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	727172
Northing (7 digits)	6565787
Description	
Stony drainage line with western myall over mixed shrubs	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**1016.21**

SEB Points required	1067.02
Hectares required	133.38
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$55,351.63**
Administration fee (GST Inclusive)	**$3,044.34**

Rangeland Assessment Scoresheet

(Version - 4 January 2018)

Block (name)	Carrapateena Northern Wellfield
NRM Region	South Australian Arid Lands
IBRA Sub Region	Arcoona Plateau
Property	Carrapateena ML

ASSESSOR(S)	Rick Barratt
DATE OF ASSESSMENT	30/06/2018

Map of the Block (Including the Sites)

Insert Map

Landscape Context Scores

Number of Landform Features within Block	4
1 = 0.01pts, 2 = 0.03pts, >2 = 0.06pts	0.06

Size of the Block	129.23
<10ha = 0; 10 - <100ha = 0.01pts; 100 - <500ha = 0.02pts; 500 - <1000ha = 0.03pts; 1000 - <2000ha = 0.04pts; 2000 - 5000 = 0.05pts; >5000pts = 0.06pts	0.02

% native veg. protected in IBRA Sub region	0
0-2% = 0.05 pts; >2-5% = 0.04 pts; >5-10% = 0.03 pts; >10-25% = 0.02 pt; >25% = 0.01 pt	0.05

Note; Blocks will score a minimum Landscape Context Score of 1

Wetland or Riparian Habitat present	
Does the block contain a wetland feature (Yes/No)	
Permanent or semi permanent = 0.08 pt *Contains water for at least 6 months of the year*	No
Occasionally contains water = 0.05 pts *Contains water approximately once every 5 years*	Yes
Very occasionally contains water = 0.02 pts *Contains water approximately once every 20 years*	No
Score	0.05

LANDSCAPE CONTEXT SCORE (max 1.25)	**1.18**

Plant Species	Common name	Palatability	Utilisation enter the tally from datasheet for each category. If a proportion (>50%, <50% or zero) was recorded in the field, enter the code for each proportion (>50% is **2**, <50% is **1,** and 0 is **0)**			Age Class (M/Y/A)	Site Utilisation Score mean
			Intact	Modified	Over utilised		
			number (tally)	number (tally)	number (tally)		
Acacia ligulata	Umbrella Bush	U		2	1	Mixed	10.83
Rhagodia spinescens	Spiny Saltbush	P	0	2	1	Mixed	
Enchylaena tomentosa	Ruby Saltbush	P	1	2		Mixed	

Threatened Fauna - Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**
Ardeotis australis	Australian Bustard		V	Y	
Phaps histrionica	Flock Bronzewing		R	Y	
Falco peregrinus	Peregrine Falcon		R	Y	
Nephrurus deleani	Pernatty Knob-tailed Gecko		R	Y	

Threatened Flora Species Recorded or Observed		Threatened Species			
Species	**Common Name**	**EPBC**	**SA**	**Past Record**	**Observed**

Vegetation Condition Scores

SITE (name):	NW 9	**SIZE OF SITE (Ha)**	0
VEGETATION ASSOCIATION DESCRIPTION	Acacia ligulata tall shrubland on sand dune		
LANDSCAPE TYPE	Dunefield		
SURFACE CHARACTER **Dominant**	Hummock	**Minor**	

Biotic Disturbance Indicators Sites with trees and large shrubs only (select one tickbox for each row)	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Presence of palatable shrubs or perennial grasses under the canopy of tree/shrub >3m	☐	☑	☐	1
Presence of mostly intact litter mats under canopy of tree/shrub >3m tall (>50% of tree canopy area has intertwined litter or shrub cover)	☑	☐	☐	2
	Total Score (Max 10 - weighted by 2.5)			**7.5**

Physical Disturbance Indicators	**Dominant >50%**	**Minor <50%**	**None - 0**	**Score**
Prevalence of large patches of bare soil (> 5m x 5m) that shows no signs of productive capacity (ie ephemeral plant litter, stems etc.)	☐	☐	☑	2
Evidence of animal tracks, vehicle tracks or other physical disturbance to the natural land surface	☑	☐	☐	0
Destabilised creek channel banks (if present), characterised by no vegetation or stabilizing roots, deflation and bank erosion. Inspect banks on both sides of channels.	☐	☐	☑	2
	Total Score (Max 18 - weighted by 3)			**12**

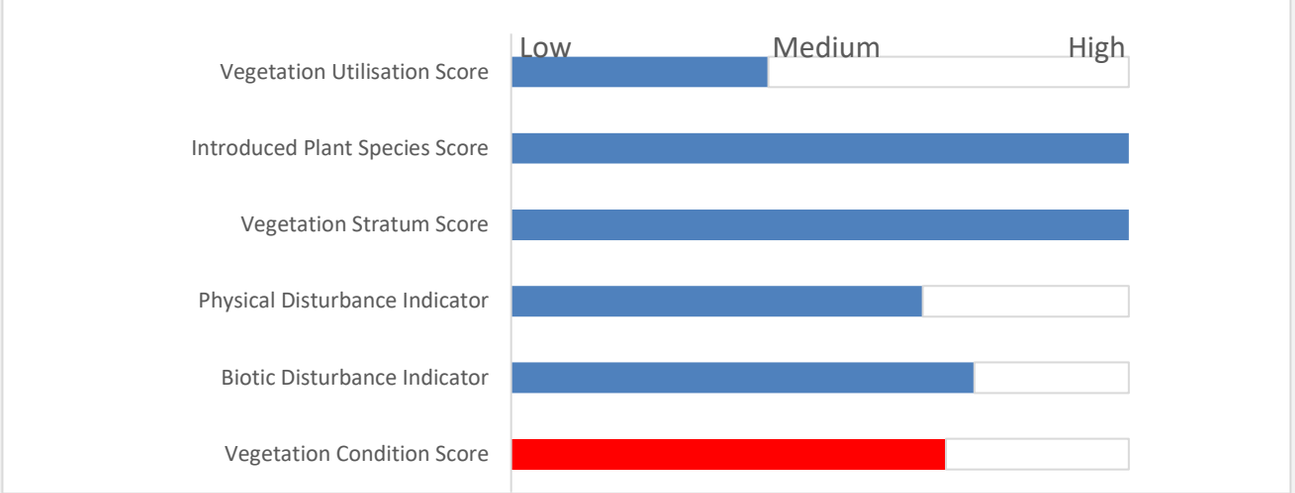
Vegetation Stratum (tick the Present box for all stratum that are present or tick for Absent box of any stratum that should be present but have been removed)	**Present**	**Absent**	*Note; don't tick either box if stratum was likely never present - e.g. Trees stratum in a low shrubland*
Trees/shrubs >3m	☑	☐	
Shrubs 1- 3m	☑	☐	
Low shrubs <1m & hummock grasses	☑	☐	
Perennial tussock grasses with basal areas >30mm	☑	☐	
	Total Score (Max 16 - weighted by 4)		**16**

Introduced Plant Species	**Select**	**Score**
Declared species present?		2
Introduced species dominate (>50% of vegetation cover)	☐	2
Moderate invasion of introduced species (5 to 50% of the vegetation cover)	☐	
Very sparse to nil introduced species present (<5% of vegetation cover)	☑	
	Total Score (Max 10 - weighted by 2.5)	**10**

Vegetation Utilisation Score	
Total Score (Max 26)	10.83

Vegetation Condition Score Calculation

VEGETATION CONDITION SCORE	**56.33**



Conservation Significance Score

Is the vegetation association considered a Threatened Ecological community or Ecosystem?	Yes/No
State (Provisional List of Threatened Ecosystems of SA) **Rare** community (0.05 pt)	☐
State (Provisional List of Threatened Ecosystems of SA) **Vulnerable** community (0.1 pts)	☐
State (Provisional List of Threatened Ecosystems of SA) **Endangered** community (0.15 pts)	☐
Nationally (EPBC Act) V**ulnerable** community (0.2 pts)	☐
Contains a Nationally (EPBC Act) **Endangered** or **Critically Endangered** community (0.3 pts)	☐
Note; all sites will score a minimum Conservation Significance Score of 1 **Score**	1

Number of Threatened Plant Species recorded for within the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species recorded (1 pt each)	0
State **Vulnerable** species recorded (2.5 pt each)	0
State **Endangered** recorded (5 pts each)	0
Nationally **Vulnerable** species recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**0**
Score	0

Potential habitat for Threatened Animal Species (number observed or recorded) for the Site	Number
**If a species has both a State (NP&W Act) and National (EPBC Act) rating, it's only recorded for its National rating.*	
State **Rare** species observed or locally recorded (1 pt each)	3
State **Vulnerable** species observed or locally recorded (2.5 pt each)	1
State **Endangered** species observed or locally recorded (5 pt each)	0
Nationally **Vulnerable** species observed or locally recorded (10 pts each)	0
Nationally **Endangered** or **Critically endangered** species observed or locally recorded (20 pts each)	0
0 = 0 pts; <2 = 0.02 pts; 2 - <5 = 0.04 pts; 5 - <10 = 0.06 pts; 10 - <20 = 0.08pts; 20 or > = 0.1 pts	**5.5**
Score	0.06

CONSERVATION SIGNIFICANCE SCORE	**1.06**

Total Scores for the Site

LANDSCAPE CONTEXT SCORE	**1.18**
VEGETATION CONDITION SCORE	**56.33**
CONSERVATION SIGNIFICANCE SCORE	**1.06**

Vegetation Condition x Landscape Context x Conservation Significance =	
UNIT BIODIVERSITY SCORE	70.46
Total Biodiversity Score (Biodiversity Score x hectares)	0.00

Photo Point and Vegetation Survey Location

Direction of the Photo	
south	
GPS Reference	
Datum	
Zone (52, 53 or 54)	53
Easting (6 digits)	719888
Northing (7 digits)	6566731
Description	
Low sand dunes with sandhill wattle tall open shrubland	

Clearance | SEB Area | Other

Assessment for Clearance

Loss Factor	1.0
Loadings for clearance of protected areas	
Reductions for rehabilitation of impact site	
SEB Points of loss	**0.00**

SEB Points required	0.00
Hectares required	0.00
Mean Annual rainfall for the site (mm)	166
Payment into the fund (GST Exclusive)	**$0.00**
Administration fee (GST Inclusive)	**$0.00**

BHP

Appendix E
Determination Terms of Reference checklist

PEPR TOR Checklist

The content of the Program for Environment Protection and Rehabilitation (PEPR) and its associated appendices have been developed in line with the Department for Energy and Mining's Determination Terms of Reference (TOR) 005 for Metallic and industrial mineral PEPRs, which is a Notice under Part 10A of the *Mining Act 1971* (SA), published on 18 March 2021 in The South Australian Government Gazette. The TOR 005 is replicated in Table 1 with the associated section of the PEPR for the required information.

Table 1 | PEPR TOR 005 Checklist

ID	TOR Requirement	PEPR Section
-	…be accompanied by a declaration of accuracy that complies with regulation 84 of the *Mining Regulations 2020*…	Acknowledged
-	…(2) Any information provided for the purposes of an application to which this regulation applies must be accompanied by a declaration, signed by the relevant prescribed person, to the effect that the person has taken reasonable steps to review the information and to ensure its accuracy. (3) In this regulation—relevant prescribed person means— (a) in the case of an application to which subregulation (1)(c) applies—the holder of the tenement in respect of which the program or revised program is to apply; and (b) in any other case—the applicant.	Declaration of Accuracy
-	FORM OF THE PEPR	
-	A PEPR for a ML and/or MPL for minerals or industrial minerals must in accordance with section 70B(4a) of the *Mining Act 1971* be submitted to the Minister for approval in the following form, unless otherwise specified by the Director of Mines or an authorised officer:	Acknowledged
-	• an electronic version of the PEPR must be submitted online through the relevant government website, or if approved by the Director of Mines or an authorised officer, submitted via email, post or courier and be marked 'Attention: Mining Assessments'	Acknowledged
-	• each page, plan or other separate sheet must include the tenement number(s), date of the PEPR preparation and sequential page numbering; and	Acknowledged
-	• the electronic version must be submitted in one single Acrobat PDF file or if requested by the Director of Mines or an authorised officer, Microsoft Word compatible files must be submitted	Acknowledged
-	A reviewed PEPR submitted to the Minister for approval under section 70C of the *Mining Act 1971*, must in accordance with regulation 63(1)(e) include a description or summary of all content changes made to the submitted PEPR.	Section 1.2 PEPR review
PEPR	A PEPR for a ML and/or MPL must comply with sections 70B and 70C of the *Mining Act 1971* and regulations 63, 64 and 66 of the *Mining Regulations 2020*, and must comply with the following determinations of this Terms of Reference as set out below:	Acknowledged
1	DESCRIPTION OF THE ENVIRONMENT	
-	In setting out a statement of criteria in accordance with section 70B(2)(b) of the *Mining Act 1971* and setting out strategies and criteria in accordance with regulation 63(b) and (c) of the *Mining Regulations 2020*, the Minister determines in accordance with regulation 63(1)(e) of the *Mining Regulations 2020* that a PEPR must include any new baseline environmental data relevant to the control strategies or criteria set out in clause 4, since the previous description of the environment or criteria was provided (in a proposal, approved PEPR or change to operations proposal).	Section 6 Description of the environment and effects
-	Where changes to the environment are identified, a PEPR must provide an updated description of the environment to describe the changes.	Section 6 Description of the environment and effects
2	DESCRIPTION OF THE MINING OPERATIONS	
-	In specifying the authorised operations that are proposed in accordance with section 70B(2)(a) of the *Mining Act 1971*, the Minister determines in accordance with regulation 63(3)(e) of the *Mining Regulations 2020* that a PEPR must include a description of the proposed operations as set out in this Terms of Reference. Each of the elements listed in clauses 2.1–2.10 must be described only to the extent that they apply to the mining operation.	Section 4 Description of the operations
2.1	**General Description and Maps/Plans of Operations**	
-	Provide a summary description of all elements of the operation, including mining, processing and waste management (include maps/plans and sections as per clause 7).	Section 4.1 Tenements and associated project elements, Figure 4.1 – Figure 4.7 and Figure 4.24.
2.2	**Reserves, Products and Market**	
2.2.1	Ore Reserves or Mineral Resources (or both)	
	• a statement of the current Australasian Joint Ore Reserves Committee (JORC) compliant ore reserve or mineral resource estimates (or both) in the tenement area; and	Section 4.6.2 Estimate of mineral resources and Section 4.6.3 Ore reserves
	• a statement of what reserve and/or resource forms the basis for the mining operation; or (if a JORC compliant reserve or resource (or both) has not been reported)	Section 4.6.1 Geology and mineralisation, Section 4.6.2 Estimate of mineral resources, Section 4.6.3 Ore reserves
	• an estimate of the resource to be mined and the basis of this estimate.	Section 4.6.2 Estimate of mineral resources
	Provide steps that have been taken to ensure mining operations will not sterilise/prevent future extraction of mineral resources.	Section 4.7.6 Sterilisation of potential future resources

ID	TOR Requirement	PEPR Section
2.2.2	Production Rate and Products	
	• a statement of the relevant commodities that are to be extracted, processed and sold, and the expected market or end use;	Section 4.6.4.1 Mine production schedule and Section 4.6.4.2 Concentrate production schedule
	• a statement of any other commodities present in the tenement area that are not to be recovered for sale, and the reasons for this decision;	Section 4.7.5 Regional mineralisation
	• a quantitative estimate of production of mine gate product(s) for the life of mine, and a schedule of the annual production of mine gate product(s); and	Section 4.6.4.1 Mine production schedule and Section 4.6.4.2 Concentrate production schedule
	• a statement if any extractive minerals (as defined by Section 6 of the *Mining Act 1971*) will leave the lease.	Section 4.6.4.3 Extractive minerals
2.3	**Exploration Activities**	
	Provide information that details all exploration activities to be undertaken within the tenement area as a part of the mining operation, including:	
	• purpose of the activities (i.e. resource drill-out or resource extension); types of drilling;	Section 4.7.1 Regional exploration drilling, Section 4.7.2 Near mine drilling, Section 4.7.3 Resource drilling, Section 4.7.4 Drilling methodology, Section 4.7.5 Regional mineralisation
	• geophysical techniques likely to be used;	Section 4.7.4 Drilling methodology
	• earthworks required to conduct exploration activities; equipment required to conduct exploration activities; and	Section 4.7.4.1 Surface drilling
	• rehabilitation methods for exploration works (including that not yet rehabilitated from previous tenure).	Section 4.7.4.2 Rehabilitation activities
	Any clearance of native vegetation due to exploration activities that had not been rehabilitated at the grant of the mining lease or licence must be included within the significant environmental benefit calculations detailed within the native vegetation management plan.	Section 4.5.1 and Appendix D
2.4	**Mining Activities**	
2.4.1	Type or Types of Mining Operation to be Carried Out	
	Provide a clear statement on the type or types of mining operation to be carried out, such as: • the mining method(s) to be adopted.	Section 4.8.1 Key elements and 4.8.2 Mine design
2.4.2	Open Pit	
	Describe, for the life of mine from inception to cessation, all open pit workings, including (but not limited to):	Not applicable
	• overall pit wall angles, bench height, berm width;	Not applicable
	• dimensions and depth of pit;	Not applicable
	• access ramps; and	Not applicable
	• maps, plans and cross-sections (as per 7.1.1, 7.1.2, 7.1.7, 7.2.1 and 7.2.2).	Not applicable
2.4.3	Underground Workings	
	Describe underground workings, including (but not limited to):	
	• stoping methods;	Executive Summary, Section 4.8.2.3 Sub-level caving
	• potential surface disturbance resulting from underground mining;	Section 4.8.3 Subsidence zone
	• declines, shafts, tunnels, bore holes, ventilation intakes and exhausts; and	Section 4.8.2.2 Decline development, Section 4.8.2.3 Sub-level caving, and Section 4.8.4 Mine ventilation, Section 4.8.5 Mine water management, Section 4.8.6 Underground supporting infrastructure

ID	TOR Requirement	PEPR Section
	• maps, plans and cross-sections (as per 7.1.1, 7.1.2, and 7.2.1).	Layout: • Figure 4.16 Carrapateena mine layout • Figure 4.19 Sub-level cave mine surface subsidence zone and abandonment bund • Figure 4.20 Schematic mine primary ventilation cross-section • Figure 4.21 Schematic mine secondary ventilation layout • Figure 4.22 Mine area surface water management infrastructure • Figure 4.23 Explosives magazine location and separation distances to infrastructure (unable to completely confirm this one as a copy hasn't been provided in draft figures folder, gone off figure title in PEPR). • Figure 4.24 Minerals processing plant layout (unable to completely confirm this one as a copy hasn't been provided in draft figures folder, gone off figure title in PEPR). Sequence: • Figure 4.18 Typical as-built sub-level came mine level layout Cross-sections: • Figure 4.16 Conceptual block cave decline alignment, Figure 4.19 SLC mine surface subsidence zones and abandonment bund. Figure 4.12 shows deposit depths.
	• Where underground fill is used, describe: ○ type of fill to be used; ○ the volume percentage of underground void to be filled; ○ sequence of filling; ○ source and proportion of fill; and	Section 4.8.2.6 Underground fill and Section 4.8.3 Subsidence zone
	○ maps, plans and cross-sections showing the fill (as per 7.1.7 and 7.2.2).	Completion map • Figure 5.1 Carrapateena area following closure • Figure 5.2 Post-completion landscape • Figure 5.3 Sub-level cave and tailings storage facility pre- and post-completion landforms Cross-section • Figure 5.4 Pre- and post-mining cross sections
2.4.4	Material Movements	
	Provide: • expected life of mine (including scope for extension); • annual mine production rates and mine production schedule of ore and waste rock over the life of mine; and • life of mine and annual strip ratios.	Section 4.6.4.1 Mine production schedule, Section 4.8.2.7 Materials management, Section 4.7.5 Regional mineralisation and Section 4.7.6 Sterilisation of potential future resources
2.4.5	Stockpiles	
	Describe for all ore, product, subsoil and topsoil stockpiles the:	
	• location, size, shape and height of ore, product, subsoil and topsoil stockpiles;	Section 4.11.4 Stockpiles, Figure 4.34 Production stockpile locations, dimensions and capacities, Figure 4.37 Topsoil stockpile locations, dimensions and capacity
	• method of placement;	Section 4.11.4 Stockpiles
	• method of stabilisation and erosion control of all stockpiles; and	Section 4.11.4.1 Product stockpile, Section 4.11.4.4 Waste rock dump and Section 4.11.4.5 Topsoil and subsoil stockpiles
	• water movement through stockpiles.	Section 4.11.4.1 Product stockpile, Section 4.11.4.4 Waste rock dump, and Section 4.11.4.5 Topsoil and subsoil stockpiles
	The location, maximum height and extent of all stockpiles must be shown on a map (as per 7.1.1).	Figure 4.34 Production stockpile locations, dimensions and capacities, Figure 4.37 Topsoil stockpile locations, dimensions and capacity
2.4.6	Use of Explosives	
	If explosives are used, describe:	
	• type of explosives used on the site;	Section 4.8.7.1 Explosives demand
	• timing and frequency of blasting;	Section 4.8.7.1 Explosives demand
	• size of blasts; and	Section 4.8.7.1 Explosives demand

ID	TOR Requirement	PEPR Section
	• storage of explosives (amount, type, detailed location and method of storage).	Section 4.8.7.2 Explosives magazine Figure 4.23 Explosives magazine location and separation distances to infrastructure
2.4.7	Type of Mining Equipment	
	Provide a description of the equipment (fixed and mobile) to be used in the mining operation in terms of:	
	• type, size and capacity of machines;	Section 4.8.6.6 Mining plant and equipment
	• approximate number of units;	Section 4.8.6.6 Mining plant and equipment
	• noise outputs;	Section 4.8.6.6 Mining plant and equipment
	• exhaust outputs; and	Section 4.8.6.6 Mining plant and equipment
	• fire ignition sources.	Section 4.8.6.6 Mining plant and equipment
	The location of fixed equipment must be shown on a map (as per 7.1.2.1).	Figure 4.16 Carrapateena mine layout, Figure 4.22 Mine area surface water management infrastructure, Figure 4.24 Minerals processing plant layout
2.4.8	Mine Dewatering	
	Provide: • estimated inflows of groundwater, stormwater and water from any other mining activities into mine workings;	Section 4.8.5.1 Mine dewatering
	• details of mine dewatering infrastructure, and mine water management and disposal;	Section 4.8.5.1 Mine dewatering and Section 4.8.5.2 Mine water supply
	• contingency measures for greater than planned water inflows into mine workings; and	Section 4.8.5.3 Excess mine water infrastructure and management
	• a mine water balance of water inflows and water outflows during operations and at mine completion (if not included in the water balance in clause 2.5.4).	Section 4.10.4.1 Inflows, outflows and water balance (TSF) and Section 4.12.7 Water Balance, Figure 4.39 Carrapateena operational water balance
2.4.9	Sequence of Mining and Rehabilitation Operations	
	Provide the following information on the sequence of operations in both text, map and cross section form (as per 7.1.2 and 7.2.1):	
	• description of the sequence of mining stages;	Section 4.8.2.3 Sub-level caving, Section 4.8.2.5 Pre-conditioning, Section 4.8.2.7 Materials management
	• sequencing of progressive and final rehabilitation, including demonstration that progressive rehabilitation has been integrated with the mining plan;	Section 5.2 Closure strategy, Section 4.4 Operations schedule and planning, Section 5.4 Closure activities
	• an estimation of the quantities of sulfide minerals that have the potential to generate acid or mobilise metals, or other hazardous minerals to be mined at each mining stage; and	Section 4.11.1 Key Elements, Section 4.11.3 Materials management
	• any mineral resource that may be sterilised from future mining by the planned mining operations.	Section 4.7.6 Sterilisation of potential future resources
2.4.9.1	Rehabilitation Strategies and Timing	
	Describe all activities, strategies and designs relating to mine closure for rehabilitation of: • open pit and/or underground workings, • stockpiles, • explosives storage, • mining equipment and • mine dewatering infrastructure.	Section 5.1 Mine closure planning, Section 5.2 Closure strategy, Section 5.4.1 Domain one – pit voids, to Domain 5.4.4 Domain four – hardstand areas and stockpiles
	Include: • timing of these activities and • all opportunities for progressive rehabilitation.	Section 5.2 Closure strategy, Section 5.4.1 Domain one – pit voids, Section 5.4.2 Domain two – underground workings to Domain 5.4.4 Domain four – hardstand areas and stockpiles
	Include (but not limited to): • the maximum area of land disturbed by mining operations at any time, • battering of mining faces and other earthworks, • mine void backfilling, • abandonment bunds, • sealing of portals and ventilation shafts, • soil management, • revegetation and • expected water infill rates.	Section 5.4.1 Domain one – pit voids, to Domain 5.4.4 Domain four – hardstand areas and stockpiles, Section 4.5.3 Proposed land disturbance

ID	TOR Requirement	PEPR Section
2.4.10	Modes and Hours of Operation	
	State if the operation will be worked on a continuous (24 hour, 7 days a week), regular periodical or campaign basis.	Section 4.3 Hours of operation
	If the operation is to be worked on a regular periodical basis, specify: • period(s) (daily, weekly and public holidays) to be worked; and • start and finish hours the site is to be worked per period.	Not applicable
	If the operation is to be worked on a campaign basis, specify: • minimum hours the site is to be worked per year; • the minimum time of each campaign; • the maximum and minimum time between campaigns; define the beginning and end of each campaign; • hours of mining operations during campaign; days of mining operations during campaign; • determining factors for initiating and ceasing a campaign; • maximum and minimum tonnage of each campaign; and • maximum and minimum tonnage of production per year.	Not applicable
2.4.11	Care and Maintenance	
	Detail all activities and strategies required for care and maintenance of the mine, should the mine suspend production, but not progress immediately to closure.	Section 5.1.2.2 Care and maintenance plan
2.5	**Crushing, Grinding, Processing and Product Transport**	
2.5.1	Crushing and Grinding Plant	
	Provide a description of the crushing / grinding plant including:	
	• area, size, type of construction and location;	Section 4.5 Project footprint, Section 4.9.1 Key elements
	• throughput rate;	Section 4.9.1 Key elements
	• a description of ore preparation for processing;	Section 4.9.3.1 Surface crushing to Section 4.9.3.4 Ball mill and classification, Section 4.11.4.1 Production stockpile and Section 4.11.4.2 Coarse ore stockpile
	• grind size of the ore;	Section 4.9.3 Ore processing
	• noise sources;	Section 4.9.4.1 Processing equipment
	• dust sources and composition;	Section 4.9.4.1 Processing equipment, Table 9.11 Summary of baseline metals in dust
	• fire ignition sources; and	Section 4.9.4.1 Processing equipment
	• maps and plans (as per 7.1.3).	Figure 4.24 Minerals processing plant layout
2.5.2	Processing Plant	
	Provide a description of the processing plant including:	
	• the methods and details of processing and value adding;	Section 4.9 Description of the minerals processing operations
	• number, location, area, size, type of construction (including lining and drainage systems, as appropriate) of processing plant;	Section 4.5 Project footprint, Section 4.9.2 Minerals processing plant design, Section 4.9.3.5 Grind circuit rougher and rougher flotation, Section 4.9.4 Processing supporting infrastructure, Section 4.12.5 Water distribution and infrastructure
	• any ancillary plant and infrastructure to be used for processing the minerals on site; examples of associated structures are concrete batching plants, wheel wash facilities, silos, fuel tanks, water tanks, chemical storage/use, reverse osmosis plants and bore fields;	Section 4.9.1 Key elements, Section 4.9.2 Minerals processing plant design, Section 4.9.4 Processing supporting infrastructure, Section 4.11.4 Stockpiles, Section 4.12.4 Operations Water, Section 4.12.5 Water distribution and infrastructure, Figure 4.40 Raw water supply wells and wellfields, Figure 4.42 Minerals processing plant surface water management system
	• if chemicals are to be used in the beneficiation or processing of ore, describe the nature and quantities of the chemicals to be used, their reactions with ore and their ultimate fate;	Section 4.9.4.4 Chemicals, reagents and consumables, Section 3.5 Impact assessment framework
	• noise sources;	Section 4.9.4.1 Processing equipment
	• dust sources and composition;	Section 4.9.4.1 Processing equipment, Table 9.11 Summary of baseline metals in dust
	• fire ignition sources;	Section 4.9.4.1 Processing equipment

ID	TOR Requirement	PEPR Section
	• other potential air emissions (including odour) and their composition; and	Section 4.9.4.1 Processing equipment, Section 4.13.4 Greenhouse gas emissions, Table 9.10 Summary of baseline air quality and air quality modelling outputs, Table 9.11 Summary of baseline metals in dust
	• maps and plans (as per 7.1.1 and 7.1.3).	Figure 4.24 Minerals Processing Plant layout
2.5.3	Heap Leach	
	Provide a description of the Heap Leach Pad and process including:	Not applicable
	• type, size and location of the Heap Leach Pad;	Not applicable
	• construction and operating specifications for the Heap Leach Pad and process, including solution containment measures;	Not applicable
	• geochemical and geotechnical assessment of the material placed on the Heap Leach Pad before and after leaching;	Not applicable
	• method and rate of ore deposition and removal;	Not applicable
	• chemical characteristics of the leach solution, pregnant liquor and raffinate solutions;	Not applicable
	• solution application rates, and method of application;	Not applicable
	• removal (where proposed) of the Heap Leach Pad at cessation of production and the method/location of disposal of leached material;	Not applicable
	• method of stabilisation and erosion control of Heap Leach Pad;	Not applicable
	• an assessment of the long term chemical and physical stability of the Heap Leach Pad post mine completion;	Not applicable
	• the source, pathway and ultimate fate of any potential mobile contaminants; and	Not applicable
	• maps and plans (as per 7.1.1 and 7.1.4).	Not applicable
2.5.4	Process Water Management	
	Provide a water balance including:	
	• approximate water volumes required;	Section 4.12.7 Water balance, Section 4.12.4.1 Demand, Section 4.12.4.2 Supply, Section 4.10.4.1 Inflows, outflows and water balance
	• a summary of the inputs and outputs (with consideration of any purge requirements);	Section 4.12.4.1 Demand, Section 4.12.5.4 Water holding, Figure 4.41 Carrapateena water distribution network, Section 4.10.4.1 Inflows, outflows and water balance
	• determination of net surplus or deficit; and	Section 4.10.4.1 Inflows, outflows and water balance
	• process flowsheet showing all streams including stormwater management and mine dewatering where these are connected to the processing circuit.	Figure 4.41 Carrapateena water distribution network, Figure 4.47 Carrapateena operational water balance, Section 4.10.4.2 Flood storage capacity
	Provide a description of all water ponds, including:	
	• size, capacity, layout and location of ponds;	Section 4.12.5.4 Water holding, Section 4.10.1 Key elements
	• design and construction methods;	Section 4.10.2.2 Engineering design basis, Section 4.12.5.4 Water holding
	• chemical composition of the solution to be stored in each pond;	Section 4.12.5.4 Water holding, Section 4.10.3 Tailings production and characterisation
	• minimum freeboard to be maintained; and	Section 4.10.1 Key elements, Section 4.10.4.3 Freeboard, Section 4.12.5.4 Water holding
	• plans (as per 7.1.2.1)	Figure 4.32 Tailings storage facility development by stage, Figure 4.42 Minerals Processing Plant surface water management system
2.5.5	Type of Mobile Equipment	
	For mobile equipment to be used in crushing / grinding, processing ore and in transporting the mine product to the point of sale, describe:	
	• type, size and capacity of machines;	Section 4.9.4.2 Mobile fleet
	• approximate number of units;	Section 4.9.4.2 Mobile fleet
	• noise outputs;	Section 4.9.4.1 Processing equipment
	• exhaust outputs; and	Section 4.9.4.1 Processing equipment
	• fire ignition sources.	Section 4.9.4.1 Processing equipment
2.5.6	Conveyors and Pipelines	

ID	TOR Requirement	PEPR Section
	Provide a description of any conveyors or pipelines to be used for transporting material to or from the mine, processing facilities and the point of sale including:	
	• length, size (volumes to be transported), design and type of construction and location;	Section 4.9.4.3 Conveyors
	• the material being transported;	Section 4.9.4.3 Conveyors
	• leak detection strategies for pipelines;	Not applicable, pipelines not used for transporting ore or concentrate
	• noise sources;	Section 4.9.4.1 Processing equipment, Section 4.9.4.3 Conveyors
	• dust sources and composition;	Table 9.11 Summary of baseline metals in dust
	• fire ignition sources; and	Section 4.9.4.3 Conveyors
	• maps, plans and cross-sections (as per 7.1.1).	Figure 4.24 Minerals processing plant operational area
2.5.7	Hours of Operation	
	Describe the hours of operation of crushing / grinding, processing and transport activities.	Section 4.3 Hours of operation
2.5.8	Care and Maintenance	
	Detail all activities and strategies required for care and maintenance of processing facilities, and material transport systems, should the mine suspend production, but not progress immediately to closure.	Section 5.1.2.2 Care and maintenance plan
2.5.9	Rehabilitation Strategies and Timing	
	Detail all activities, strategies and designs relating to mine closure for • removal, disposal, and rehabilitation of processing facilities, and • material transport systems, • including timing of these activities.	Section 5.2 Closure strategy, Section 5.4.3.1 Mine surface infrastructure, Section 5.4.4 Domain four hardstand areas and stockpiles, Section 5.4.8.1 Minerals processing plant. Figure 4.10 Project schedule – decommissioning and closure
	For rehabilitation strategies and timing related to Heap Leach, provide: • a Heap Leach detoxification strategy; • identification of the volumes of process solution and flush water to be disposed of at closure; and • a methodology for the disposal of residual process solution and flush water at closure	Not applicable
2.6	**Wastes**	
2.6.1	Waste Rock and Tailings Storage Facilities	
	The standards set out in Minerals Policy MPOL007 must be used for the planning, design and assessment of tailings generation and management relating to all aspects of the tailings lifecycle (i.e. construction, operation, rehabilitation, closure and governance).	Section 4.10.2.1 Standards
	For waste rock and tailings storage facilities (TSF) provide:	
	• the estimated tonnes and volumes of all waste rock and tailings to be stored;	Section 4.10.1 Key elements, Section 4.11.4.4 Waste rock dump
	• the reserve and any resource or potential resource that the estimated tonnes and volumes of waste rock and tailings is based on;	Section 4.10.1 Key elements
	• the type, location, size, shape, height and method of construction of permanent and temporary waste storage facilities;	Section 4.10.1 Key elements, Section 4.10.2.2 Engineering design basis, Section 4.10.5 Tailings storage facility and decant dam embankment, Section 4.11.4.4 Waste rock dump
	• a geochemical and geotechnical assessment of the waste rock and tailings based on the geochemical and geotechnical properties determined from the analysis of representative sampling of all waste rock types and tailings to be disposed;	Section 4.10.2.2 Engineering design basis, Section 4.10.3.5 Geochemical properties, Section 4.10.5.4 Embankment stability, Section 4.11.3.1 Geochemical classification
	• an assessment on the weathering and erosive potential of waste rock to be disposed;	Section 4.10.2.2 Engineering design basis, Section 4.11.4.4 Waste rock dump, Section 4.10.5.4 Embankment stability
	• specifications, drawings and plans for the design, construction, operation and completion of all facilities (as per 7.1.5);	Figure 4.29 Tailings storage facility embankment cross-section, Figure 4.32 Tailings Storage Facility development by stage, Figure 4.36 WRD layout and surface water management features
	• the method and rate of waste rock/tailings disposal;	Section 4.10.1 Key elements, Section 4.10.6 Tailings delivery and return water infrastructure, Section 4.11.4.4 Waste rock dump
	• where relevant, a description of the placement and encapsulation of waste material deemed to be hazardous, including potentially acid forming material (PAF);	Section 4.11.1 Key elements, Section 4.11.3 Materials Management, Section 4.11.4.1 Production stockpile
	• the method of stabilisation and erosion control of waste storage facilities, both during operations and post completion;	Section 4.10.5 TSF and decant dam embankments, Section 4.11.4.4 Waste rock dump

ID	TOR Requirement	PEPR Section
	• surface water runoff control on disturbed and rehabilitated areas;	Section 4.10.4.1 Water balance, Section 4.10.4.2 Flood storage capacity, Section 4.11.4.4 Waste rock dump, Section 5.4.8 Domain eight – specific features
	• a geotechnical stability assessment and a factor of safety analysis;	Section 4.10.5.4 Embankment stability
	• an assessment of seepage of liquids through the waste rock and tailings storage facilities;	Section 4.10.4.1 Water balance, Section 4.10.4.6 Seepage management
	• strategies for the containment of any seepage that has the potential to impact the environment;	Section 4.10.4.6 Seepage management, Section 4.11.4.4 Waste Rock Dump
	• an assessment of the post completion chemical and physical stability of the structure following rehabilitation, including the expected extent of erosion;	Section 5.4.8.2 Tailings storage facility and decant dam. No waste rock will remain in the WRD following closure.
	• an assessment of the source, pathway and ultimate fate of any potential mobile contaminants; and	Section 7.3.12.1 Erosion and sedimentation, Section 7.3.12.3 Tailings storage facility, Section 7.3.12.4 Acid and metalliferous drainage, Section 7.3.13.1 Tailings storage facility, Section 3.5 Impact assessment framework
	• a description of the governance arrangements for the design, construction, operation and closure including when it is proposed to use third party verification.	Section 4.10.2.1 Standards, Section 4.10.2.5 Radiological risk assessment, Section 4.10.2.7 Consequence category, Section 5.4.8.2 Tailings storage facility and decant dam, Table 9.2 TSF design, audits, monitoring and test work
	Include a water balance for the TSF (if not included in the water balance in clause 2.5.4).	Section 4.10.4.1 Water balance
2.6.2	Other Processing Wastes	
	Provide: • the volumes and composition of all solid and liquid wastes produced;	Section 4.12.5.5 Water treatment and Section 4.15.2 Waste characterisation, Section 4.15.4.3 Landfill, Table 4.62 Wastewater specification for reuse
	• estimated volumes of waste processing water, reverse osmosis reject water, water content of solid wastes, and method of disposal or recycling;	Section 4.12.5.5 Water treatment, Section 4.15.2 Waste characterisation
	• waste water composition;	Section 4.12.5.5 Water treatment
	• disposal and management of any hazardous material or contaminants within waste including radioactive, toxic, corrosive or flammable materials; and	Section 4.12.5.5 Water treatment and Section 4.15.2 Waste characterisation
	• the source, pathway and ultimate fate of any potential mobile contaminants.	Section 4.12.5.5 Water treatment and Section 7.3.9 Land and soil, Section 7.3.12 Surface water, Section 4.15.3 Contaminated wastes, Section 3.5 Impact assessment framework
2.6.3	Industrial and Commercial Wastes	
	List any industrial and commercial wastes generated including, but not limited to: • putrescible waste, including sewage;	Section 4.15.2 Waste characterisation
	• oils and other hydrocarbons; and	Section 4.15.2 Waste characterisation
	• tyres.	Section 4.15.2 Waste characterisation
	For each waste type, describe the method of disposal including:	
	• offsite disposal;	Section 4.15.2 Waste characterisation, Section 4.15.4 Waste management facilities and infrastructure
	• on site waste disposal (including size, location and construction details);	Section 4.15.2 Waste characterisation, Section 4.15.4 Waste management facilities and infrastructure
	• recycling (either on or offsite);	Section 4.15.2.3 Contaminated waste, Section 4.15.3 Waste management, Section 4.15.4 Waste management facilities and infrastructure
	• the type, area and layout of sewage systems to be installed at the site; and	Figure 4.50 Tjungu Village layout, Section 4.15.2 Waste characterisation, Section 4.15.3.2 Source separation, Section 4.12.5.5 Water treatment
	• describe what, if any approvals are required for the disposal of waste.	Section 4.15 Waste Management
	For each type of waste, describe: • any potential contaminants that may be generated from onsite storage, and	Section 4.15.3 Contaminated wastes
	• the ultimate fate of those contaminants.	Section 4.15.3 Contaminated wastes, Section 3.5 Impact assessment framework
2.6.4	Care and Maintenance	
	Detail all activities and strategies required for care and maintenance of waste rock and tailings and any other waste left on site, should the mine suspend production, but not progress immediately to closure.	Section 5.1.2.2 Care and maintenance plan
2.6.5	Rehabilitation Strategies and Timing	

ID	TOR Requirement	PEPR Section
	Detail all activities, strategies and designs relating to mine closure, including: • timing of these activities and • all opportunities for progressive rehabilitation of waste rock and tailings and any other waste to be left on site.	Section 5.2 Closure Strategies, Section 5.4.3.4 Landfill, Section 5.4.4.2 Stockpiles, Section 5.4.8.2 Tailings storage facility and decant dam, Section 5.4.4 Domain four – hardstand areas and stockpiles, Figure 4.10 Project schedule – decommissioning and closure.
	The standards set out in Minerals Policy MPOL007 must be used for the planning, design and assessment of tailings generation and management relating to cover systems, rehabilitation, and closure.	Section 4.10.2.1 Standards
2.7	**Supporting Surface Infrastructure**	
2.7.1	Access	
	Describe: • access route to the mining operations and show on a map (as per 7.1.6);	Section 4.14.4 Vehicle access, Figure 1.1 Project location, Figure 4.4 MPL 152 tenement and key project elements and Figure 4.48 Electricity supply infrastructure and transmission line alignment
	• indicate if any new roads are to be constructed, or if existing roads or intersections (public and private) are to be upgraded;	Section 4.5.3 Proposed land disturbance
	• transport system(s) used to and from the mining operations and the estimated number of vehicle movements per day; and	Section 4.14.2 Logistics
	• airport/airstrips to be constructed.	Section 4.14.3 Airstrip
2.7.2	Accommodation and Offices	
	Describe onsite personnel accommodation and offices, including (but not limited to):	
	• number, area, size, type of construction and location of accommodation, office, meals or laboratory buildings, caravans or camp, and associated structures to be used on site; and	Section 4.14.6 Accommodation (Tjunga Village), Section 4.14.7 Offices, workshops and laboratories, Section 4.14.5 Site security
	• state if temporary or permanent.	Section 4.14.6 Accommodation (Tjunga Village)
2.7.3	Public and Private Services and Utilities Used by the Operation	
	Describe: • sources of services that are supplied to the operations, including (but not limited to) power, water, telecommunications; • routes for connection if any new connections to public infrastructure are required; and • any existing surface infrastructure that has been and/or the extent it may be affected by the mining operations.	Section 4.14.8 Communication, technology and information system, Section 4.13.1 Key elements, Section 4.12.4 Operations water
2.7.4	Visual Screening	
	Describe the type of screening, including:	
	• existing or planned vegetation (i.e. species and density of plantings) and	Section 4.14.5 Site security (outlines not applicable)
	• show on a map (as per 7.1.1).	Not applicable
2.7.5	Fuel and Chemical Storage	
	For all fuels and chemicals stored on site show the proposed location of storage on a map (as per 7.1.1) and provide detail on:	Section 4.9.4.4 Chemicals, reagents and consumables, Section 4.13.1 Key elements, Section 4.14.7 Offices, Workshops and laboratories, Section 4.14.3 Airstrip
	• types of bulk chemicals and the volumes of each; and	Section 4.9.4.4 Chemicals, reagents and consumables, Section 4.13.1 Key elements, Section 4.14.3 Airstrip
	• details on storage, bunding and containment for all chemical and fuel storage vessels.	Section 4.9.4.4 Chemicals, reagents and consumables, Section 4.15.1 Key elements
2.7.6	Site Security	
	Describe and show on a map (as per 7.1.2.1) • infrastructure and • measures that will be adopted to prevent unauthorised access by the public, including fencing, signage etc.	Section 4.14.5 Site security, Figure 4.4 MPL 152 tenement and key project elements
2.7.7	Stormwater, Silt Control and Drainage	
	Describe: • location and design of silt management structures;	Section 4.12.6.2 Interaction with on-lease infrastructure, Section 4.12.6.3 Interaction with off-lease infrastructure, Section 4.15.4.3 Landfill, Section 4.11.4.5 Topsoil and subsoil stockpiles, Section 4.8.5.2 Mine water supply, Section 4.12.6.4 Sediment and stockpile run-off containment ponds
	• runoff control on disturbed and rehabilitated areas;	Section 4.12.4.2 Supply, Section 4.12.5.4 Water holding, Section 4.12.6.1 Management approach, Section 4.12.6.2 Interaction with on-lease infrastructure, Section 4.12.6.4 Sediment and stockpile run-off containment ponds, Section 5.4.8.1 Minerals processing plant

ID	TOR Requirement	PEPR Section
	• storage, diversion and release of clean water (discharge water must comply with the applicable Environment Protection Authority South Australia water quality policy); and	Section 4.8.5.1 Mine dewatering,
	• a whole of site stormwater balance, if not included in the water balance in clause 2.5.4.	Figure 4.47 Carrapateena operational water balance
	• Provide a plan showing the surface water movement for the whole mine site (as per 7.1.1).	Figure 4.41 Carrapateena water distribution network
2.7.8	Care and Maintenance	
	Detail all activities and strategies required for care and maintenance of supporting surface infrastructure, should the mine suspend production, but not progress immediately to closure.	Section 5.1.2.2 Care and maintenance plan
2.7.9	Rehabilitation Strategies and Timing	
	Detail all activities, strategies and designs relating to mine closure for rehabilitation of supporting surface infrastructure. Provide details for timing of closure activities, including all opportunities for progressive rehabilitation.	Section 5.4.3 Domain three – infrastructure
2.8	**Vegetation Clearance**	
	If clearance of native vegetation is to occur, a Native Vegetation Management Plan (NVMP) prepared by an accredited consultant must be included with the PEPR.	Acknowledged
	The NVMP must: • describe the vegetation type to be cleared and include a map (as per 7.1.2) showing the proposed clearance area; and	Figure 4.11 As-built and proposed land disturbance footprint and Appendix D NVMP (Table 4.5, Table 4.6 and Figure 4.5 showing Carrapateena disturbance per vegetation association, and Table 4.17 and Figure 4.9 showing Northern Wellfield disturbance per vegetation association)
	• state the quantum of significant environmental benefit (SEB) to be gained in exchange for the clearance and describe how the SEB will be provided.	Appendix D NVMP (Section 6.1 Carrapateena Operations SEB and Section 6.2 Northern Wellfield SEB)
2.9	**Mine Completion**	
2.9.1	Description of Mine Site at Completion	
	Provide a description, plans and cross sections of the mine site (as per 7.1.7 and 7.2.2) as it will be at completion after all rehabilitation and closure activities have been completed, including:	Figure 5.1 Carrapateena area following closure to Figure 5.5 Closure domains, Section 5 Closure
	• final post completion land use;	Section 5.3 Post-operations land use
	• landforms;	Section 5.2 Closure strategy
	• vegetation covers (including native vegetation that will not be disturbed due to mining operations);	Section 5.2 Closure strategy, Section 5.4 Closure activities
	• natural contours of land not to be disturbed by mining operations;	Section 4.5 Project footprint
	• any mining infrastructure that will remain on site and will become the responsibility of the landowner;	Section 5.4.3.3 Accommodation village and airstrip, Section 5.4.5 Domain five – roads and corridors, Section 5.4.6 Domain six – water management infrastructure
	• location, description and management of waste disposal areas;	Section 5.2 Closure strategy, Section 5.4.1.2 Mine area borrow pit, Section 5.4.2 Domain two – underground workings, Section 5.4.3.4 Landfill, Section 5.4.4.2 Stockpiles, Section 5.4.8.2 Tailings storage facility and decant dam
	• location of reshaped and rehabilitated areas showing surface contours and revegetation;	Figure 5.1 Carrapateena area following closure, Section 5.4 Closure activities
	• mine voids (open pit and/or underground);	Section 5.4.1 Domain one – pit voids, Section 5.4.2 Domain two – underground workings
	• location of stored and/or exposed PAF material and/or other hazardous materials;	Section 5.2 Closure strategy, Section 5.4.4.2 Stockpiles
	• expected final water level and time to reach this level, and water quality of mine voids;	Section 5.4.1.1 Sub-level cave
	• location of surface water infrastructure including ponds and diversions; and	Section 5.4.6 Domain six – water management infrastructure
	• representative plans and cross-sections that show: ○ pre-mining natural surface ○ emplacement areas, waste disposal areas and disturbed areas final rehabilitated surface ○ where relevant, backfilled and remaining underground workings predicted final groundwater levels ○ interpreted geology including all rock types.	Figure 5.4 Pre- and post-mining cross sections
	Provide a description of the mechanism for transferring responsibility for any potential residual liability (i.e. ongoing maintenance or monitoring) subsequent to surrender of the tenement.	Section 5.4.3.3 Accommodation village and airstrip, Section 5.4.5 Domain five – roads and corridors, Section 5.4.6 Domain six – water management infrastructure
2.9.2	Rehabilitation Liability Estimate	

ID	TOR Requirement	PEPR Section
	Provide the maximum third party cost of rehabilitation at any time over the life of mine covered by the PEPR. The estimate must be based on reasonable third party costs of undertaking the rehabilitation strategies as outlined in clause 2 and include costs for project management, inflation, normal project variation, and contingency provision for risk associated with the strategies and uncertainty in the cost estimates.	Section 5.5 Rehabilitation liability estimate
2.10	**Resource Inputs**	
2.10.1	Workforce	
	For the workforce for all operations (mining, processing, waste management and supporting surface infrastructure), describe:	
	• how operations on the site will be managed;	Section 4.14.9 Workforce
	• number and workforce breakdown by job type;	Executive Summary, Section 4.1 Tenements and associated project elements, Section 4.14.9 Workforce
	• number of full-time employee positions that would be directly created by the proposal (not to include existing positions);	Section 4.14.9 Workforce
	• the proportion of the workforce that would reside in the local community and the estimated impact on local employment;	Section 6.6
	• any programs to target and assist Indigenous or local employment at the mine;	Not applicable
	• training to be provided to employees and potential employees;	Not applicable
	• approximate timelines for creation of the positions; and	Not applicable
	• potential for local business participation, and procurement of local goods and services.	Not applicable
2.10.2	Energy Sources	
	For the energy sources and usage provide:	
	• estimates of total annual energy usage (from all sources, including personnel transport and ore transport to point of sale);	Section 4.13.1 Key elements
	• expected sources of energy;	Section 4.13.1 Key elements, Section 4.13.3 Electricity
	• potential for efficiency gains;	Section 4.13.5 Energy efficiency and offsets
	• amount and percentage of zero emission energy to be utilised;	Section 4.13.5 Energy efficiency and offsets
	• equivalent annual CO2 generated; and	Section 4.13.2 Greenhouse gas emissions
	• any carbon offsets proposed.	Section 4.13.5 Energy efficiency and offsets
2.10.3	Water Sources	
	Provide details on the source(s) of water to be used, expected usage and any discharge, including:	
	• expected annual water usage by source;	Section 4.12.1 Key elements, Section 4.12.4.1 Demand
	• indicate if any water usage by source will be more than 5% of the total annual water withdrawal for that source;	Not applicable
	• percentage of water that will be recycled; and	Section 4.12.5.5 Water treatment
	• water discharge by quality and destination.	Section 4.12.5.4 Water holding, Section 4.12.6.2 Interaction with on-lease infrastructure
3	CONSULTATION	
	In setting out the result of the consultation undertaken in connection with the proposed operations in accordance with regulation 64 of the *Mining Regulations 2020,* the Minister determines in accordance with regulation 63(1)(e) of the *Mining Regulations 2020* that a PEPR must include:	
	A description of: • the process undertaken for identifying stakeholders with an interest in, or stakeholders likely to be directly affected by the mining operation; • the process undertaken for the delivery of information to, gathering of feedback from, and responding to those identified stakeholders; • if any individual or group of similar affected persons were not able to be consulted, the steps taken to consult with them.	Section 3.1.5.5 Engagement Section 3.3 Stakeholder
	The results of the consultation undertaken with those identified stakeholders, including: • the persons consulted; • any concerns / issues raised; and • the response and steps (if any) taken or proposed to address those concerns.	Section 3.3.2 Engagement outcomes

ID	TOR Requirement	PEPR Section
4	ENVIRONMENTAL OUTCOMES, STRATEGIES, CRITERIA AND MONITORING	
4.1	**Environmental Outcomes**	
	A PEPR must set out environmental outcomes (including completion outcomes) in accordance with section 70B(2)(b)(i) of the *Mining Act 1971*, or as required by the lease/licence or change to operations proposal	Acknowledged, Section 7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria, Section 7.3 Statement of environmental outcomes and measurement criteria
	For each environmental outcome, the information described in clauses 4.2, 4.3 and 4.4 must be provided.	Acknowledged, Section 7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria, Section 7.3 Statement of environmental outcomes and measurement criteria
4.2	**Control and Management Strategies**	
	In setting out the control and management strategies adopted to demonstrate that the environmental outcomes can be and will continue to be achieved in accordance with regulation 63(1)(b) of the *Mining Regulations 2020*, the Minister determines in accordance with regulation 63(3)(e) of the *Mining Regulations 2020* that a PEPR must:	Section 3.5 Impact assessment framework, Section 7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria, Section 7.3 Statement of environmental outcomes and measurement criteria
	• demonstrate that the control and management strategies are commensurate with the impacts, achieve compliance with other applicable statutory requirements and promote progressive rehabilitation;	Section 3.5 Impact assessment framework discusses the generalised approach, Section 7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria, Section 7.3 Statement of environmental outcomes and measurement criteria
	• describe any significant degree of uncertainty in accordance with regulation 63(3)(c) pertaining to the likely effectiveness of control and management strategies, including (but not limited to) lack of site specific information, limitations on modelling and quality of data. Describe any assumptions connected with the identified uncertainty;	Section 3.5 Impact assessment framework discusses the generalised approach, Section 7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria, Section 7.3 Statement of environmental outcomes and measurement criteria
	• so far as is relevant, identify the sensitivity to change of any assumption that has been made in accordance with regulation 63(3)(d) and assess the likelihood of an outcome not being achieved if an assumption is later found to be incorrect;	Section 3.5 Impact assessment framework discusses the generalised approach, Section 7.2 Impacts, outcomes, strategies, uncertainty and measurement criteria, Section 7.3 Statement of environmental outcomes and measurement criteria
	• provide a description and list of current and future works (for example (but not limited to) trials, test work, studies, modelling, validations) that are to be undertaken to address the identified uncertainty or assumption;	Section 9 Future works, audits and monitoring
	• provide a schedule of the timing that the future works will be undertaken and completed; and	Section 9 Future works, audits and monitoring
	• based on the schedule of future works, state the timing for review of the PEPR in accordance with Section 70C(1) of the *Mining Act 1971*.	Section 1.2 PEPR review
4.3	**Measurement Criteria**	
	In preparing a statement of the criteria to be adopted to measure each of the environmental outcomes in accordance with section 70B(2)(c) of the *Mining Act 1971* and regulation 63(1)(c) of the *Mining Regulations 2020*, the Minister determines in accordance with regulation 63(3)(e) of the *Mining Regulations 2020* the following:	
	Set out a statement of criteria for each environmental outcome (including completion outcomes).	Section 7.3 Statement of environmental outcomes and measurement criteria
	The criteria must comply with the five elements of regulation 63(1)(c) and must include details about: • responsibility (who will measure); • record keeping; and • frequency of reporting to management and any external parties.	Section 7.3 Statement of environmental outcomes and measurement criteria
	The statement of criteria must be developed separately for construction, operation and mine completion, as appropriate.	Section 7.3 Statement of environmental outcomes and measurement criteria
	Where appropriate, recognised industry standards, codes of practice or legislative provisions from other Acts can be used as criteria.	Section 7.3 Statement of environmental outcomes and measurement criteria
	All point-related measurement criteria, such as water bores, sampling points and photo points (including direction) must be included on a map.	Figures referenced as appropriate throughout Section 7.3 Statement of environmental outcomes and measurement criteria
	When control or baseline data is used, this must be included in the PEPR.	References baseline data as appropriate in Section 7.3 Statement of environmental outcomes and measurement criteria
	Where groundwater modelling is to be relied upon to demonstrate achievement of groundwater completion outcomes, the statement of criteria must include a process must be provided for validation of predictive modelling, including a description of the model and assumptions used.	Modelling not used to confirm OMC for completion phase
	Where native vegetation clearance is planned and in the case where an on ground offset by the operator is to be used to demonstrate the Significant Environmental Benefit (SEB), the statement of criteria must demonstrate the successful implementation of the on ground offset through the native vegetation management plan.	All native vegetation clearance has been offset either via payment to the Native Vegetation Fund (NVF) or through purchase of credit from and offset by an accredited third party (Nature Foundation). Refer NVMP Appendix D, Section 6.1 Carrapateena Operations SEB and Section 6.2 Northern Wellfield SEB.

ID	TOR Requirement	PEPR Section
4.4	**Leading Indicator Criteria**	
	If required by the lease/licence and/or where there is a high level of reliance on control strategies to achieve an environmental outcome, set out leading indicator criteria as required by regulation 63(1)(d) of the *Mining Regulations 2020* that will be used to give an early warning that a control strategy may fail or be failing.	Acknowledged
	Set out leading indicator statement of criteria where required (including mine completion outcomes). The leading indicator criteria must comply with the five elements of regulation 63(1)(c) of the *Mining Regulations 2020* and the statement of criteria must include details about: • responsibility (who will measure); • record keeping; and • frequency of reporting to management and any external parties.	Section 3.5 Impact assessment framework discusses the generalised approach, Section 7.3 Statement of environmental outcomes and measurement criteria
5	OPERATOR CAPABILITY	

	In preparing information about the ability of the tenement holder (and any other person who may be acting on behalf of the tenement holder) in accordance with section 70B(2)(d) of the *Mining Act 1971*, the Minister determines in accordance with regulation 63(3)(e) of the *Mining Regulations 2020* that this information must be accompanied by:
	• relevant evidence demonstrating that the tenement holder (and any other person who may be acting on behalf of the tenement holder as an operator) has
	  ○ appropriate experience,
	  ○ processes and procedures in place to be able to achieve the environmental outcomes.
		Section 3 Operator capability, inclusive of:
		• 3.1 – Management capability
		• 3.2 – Environmental management
		• 3.3 – Stakeholder engagement
		• 3.4 – Legislative requirements
		• 3.5 – Impact assessment framework
		• 3.6 – Project variation assessment

6	LEASE/LICENCE	
	Where the lease or licence includes specific conditions or requirements that are not environmental outcomes, in accordance with regulation 63(1)(e) a PEPR must include a section that demonstrates where the respective conditions or requirements have been addressed in the PEPR (if relevant) or demonstrates how otherwise they have or will be complied with.	Appendix A7
7	MAPS, PLANS AND CROSS SECTIONS	
	In preparing a PEPR in accordance with section 70B(2) of the *Mining Act 1971* and regulation 63 of the *Mining Regulations 2020*, the Minister determines in accordance with regulation 63(3)(e) of the *Mining Regulations 2020* that all maps, plans and cross sections must comply with the following requirements relating to the amount of detail or information to be provided: • state and show the relevant datum (Australian Height Datum (AHD) is preferred); • metric units; • title, north arrow, scale bar, text and legend; • date prepared and author; • be of appropriate resolution and scale for represented information; and • be legible in both the hardcopy and electronic versions of the submission.	Acknowledged
	All cross-sections must conform to the following standards: • state and show the relevant datum (Australian Height Datum (AHD) is preferred); • metric units; • title, scale bar, text and legend; • date prepared and author; • be of appropriate resolution and scale for represented information; • be legible in both the hardcopy and electronic versions of the submission; and • be accompanied by a map showing the orientation of the cross-sections.	Acknowledged
7.1	**Map(s) and Plan(s) required for Description of Operations (as per clause 2)**	
7.1.1	Site Layout Map showing all components of the operation including (but not limited to)	
	• tenement area boundaries;	Figure 4.1 Carrapateena tenements
	• location of surface water and sediment management infrastructure;	Figure 4.42 Minerals Processing Plant surface water management system, Figure 4.22 Mine area surface water management infrastructure
	• location of process water dams;	Figure 4.42 Minerals Processing Plant surface water management system
	• location of fuel and chemical storage areas;	Figure 4.24 Minerals processing plant operational area
	• location of haul/access roads;	Figure 1.1 Project location, Figure 4.4 MPL 152 tenement and key project elements

ID	TOR Requirement	PEPR Section
	• location of fixed plant;	Figure 4.2 ML 6471 tenement and key project elements, Figure 4.3 MPL 149 tenement and key project elements, Figure 4.4 MPL 152 tenement and key project elements, Figure 4.5 MPL 153 tenement and key project elements, Figure 4.6 MPL 154 tenement and key project elements, Figure 4.1 Carrapateena project tenements, Figure 4.19 SLC mine surface subsidence zone and abandonment bund and Figure 4.24 Minerals processing plant operational area
	• location of mobile plant for stage 1 of mining;	Mining already commenced
	• location of visual screening measures;	Not applicable
	• location of fencing;	Described in Section 4.14.5 Site security
	• location and extent of topsoil/subsoil and product stockpiles.	Figure 4.34 Production stockpile locations, dimensions and capacities, Figure 4.37 Topsoil stockpile locations, dimensions and capacity
	• location and extent of all areas proposed to be disturbed from mining including waste rock, silt/slime dams, mine infrastructure, processing plant, process water ponds, waste disposal facilities; and	Figure 4.11 As-built and proposed land disturbance footprint and Figure 4.22 Mine area surface water management infrastructure
	• location and extent of open pit(s) and/or underground workings.	Figure 4.18 Typical as-built sub-level cave mine level layout, Figure 5.1 Carrapateena area following closure
	• location of key environmental features that are within or in close proximity to the Tenement and that are relevant to the design of the Site Layout Plan, including but not limited to:	Acknowledged
	○ housing and infrastructure,	Figure 2.1 BHP tenements and underlying exploration licences
	○ existing heritage sites,	Not applicable
	○ existing ephemeral and permanent rivers,	Figure 4.22 Mine area surface water management infrastructure and Figure 4.42 Minerals Processing Plant surface water management system
	○ watercourses,	Figure 4.1 Carrapateena site layout
	○ creeks or dams	Figure 4.22 Mine area surface water management infrastructure and Figure 4.42 Minerals Processing Plant surface water management system
	○ and/or existing native vegetation	Appendix D NVMP Figure 4.1 (Carrapateena Native Vegetation Associations) and Figure 4.8 (Northern Wellfield Native Vegetation Associations).
7.1.2	Sequence of Mining and Progressive Rehabilitation Map showing:	
	• tenement area boundaries;	Figure 5.1 Carrapateena area following closure
	• staging of each progressive mining stage;	
	• native vegetation clearance;	
	• location and applicable buffer zones for protection of native vegetation that will not be cleared; and	
	• conceptual staging of each progressive rehabilitation stage.	
7.1.3	Crushing, Grinding and Processing Plant Plan	
	• tenement area boundaries	Figure 4.24 Minerals processing plant operational area
	• layout of crushing, grinding and processing plant(s) and ancillary plant and infrastructure; and	
	• if required; including lining and drainage systems.	
7.1.4	Heap Leach Pad Plan	
	• tenement area boundaries	Not applicable
	• construction and design drawings of heap leach pad (including size and batters); and	
	• solution containment measures	
7.1.5	Tailings Storage Facility (TSF) Plan	
	• tenement area boundaries	Figure 5.1 Carrapateena area following closure
	• drawings and plans for design, construction, operation and completion of all facilities;	Figure 4.27 Tailings storage facility decant system, Figure 4.29 Tailings storage facility embankment cross-section, Figure 4.30 Tailings storage facility decant dam embankment cross-section, Figure 4.39 TSF borrow pit locations and example sections

ID	TOR Requirement	PEPR Section
	• size, shape, height and method of construction; and	Figure 4.27 Tailings storage facility decant system, Figure 4.29 Tailings storage facility embankment cross-section, Figure 4.30 Tailings storage facility decant dam embankment cross-section, Figure 4.39 TSF borrow pit locations and example sections
	• location of any waste material deemed to be hazardous including potentially acid forming material.	Not applicable
7.1.6	Access Route Map showing:	
	• tenement area boundaries; • access route for heavy vehicles; • exit route for heavy vehicles; and • any road upgrades or new roads to be constructed.	Figure 1.1 Project location and Figure 4.11 As-built and proposed land disturbance footprint
7.1.7	Completion Map showing	
	• tenement area boundaries	Figure 5.1 Carrapateena area following closure
	• conceptual final landforms (including rehabilitated and non-disturbed areas);	Figure 5.1 Carrapateena area following closure
	• topographical contours of the entire site (including rehabilitated and non-disturbed areas);	Figure 5.1 Carrapateena area following closure
	• backfilled and remaining underground workings;	Figure 5.1 Carrapateena area following closure
	• location of waste disposal areas (including waste rock dumps, tailings storage facilities and PAF encapsulation); and	Figure 5.1 Carrapateena area following closure
	• interpreted geology including all rock types.	Section 4.6.1 Geology and mineralisation and Figure 4.12 Cross-section through the Carrapateena deposit
7.2	**Cross-Sections required for Description of Operations (as per clause 2)**	
7.2.1	Mining Operation Cross-Section(s) showing:	
	• pre-mining natural surface; • pit depth; • pit dimensions (length and width); • pit batters and benches; • location of underground shafts and stopes; and • stages of operation.	Figure 4.16 Conceptual block cave decline alignment, Figure 4.19 SLC mine surface subsidence zones and abandonment bund and Figure 4.12 Cross-section through the Carrapateena deposit
7.2.2	Completion Cross Section(s) showing:	
	• pre mining natural surface;	Figure 5.2 Post-completion landscape, Figure 5.3 Sub-level cave and tailings storage facility pre- and post-completion landforms, Figure 5.4 Pre- and post-mining cross-section
	• rehabilitated final batters and benches;	Not applicable
	• location of underground backfill in shafts and stopes;	Figure 5.2 Post-completion landscape, Figure 5.3 Sub-level cave and tailings storage facility pre- and post-completion landforms, Figure 5.4 Pre- and post-mining cross-section
	• predicted final groundwater elevations; and	Described in Section 6.4.1.1 Groundwater (pathway)
	• final rehabilitated surface.	Figure 5.2 Post-completion landscape, Figure 5.3 Sub-level cave and tailings storage facility pre- and post-completion landforms, Figure 5.4 Pre- and post-mining cross-section

BHP

BHP